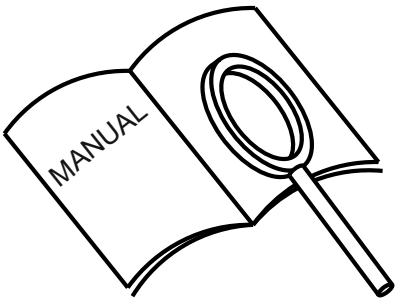
USER-MANUAL
Tamson Filter Blocking Tendency (TFBT)

CONTENTS

1 SAFETY, WARNINGS and WARRANTY



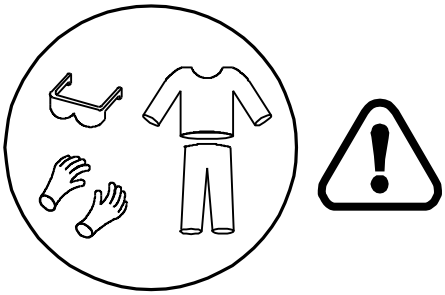
Make sure before installing or operating the equipment to read and understand all instructions and safety precautions listed in this manual. If there are any questions concerning the operation of the equipment or about the information given in this manual please contact your local dealer or our sales department first.

Performance of installation, operation, or maintenance other than those described in this manual may result in a hazardous situation and may void the manufacturer's warranty.

Never operate equipment that is not correctly installed. Unqualified personnel must not operate the equipment. Avoid damage to the equipment, or its accessories, caused by incorrect operation.

Important:

When performing service, maintenance or moving the apparatus, always disconnect the apparatus from mains socket.



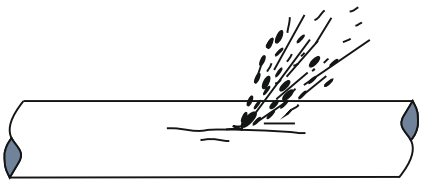
Only properly skilled and trained personnel are allowed to operate this equipment.

- Take notice of warning labels
- Never remove notice and warning labels
- Refer service and repairs to qualified technician

If a problem persists, contact your supplier or Tamson Instruments b.v.

Use personal protection:
- Wear eye protection
- Gloves
- Use protective clothing

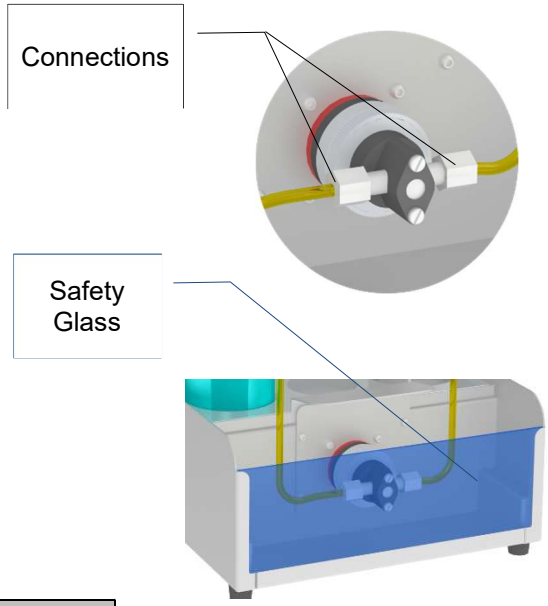
When working with fluids be aware of
- Spillage
- Leakage
- Splashing



Use precautions and use the right equipment to protect and clean.

For safe and correct operation always check connections of the pump hose. Connection must be mechanically safe and fluid tight. No leakage is allowed.

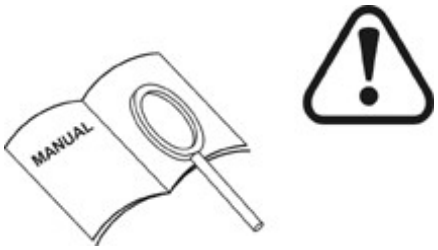
During operation of the pump always use the blue transparent safety glass



Environment	
Panel sealing	Confirms EN60529: IP65
Environment Temperature	0 to 35°C. Supply enough ventilation
Humidity	5 to 95 %, non condensating
Atmosphere	Not suited for altitudes above 2000m or explosive/corrosive environment
Pollution cat. 2	Conducting pollution must be prevented

1.1 PRECAUTIONS AND HAZARDS

Before attempting to operate the apparatus, please read all parts of this manual carefully to insure smooth operation and avoid damage to the equipment or its accessories.



READ CAREFULLY

If a malfunction occurs, consult section TROUBLE SHOOTING at the end of this manual.

If problem persists, call your supplier or Tamson Instruments bv. Never operate the equipment if not correctly installed. The equipment must be operated only by qualified personnel. Avoid damage to the equipment or its accessories through incorrect operation.

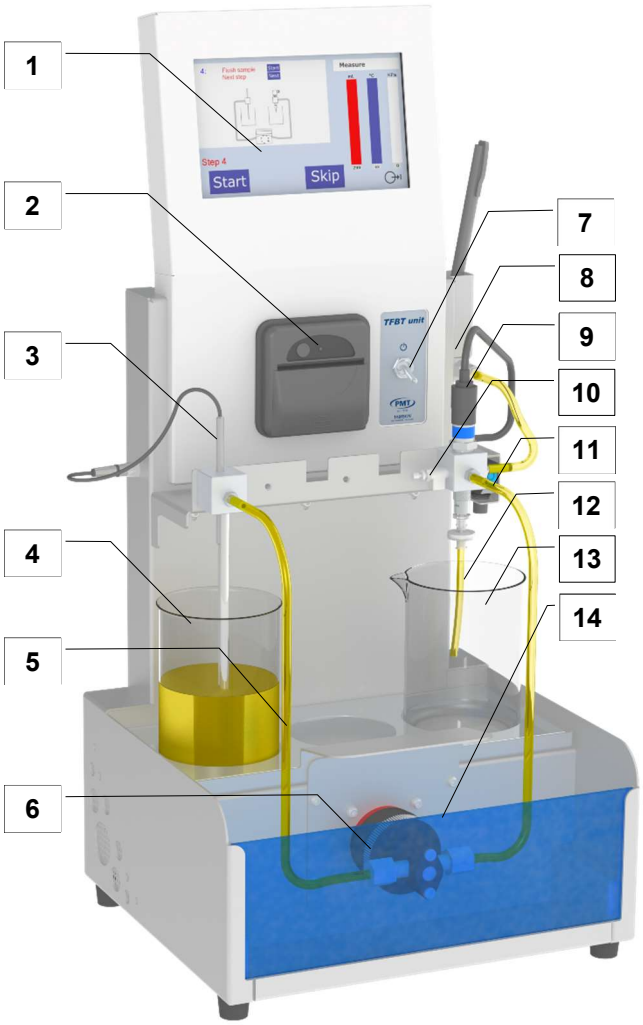
1.2 WARRANTY

Tamson Instruments b.v. warrants that all their manufactured equipment is free from defects in material and workmanship, preventing the machine from normal operation. Tamson Instruments b.v does not warranty that the equipment is fit for any other use than stated in this manual. The manufacturer can only be held responsible for the security, reliability and performance of the equipment, when operated in accordance with the operating instructions, extensions, adjustments, changes and/or if repair is performed by Tamson Instruments b.v. or authorized persons only. This warranty is limited to one year from the date of invoicing. All equipment and materials are subject to standard production tolerances and variations.

2 OPERATION

2.1 WHAT IS WHAT

Operating the FBT		
Item	Description	Remark
1	Touch Display	Graphical colour
2	Printer	
3	Temperature sensor	PT100
4	Beaker 400ml	Sample
5	Hose	Tygon
6	Piston Pump	
7	On/off	Switch
8	Overpressure safety	
9	Pressure sensor and filter	
10	Overpressure release	
10	Level sensor	Ultrasonic
12	Anti-splash tubing	Removable
13	Beaker	Receiver
14	Safety Glass	Removable



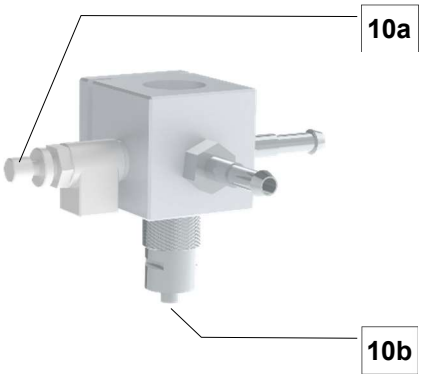
The touch panel can be finger operated. As it is resistive it operates less sensitive than a capacitive screen (like on a mobile phone). Resistive however also can be used when wearing gloves.

Never use metal or sharp objects to operate the touch screen. Also be aware of solvents touching or splashing the screen.

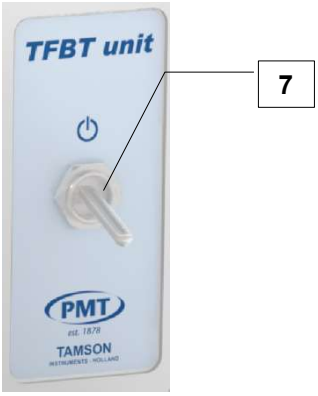
In case you do want to use a pen instead of your finger, use a “stylo” or a **plastic** pen with the inner ballpoint removed. Never touch the screen with the ballpoint as this may cause scratches and will permanently damage the screen.

Operating the FBT	
Item	Description
8a	Overpressure safety and damper The overpressure is set to 2 bar.
8b	Spillage beaker

Operating the FBT	
Item	Description
10a	Pressure release Open valve to release pressure and safely change filter or filter adapter “A” or “B”
10b	Filter or filter adapter attached here



2.2 Switching on



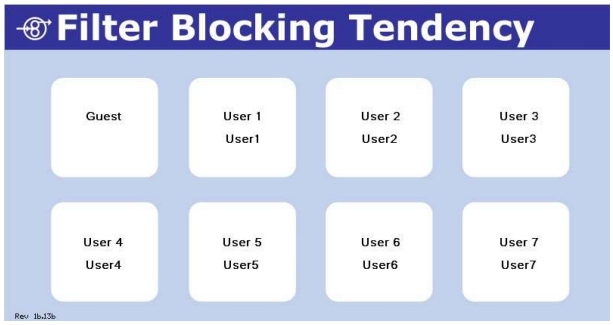
Switch the instrument on using the on/off switch located on the front panel (7).

Operating system and software is loaded and needs a minute to start.

When ready the start screen is displayed. Now a user can be selected by touching the screen.

