User Manual

CASELLA≡
CEL

MicroDust Pro
Aerosol Monitoring System

HB3275-07

User Manual

Contents

1   Introduction

The MicroDust Pro instrument measures the levels of particulate matter such as dust, smoke, fumes, pollen and other aerosols from combustion, materials processing, manufacturing, energy generation, vehicle engine emissions, and construction. Pollutants of this type reduce visibility, spread contamination and can cause illness and low worker productivity from the inhalation of toxic substances. Many of them are also recognised as contributory factors to many chronic and acute medical conditions, including asthma, bronchitis, and lung cancer.

The MicroDust Pro instrument is not like traditional gravimetric methods of dust measurement, which require a significant sampling period and are not suited to the real-time evaluation of trends in concentration levels. The MicroDust Pro is an ideal survey instrument for the assessment of real-time particulate concentration in mg/m³. It is totally portable, and has a detachable probe that allows operation in relatively inaccessible areas, making it suitable both for fixed site and for general survey applications.

The MicroDust Pro uses a proven forward light scattering principle to make accurate and repeatable measurements of dust concentration. It provides the following features as standard:

- Graphical representation of concentration trends
- Internal data logging
- A simple and clear user interface
- Digital calibration suitable for any dust sampling scenario

The Casella Insight data management software application supplied as an option allows you to download and view data from the MicroDust Pro instrument. It also offers a real-time display of particulate concentration levels measured by the instrument. Refer to the on-line help system installed with the Casella Insight data management software for full instructions to use this software application.

Principle of operation

The MicroDust Pro instrument uses a modulated beam of infra-red light projected into a measurement chamber.

Figure 1.   Sampling probe
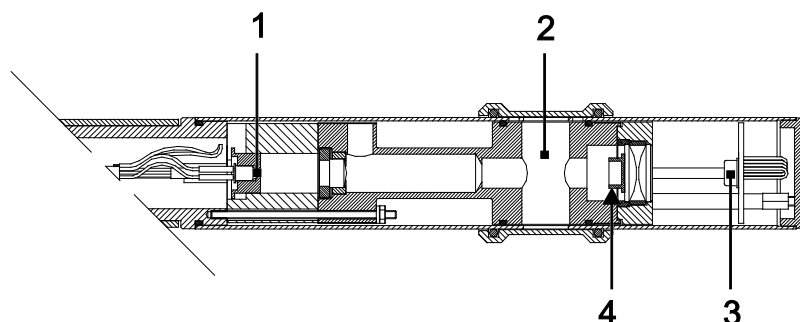
1. Infra-red emitter
2. Sample volume
3. Infra-red detector
4. Light stop

Under clean-air conditions, all light is prevented from reaching the received by a light stop (**4**). When dust particles enter the sample volume (**2**), the beam of infra-red light is scattered within a narrow angle (12° to 20°) to the receiver (**4**).

By using a narrow angle of scatter, the instrument is made less sensitive to variations in the refractive index and colour of measured particulate.

1.1 Structure of this User Manual

The structure of this User Manual is designed to help you find the information and instructions you need to complete a task easily. Refer to section 3 "Using the instrument" on page 12 for instructions to use the MicroDust Pro instrument.

To help you find the information you need quickly in the electronic version of this User Manual, it includes 'clickable' links. The links appear as blue underlined text. You can also click the names of chapters and sections in the bookmark panel, and in the table of contents, to jump to that part of the manual.

1.2 Safety

The MicroDust Pro instrument does not present a safety risk when you use it as instructed in this User Manual. However, it is possible that the environment where you use the instrument may present a safety risk, and you must ALWAYS **follow correct, safe working practices.**

WARNING

Always be aware of the risks in the environment where you are working.

