FS9V4

Fuel & Oil Cleanliness Analyser

User Manual

March 2023

V1.05

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Registered in England No: 03969985 VAT No: 760 821 731 Certification No. UK002838

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Specifications

Specification	Detail
Dimensions	Small – (w)314mm x (d)257mm x (h)152mm (12.4” x 10.1” x 6.0”) Large – (w)398 mm x (d)310 mm x (h)172 mm (15.7” x 12.2” x 6.8”)
Weight	Small – 4.46 kg (9.8 lbs) Large – 7.10kg (15.7 lbs)
Finish	Black impact resistant case
Nominal Battery Voltage	22.5 VDC
Charge Voltage	25.2 VDC
Capacity	4000 mAh
Charge time	2 hours (80%) 5 hours (100%)
Run time	Up to 10 hours (depending on fluid viscosity)
Modes of operation	Tank sampling Bottle sampling (200ml minimum sample bottle recommended)
Cleanliness standards	ISO 4406, NAS 1638, SAE AS4059
Pump type	Gear pump
Duty cycle	Continuous
Viscosity range	Small Unit – 1-320 cSt (1-300 cSt with High Pressure device) Large Unit – 1-2400 cSt (1-300 cSt with High Pressure device)
Fluid compatibility	Diesel & oil (hydraulic, lubrication, mineral, synthetic)
Fluid temperature	0 to 60°C (oils) 0 to 50°C (diesel)
Ambient temperature	0°C to +60°C
Environment	Lid closed – IP67 Lid open – IP54
Connections	1604 minimess test points, with 0.6m long 8mm tubing
Pressure	2.5 bar max (up to 350 bar with optional High Pressure device)
Maximum humidity	97% relative humidity, non-condensing
Certification	Factory calibration certificate CE declaration
Verification frequency	12 months recommended
PC requirements	Windows/Mac (with USB port), spreadsheet software (e.g. MS Excel)

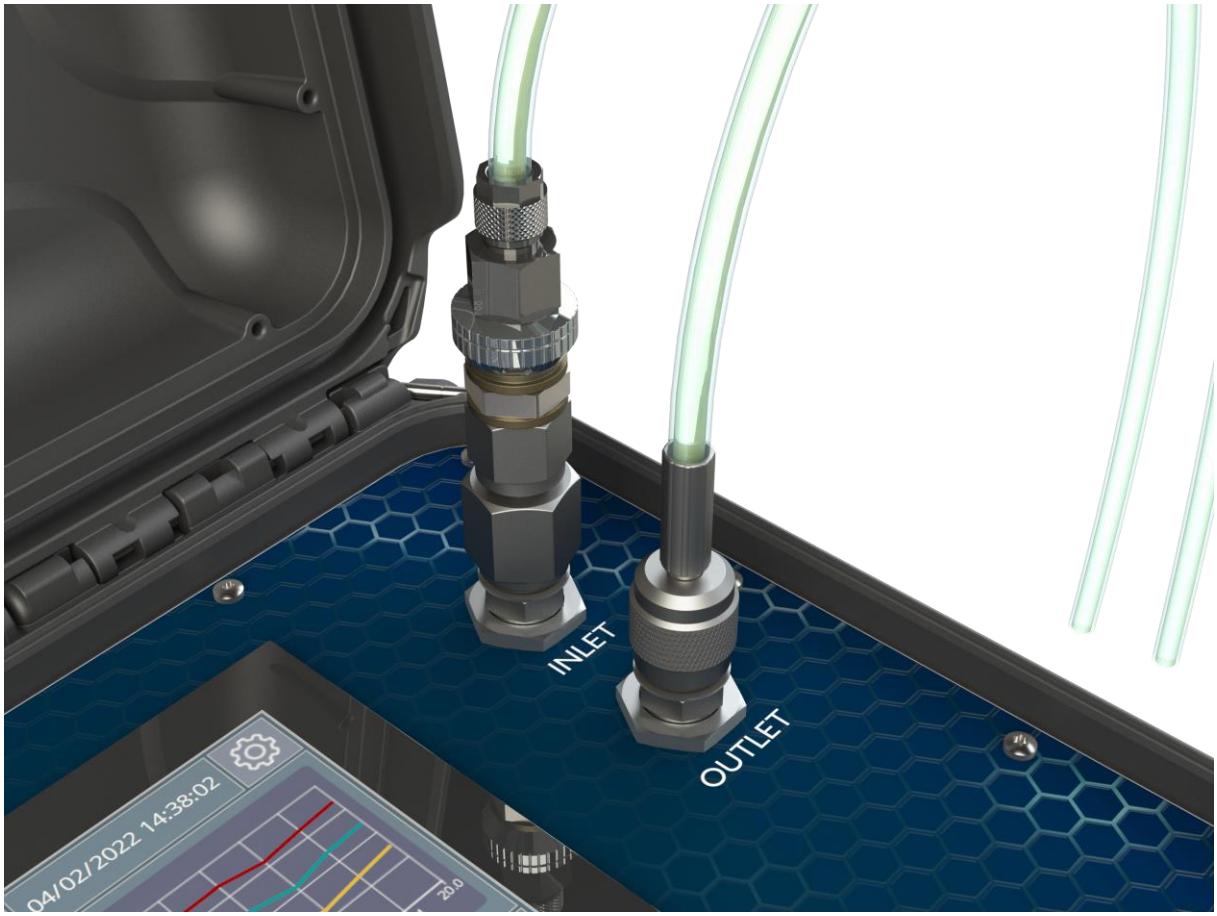
Component Identification

Key:

1.) Touch screen display	5.) Return / Outlet (Minimess Test Point)
2.) Pump on/off switch	6.) Suction / Inlet (Minimess Test Point)
3.) Display/sensors on/off switch	7.) USB port (at rear of case)
4.) Charging port	

Suction & Return Hose Connections

The unit comes equipped with Minimess Test Points. These seal automatically as the coupling is removed, so the connections won't leak during transit.



To connect the hoses, screw them onto the Minimess Test Points, hand tight only.

Make sure the hose assembly with the strainer is always used on the suction/inlet port.

To disconnect the hoses, unscrew from the Minimess Test Point. The hose assemblies do not contain a self-seal mechanism and may drip; keep an oil absorbent spill mat ready and store hoses in a clean plastic bag when not in use. Placing a finger over the end of the hose can prevent oil dripping out of the test point onto the fascia of the unit.