Never use sharp plastic or metal object to select items on the touch screen. They may scratch the surface.

Be aware of aggressive fluids and solvents. Do not spill or contaminate the screen.

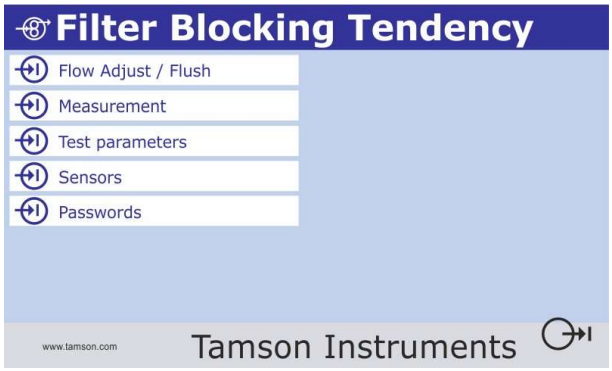


The user is password protected, except for the “Guest”. The single purpose of selecting a user, is to print the operator name on the print-out. In the password menu, an individual password can be selected for each user. Leaving the password blank will skip the password. When skipped, the user can be selected without typing a numerical number.

After selecting a user, the main screen is showed. A test can be started when pressing “Measurement”.

One can recover from all screens using the special key:

During measurement, the FBT shows the pressure graphically and plots pressure versus pumped volume.



The TFBT facilitates easy setting of parameters and calibration of the sensors.

For the test it uses three sensors:
- Pressure (0 .. 1500 mBar)
- Temperature 0 .. 40 °C
- Level (0 .. 70 mm)

The motor speed can be set for adjusting the flow. The pump motor has a built-in feedback system. When the pump load is increased during pressure build up, the turning speed is kept constant due to automatic increase of torque. Via this feedback system, a constant flow is guaranteed. This constant flow is fully independent from the load (pressure build-up).

3 FILTER BLOCKING TENDENCY

The Tamson Filter Blocking Tendency-tester (TFBT) is an automated instrument designed to test the Filter Blocking Tendency (FBT) of distillate fuels including diesel, biodiesel (B100 & B5/7/20/30), gas oil, gas turbine fuel, and kerosene. It conforms to ASTM D2068 and IP 387.

For this test 300 ml of sample is passed at a constant flow rate (20 ml/min) through a specified filter medium. Both pressure difference across the filter, and the volume of fuel passing the filter, are monitored until the pressure reaches 105 kPa or the volume of fuel passing the filter medium reaches 300 ml. When 300 ml of fluid is pumped, the end pressure is used to calculate the FBT number. However when the pressure reaches 105 kPa *before* the 300 ml is passed, the volume of fluid pumped at this point is used to calculate the FBT number.

The FBT-test determines whether fuel can potentially block filters in the distribution network or during use in a vehicle or power plant.

Cold flow issues with diesel containing FAME (biodiesel) and FAME material has resulted in the development of the new "E.I. - Industry test method standard" to check quality of FAME and diesels to avoid major fuel operability problems.

Fuel cleanliness is also an important issue as modern fuel injectors and injection pumps are being manufactured to more precise tolerances. Particles due to contamination, degradation, or corrosion of storage vessels can quickly clog filtration systems.

The automated TFBT provides a graphical guided user interface using a resistive touch screen. This screen guides the user through the test procedure. The guidance results in reliable performance of this test and the user can see what the apparatus is doing when it strictly follows the prescribed steps in the test method.

The fuel sample is drawn from the integral fuel reservoir by the pump, and a pulse damper provides smooth and continuous flow. The pressure and temperature of the fuel are continuously monitored while it is pumped through the specified filter into the waste container. Depending on the test, the result is calculated when 300 ml of sample is pumped or the test is aborted when the maximum pressure is exceeded. The printout states how the test is ended or performs the FBT calculation. Together with the test results, also the operator's name, time and date are printed using the built-in realtime clock.

In the menu different parameters can be set for the test and calibration of the temperature, pressure, pump speed, and level sensor. The display provides the operator with test procedure information. Following test results are printed:

Date / time
Operator
Method A or B. (C is unavailable).
Test result
Time
Flow (calculated)
Sample temperature
Pressure
Volume
FBT Value
Bias between procedure "A" and "B"

One guest and seven operators can be entered in the software. Only the operator who has the password for this page can perform a calibration of temperature, pressure, sample level, and pump speed. Calibration is easily performed and fully electronic using the graphical display, so no screwdrivers or knobs are needed. The software permits the operator to set the maximum pressure system and readout in mBar instead of kPa.

The operator further is able to set different parameters via a password protected menu. This way he is able to work according to ASTM D2068 or change the parameters in order to do a quicker test or set other rounding or pressure limits.

Test parameters for ASTM D2068/IP 387 (procedures "A" and "B") are pre-programmed, and the menu offers the possibility of testing other types of fuel and adopting future filtration and filterability tests. Procedure C is not available.

3.1 Summary of the method

A test portion of the fuel to be analyzed is passed at a constant rate of flow (20 mL/min) through a specified filter medium. The pressure difference across the filter, and the volume of fuel passing the filter, are monitored until the pressure reaches 105 kPa or the volume of fuel passing the filter medium reaches 300 ml. The pressure and flow are then used to calculate the filter blocking tendency, where a low number indicates a good fuel

The glass fiber filters specified for Procedures A and B are both 1.6 µm nominal pore diameter. Filter B is a pre-assembled encapsulated type. The pre-assembled nylon filter specified for Procedure C has a 5 µm nominal pore diameter. This procedure however is not actively supported anymore by the industry.

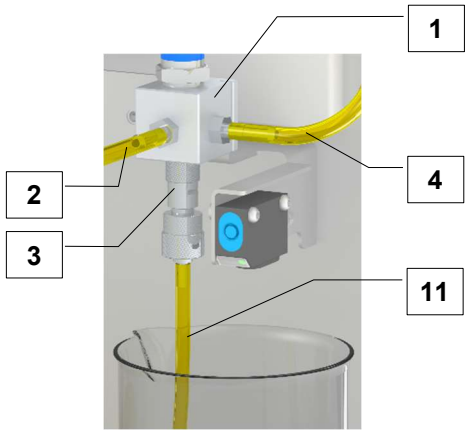
3.2 Procedure A

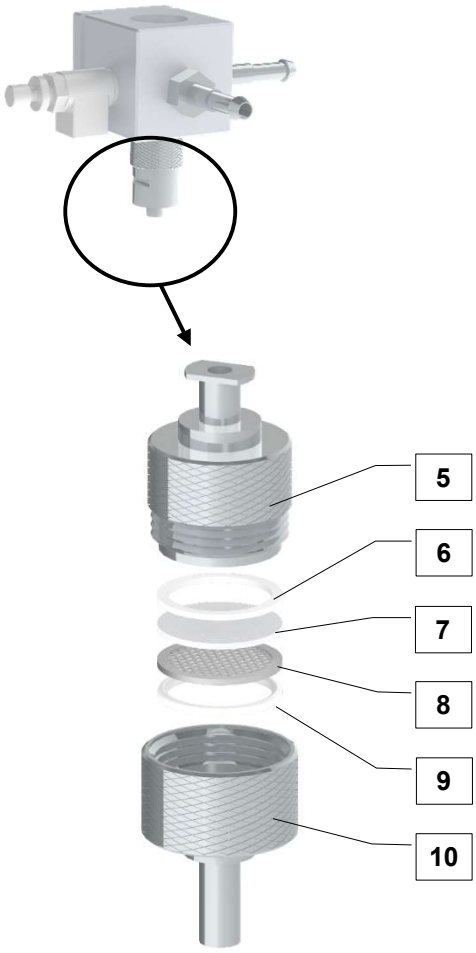
Attach the assembled Filter A assembly to the Luer fitting on the system.

When the test is started, the pump is halted after 20 seconds. The pressure is displayed and it should be within the range of 7 to 40 kPa. If the pressure gauge reading is not within the correct range check the apparatus for faults. A pressure reading greater than 40 kPa can indicate an incorrect installation of the filter media.

On the printout the pressure, taken after 20 seconds running, will always be shown.

Observe the pressure gauge reading as pumping continues. If the pressure rises to 105 kPa the apparatus stops. The result is displayed on the screen and available as print-out.

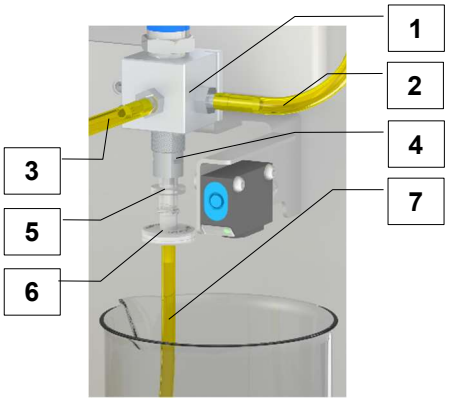




Filter procedure " A "	
1	Adapter block
2	From piston pump
3	Luer Fitting
4	Outlet pressure-peak damper
5	House top
6	Sealing ring PTFE**
7	Filter media
8	Filter support disc
9	Sealing ring PTFE flat**
10	Housing bottom
11	Hose prevent splashing* (4 mm inner diameter)

* The hose must be cut-off just above the fluid level which is reached after pumping 300 ml of sample.
** Exchange can cause leakage!

3.3 Procedure B



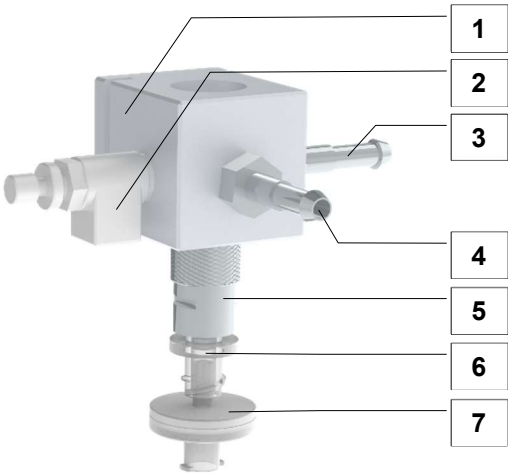
Procedure B uses a syringe filter in an “upside down” orientation.

When the test is started the display shows the initial pressure building up. When on the screen "settings" `the software setting "Pre test pause" is set to "on" the display will show the pressure reached after 20 seconds which should be within 7 and 40 kPa (70 .. 400mBar). When the software setting is set to "Off" the test will automatically continue. However the pressure measured at this point in the test will be displayed.