- The MicroDust Pro instrument is NOT intrinsically safe. DO NOT use it in an atmosphere where explosive vapours or dusts might exist.
- Wear an approved dust mask when making measurements in dusty environments.
- Wear approved protective clothing and footwear suitable for the environment where you are making measurements.
- Always follow local safety regulations, and be aware of risks in the area where you are working.

CAUTION

Use the MicroDust Pro instrument only as instructed in this User Manual. Do not use the instrument for any purposes for which it has not been designed.

CAUTION

The MicroDust Pro is a precision instrument. Always handle it with care.

Do not use the instrument if it has been damaged. Refer to section 9 "Servicing and Warranty arrangements" on page 49 for instructions to follow if the instrument has been damaged or has developed a fault.

CAUTION

The MicroDust Pro can operate from a battery power supply.

- Use only batteries of the correct type, and do not mix battery types in the instrument. Refer to Battery supply on page 13 for advice about battery types.
- Do not try to charge non-rechargeable batteries.
- Do not leave discharged batteries in the MicroDust Pro instrument.
- Install new batteries as a complete set. Do not fit batteries that have a mixed state of charge. Refer to How to fit new batteries on page 14 for instructions to install batteries.
- Remove all batteries from the MicroDust Pro instrument if you will not use the instrument for a long time.
- Always follow local regulations to dispose of used batteries.

CAUTION

The MicroDust Pro instrument is not waterproof. Do not immerse the instrument in water or use it in the rain.

CAUTION

Do NOT use solvent-based cleaners to clean the MicroDust Pro instrument. Follow the advice on page 46 to clean the instrument.

CAUTION

The MicroDust Pro instrument contains no user-serviceable parts. Do NOT try to open it. If you suspect the instrument has developed a fault condition, contact Casella CEL for advice and be ready to return the instrument to Casella CEL for repair. Refer to section 9 "Servicing and Warranty arrangements" beginning on page 49 for advice on servicing the instrument.

2 Features

Figure 2 shows the main features of the MicroDust Pro instrument. Refer to Figure 2 when you perform the tasks and instructions in this User Manual.

Figure 2.   **Main features of the MicroDust Pro**
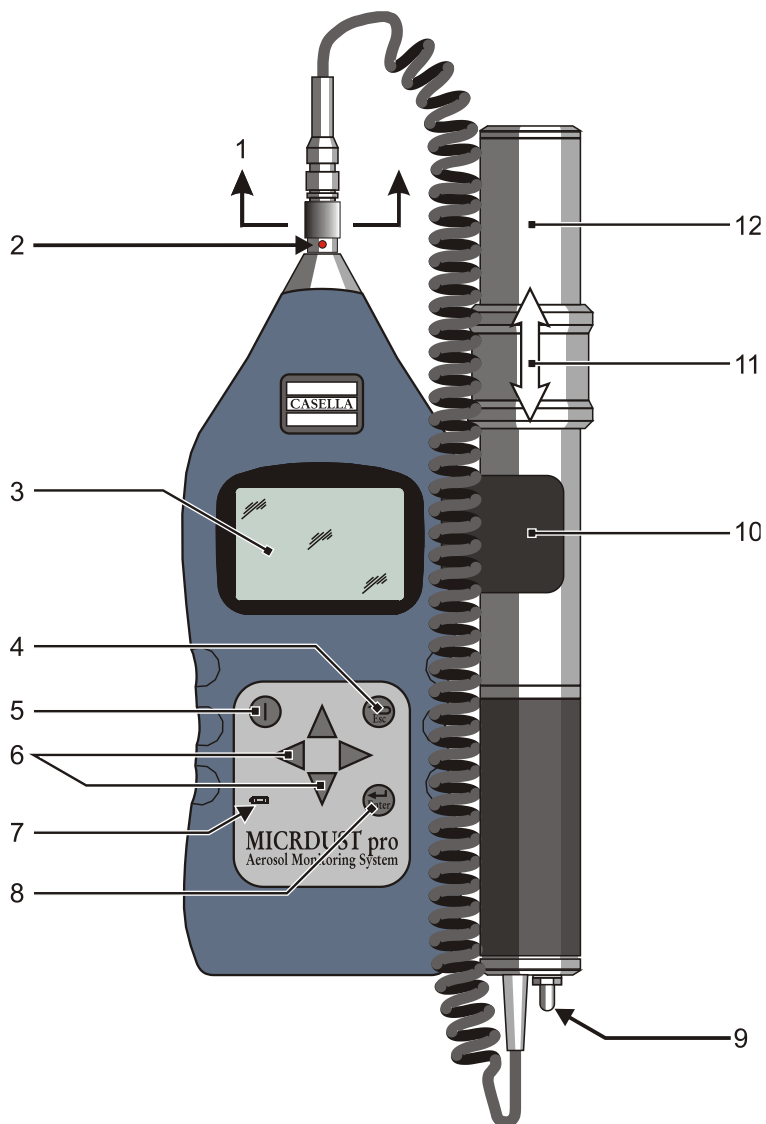
1. Pull the knurled sleeve outwards to release the connector
2. Red dot
3. Display screen
4. Escape key
5. ON / OFF key
6. Navigation keys
7. Battery charging indicator
8. Enter key
9. Probe purge inlet
10. Clip for probe