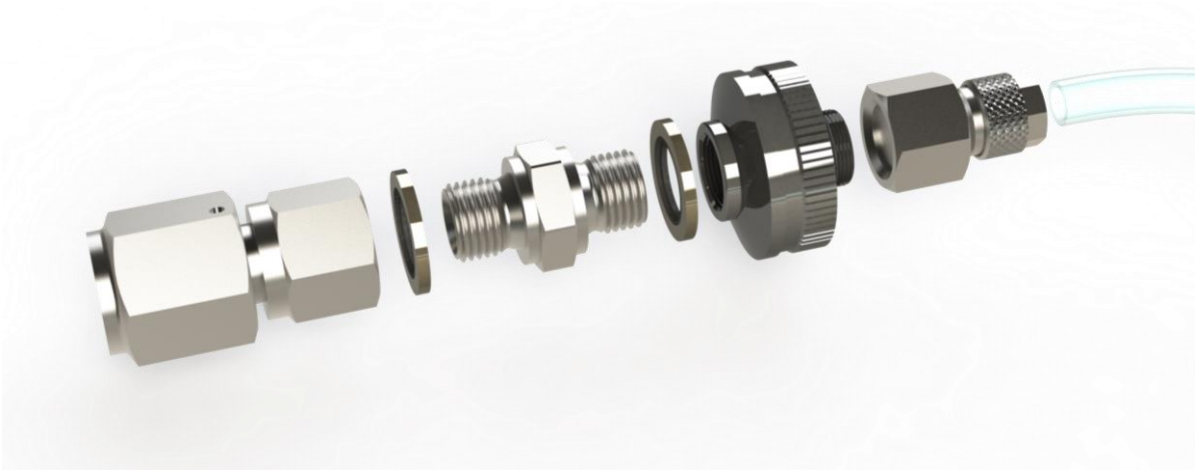
Suction Strainer

Units are supplied with a strainer fitted to the suction tube assembly. The inline strainer has a 270 micron mesh and is used for keeping accidental debris from damaging the pump gears or clogging other components.

The strainer must always be used, otherwise the units warranty may become void.

The strainer can be disassembled for cleaning as shown below and should be checked periodically to ensure the flow is unrestricted.

When taking apart the strainer, note the orientation of the mesh for correct reassembly.

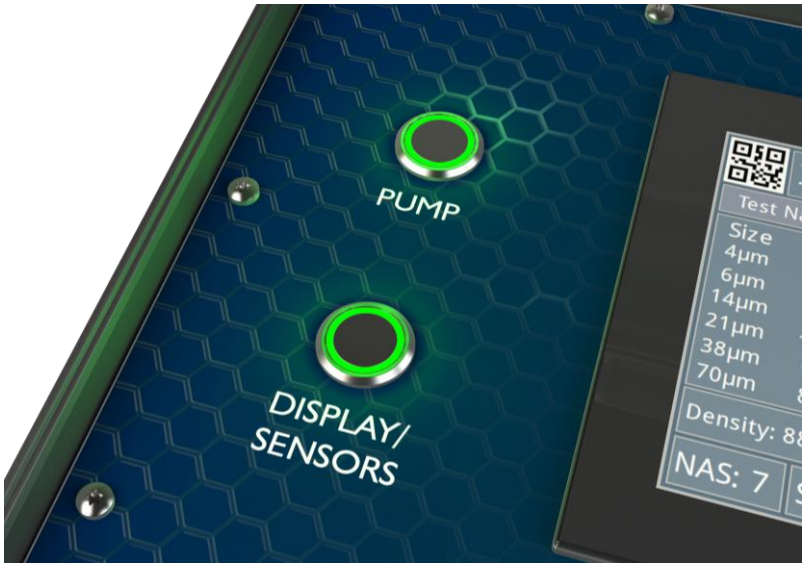


Operating the Unit

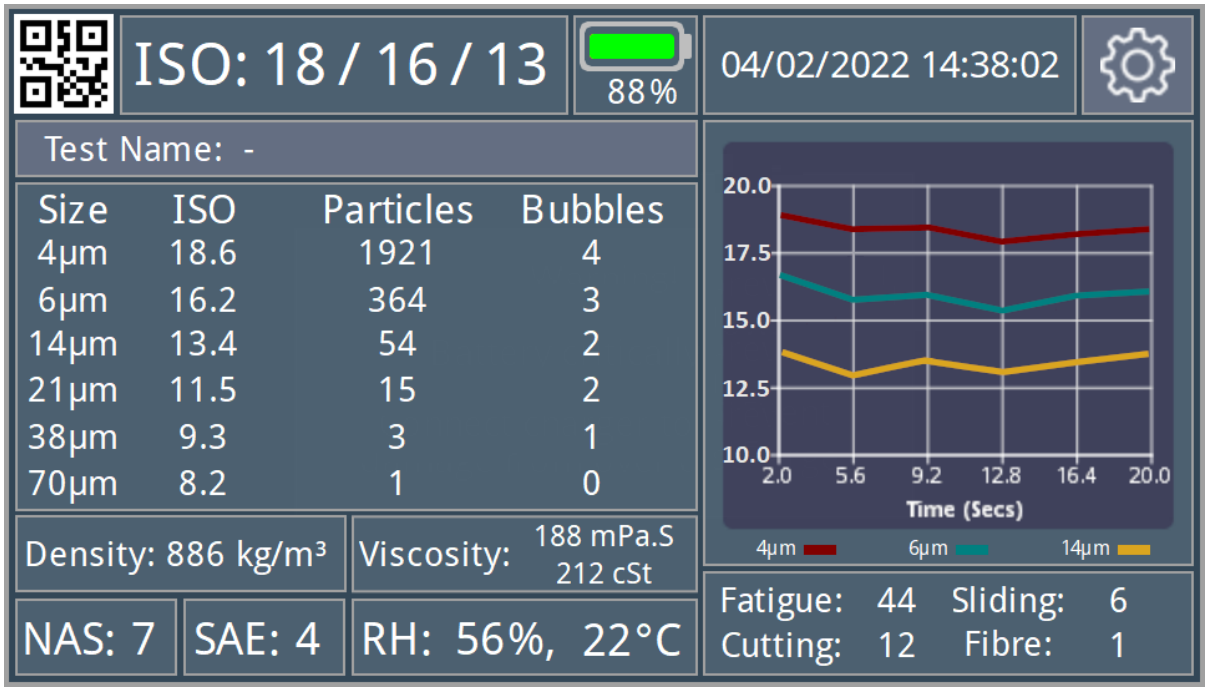
On/Off Switches

Units have two push button switches, one for the pump and one for the touch screen.

Note that because the screen regulates the pump speed, the pump will only work when the screen is switched on