Observe the pressure gauge reading as pumping continues. If the pressure rises to 105 kPa the apparatus stops. The result is displayed on the screen and available as print-out.

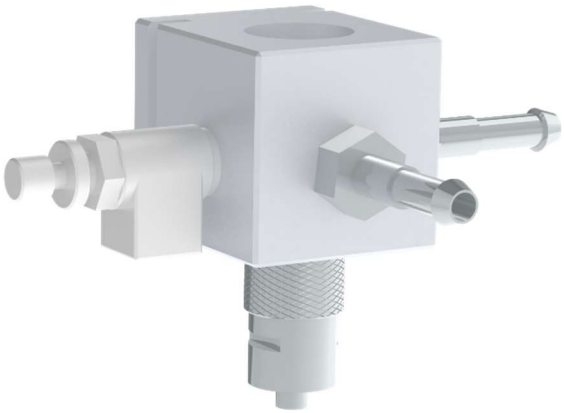
Filter procedure “ B “	
1	Adapter block
2	Pressure release
3	Outlet pressure-peak damper
4	From piston pump
5	Luer Fitting
6	Luer male - female
7	Whatman filter media

* The hose must be cut-off above the level reached after pumping 300 ml of sample.

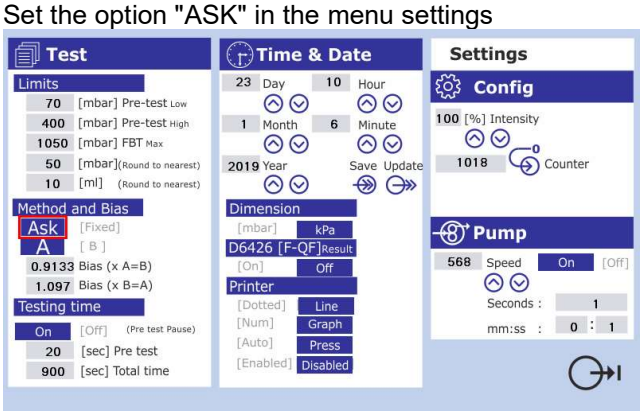


3.4 Procedure A / B

Both procedures "A" and "B" be used on the TFBT. The filter adapter has p/n 15T0005.



Set the option "ASK" in the menu settings

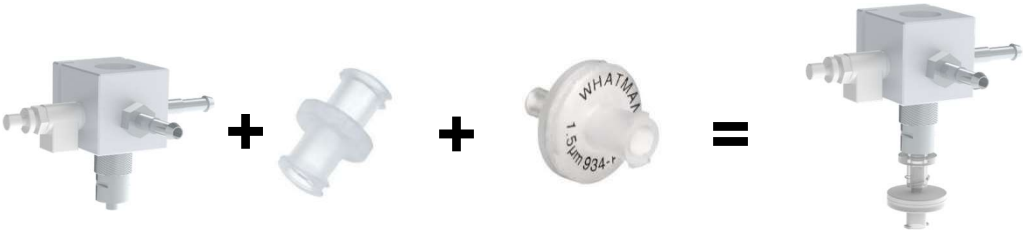


During the test, the menu will ask for the use of either method "A" or "B".

Method "A"

p/n 15T0005 p/n 24T0060

Method "B"



p/n 15T0005 p/n 24T0075 p/n 24T0067

3.5 Calculation

Equation 1 applies when 300 mL of fuel has passed the filter medium at a pressure below 105 kPa,

$$FBT = \sqrt{\left(1 + \left(\frac{P}{105}\right)^2\right)} \qquad (1)$$

Calculate the filter blocking tendency (FBT) using **equation (1)**

Equation 2 applies when the test has been discontinued as the pressure exceeded 105 kPa.

$$FBT = \sqrt{\left(1 + \left(\frac{300}{v}\right)^2\right)} \qquad (2)$$

P = maximum pressure reading obtained for 300 ml of fuel to pass the filter, in kilopascals.

v = volume of fuel in ml, passed prior to the pressure rising to 105 kPa.

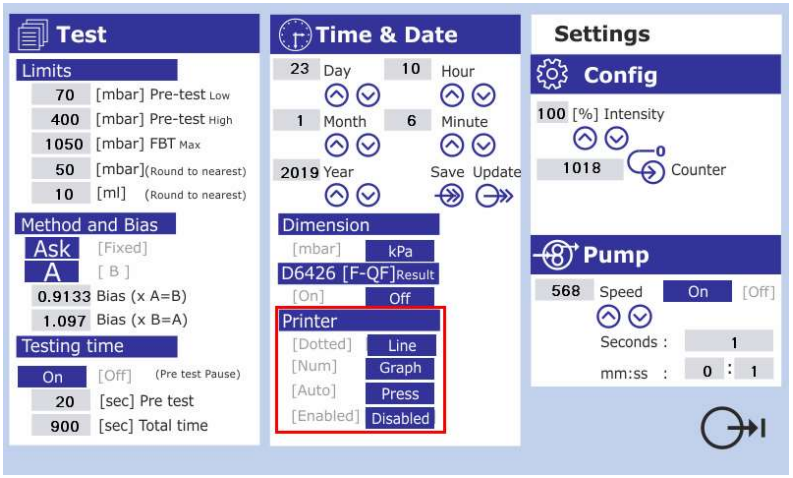
300ml Passed (1)	
kPa	FBT
20	1,017979
40	1,070105
60	1,151751
80	1,257179
100	1,380952
105	1,414214

Calculated FBT using **(1)** when 300 ml passes. Based on pressure (in kPa)

Calculated FBT using **(2)** the volume pumped prior to reaching 105 kPa

Overpressure (2)	
ml	FBT
10	30,01666
20	15,0333
30	10,04988
40	7,566373
50	6,082763
100	3,162278
150	2,236068
200	1,802776
250	1,56205
300	1,414214

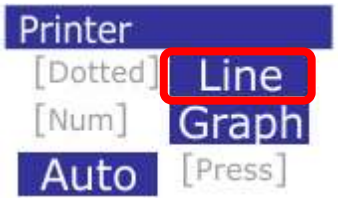
3.6 Graphical print-out



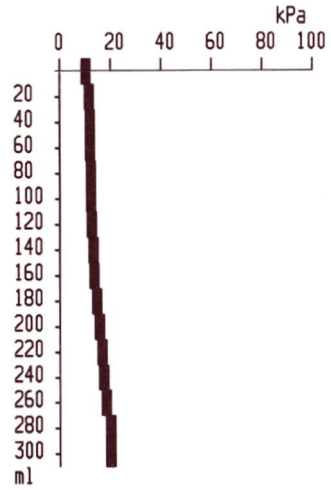
Graphical layout
- Dotted (ASTM Preference)
- Line

Output
- Graph (always display graph)
- Num (Graph only when pressure < 105kPa or 1050 mba)

Print at end of test
- Always (auto)
- When key is pressed (Press):



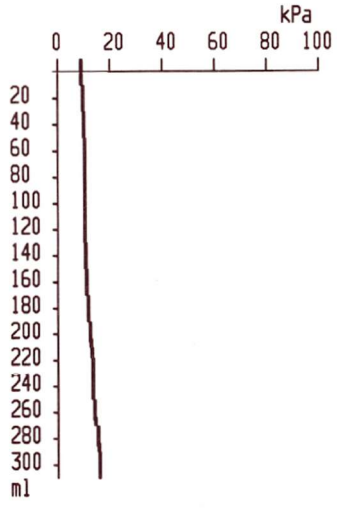

```
Test :  .................
ASTM D2068 software: Rev 1b.23
10th Jan 2018 10:30
Operator      : Guest
```




```
Test          : Completed
Time          : 900 sec
Flow          : 19,9 ml /min
Temperature   : 22,3 'C
Pre-test      : 20 sec
  Pressure    : 8 kPa
  Range       : 7 ... 40 kPa
Test Total    : 900 sec
  Pressure    : 20 kPa@end
Volume        : 300 ml
Method        : B
FBT Value     : 1.02

Using Bias    : 1.0970
FBT A from B  : 1.12
F-QF          : 90.38
```

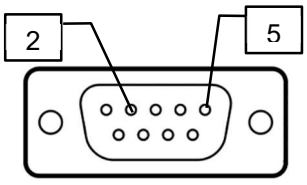
```
Test :  .................
ASTM D2068 software: Rev 1b.23
10th Jan 2017 10:30
Operator      : Guest
```




```
Test          : Completed
Time          : 900 sec
Flow          : 19,9 ml /min
Temperature   : 22,3 'C
Pre-test      : 20 sec
  Pressure    : 8 kPa
  Range       : 7 ... 40 kPa
Test Total    : 900 sec
  Pressure    : 20 kPa@end
Volume        : 300 ml
Method        : B
FBT Value     : 1.02

Using Bias    : 1.0970
FBT A from B  : 1.12
F-QF          : 90.38
```

3.7 Serial output

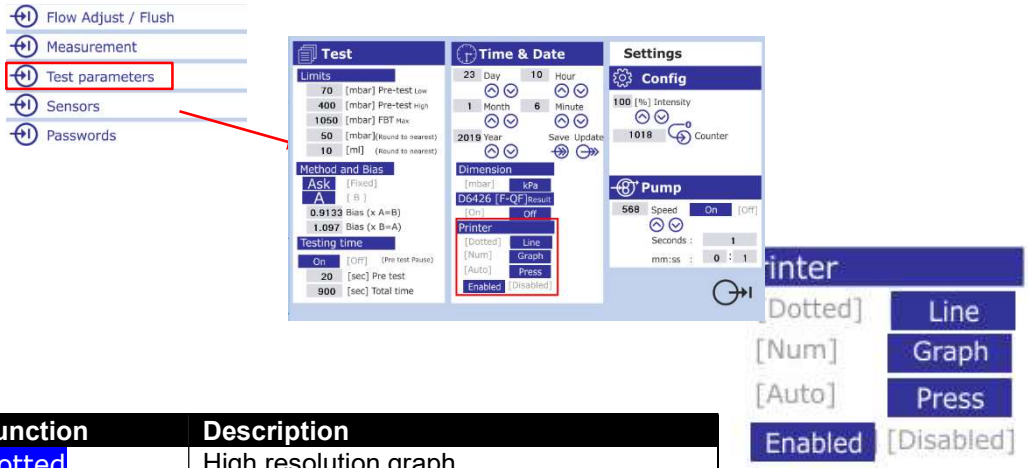


Optional available is an external output for the test data. This serial output is located on the backside and comprises as a RS232 port. It is a 9 pin Sub D female connector. Pin 5 is "Ground" and Pin2 is "Data".