11. Slide the probe collar up or down to expose the measurement chamber
12. Sampling probe

2.1 Control functions

You operate the instrument through the menu structure by using a combination of function keys and navigator keys on the instrument's front panel.

The key functions are listed below.

△ and ▽	Navigator keys used to move around the current menu options.
▷ and ◁	Navigator keys used to change the contents of the selected field, for example the indicated date, time, logging interval and so on.
(Enter)	Enter key that accepts the current menu option or the current highlighted option.
(Esc)	Esc (escape) key that steps back to a previous menu item. Press this key several times for a short cut back to the main menu.
(I)	Power ON/OFF key.

2.2 Connections

Power

The power input port at the bottom of the instrument allows you to connect a Casella DC power supply (part number -PC18) to operate the instrument.

The port has a 2.1 mm centre pin for the positive supply.

⚠️ **CAUTION**

You must make certain the DC power input ground is kept isolated from any signal ground.
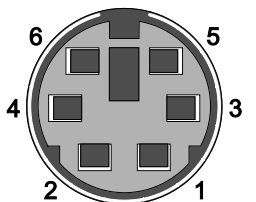
Refer to "Powering the instrument" on page 13 for information about the instrument's power supply options.

Signals

A 6-way port at the bottom of the MicroDust Pro instrument provides the following connections;

- RS232 serial digital communications for connecting the instrument to a PC
- An analogue output signal for connecting the instrument to a chart recorder or to an external data logger.

Table 1.   6-way port

Pin	Wire colour	9-way D-type pin and function	Function
1	Yellow	N/A	Analogue ground
2	Red	N/A	Analogue out
3	White	3 (TX out)	RS232 receive in
4	Black	2 (Rx in)	RS232 transmit out
5	Blue	5 (Ground)	Comms ground
		4 (DTR 8 (CTS) 6 (DSR) Linked together	

The analogue output signal has a full-scale range of 0 to 2.5 volts and an output impedance of approximately 500 Ω. The full-scale output voltage is proportional to the full-scale indication of the active range. For example, if the active range is 0 to 25 mg/m³, and output signal of 2.5 volts represents a dust concentration of 25 mg/m³ (meaning the analogue output is scaled at 1 mV per 0.01 mg/m³).

IMPORTANT
The analogue output is available only when using a fixed measurement range (that is, when NOT using Auto Range).