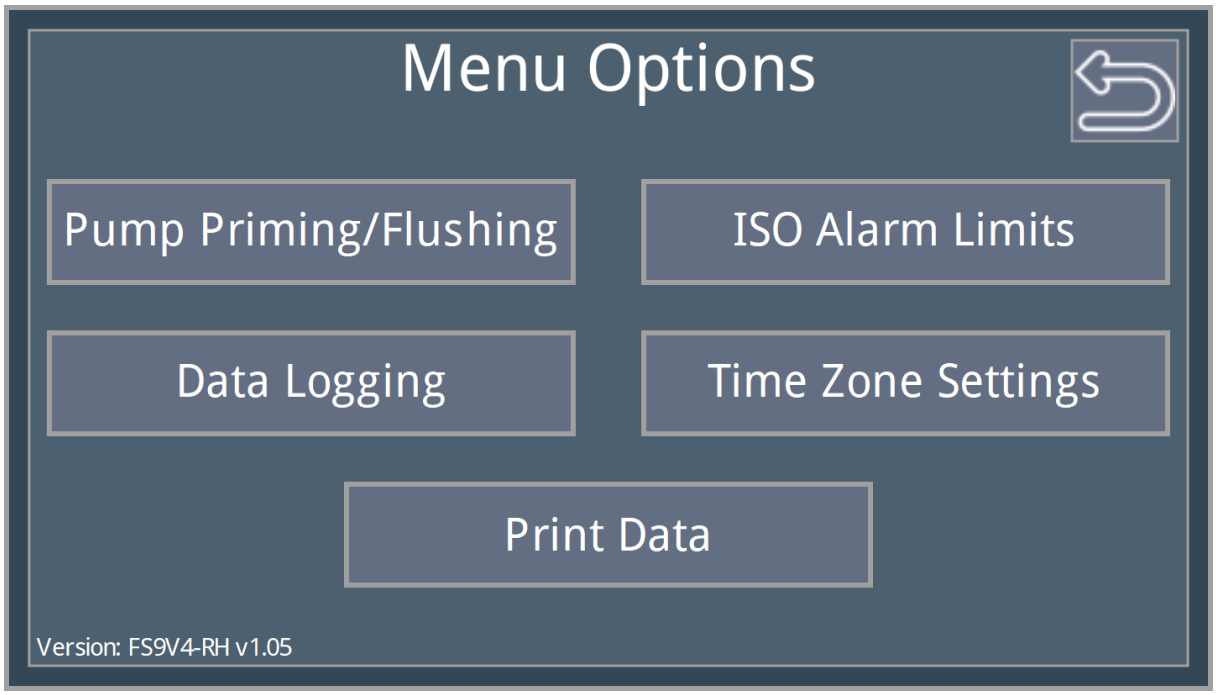
Touch Screen Layout



The main window of the touch screen displays all information provided by the particle counter and any other sensor that may be installed. Time and remaining battery capacity is also displayed. The ISO code can change from white to green or red depending on the alarm limits set.

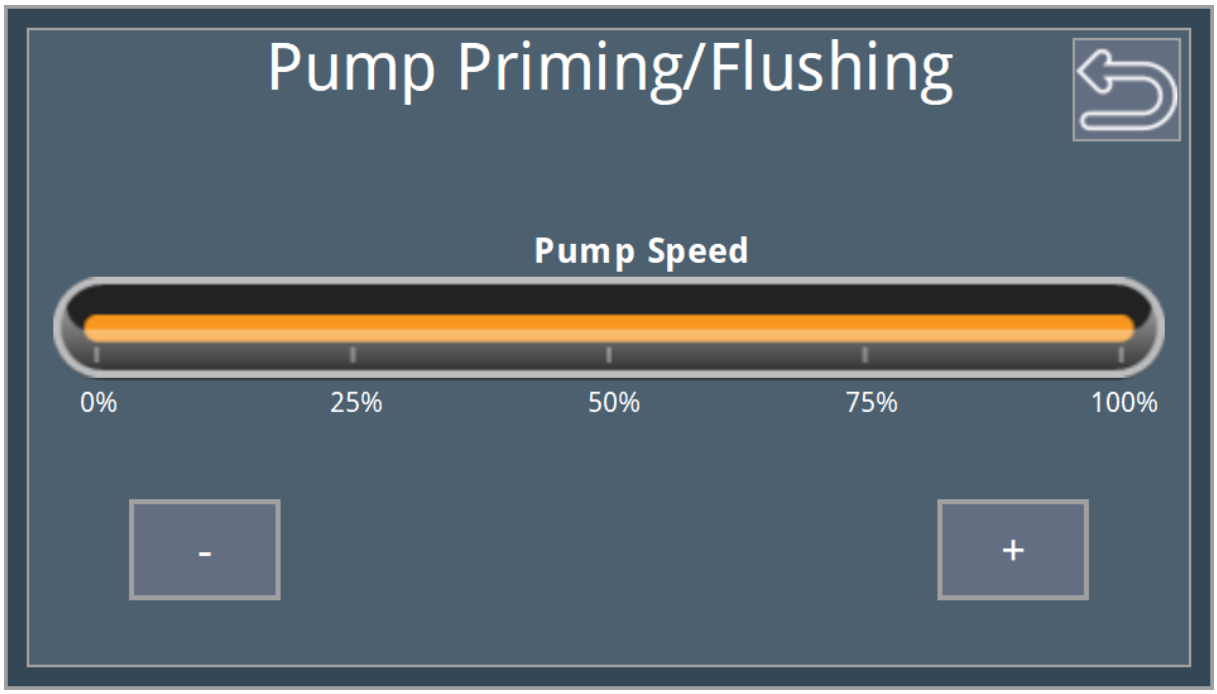
If the unit display temperature, pressing the value will switch between Celsius and Fahrenheit.

In the top right corner of the screen is a settings icon, clicking this will open the settings page.



At the bottom left of the settings page the software version is displayed.

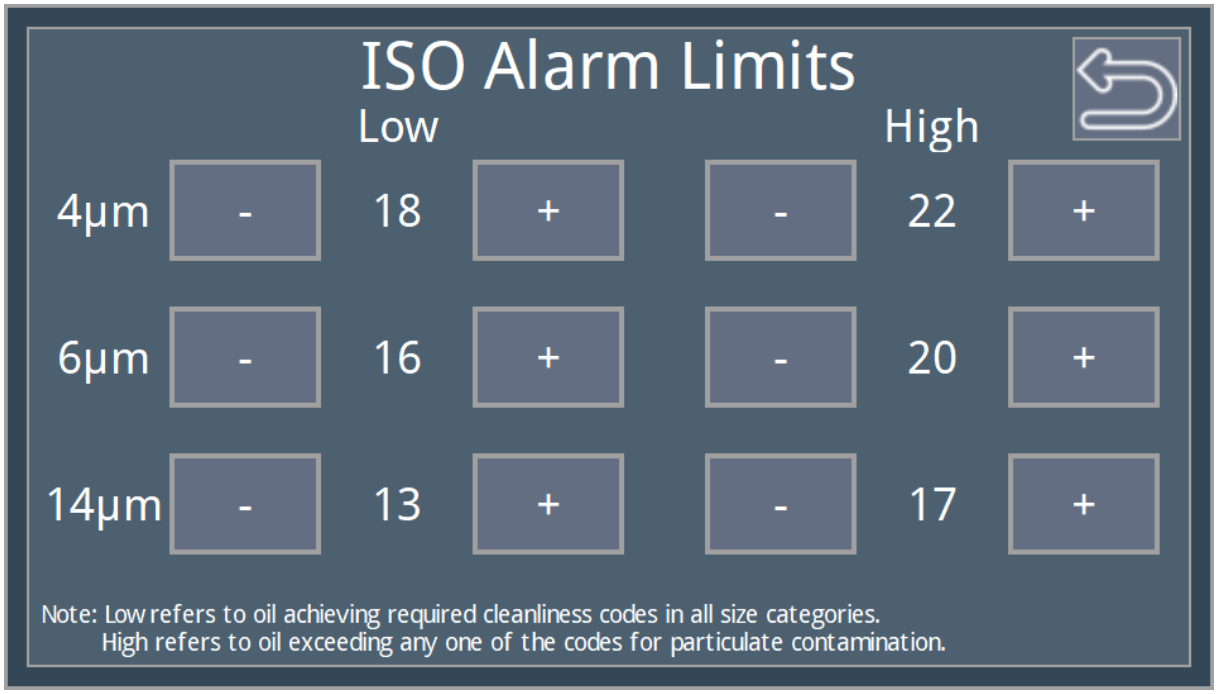
Priming and Flushing the Pump



In some situations, the pump speed may need to be increased for priming or flushing the unit.