When the unit sends data to the printer, the data is also copied in ASCII format to the serial port. The format is set to 9600 Baud, No parity, 8 Databit and 1 stop bit.

If a paper printout of the data is not required the paper printout can be disabled. See below, tis can be set under “Printer”.

Pin layout	
PIN 2	Data (Tx)
PIN 5	GND
Data format	
Baudrate	9600
Parity	No (N)
Data bits	8
Stop Bits	1

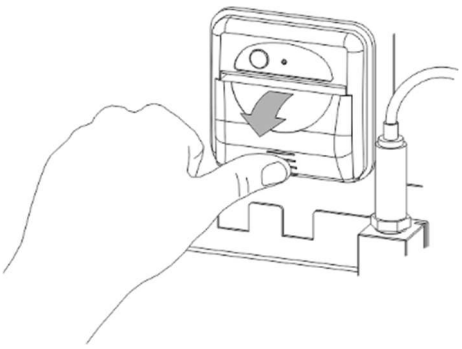


Button	Function	Description
Dotted – Line	Dotted	High resolution graph
	Line	ASTM typical graph
Num - Graph	Num	Graphical output when > 20ml is pumped
	Graph	Always graphical output
Auto – Press	Auto	Print automatically after test
	Press	Print when button pressed
Enabled – Disabled	Enabled	Enable paper printout
	Disabled	Disable* paper printout

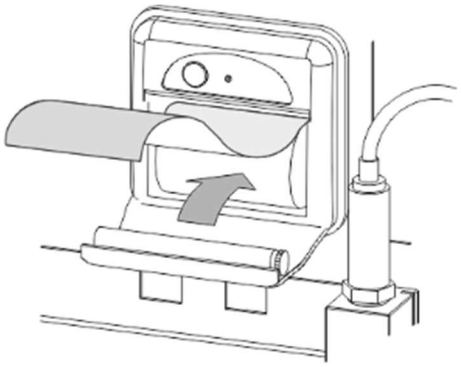
*RS232 Output is not disabled.

3.8 Replacing printer paper

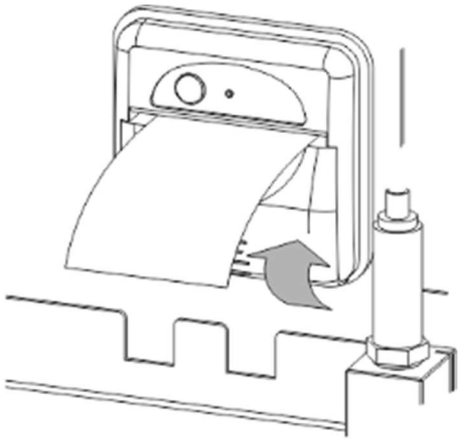
Open the printer compartment by firmly pressing.

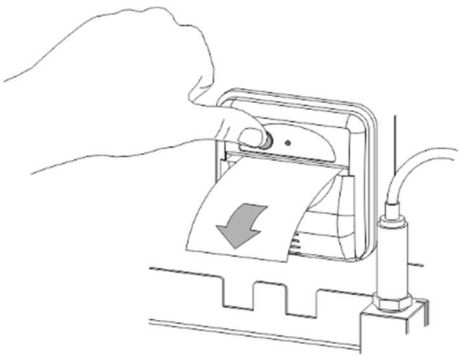


Replace printer paper. Only one side is thermally sensitive, keep this side (indicated in grey) on top.



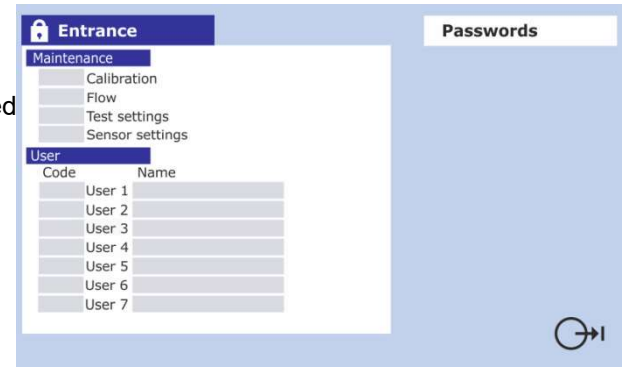
Close the printer compartment.
Press the button to feed the paper.





4 MENUS

4.1 Passwords



There are seven users which can be password protected By selecting a user the username will be printed on the test result.

A user can be password protected.

There are four password settings to protect calibration data and settings. A setting i.e. is the system date and time, method, or pump speed.

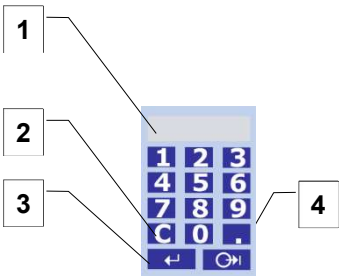
Calibration data also is password protected. This menu enables to calibrate the pressure and level sensor and the thermometer (PT100).

The passwords can be customer set. A general password is available in case passwords are lost.

A password number can be entered for one of the seven users.

A password can be entered for each of the listed menus.

Important! If the password field is left blank, the menu can be entered by simply pressing the enter key [3]. So no password input is needed when asked for.



Keypad to enter Password

Numerical keypad	
1	Display value
2	Correction (backspace)
3	Minus sign
4	Enter parameter
5	Escape

Overview passwords	
Menu	Password to open
Flow adjust	No password required
Measurement	No password required
Test parameters	Calibration Test settings Flow Sensor Settings
Sensors	Calibration Sensor settings
Passwords	Calibration "5662" *

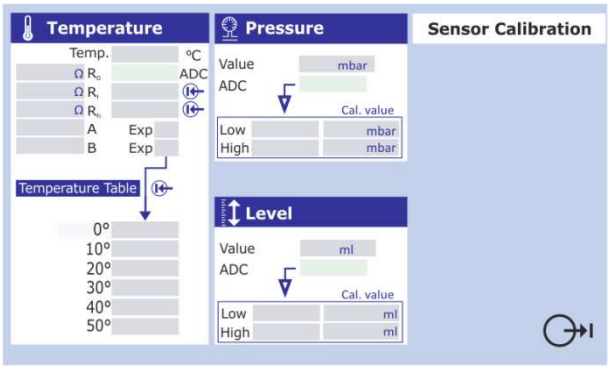
* This can be used to reset all passwords

4.2 Calibration

When altering settings or calibration parameters, equipment must be left to climatise for at least four hours. The environment must be left thermally stable (± 2° C). Change settings only after the FBT unit is switched on for 20 minutes.

Following parameters can be calibrated:

- Pressure
- Temperature
- Level
- Screen

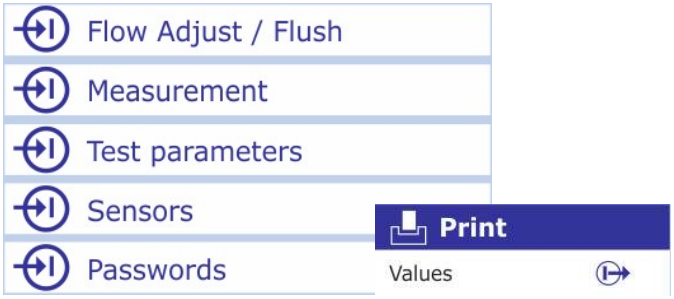


Menu for calibrating sensor

4.3 Initial settings

Temperature		
R0	100	Ohm
Rl	47.49	Ohm
Rh	190.94	Ohm
A	3.9080	
exp 10^{-x} X=:	3	
B	-5.8020	
exp 10^{-x} X=:	7	
Pressure		
Low ADC value	7	
Value low	0	mBar
High ADC value	1200	mBar
Value high	1519	
Level		
Low ADC (Value low level)	0	
ADC - value low*	783	ml
Cal High (Value high level)	300	
ADC - value high	48	ml

* A low fluid level leads to a high distance between sensor and fluid hence a high ADC value.
An high fluid level leads to a small distance between sensor and fluid, hence a low ADC value.
A full overview is available using the printout from the sensor menu "Sensors"




```
Tamson FBT
Service values
Rev 1b.43 - software
Counter test 1234
***   Temperature    ***
R0           : 100.00 Ohm
R1           : 49,81 Ohm
Rh           : 199.46 Ohm
A            : 3.9080 E-3
B            : -5.8020 E-7
0 degree C   : 7138462
10 degree C  : 7416994
20 degree C  : 7694698
30 degree C  : 7971574
40 degree C  : 8247622
50 degree C  : 8522841

***     Pressure     ***
Cal Low      : 0 mBar
ADC Low      : 7
Cal High     : 1200 mBar
ADC High     : 1519
Round        : 50 mBar

***      Level       ***
Cal low      : 0 ml
ADC low      : 783
Cal high     : 300 ml
ADC high     : 48
Round        : 10ml

***       Pump       ***
Speed pump   : 624

***      General     ***
Graph        : Line
Graph        : Always on
Test method  : B
Testresult   : mBar
D6426        : Showresult
FBT A to B   : 0.9133
FBT B to A   : 1.0970
P Limit Low  : 70 mBar
P Limit High: 400 mBar
P max        : 1050 mBar
Pretest time: 20 sec
Total time   : 900 sec
```

4.4 Temperature calibration and adjustment

4.4.1 Calibrate the temperature readout

To check weather the temperature measurement needs adjustment first calibrate.

Use a reference thermometer and a 500ml beaker filled with water.

Verify using two temperatures.
Fill a 500ml beaker filled with water @± 15°C and place both the PT100 and a reference thermometer in the beaker. When the readout is stable, write down both temperatures (reference thermometer and the TFBT-PT100).

Fill a 500ml beaker filled with water @± 35°C and place both the PT100 and reference thermometer in the beaker. When the readout is stable, write down both temperatures (reference thermometer and the TFBT-PT100).

Confirm entered values with this button

When the temperature deviates more than +/- 0.5°C the temperature only than readout needs adjustment.

4.4.2 Adjust the temperature readout

Only perform adjustment if calibration shows a temperature deviation of more or less than 0.5°C

This procedure consists of two parts:

a. Calibration of TFBT apparatus, analog to digital converter.
b. Calibration of PT100.