2.3 Parts supplied

Figure 3.   MicroDust Pro installed in the carry case
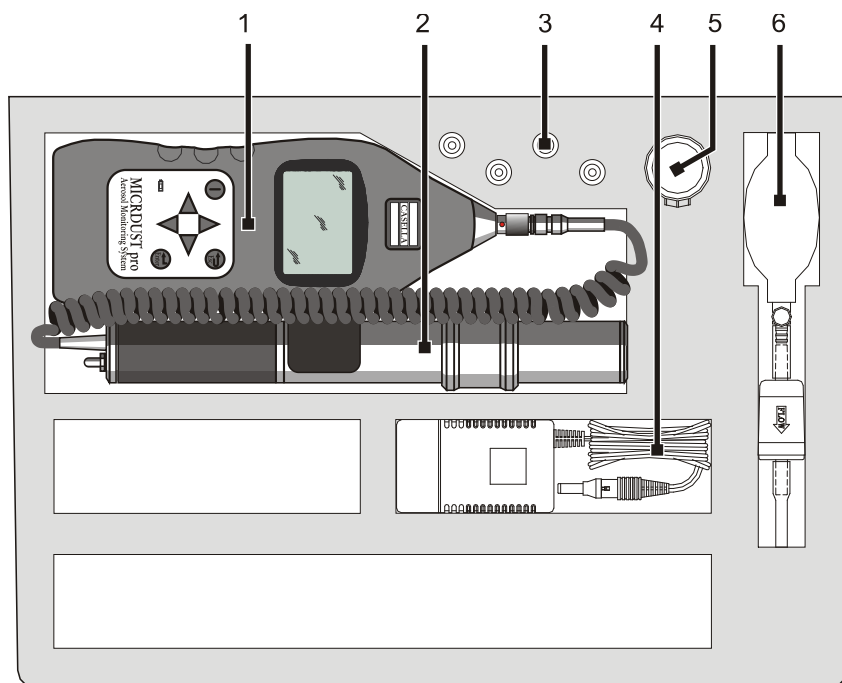
Parts supplied as standard with the MicroDust Pro are as follows:

- The MicroDust Pro control unit (1)
- The MicroDst probe (2)
- Four AA-size rechargeable battery cells (3)
- The -PC18 mains DC adaptor (4)
- A calibration filter (5)
- The purge bellows (6)
- The carry case with shaped, protective foam insert
- RS232 lead
- User manual

3   Using the instrument

The MicroDust Pro is a sensitive scientific instrument that must be protected against excessive moisture, vibration and physical shock. Follow the instructions in this User Manual carefully to avoid causing damage to the instrument.

This section of the manual describes the tasks you must perform to make the MicroDust Pro instrument ready to make measurements. You should try to complete the tasks in the sequence they are included.

- Preparing the instrument for use
- Preliminary operations
- Calibration

IMPORTANT

For optimum accuracy, you should always perform a user calibration to correct your instrument for the type of particulate to be measured. Refer to "Calibrating the instrument for a specific type of particulate" on page 25 for instructions to do this.

- Making measurements
- Data logging

3.1   Preparing the instrument for use

Setting the DIP switches

WARNING

DO NOT enable the charger circuit while there are non-rechargeable batteries installed in the MicroDust Pro instrument.

The MicroDust Pro instrument has a built-in fast-charging circuit that uses power supplied by the 12 V DC supply. This allows you to recharge suitable rechargeable batteries without the need to remove them from the instrument.

Before you can use this feature, you must set the **Charger Enable** DIP switch to the ON position, as shown by item (2) in Figure 4. The DIP switches are located in the battery compartment.

If you use non-rechargeable batteries to operate the instrument, it is very important to set the **Charger Enable** DIP switch to the OFF position.