Speed can be adjusted using the "-" and "+" buttons. When moving away from this page the pump will return to its normal speed.

ISO Alarm Limits

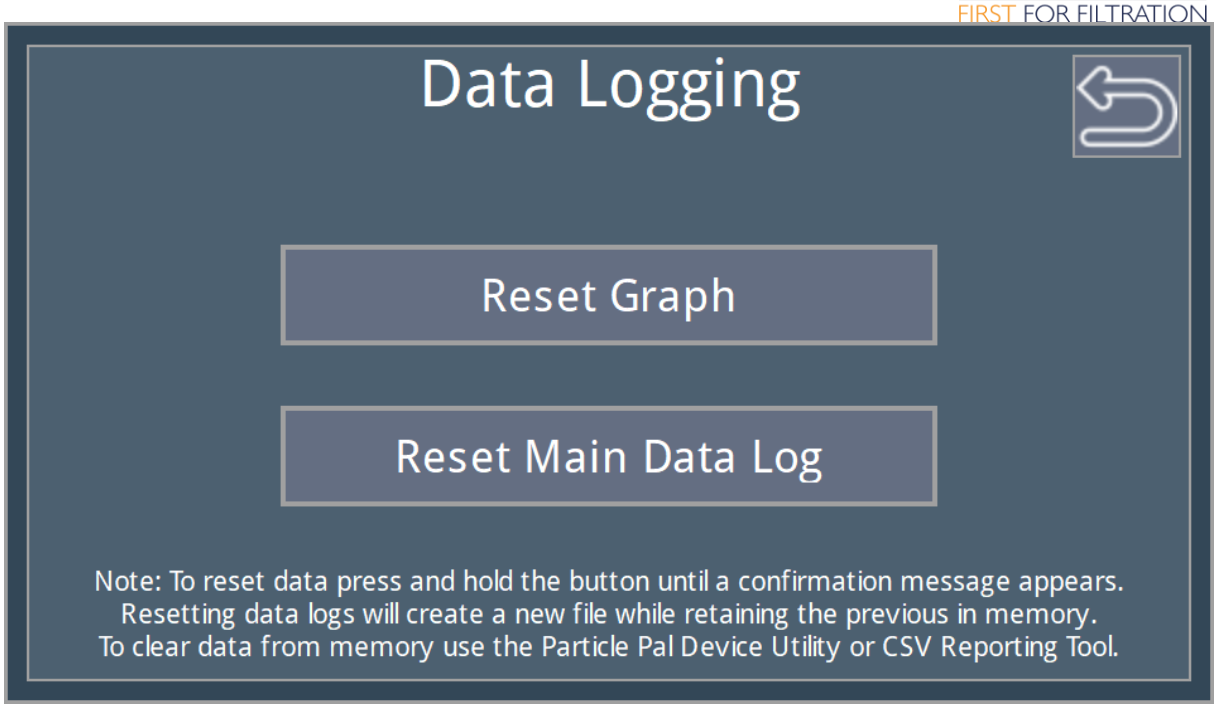


Alarm limits for low (clean) or high (dirty) can be set. Low refers to oil achieving required cleanliness codes in all size categories. High refers to oil exceeding any one of the codes for particulate contamination. When the oil is clean the ISO code on the main screen will turn green, when dirty it will become red, between the two values the text is white.

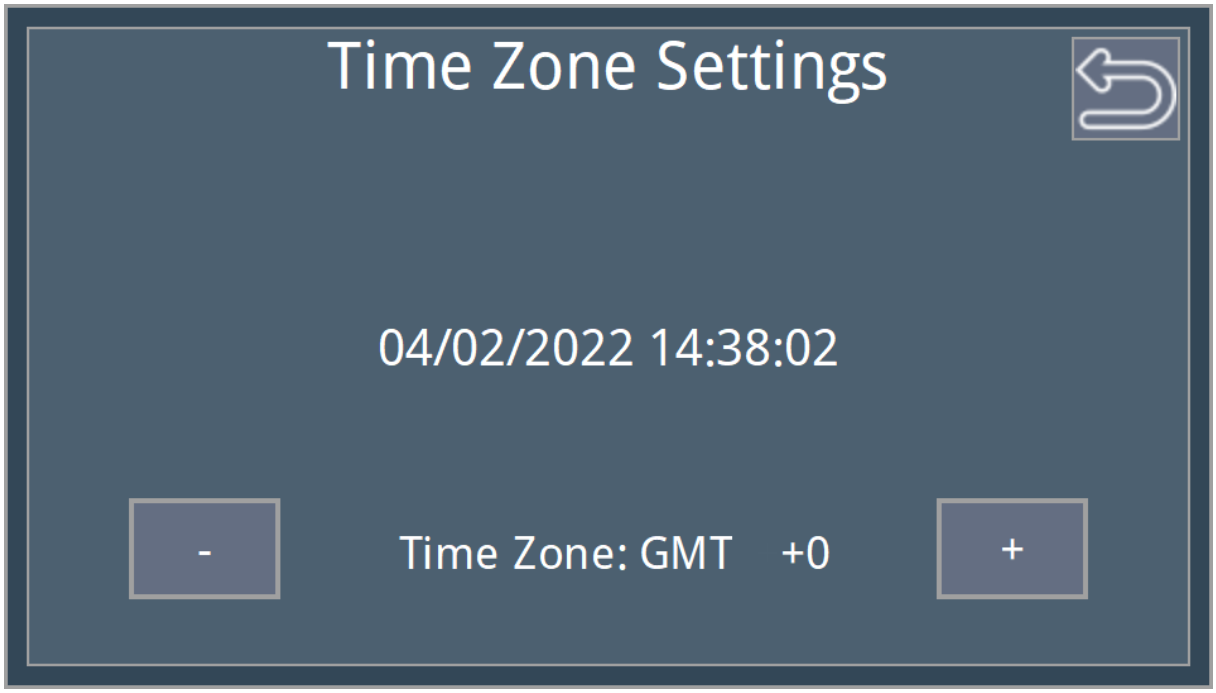
Datalogging

The unit contains two internal dataloggers, one for the graph and one for the tests. Whenever the unit is switched off the graph will be reset, but this can also be done from the screen without having to switch off the unit. The main data log tied to the sensors will hold 100,000 lines of data (100,000 polls of the sensors) which equates to 138 days of testing.