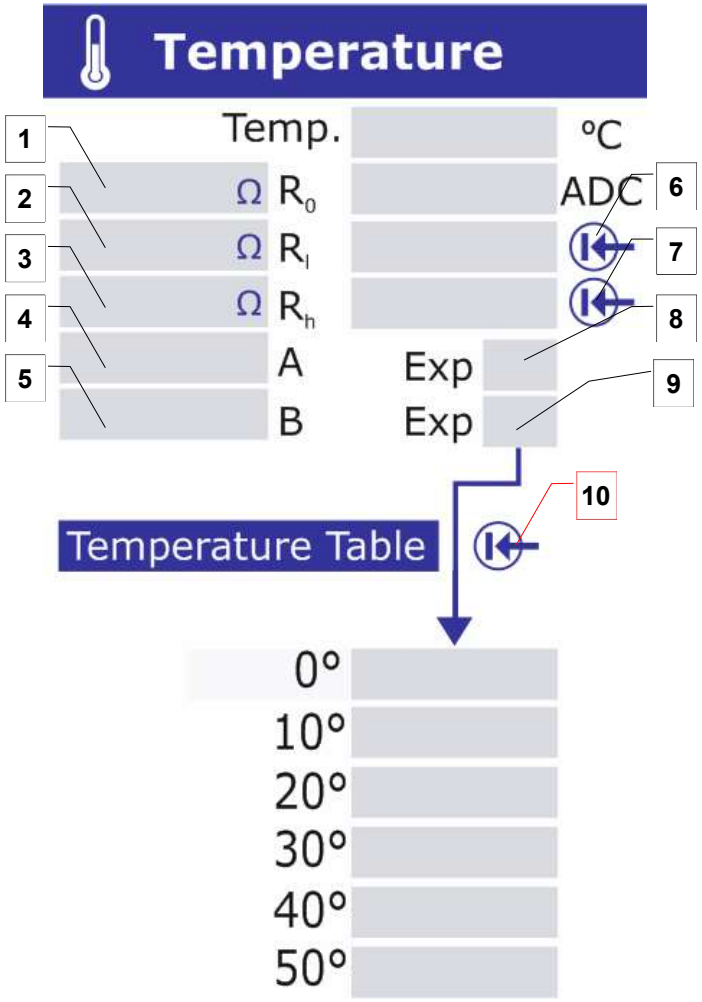
Ad a.)

This part can be skipped if no reference resistors are available.

These values are initially set when the apparatus leaves the factory.
Reference resistors:

R_L => SKU: 14T0306
TEMP CAL. RESISTOR LOW (50R)
R_H => SKU: 14T0307
TEMP CAL. RESISTOR HIGH (200R)

Ad b.)
This step has to be followed when a PT100 is replaced. Use the R0, coefficient - A and coefficient - B data from the PT100 supplier or calibration lab who provided the PT100.



Part a)
Remove PT100 connector from the PCB.
Connect R_L resistor onto this connector.
Enter the exact resistance value in field R_L.
Wait until reading is stable.
Confirm ADC reading by pressing (8)

Remove R_L resistor and connect RH resistor.
Enter the exact resistance value R_H (3).
Wait until reading is stable.
Confirm ADC reading by pressing (8).

The ADC now is calibrated

Part b)
Step 2 calibrates the temperature using a compensation table (IEC 751)

This table is generated using the following parameters:

- R_0
- Coefficient "A"
- Coefficient "B"

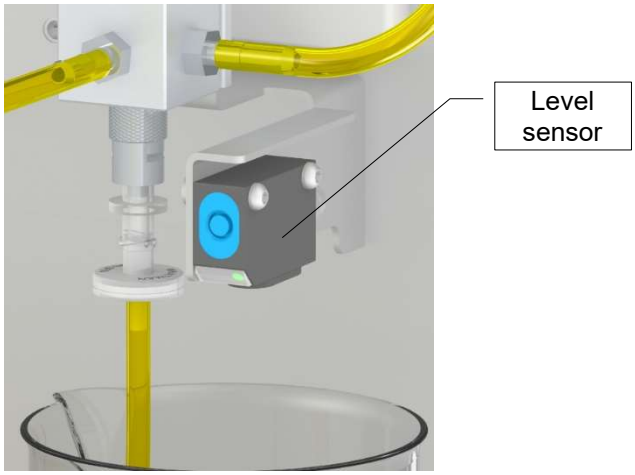
These parameters can be obtained from a calibration lab or the supplier of the (replacement) PT100.

When the parameters are entered the table can be generated using the "confirm" button [10].

4.5 Calibrating the level

Switch on the apparatus. Wait at least 15 minutes before calibrating the level detection.

The level sensor must be free from fluid, moisture, dirt, spatter, etc.

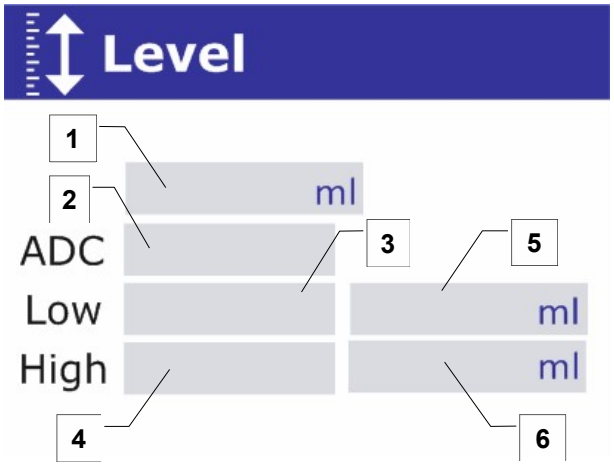


Numerical keypad	
1	Display measured level in [ml]
2	Analog to digital(ADC) value level sensor
3	ADC low level value
4	ADC high level value
5	Setpoint calibration high
6	Setpoint calibration low

Procedure
(A) Zeroing
Place empty beaker (0 ml)
Set [5] to 0 ml
Take ADC readout [2]
Enter ADC readout in [3]

(B) Span

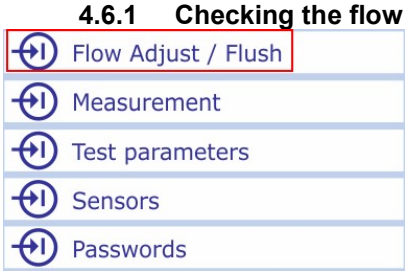
Fill beaker to max (300 ml) using a measuring cylinder.
Set [6] to 300
Take ADC readout [2]
Enter ADC readout in [6]

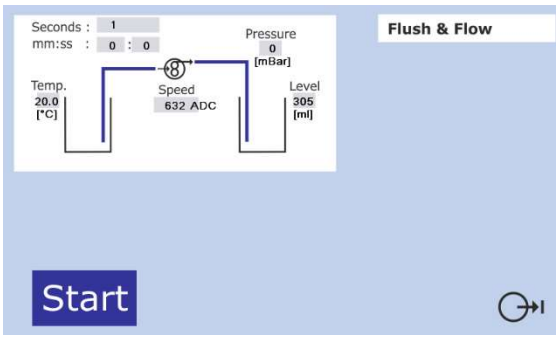


4.6 Flow Adjustment

Flow must be checked periodically. There are two menus available.
- Check of flow, no adjustment
- Check and adjustment of flow

4.6.1 Checking the flow





This menu can be used to check all sensors and also the pumped volume.

Fill the left beaker with clean diesel and empty the right beaker.

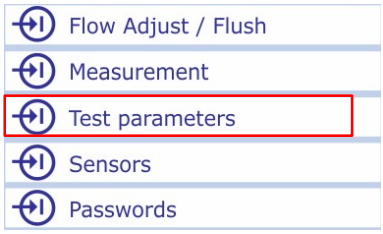
Start the flow and make sure that air is out of the system.

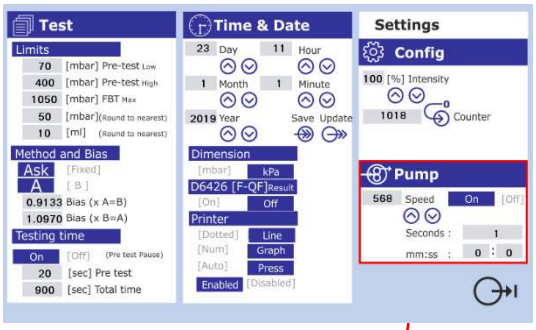
Clean the right beaker.

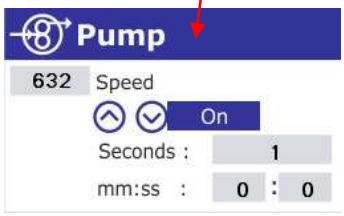
Start the pump again and pump for 300 seconds or 15 minutes (15:00). Stop the pump.

Measure the pumped volume using an accurate measuring beaker with +/- 1ml accuracy.

4.6.2 Adjusting the flow







According to the method the flow must run at a constant rate which is 20ml per minute. So after 15 minutes 300ml of fluid must be pumped. A margin is accepted of +/- 15ml.

With the "Up" and "Down" buttons the pump speed can be adjusted to meet this specification. Each step varies the flow with about 0,5ml.

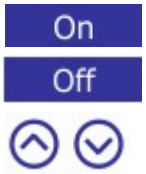
Use a measuring cylinder to verify the pumped volume within +/- 1ml.

The stopwatch indicates the time in both minutes:seconds and total seconds.

Practice
Fill the left beaker to 350 .. 400ml with clean diesel. Empty the receiving beaker on the right. Make sure all air is out of the system by running the pump.

Again empty the receiving beaker by pouring its contents into the left beaker.

Now start the pump and pump for 15 minutes.
Stop the pump at 15:00 or 300 seconds and measure the pumped volume and adjust the pump speed if the 300ml +/- 15ml is not reached. Each step is about 0.5 ml. Repeat until the desired volume is pumped.

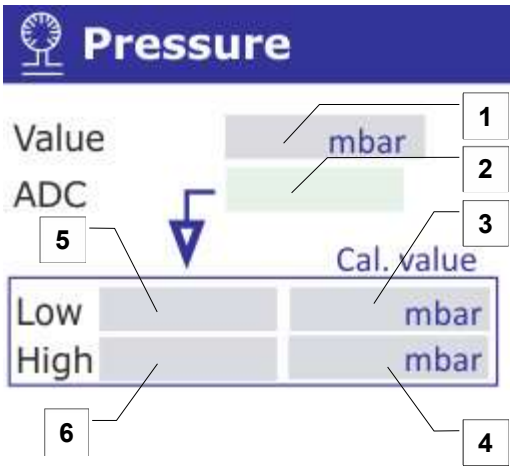


It is not necessary to use and connect a filter. The pump compensates for counter pressure. For adjustment the pump can run without a filter attached.