Figure 4.   Location of DIP switches
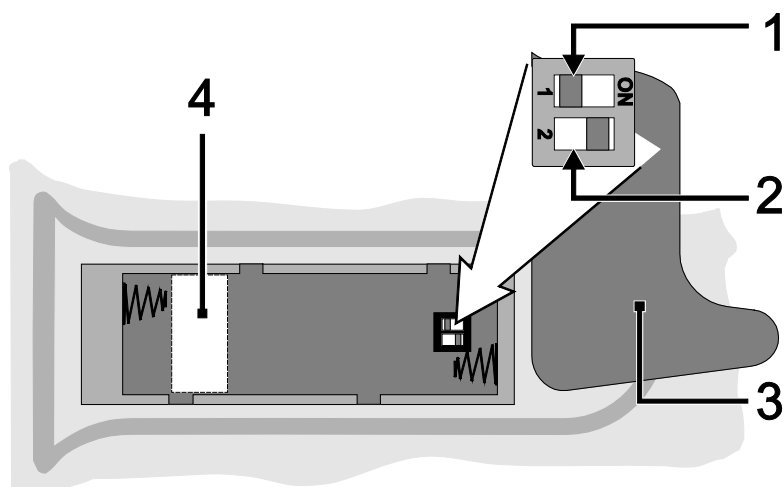
1. Boot mode DIP switch (normally in the OFF position)
2. Charger enable switch
3. Supporting clamp for the probe
4. Serial number label

Charging stops automatically when the batteries have received a full charge. This can take approximately three hours when charging batteries from a fully discharged condition.

Powering the instrument

The options for powering the instrument are as follows:

- Batteries
  Note that the rechargeable batteries supplied by Casella will be in a discharged state. To obtain maximum capacity from the new batteries, you may have to give them several charge/discharge cycles.
- 12 V DC adaptor (Casella part number -PC18)
- USB connection

Battery supply

You can use alkaline or rechargeable AA batteries to operate the instrument. Do not use a mixture of alkaline and rechargeable batteries at the same time.

The operating time that you can expect from a fully charged or new set of batteries depends on the battery capacity and whether you use the instrument's backlight. Environmental conditions such as the ambient temperate also affect battery life. See section 7 "Specifications" beginning on page 42 for some typical battery life examples.

You should also carry a spare set of batteries.

How to fit new batteries

Before you begin:

Read the caution notice about [Batteries](#) on page 6.

You should fit new or fully-charged batteries into the instrument before you start a set of measurement.

Fitting the batteries

If necessary, press the power ON/OFF key to switch the instrument OFF.

Figure 5.   **Fitting new batteries**
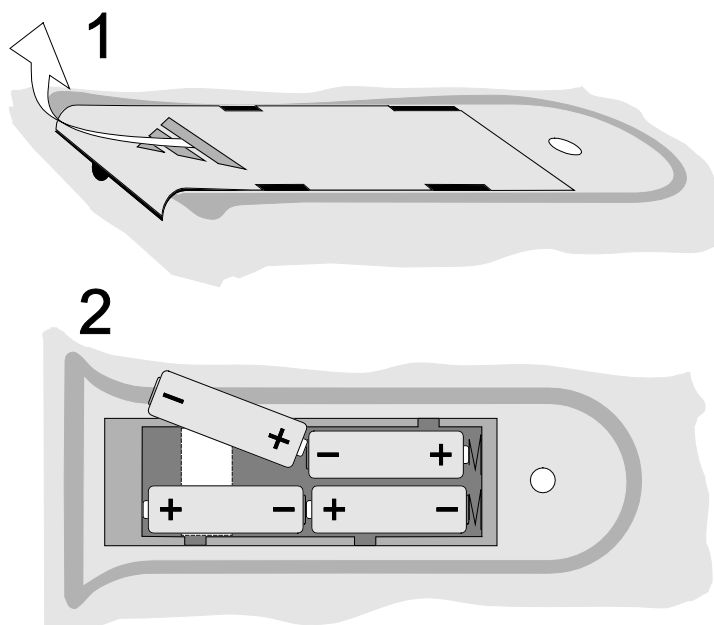
1. Lift and slide the battery cover towards the bottom of the instrument and lift the end to release the cover.
2. Remove the four exhausted batteries from the battery compartment and fit new ones, observing the correct polarity.
3. Press the power ON/OFF key, and check the battery symbol shows the batteries have a good charge.