To create a new log file the button needs to be held down for a couple of seconds, until a confirmation message is displayed. This creates a new log file but does not delete the previous. Clearing log files from the device must be done through the software, either the Particle Pal CSV Reporting Tool or the Particle Pal Device Utility.



Time Zone Adjustment

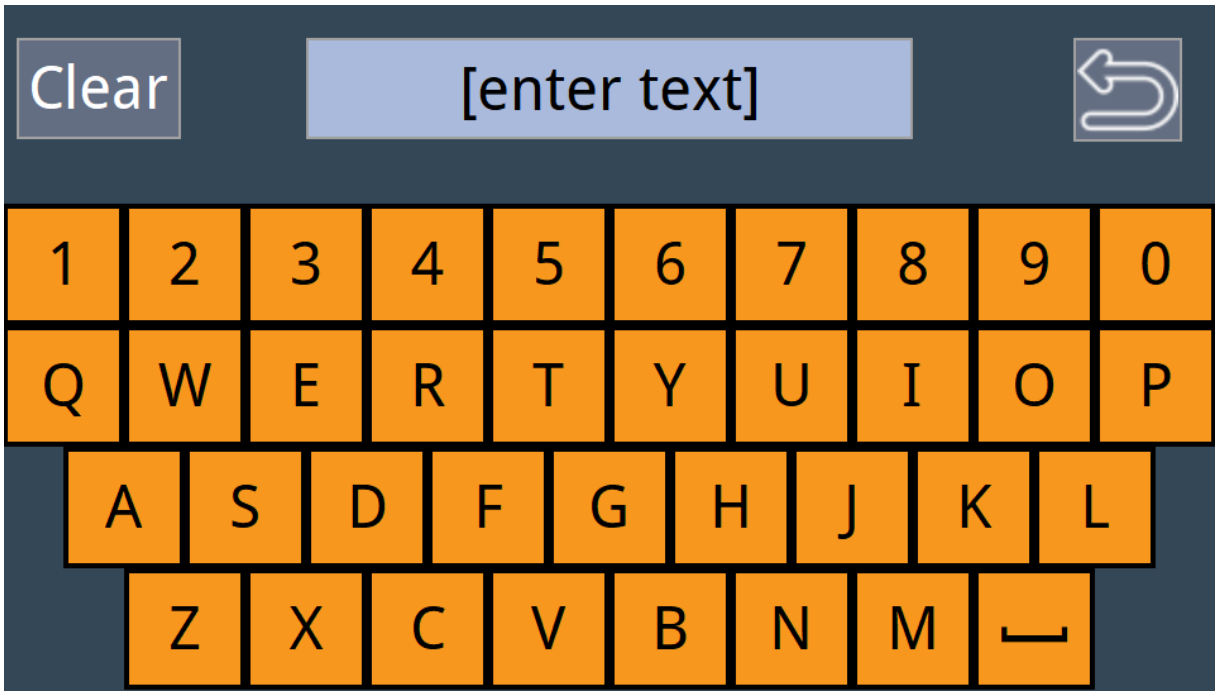


The display screen is pre-set with the date and date to GMT +0 (UK time) this can be adjusted according to your time zone if required. Specific time adjustments can be done via the Particle Pal Device Utility software.

Entering a Test Name

The main screen shows a “Test Name” field, which can be clicked to bring up a new window. Here a test name can be entered and when the back button is clicked this will be stored in memory. Even if the unit is switched off this test name will remain in memory until it’s been cleared or changed.

The test name will show as a repeating field in the data log file, for easily finding the relevant test.



QR Code

The main screen shows a QR code symbol in the top left. When clicked this will display a full screen QR code containing a web link with all the data from the last 5 tests. Scanning this with your phone will open a webpage where all the data will be mapped into tables and charts, ready for saving as a PDF.

It is best practice to make sure the unit runs long enough to gather 5 sets of data, otherwise the QR code will contain data from previous tests.

Once new data is displayed on the screen wait a minute for all data log files to update before pressing the QR code button. Pressing the button too early may results in data not being included in the code, showing zero values in the report.

Printer

Units have the option of being supplied with a thermal printer. The most recent set of results shown on the screen can be printed by going to the settings page and clicking the print button.

Periodically charge the printer with the supplied charging unit to keep the batteries in optimum condition.

The printer uses a 57mm wide paper roll, with a maximum diameter of 55mm.

Battery Charging

Units are fitted with a 6S lithium battery pack and require use of the supplied 25.5V battery charger.

A charge port on the side of the case allows for charging of the battery, which from a complete discharge takes approximately 5 hours (2 hours to reach 80% charge).

To maintain the overall life of the battery, avoid complete discharges.

If the unit is to be stored for prolonged periods of time the battery is best left at 60% charge to maintain an optimum lifespan.

Battery Charging Unit

The battery charge unit is designed for indoor use only and should not come into contact with water, dust, oils or grease. To prevent overheating, the product should not be covered whilst in use.

The mains socket should be easily accessible. In the event of operational error, the plug should be immediately removed from the socket.

A fuse protects the product against short circuit and overload. If the fuse needs to be replaced, the same type and size of fuse should always be used.

Charging Instructions

The charger has a small LED which when connected to a discharged unit will illuminate red. Once charging is complete the LED will turn green.

Note the LED will not turn green if the unit is switched on and in use.

Fluid Viscosity

The portable analysers are designed to handle a fluid viscosity of up to 320 cSt for the small unit or 2400 cSt for the larger units. It's possible to pass high viscosity oils through the unit if they are preheated as per the below table.

Note that as a pre-heated oil passes though the unit it will cool, therefore increasing its viscosity and strain on the pump.

Temperature °C	Viscosity (cSt)								
	ISO 32	ISO 46	ISO 68	ISO 100	ISO 150	ISO 220	ISO 320	ISO 460	ISO 680
10.0	161	262	442	711	1185	1921	2911	4827	8042
12.0	141	227	379	605	1001	1611	2435	3991	6588
14.0	124	198	327	518	850	1358	2048	3318	5427
16.0	109	173	283	446	726	1150	1730	2774	4496
18.0	97	152	246	385	622	979	1469	2331	3745
20.0	86	134	215	334	536	838	1254	1968	3135
22.0	77	118	188	291	464	720	1074	1670	2638
24.0	69	105	166	255	403	621	925	1423	2230
26.0	62	94	147	224	352	538	799	1219	1894
28.0	56	84	130	198	308	469	694	1048	1616
30.0	51	75	116	175	271	409	604	905	1385
32.0	46	68	103	155	239	359	528	784	1192
34.0	42	61	93	139	212	316	464	683	1030
36.0	38	56	83	124	188	279	408	596	894
38.0	35	50	75	111	168	247	361	523	778
40.0	32	46	68	100	150	220	320	460	680
42.0	29	42	62	90	135	196	285	406	596
44.0	27	38	56	82	121	176	254	360	525
46.0	25	35	51	74	109	158	227	320	463
48.0	23	33	47	67	99	142	204	285	411
50.0	21	30	43	62	90	128	183	255	365