4.7 Calibrating the pressure

4.7.1 Starting the calibration

Switch on the apparatus. Wait at least 20 minutes before calibrating the the level detection.



Numerical keypad	
1	Display measured pressure in [ml]
2	Analogue to digital (ADC) value pressure sensor
3	Set point calibration low value
4	Set point calibration high value
5	ADC high level low
6	ADC high level high

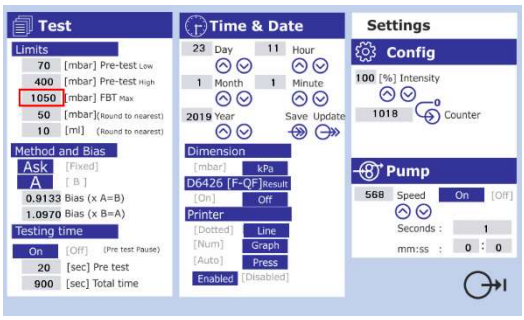
The calibration "pressure 3" must be higher than the maximum test pressure*.

When using the ASTM D2068 the pressure to calibrate at must be greater than 105 kPa or 1050 mBar. It is advised to calibrate at 1200 mBar (120 kPa).

The maximum working pressure of the sensor is 250 kPa or 2500 mBar.

Pressure exceeding 2500 mBar can damage the pressure sensor.

Calibration values and limits are in mBar.



* The maximum test "pressure 3" can be found in the "settings" screen. This value sets the pressure value above which the apparatus must indicate overpressure during the test.

4.7.2 Pressure calibration procedure

(A) Zeroing
Disconnect all hoses and filters and ensure
the FBT pressure sensor (as indicated in “what is What”)
is in free air.

Set cal value “Low” [3] to 0 mbar
Take ADC readout [2]
Enter ADC readout in [5]

(B) Span
Fill then system with clean diesel
Connect external pressure reader
Start pump
Pump to 1200 mBar

Do not exceed 2000 mBar

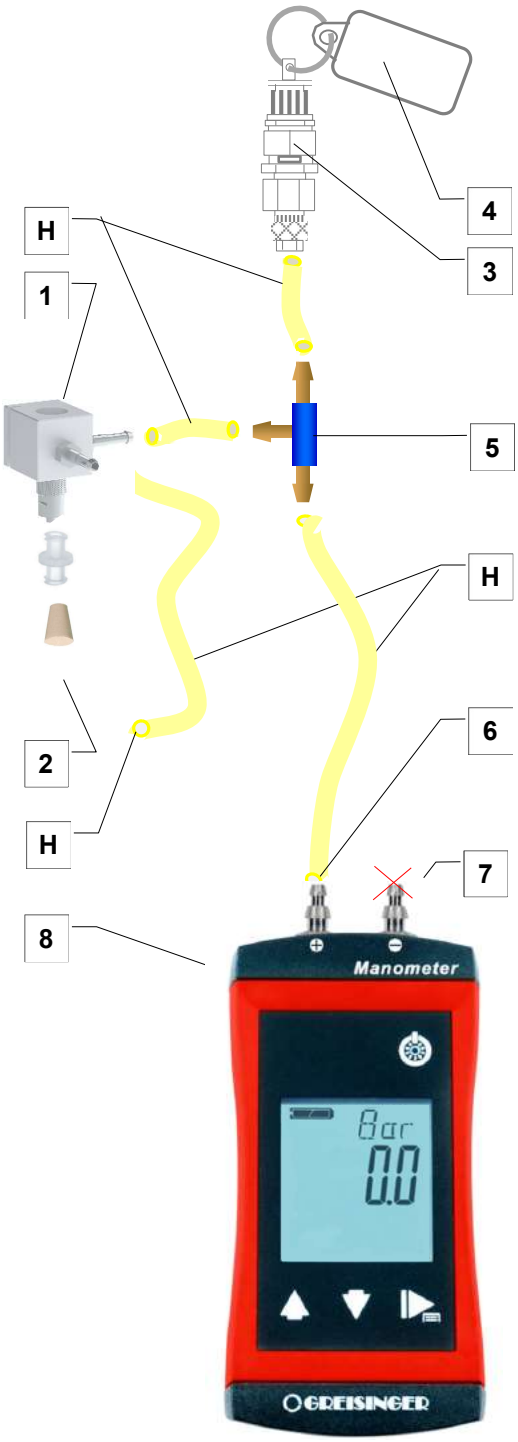
Wait until readout is stable (max 1 mbar pressure drop every second)
Take reading
On pressure monitor
ADC readout [2]
Now enter
Value pressure monitor [4]
ADC value [6]

The pressure readout [1] now must be equal to the readout on the pressure monitor [± 2 mBar]

Pressure monitor

4.7.3 Connect pressure monitor

Numerical keypad	
H	Hose (Tygon 3.2 x 6.4 mm 24T0052)
1	Universal adapter (15T0006)
2	Adapter 24T0075 + Stopper 31T2007
3	Overpressure device
4	Label with overpressure (<= 2 Bar ±0.2)
5	T – Piece (28T4148)
4	To piston pump (pressure side)
6	"+" pressure side
7	"-" pressure side, do not use
8	Pressure monitor



Make a note of the precautions below

Wear safety gloves and glasses as overpressure may cause fluid to splash

To release the pressure build up gently open the valve [2] Be aware of splashing!

Do not connect hose on negative pressure side [7]!

When starting the pump watch the pressure monitor and stop the pump when a readout exceeds 1200 mBar.

Wait until pressure settles and then start pump again.

Repeat this to reach a stable pressure around 1200 mBar ± 50 mBar.

The pressure is more or less "stable" if it drops like 1 mBar every second, but preferably less.

If the readout on the pressure monitor can't be kept stable, please check for leaks.

4.7.4 Calibration details pressure monitor

(Data below only is provided when the optional calibration kit is ordered)

Date of calibration ..... [dd-mm-yyyy]

Expiration ..... [months]

Serial number .....

Performed by .....

Pressure montor

Zero

Readout pressure monitor (zero) ..... [mBar]

Readout reference (zero) ..... [mBar]

High value

Readout pressure monitor (high) ..... [mBar]

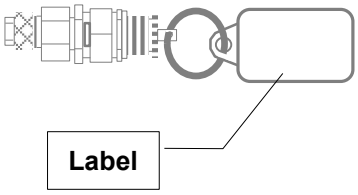
Readout reference (high) ..... [mBar]

Correction set on G1113 ..... [SCL]

4.7.5 Calibration detail overpressure device

Pressure tested at ..... [Bar]

Label ..... [Bar]

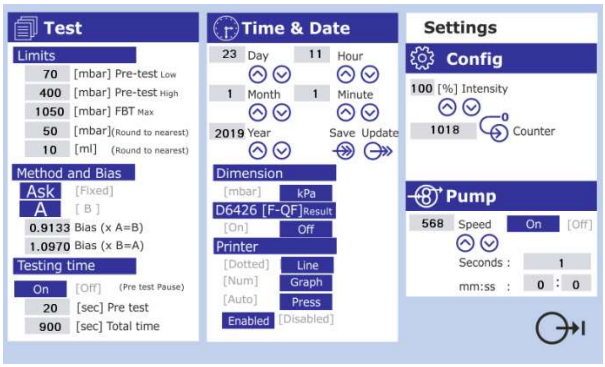


Pressure reference used

Pressure sensor

Type	GHM Pressure sensor SL-01R
Serial	14026635
Range	-1000 .. 1500mbar
Reader	serial 37200058
Certificate	..... by Deutsche Kalibrier Dienst (DKD), Traceable to national standards

4.8 Timer



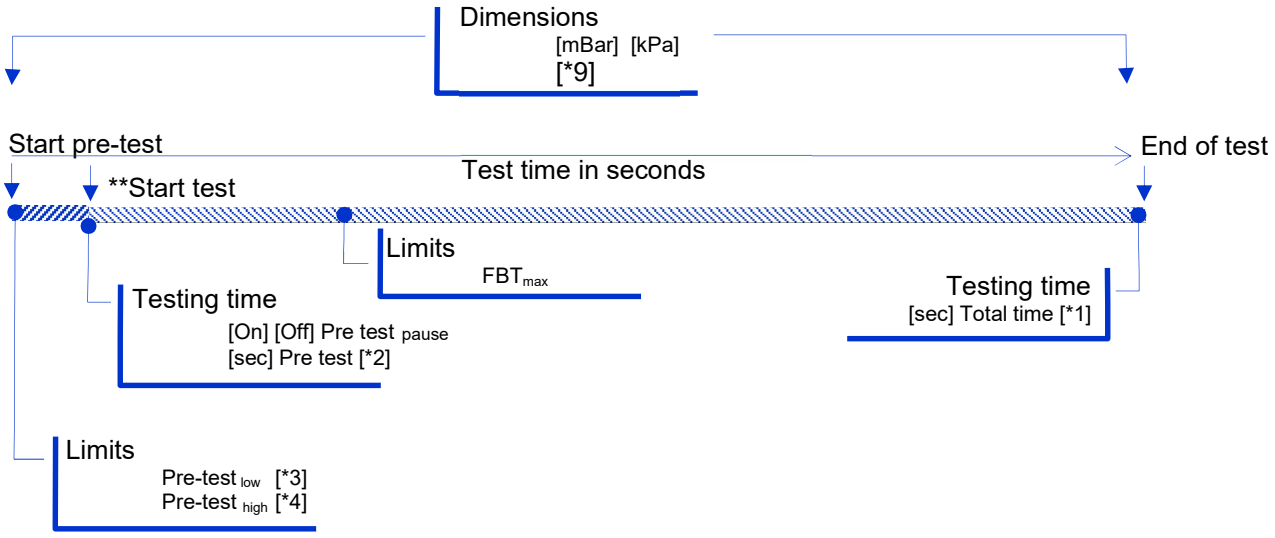
The timer is crystal based and does not need calibration. A built-in crystal provides an accuracy of ± 0.001 sec or better.

4.9 Test parameters

The test procedure offers multiple settings for the test procedure.