Mains DC supply

If you need to operate the instrument for a long period, you should operate the instrument from a Casella -PC18 DC power supply if possible. This avoids the run being interrupted by battery failure. When you use a DC power supply to operate the MicroDust Pro, the instrument can operate without batteries installed.

USB supply

When you connect the instrument to a PC through a USB cable, the instrument receives power to operate at 5 V DC from the PC. There is no need to use a mains DC power supply to operate the MicroDust Pro instrument when you connect it to a PC.

Battery condition indicator

When the MicroDust Pro receives power from a mains DC power supply or from a USB port on a PC, the battery condition symbol on the instrument's screen always shows a fully charged battery condition, even if the batteries are not fully charged.

Sampling probe

IMPORTANT
The instrument may give reading errors when you use it in very bright or changing ambient light conditions. This is because the measurement method depends on the scattering of infra-red light.
You should exercise care when you use the instrument in direct sunlight. Shield the probe from direct light sources. You can use an aspirated or gravimetric adaptor, or use the MicroDust Pro within the environmental enclosure to reduce the effects of ambient light.

The detachable sampling probe houses the measurement chamber together with the associated optics, including the infra-red emitter and receiver.

Connect the sampling probe by aligning the red dot on the connector to face forward on the instrument, and insert the connector into the socket at the top of the instrument.

To disconnect the sampling probe

CAUTION
DO NOT pull on the cable to disconnect the sampling probe.

To disconnect the sampling probe, pull outwards on the connector's knurled sleeve in the direction of the arrows shown in Figure 2.

You can un-clip the sampling probe from the control unit for hand-held operation.

Supporting the instrument

For general monitoring applications you can attach the instrument to a suitable tripod (available from Casella CEL).

3.2 Preliminary operations

Switching the instrument ON and OFF

1. Press the power ON/OFF key ⏻ to switch the MicroDust Pro instrument ON.

   The instrument displays a welcome screen, and then shows the measurement display.
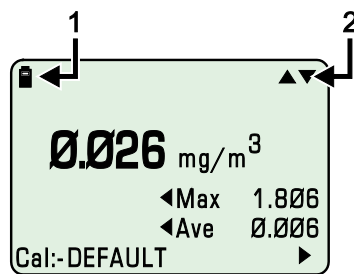
(display showing) 1 2 0.026 mg/m^3 ◀Max 1.806 ◀Ave 0.006 Cal:-DEFAULT ▶	1. Icon to show current battery charge. 2. Icons to show which navigator keys are currently active (▲ and ▼).

   When the instrument is first switched on, the measurements may drift by a small amount. Allow the instrument to settle for one minute before you begin using the measurements.

   Before you start making measurements, you should check that the zero and the span (sensitivity) settings are correct, and you should calibrate the instrument for the type of particulate to be measured. Refer to "Calibrating the instrument for a specific type of particulate" on page 25 for instructions to make these checks.

2. Press the left-hand navigator key ◀ to reset the maximum and the average levels.
3. Press the up ▲ or the down ▼ navigator keys to display a profile graph of the current particulate concentration.
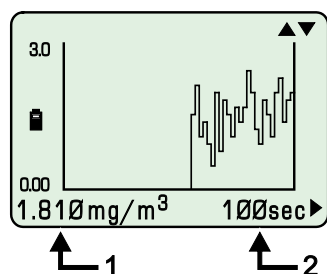
(graph display) 3.0 0.00 1.810 mg/m^3 100sec ▶ 1 2	1. Current value. 2. Graph time base. Press the right-hand navigator key ▶ to cycle through the options 100 seconds, 200 seconds, 15 minutes, 60 minutes.

4. Press the up or the down navigator key again to return to the measurement display.
5. Press the power ON/OFF key to switch the MicroDust Pro instrument OFF.