Internal Gear Pump

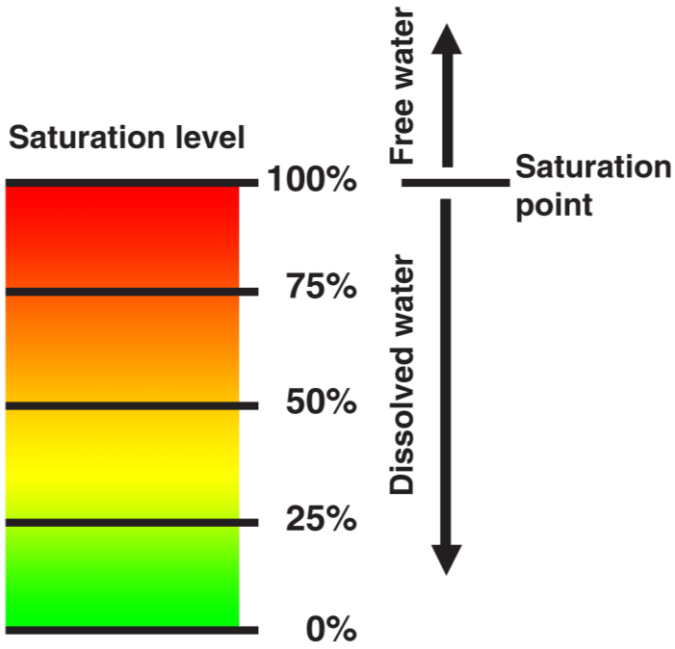
The internal gear pump provides a steady flow for accuracy of results. Fluids above the rated viscosity can cause excess motor strain and cause it to overheat or slip. It's important to pay attention to the grade of oil being analysed and its temperature.

Water Sensor – % Saturation (RH)

The RH option incorporates a sensor into the fluid circuit which measures water saturation as a percentage.

The RH sensor measures water content relative to the saturation point of the liquid and outputs the degree of saturation in the range 0-100%. A reading of 0% would indicate a fluid free of water, while a reading of 100% would indicate a fluid that is saturated with water (see diagram below). The capacitance sensor absorbs water molecules from the fluid which change its capacitance value, that capacitance value is directly proportional to the saturation level of the fluid.

Since the effects of free water are more harmful than those of dissolved water, water levels should be maintained well below the saturation point. However, even dissolved water can cause damage, therefore every reasonable effort should be made to keep the saturation levels as low as possible.

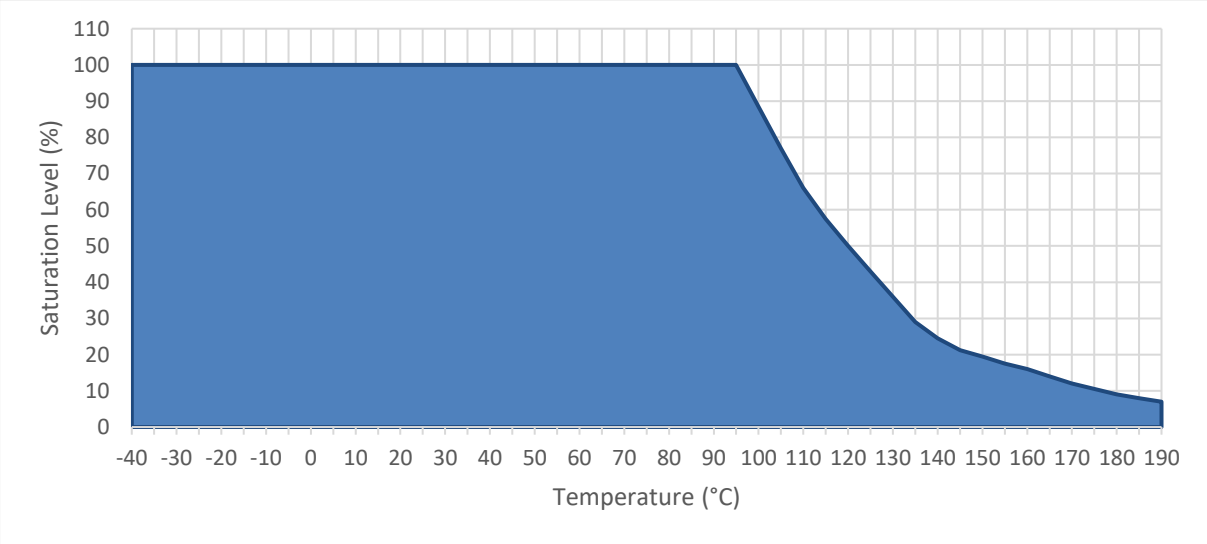


As a guideline we recommend maintaining saturation levels below 45% in all equipment.

Sensor Specifications

Specification	Details
Fluid type	Oil
Measurement range	0-100%
Measurement temperature range	0-100°C
Measurement accuracy	±3%
Operating pressure	-0.5 to 50 bar
Voltage supply	1-32 VDC
Power consumption	30-60 mA
Output	4-20 mA
Protection type	IP67
Recalibration	Intervals depend on use, recommended annually

Sensor Working Range



The graph shows the permitted working range for RH sensor. If the sensor is operated permanently outside the range indicated in blue, lasting damage can occur to the sensor element.

If the fluid sample contains free water, it should not be passed through the portable analyser.

Water Sensor – Parts Per Million (PPM)

The PPM option incorporates a water moisture sensor into the fluid circuit of the portable analyser.

The sensor offers real time measurement of absolute water content in ppm (parts per million) and outputs a value up to the fluids saturation point.

As per BS EN 590 diesel fuel should contain no more than 200ppm (0.02%) of water.

The sensor is calibrated specifically for use with diesel fuel, use with other fluid types will provide inaccurate readings.

Note: If the fluid sample contains free water or has a water content of above 300ppm (cloudy/hazy appearance) it should not be passed through the portable analyser. Samples above 300ppm will cause the sensor to lock out. If this occurs, clean dry diesel (<100ppm) will need to be flushed through the unit for 15 minutes to 2 hours (depending on level of exposure), where the readings will gradually fall back within its normal operating range.

Specifications

Specification	Details
Fluid type	Diesel
Measurement range - water content	0-300 ppm
Measurement temperature range	0-50°C
Measurement accuracy	Less than 10% of limit of measurement range accessible
Operating pressure	Vacuum to 300 bar
Voltage supply	18-28 VDC
Power consumption	30-70 mA
Output	4-20 mA
Protection type	IP65
Recalibration	Intervals depend on use, recommended annually

Density and Viscosity Sensor

The density and viscosity sensor uses a piezo electric device for continuous determination of fluid density and viscosity.

To ensure accurate density and viscosity readings the fluid should be clean and maintained at a steady temperature similar to the unit. Contaminant in the form of water or solids may cause higher than expected readings, while an aerated fluid sample will cause lower than expected readings.