4.9.1 Settings

Following parameters have influence on the test procedure

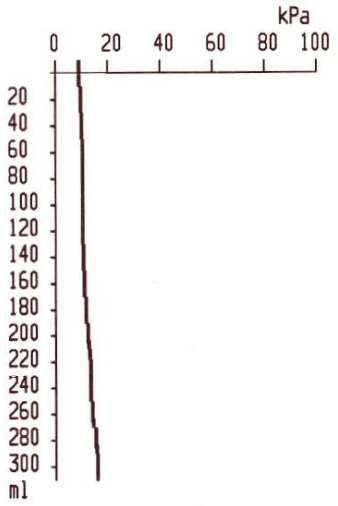


Parameters list

Printout parameters

Limits	
[mbar] Pre-test	[*3]
[mbar] Pre-test	[*4]
[mbar] round to nearest	
[ml] round to nearest	
Method and bias	
[A] [B]	[*5]
Bias (x A = B)	[*6]
Bias (x A = B)	[*6]
Time & Date	
Day, Month, Year	[*7,8]
Hour, minute	[*8]
Dimensions	
[mbar] [kPa]	[*9]
D6426 [F-QF] result	[*10]
Printer	
[Dotted] [Line]	[*11]
[Num] [Graph]	[*12]
[Auto] [Press]	

```
Test :   ................
ASTM D2068 software: Rev 1b.23
10th Jan 2017 10:30          [*7,8]
Operator      : Guest
```

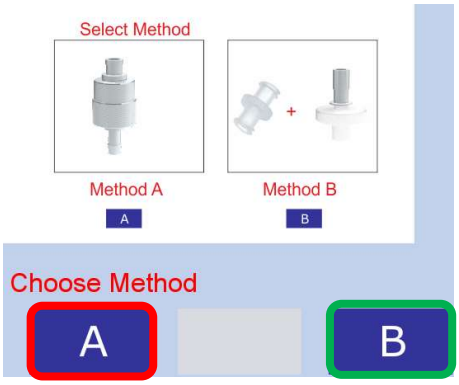



```
Test          : Completed
Time          : 900 sec          [*1]
Flow          : 19,9 ml /min
Temperature   : 22,3 'C
Pre-test      : 20 sec           [*2]
  Pressure    : 8 kPa
  Range       : 7 ... 40 kPa     [*3,4,9]
Test Total    : 900 sec
  Pressure    : 20 kPa@end       [*9]
Volume        : 300 ml
Method        : B                [*5]
FBT Value     : 1.02

Using Bias    : 1.0970           [*6]
FBT A from B  : 1.12
F-QF          : 90.38            [*13]
```

4.9.2 Specific remarks

Asking for Method
When using adapter p/n 15T0005 both methods can be performed.
To enable the output to print the correctly used method a setting in the menu can be set to "Ask" where during the test preparation the setting for the method will be asked.



When the option "Fixed" is set, the result of the FBT test will be displayed and printed conforming the method set in this settings menu here.

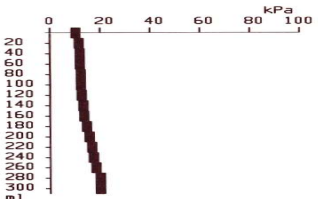
So if "**A**" is set in this menu, results are printed on screen and paper as method "A". If "**B**" is selected, results are displayed as method "**B**"

The Pre test pause option:
When set to "On" The program will halt after at the “Pre test” point. This means the FBT will run for this period (20 seconds) and then pause, showing the pressure. Pressing [Start] on the screen will continue the test.
When set to "Off" the program will perform the full test. The pressure value taken (at 20 seconds) will be printed on the ticket.

Off - The program will not halt after "[sec] Pre test" and continue testing. The pressure result taken at "[sec] Pre test" will be printed on the ticket [*9]

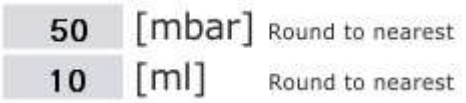
D6426 result
The test result is calculated conforming to D6426 and printed [*13]. When "off" is selected nothing is printed.

Num or Graph
When “Num” is selected and when pressure exceeds the max set pressure ([mbar] FBT $_{max}$ or 105 kPa) no graph is printed. In other words when a test finishes before the end of run (300 ml or 900 seconds) the machine will only print the numerical values and no graph. When the option [Graph] is set, both the FBT result and graph will be displayed.
Dotted or Line defines the graphical output. The option "Line" will give more detail. "Dotted" conforms to the D2068 method.



The result is printed automatically when the third option is set to "Auto". Otherwise a keypress is needed to print the result.

Round to nearest
The test outcome of both pressure and volume can be rounded. A value of 1 here will not round the measured value.



When rounding to nearest 50 means that a value of 25 and higher will round to 50, values below 25 will round to 0.

When rounding to nearest 10 means that a value of 5 and higher rounds to 10, a value lower than 5 will be rounded to 0.

5 TECHNICAL

5.1 Specification Details

Technical details

Specification		
Dimension		
Length	280	mm
Width	350	mm
Height	620	mm
Weight	11	Kg
Mains	85 .. 264	Volt
	47 .. 63	Hz
Consumption	40	Watt
Fuse	800	mA - T (slow)
Pressure		
Range	0 - 1500	mBar
Linearity	0,5	% Best Fit Straight Line
Resolution	1	mBar
Level		
Range	0 - 300	ml
Linearity	0,2	ml
Resolution	0,5	ml
Temperature		
Range	15 .. 40	°C
Linearity	0,02	°C
Resolution	0,1	°C
Timer		
Accuracy	0,001	sec

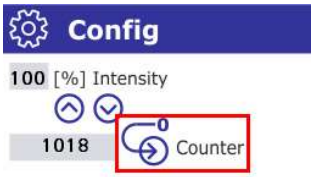
5.2 Serial Printout

The serial printout has 2 formats

- Printing the calibration data
- Printing the test result

Each test result has a unique number. To reset this counter open the menu "Test parameters"

and press "counter" to reset to 0



Calibration values

Code	software parameter	Description	Value
	Test reference		
[CALDT]			
[CNTR*]	CounterTestTXT	Counter index test	Integer (2 bytes)
[RTC**]	RTCVar	Date & Time	**dd mm yy hh:mm:ss** ie. 14/09/12 9:50:06
[SOFT*]	SoftRev	Software value	i.e. 1b.43
	Temperature calibration		
[R0***]	R0OhmTxt	Value R0	Float, 2 decimals
[R1***]	RlOhmTxt	Value R1	Float, 2 decimals
[RH***]	RhOhmTxt	Value Rh	Float, 2 decimals
[AMAN*]	A_MantisseTxt	Value A Ground value	Float, 2 decimals
[AEXP*]	A_ExpTxt	Value A Mantisse value	byte
[BMAN*]	B_MantisseTxt	Value B Ground value	Float, 2 decimals
[BEXP*]	B_ExpTxt	Value B Mantisse value	byte
[TT0C*]	Table0Txt	Temperature table 0'C value	Integer (4 bytes)
[TT10C]	Table10Txt	Temperature table 10'C value	Integer (4 bytes)
[TT20C]	Table20Txt	Temperature table 20'C value	Integer (4 bytes)
[TT30C]	Table30Txt	Temperature table 30'C value	Integer (4 bytes)
[TT40C]	Table40Txt	Temperature table 40'C value	Integer (4 bytes)
[TT50C]	Table50Txt	Temperature table 50'C value	Integer (4 bytes)
	Pressure calibration		
[PCALL]	PLowValTxt	Pressure zeroing mBar value [mBar]	Integer (2 bytes)
[PADCL]	PLowADCTxt	Pressure zeroing ADC value	Integer (2 bytes)
[PCALH]	PHighValTxt	Pressure calibration point mBar value	Integer (2 bytes)
[PADCH]	PHighADCTxt	Pressure calibration point ADC value	Integer (2 bytes)
[PRND*]	TRoundmBar	Pressure averaging factor mBar for FBT formula	Integer (2 bytes)
	Level Calibration		
[LCALL]	LLowValTxt	Level zeroing ml value [ml]	Integer (2 bytes)
[LADCL]	LLowADCTxt	Level zeroing ADC value	Integer (2 bytes)
[LCALH]	LHighValTxt	Level calibration point mBar value	Integer (2 bytes)
[LADCH]	LHighADCTxt	Level calibration point ADC value	Integer (2 bytes)
[VRND*]	RoundmLTXT	Volume averaging factor mBar for FBT formula	Integer (2 bytes)
	Pump calibration		
[PSPD*]	PSpeedTxt	Pump speed setting	Integer (2 bytes)
	General data		
[GD-G*]	PDotOrGraphTxt	Graph plotted block or fine line	Dot; Line
[MET**]	MethodTxt	Method "A" or "B"	A; B
[PDIM*]	DimPressureTxt	Pressure in mBar or Bar	mBar;kPa
[D6426]	OnOffD6426TXT	Print result D6426	Show Results; Off
[BATOB]	BiasAtoBTXT	Bias value convert method A to B	Float, 4 decimals
[BBTOA]	BiasBtoATXT	Bias value convert method B to A	Float, 4 decimals
[PLLO*]	PLimLowTXT	Pressure limit low (70mBar)	Integer (2 bytes)
[PLHI*]	PLimHighTXT	Pressure limit high (400mBar)	Integer (2 bytes)
[PMAX*]	PMaxmBarTXT	Maximum pressure (1050)	Integer (2 bytes)
[PTIM*]	PreTestTimeTXT	Pre test time (20sec)	Integer (2 bytes)
[TTOT*]	EndTestSecTXT	Total test seconds (900)	Integer (2 bytes)
			In blue is text value output
[END**]			

Test result

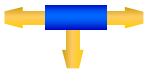
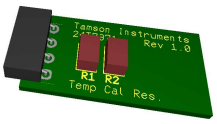
Code	software paramete	Description	Value
	Test reference		
[CNTR*]	CounterTestTXT	Counter index test	Integer (2 bytes)
[RTC**]	RTCVar	Date & Time	dd mm yy hh:mm:ss ie. 14/09/12 9:50:06
[SOFT*]	SoftRev	Software value	text
[TSTPR]#		Test exit pressure > 1050 mBar	
[TSTVO]#		Full volume is pumped (300ml)	
[OPERA]			
[ERRO1]***		Overperssure during first 20sec of FBT test - TEST is ABORTED Result must be rejected	
[FBT-P]#		Result FBT calculated on pumped volume	
[Aoxx]	PointerArrayU16	Array contains 420 values Array value is pressure, integer of 2 bytes 420 corresponds with 300ml Each 5th **A**rray-value is exported as **O**utput In total 84 values [**AO**] are sent [AO05]<integer> ↓ [AO420]<integer> Where integer is pressure in mBar & >0 & <1 050	Integer (2 bytes)
[RESLT]	aSttusFbtTXT	Calculated FBT value	
[TIME1]	FBT_Time		Integer (2 bytes)
[MLFBT]	FbtFlowTXT	Pumped Volume [ml]	Integer (2 bytes)
[TEMP*]	TempVal	Float, 4 decimals	Float, 1 decimal
[TIME2]	PreTestTimeTXT		Integer (2 bytes)
[PFBT]	FbtPressIntmBarTXT		Integer (2 bytes)
~~[PLLO*]~~	~~PLimLowTXT~~	~~Pressure limit low (70mBar)~~	~~Integer (2 bytes)~~
~~[PLHI*]~~	~~PLimHighTXT~~	~~Pressure limit high (400mBar)~~	~~Integer (2 bytes)~~
~~[TIME3]~~	~~EndTestSecTxt~~	~~Seconds test has ran~~	~~Integer (2 bytes)~~
[MLFBT]	mLRoundedTXT	Flow in ml/min	Integer (2 bytes)
[MET**]	MethodTxt	Method "A" or "B"	A; B
[REFBT]	FbtValTXT	FBT Result	Float, 2 decimals
[BBTOA]**		Bias value convert method B to A	Float, 4 decimals
[BATOB]**		Bias value convert method A to B	Float, 4 decimals
[BIFBT]	ResultBiasTXT	FBT result calculated using bias	Float, 2 decimals
[F-QF*]*	F_QfValTXT		Float, 2 decimals
[END**]		End of serial output	