Checking battery status and firmware version

The instrument displays the internal battery voltage on the Status screen, together with the installed firmware version.

Switch the instrument ON (see page 16) and wait until it displays the measurement screen.

Figure 6.   Checking battery status and firmware
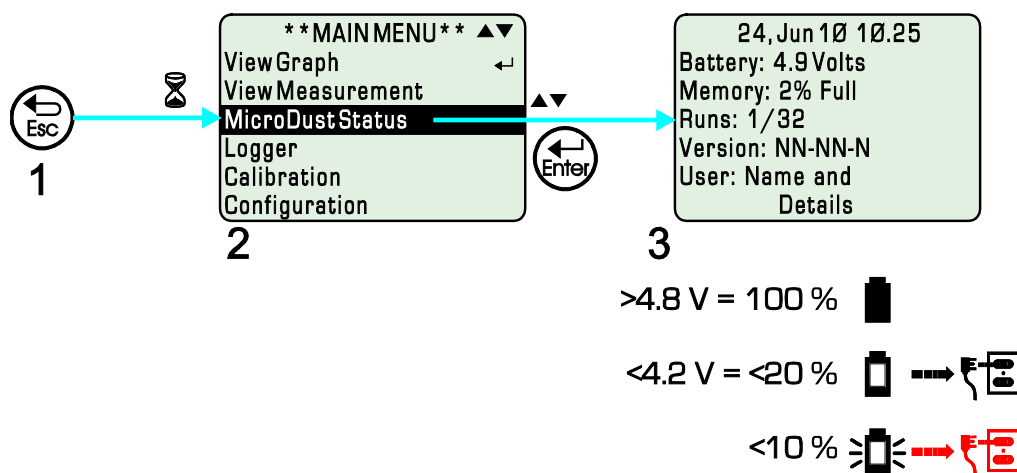
Battery status

IMPORTANT
Ignore the battery voltage displayed on the Status screen when you use a mains DC power supply to operate the instrument.

The batteries are in a fully charged condition when the battery voltage displayed on the Status screen is 4.8 V or more.

If you are using rechargeable batteries and the battery voltage displayed on the Status screen is less than 4.2 V, less than 20 % of the battery capacity remains. You should consider recharging the batteries when this condition occurs.

The battery icon flashes when the internal battery is almost fully discharged. When the batteries become discharged, the instrument stops logging and begins to shut down automatically.

Firmware version

The Status screen shows the version of firmware installed in the instrument. You will need this information if you call the Casella CEL service team for technical support.

Setting the display language

Set the language that the instrument uses for menus.

Figure 7.   Setting the display language
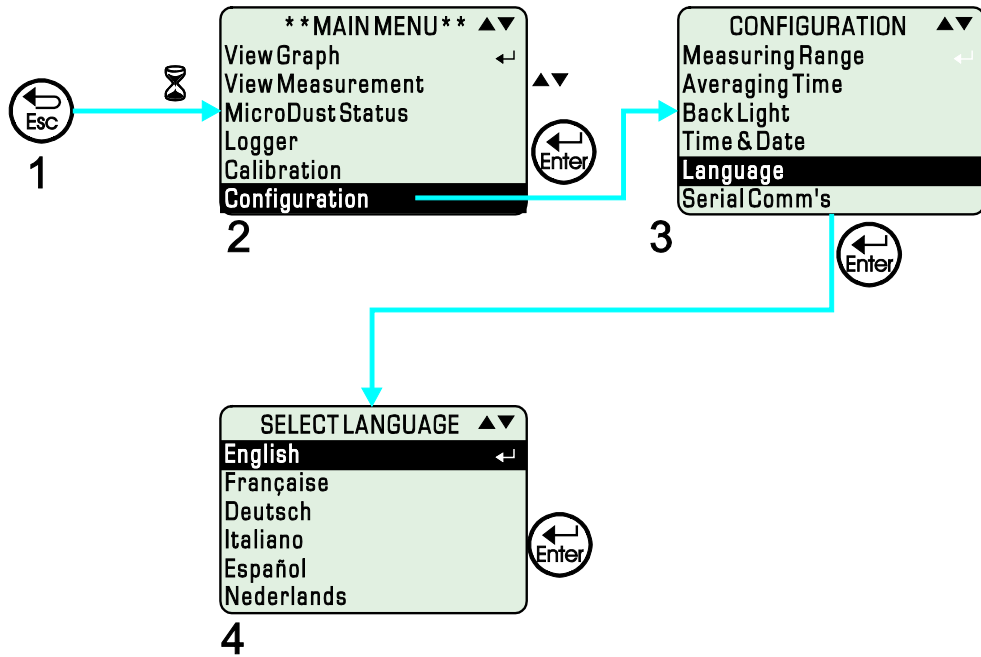
Setting the Date and Time