Specifications

Specification	Details
Accuracy	Density – 2% Viscosity – 5%
Measurement Range	Density – 0.6 g/cm³ - 1.3 g/cm³ Viscosity – 25 - 400mPa·s
Resolution	Density – 0.001g/cm³ Viscosity – 0.1mPa·s
Working Voltage	DC 9V-32V
Power Consumption	< 30mA @ 24Vdc
Operating temperature	0°C to 70°C (0°C to 50°C for diesel)
Operating pressure	10 bar
Applicable standards	ASTM1657, EN61326-1, EN61326-2-3, ICES-003 B

Density

The unit displays density as kg/m³, which is the same as g/cm³. To convert this to a units such as kg/l divide the value by 1000.

Viscosity

The unit displays dynamic viscosity as mPa.s (millipascal-second). This is the same as cP (centipoise) e.g. 100 mPa.S = 100 cP.

To convert from dynamic to kinematic viscosity such as centistokes, the dynamic viscosity value must be divided by the fluid density.

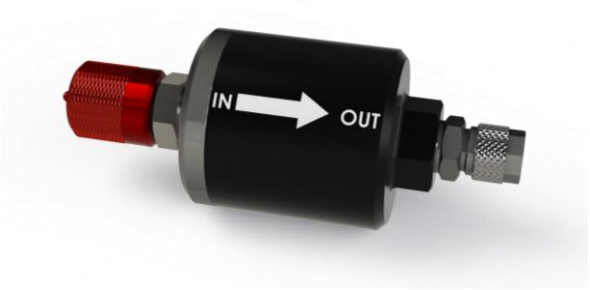
Example:

If the unit is showing a viscosity of 150 mPa.s and density of 886 kg/m³ then, 150 / 0.886 = 169.3 cSt

High-Pressure Device (HP)

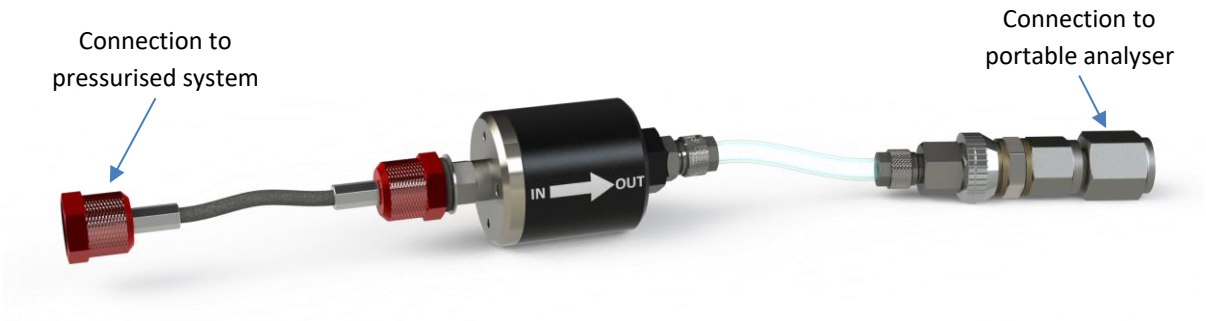
The high-pressure device allows the portable analyser to sample directly from a high-pressure line with a maximum allowable inlet pressure of 350 bar, reducing this down to 2.5 bar at the outlet. It has a working viscosity range of 1-300 cSt.

The High-Pressure Device can be purchased separately and used with existing units by connecting it to the end of the suction tubing. When receiving the device, the stem adaptor on the outlet side will need to be replaced with the tube push-on fitting.



While the High-Pressure Device feeds the portable analyser with fluid pressurised to 2.5 bar, the pump must be switched on to maintain a steady flowrate.

Fluid passing out of the discharge/outlet tube should be fed into a suitably sized sample container for disposal or emptying back into the fluid reservoir.



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Troubleshooting

General Operational Errors

Problem	Possible Cause	Solution
Unit will not switch on.	Fully discharged battery.	Connect to the mains and fully charge the unit. If the LED switches still fail to illuminate there could be an electrical fault or damage to the battery pack from over discharge.
Unit will not prime/run.	Internal tubing/pump gears are dry. High viscosity fluids. Restriction in the suction/discharge lines.	Go into the settings for priming to increase the pump speed and switch the pump off/on. Raise the height of the fluid sample to gravity assist, or create a vacuum using a hand operated thief pump to pull fluid through. Check the hoses and strainer for blockages.
Screen is behaving erratically.	Dirt on the screen or hands.	Wipe the screen clean to remove traces of dirt or oil. In most cases gloves will not work with the touch screen.

Particle Counting

Problem	Possible Cause	Solution
Contamination codes dropped to near zero	A blockage in the flow path	Check there is adequate flow going through the unit (approximately 20-100ml/min) Check/clean the suction strainer for any contamination
Erratic count levels	Unstable sample	Check for the presence of air. Bubble counts should be maintained below 200 bubbles/ml in each channel.

RH & Water Content

Problem	Possible Cause	Solution
Water content is above 95%	High moisture levels in the sample. Damaged moisture sensor.	Flush the unit immediately with dry oil to avoid damage to the moisture sensor. If levels still don't fall the sensor could be permanently damaged.
Water content bouncing from near 0 to 100%	Damaged moisture sensor.	Permanent damaged due to excessive moisture. Sensor will require replacing.

Water Sensor - % Saturation (RH)

The most common fault with RH sensors is displaying high readings at around 100% where the value will not come down. This is known at sensor lockout and occurs from exposure to a fluid sample where the water content is above the oil's saturation point.

Sensor lockout is resolved by passing clean, dry oil through the unit until the readings start to come down. This could take 15 minutes, or up to 2 hours depending on the level and duration of exposure to water.

Over time, continued exposure to oil above its saturation point will damage the sensor, causing it to respond slower and shorten its useful life.

Water Sensor – Parts Per Million (PPM)

Exposing the PPM sensor to diesel above 300ppm will cause sensor lockout. This be resolved by passing clean, dry diesel (<100 ppm) through the unit until the readings start to come down. This could take 15 minutes, or up to 2 hours depending on the level and duration of exposure to water.

Over time, continued exposure to diesel above 300ppm will damage the sensor, causing it to respond slower and shorten its useful life.

Density & Viscosity Sensor

Errors & Corrective Actions

Problem	Possible Cause	Solution
Negative measuring error Unstable display	Air locks or gas bubbles inside the transducer	De-aerate the fluid sample Rotate the unit around its axis to try and release any trapped air inside
Positive measuring error Long-term drift	Sedimentation in the transducer	Flush the unit with clean fluid to remove any debris Rotate the unit around its axis to try and release any trapped dirt inside the transducer
Negative measuring error Long-term drift	Corrosion Abrasion	Return to supplier for cleaning or repair

Particle Count ISO Codes

ISO Codes (ISO4406)

The table below shows the ISO 4406 codes by number of particles per 1 ml of fluid sampled.

ISO 4406 Code	Counts/mL	
	Greater than	Up to/including
0	0	0.01
1	0.01	0.02
2	0.02	0.04
3	0.04	0.08
4	0.08	0.16
5	0.16	0.32
6	0.32	0.64
7	0.64	1.3
8	1.3	2.5
9	2.5	5
10	5	10
11	10	20
12	20	40
13	40	80
14	80	160
15	160	320
16	320	640
17	640	1300
18	1300	2500
19	2500	5000
20	5000	10000
21	10000	20000
22	20000	40000
23	40000	80000
24	80000	160000
25	160000	320000
26	320000	640000
27	640000	1300000
28	1300000	2500000
29	2500000	∞

ISO Decimal Codes

The S120 particle counter gives a greater insight into cleanliness by showing ISO decimal codes, with the particle counts as per the below table.