\# Printed when valid
* Print depends on selection in setup
** Depends on selection in menu settings
*** Only printed when true

5.3 Spareparts

Spare parts TFBT			
Item	Part number	Description	Remark
1	24T0064	Pack (100) of filter discs for adapter “A” Whatman GF/A (FBT)	
2	24T0060	Sparepart filter housing adapter “A” Millipore M5	 
3	24T0061	Sparepart kit adapter “A” Millipore 4 x set of : O - ring (thick) O - ring thin Stainless disc	
4	24T0067	Pack (98) of filter for adapter “B” Whatman Syringe GF/A	
5	24T0052	Hose Tygon 15mtrs 3,2 x 6,4mm	
6	15T0005	Procedure "A" or "B" Adapter Block Stainless Steel	
7	24T0075	Adapter Whatman Filter - 24T0067 (Method B p/n 15T0005)	
8	31T2007	Silicone stopper 3,5mm	
9	34T0052	Needle valve M5	
10	28T7035	Printer paper, thermally, set of 5 rolls, 57mm x Φ 30mm x 8 mm	
11	25T2230	FBT verification fluid for procedure "B"	

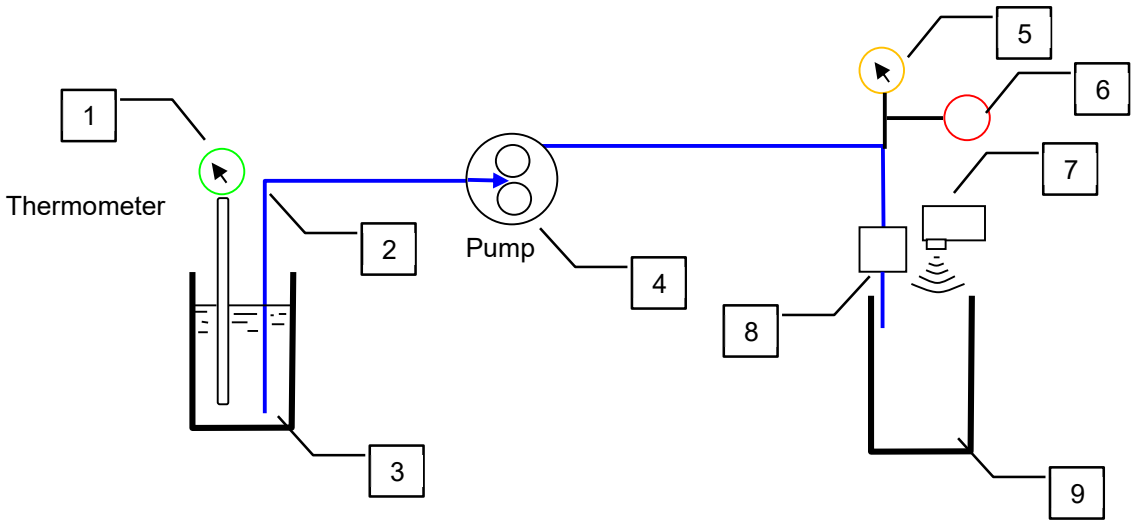
5.4 Parts for calibration

Parts for calibration TFBT			
Item	Part number	Description	Remark
1	31T2005	Beaker 400 ml Glass	
2	31T2004	Beaker 150 ml Glass	
3	31T2010	500 ml measuring cylinder for level calibration	
4	19T9030	Level and pressure calibration kit	 
5	14T0305	Overpressure complete. Set to 2 bar	
6	28T4148	T - piece	
7	31T2006	Beaker 2,5-15ml	
8	14T0306	Temp CAL. Resistor LOW (50R)	
9	14T0307	Temp CAL. Resistor HIGH (200R)	
10	31T2007	Silicone stopper 3,5mm	

5.5 Spareparts for service

Service parts TFBT			
Item	Part number	Description	Remark
7	24T8556	On / off switch	
8	28T0200	Connector sensor "plug"	
9	28T0201	Connector sensor "chassis"	
10	27T2998	Screen gasket neoprene	
11	27T2990	Touch display	
12	27T9200	Printer	
13	27T9300	Sensor pressure	
14	24T0377	Seal 1/4” White PVC	
15	27T9310	Sensor level	
16	25T1302	Piston Pump head only (no drive)	
17	24T0031	Power supply 5V - 3A	
18	24T0029	Power supply 24V- 1A5	
19	25T1305	Pump motor	
20	25T2355	PT100 probe + connector	

5.6 Principal Diagram



No.	Item
1	Thermometer
2	Sucktion rod
3	Beaker with samle
4	Piston pump
5	Pressure sensor
6	Pressure-peak damper
7	Level sensor
8	Filter
9	Receiver beaker

6 TROUBLE SHOOTING

Flow lower than expected.

The tube is fitted incorrectly in the pump head.

Correct placement of tube.

The filter is leaking (Procedure "A")

Check stacking.
Check if parts screwed together.

Placement of O-rings filter disk and support disc must conform to drawing. Body bottom and top must be well screwed together.

The indicated level is not stable or shows peaks

Check the level sensor for fluid splashes or sample residue. Fluid tends to cause resonance resulting in an unstable indicated level.

The sensor must be free from fluid.
Sample can splash and hit the cover.

Touch screen does respond correctly
Calibration values are corrupted. A power cut can cause loss of calibration. The screen incidentally respond but items cannot be selected.

Recalibrate the touch screen. See index.

Filter Leaks
When performing procedure "A", a not firmly closed filter adapter can cause leakage. Check the filter housing for correct placement of O-rings. Impurtities, particles or particles may be the problem of a not well sealed adapter housing.

Clean the filter housing. Remove dirt and particles. Close housing firmly

Touch screen seems insensitive

The touch screen is a resistive type. This means it is less sensitive than a capacitive screen

- Hold the touch area a bit longer
- Use a stylo as a touch device

Do not use metal or sharp objects as a touch device. These devices can scratch the display

Date and time corrupted

After adjusting clock gives wrong numbers
Date and time all are zeroed

A battery powers the real time clock and probably ran low

```
Replace battery. Type is BR1225.
```

Fluid is not pumped

Pump is running but no fluid is pumped.

If there's a leak on the suction side, air can be sucked in preventing the suction of the sample fluid. Check for leakages. Check the tube, riser pipe and all connections.

```
Repair any leakages.
```

Suction side is blocked

```
Check for blockages or air
```

Tube is worn

```
Replace tube
```

Graph plummets

From a physical point of view it is not possible that the graph dplummets (pressure gets less).

```
In these cases fluid leaks. Check the system for leakages or a malfunctioning filter

When using filter "A", check positioning of the O-rings. The flat O-ring must be on top, the round O-ring on the bottom.
```

Graph fluctuates on X-axis (volume)

Fluid droplets dripping on the fluid surface interfere with the fluid level measurement

```
Connect a piece of hose onto the filter as indicated in chapter six.
```

Printout is blank

The printing paper has one active side which is thermal sensitive

Check correct placement of the printing paper

Can not calibrate level sensor

Between 0 and 300ml the volume can not be calibrated correctly.

The sensor needs a reset in order to adjust the volume reading between 0 .. 300ml is incorrect.

Contact our technical department assist

7 CE DECLARATION

Following equipment is in compliance with EMC Directive 2014/30/EU:

Product: Filter Blocking Tendency
Model: TFBT
Serial code: Effective from 16Txxx
Manufacturer: Tamson Instruments bv
van 't Hoffstraat 12
2665 JL Bleiswijk
The Netherlands

The products are in conformity with the following specifications:

Item	Reference	Description	Test result
a	**RoHS Directive**	2011/65EU	p
b	**EN61010-2-010**	Safety requirements for electrical equipment for measurement, control, and laboratory use. Particular requirements for laboratory equipment for the heating of material	
c	**Machine Directive 2006/42/EC**	Machinery Directive, of the European Parliament and of the Council of 17 May 2006/42/EC 2nd Edition June 2010	p
d	**EN 60204**	Machinery Directive and Safety requirements	p, p^i
e	**EN60950-1**	Low Voltage Directive	p
f	**EN61000-3-2**	Harmonics	p
g	**EN61000-3-3**	Flicker	p^3
h	**EN61000-4-2 +A1+A2**	ESD	p
i	**EN61000-4-3 +A1+A2**	Radiated immunity	p (anechoic room)
j	**EN61000-4-4**	Electrical Fast Transients	Minimum requirements pass
k	**EN61000-4-5+A1**	Surges	Minimum requirements pass
l	**EN61000-4-6+A1**	Conducted immunity	p
m	**EN61000-4-11 +A1**	Voltage dips and Voltage variations	p
n	**EN55016-2-1**	Conducted emission	p
o	**EN55016-2-3**	Radiated emission	p (anechoic room)

p = Pass
p^i = Individually tested
p^3 = Pass, condition of operating during Pst measurement: Operational with heating element 1400W. P_{st} and P_{lt} are not evaluated in accordance with A.5 of Annex A of EN 61000-3-3(1995) + A1(2001).

not applicable were:
Conducted discontinuous emissions (Clicks)
Radiated emission (OATS)
Magnetic field immunity

Entity responsible for marking this declaration :
Manufacturer, Tamson Instruments bv, van 't Hoffstraat 12, Bleiswijk The Netherlands,

Name : R.C. van Hall
Function : Director
Date : September, 2017
Version : 1.03

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