Code	Counts/mL	Code	Counts/mL	Code	Counts/mL	Code	Counts/mL	Code	Counts/mL
5	0.16	10	5	15	160	20	5000	25	160000
5.1	0.176	10.1	5.5	15.1	176	20.1	5500	25.1	176000
5.2	0.192	10.2	6	15.2	192	20.2	6000	25.2	192000
5.3	0.208	10.3	6.5	15.3	208	20.3	6500	25.3	208000
5.4	0.224	10.4	7	15.4	224	20.4	7000	25.4	224000
5.5	0.24	10.5	7.5	15.5	240	20.5	7500	25.5	240000
5.6	0.256	10.6	8	15.6	256	20.6	8000	25.6	256000
5.7	0.272	10.7	8.5	15.7	272	20.7	8500	25.7	272000
5.8	0.288	10.8	9	15.8	288	20.8	9000	25.8	288000
5.9	0.304	10.9	9.5	15.9	304	20.9	9500	25.9	304000
6	0.32	11	10	16	320	21	10000	26	320000
6.1	0.352	11.1	11	16.1	352	21.1	11000	26.1	352000
6.2	0.384	11.2	12	16.2	384	21.2	12000	26.2	384000
6.3	0.416	11.3	13	16.3	416	21.3	13000	26.3	416000
6.4	0.448	11.4	14	16.4	448	21.4	14000	26.4	448000
6.5	0.48	11.5	15	16.5	480	21.5	15000	26.5	480000
6.6	0.512	11.6	16	16.6	512	21.6	16000	26.6	512000
6.7	0.544	11.7	17	16.7	544	21.7	17000	26.7	544000
6.8	0.576	11.8	18	16.8	576	21.8	18000	26.8	576000
6.9	0.608	11.9	19	16.9	608	21.9	19000	26.9	608000
7	0.64	12	20	17	640	22	20000	27	640000
7.1	0.706	12.1	22	17.1	706	22.1	22000	27.1	706000
7.2	0.772	12.2	24	17.2	772	22.2	24000	27.2	772000
7.3	0.838	12.3	26	17.3	838	22.3	26000	27.3	838000
7.4	0.904	12.4	28	17.4	904	22.4	28000	27.4	904000
7.5	0.97	12.5	30	17.5	970	22.5	30000	27.5	970000
7.6	1.036	12.6	32	17.6	1036	22.6	32000	27.6	1036000
7.7	1.102	12.7	34	17.7	1102	22.7	34000	27.7	1102000
7.8	1.168	12.8	36	17.8	1168	22.8	36000	27.8	1168000
7.9	1.234	12.9	38	17.9	1234	22.9	38000	27.9	1234000
8	1.3	13	40	18	1300	23	40000	28	1300000
8.1	1.42	13.1	44	18.1	1420	23.1	44000	28.1	1420000
8.2	1.54	13.2	48	18.2	1540	23.2	48000	28.2	1540000

8.3	1.66	13.3	52	18.3	1660	23.3	52000	28.3	1660000
8.4	1.78	13.4	56	18.4	1780	23.4	56000	28.4	1780000
8.5	1.9	13.5	60	18.5	1900	23.5	60000	28.5	1900000
8.6	2.02	13.6	64	18.6	2020	23.6	64000	28.6	2020000
8.7	2.14	13.7	68	18.7	2140	23.7	68000	28.7	2140000
8.8	2.26	13.8	72	18.8	2260	23.8	72000	28.8	2260000
8.9	2.38	13.9	76	18.9	2380	23.9	76000	28.9	2380000
9	2.5	14	80	19	2500	24	80000	>29	2500000
9.1	2.75	14.1	88	19.1	2750	24.1	88000	–	–
9.2	3	14.2	96	19.2	3000	24.2	96000	–	–
9.3	3.25	14.3	104	19.3	3250	24.3	104000	–	–
9.4	3.5	14.4	112	19.4	3500	24.4	112000	–	–
9.5	3.75	14.5	120	19.5	3750	24.5	120000	–	–
9.6	4	14.6	128	19.6	4000	24.6	128000	–	–
9.7	4.25	14.7	136	19.7	4250	24.7	136000	–	–
9.8	4.5	14.8	144	19.8	4500	24.8	144000	–	–
9.9	4.75	14.9	152	19.9	4750	24.9	152000	–	–

Warranty Statement

All products manufactured or distributed by Filtertechnik Ltd are subject to the following, and only the following, Limited Express Warranties, and no others:

For a period of one (1) year from and after the date of delivery of a new Filtertechnik product, Filtertechnik warrants and guarantees only to the original purchaser/user that such a product shall be free from defects of materials and workmanship in the manufacturing process. The warranty period for pumps and motors is specifically limited to ninety (90) days from the date of delivery. A product claimed to be defective must be returned to the place of purchase. Filtertechnik, at its sole option, shall replace the defective product with a comparable new product or repair the defective product. This express warranty shall be inapplicable to any product damaged or impaired by external forces or used for any purpose other than that for which it was originally sold.

THIS IS THE EXTENT OF WARRANTIES AVAILABLE ON THIS PRODUCT. FILTERTECHNIK SHALL HAVE NO LIABILITY WHATSOEVER FOR CONSEQUENTIAL DAMAGES FOLLOWING THE USE OF ANY DEFECTIVE PRODUCT OR BY REASON OF THE FAILURE OF ANY PRODUCT. FILTERTECHNIK SPECIFICALLY DISAVOWS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED INCLUDING, WITHOUT LIMITATION, ALL WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE (EXCEPT FOR THOSE WHICH APPLY TO PRODUCT OR PART THEREOF THAT IS USED OR BOUGHT FOR USE PRIMARILY FOR PERSONAL, FAMILY OR HOUSEHOLD PURPOSES), WARRANTIES OF DESCRIPTION, WARRANTIES OF MERCHANTABILITY, TRADE USE OR WARRANTIES OF TRADE USAGE.

EC Declaration of Conformity

Manufacturer's Name:	Filtertechnik Ltd.
Manufacturer's Address:	1 Central Park, Lenton Lane, Nottingham, NG7 2NR
EC Representative's Name:	N/A
EC Representative's Address:	N/A
Equipment Description:	Portable analysers for fuel and oil
Equipment Model Designation:	FS9V4

Application of Council Directive:

EMC Directive 2004/108/EEC
Low Voltage Directive 2006/95/EC
Batteries Directive 2006/66/EC

Referenced Standards:

EN61000-6-3: 2001
EN61000-6-1: 2001
EN61326-1: 2006
CISPR 11
EN60825-1: 2007
EN61010-1:01

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Signature: 

Printed Name: Daniel Whittaker

Title: Engineering Director

Date: 17th February 2022