The instrument uses information from its internal real-time clock to log measurements against the current date and time.

Figure 8.   Setting the Date and Time
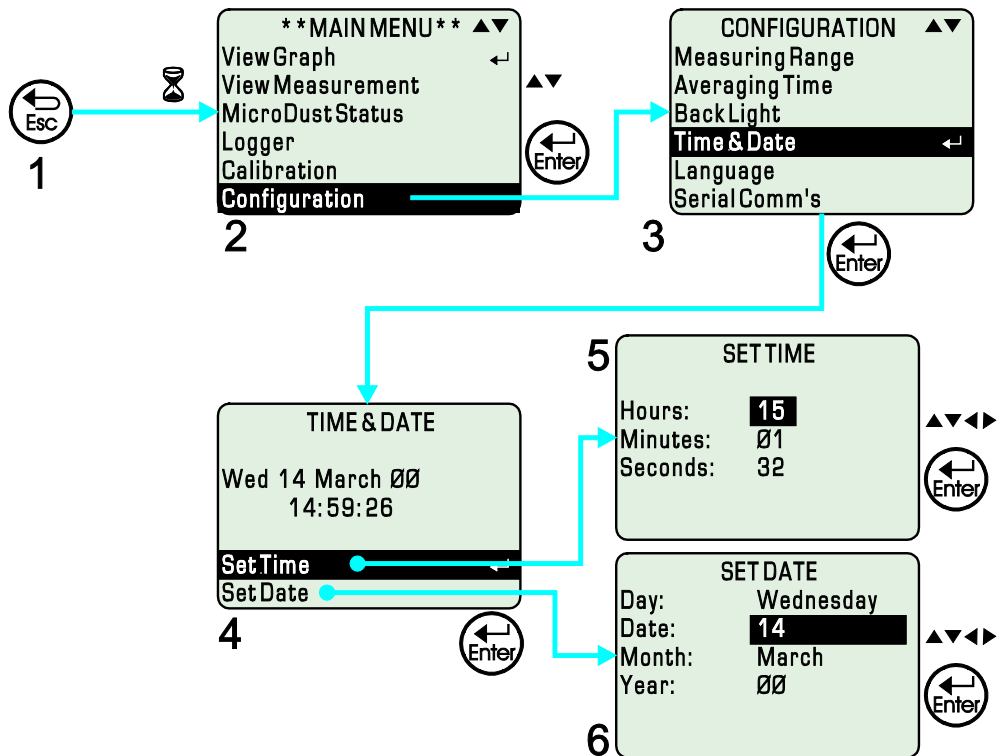
> The MicroDust Pro instrument synchronises its internal real-time clock with the PC's clock when you connect the instrument to a PC running the Casella Insight data management software.

Setting the Measurement Range

Set the MicroDust Pro instrument to a suitable range for the expected particulate concentration, or set the instrument to select the range automatically.

Figure 9. Setting the measurement range
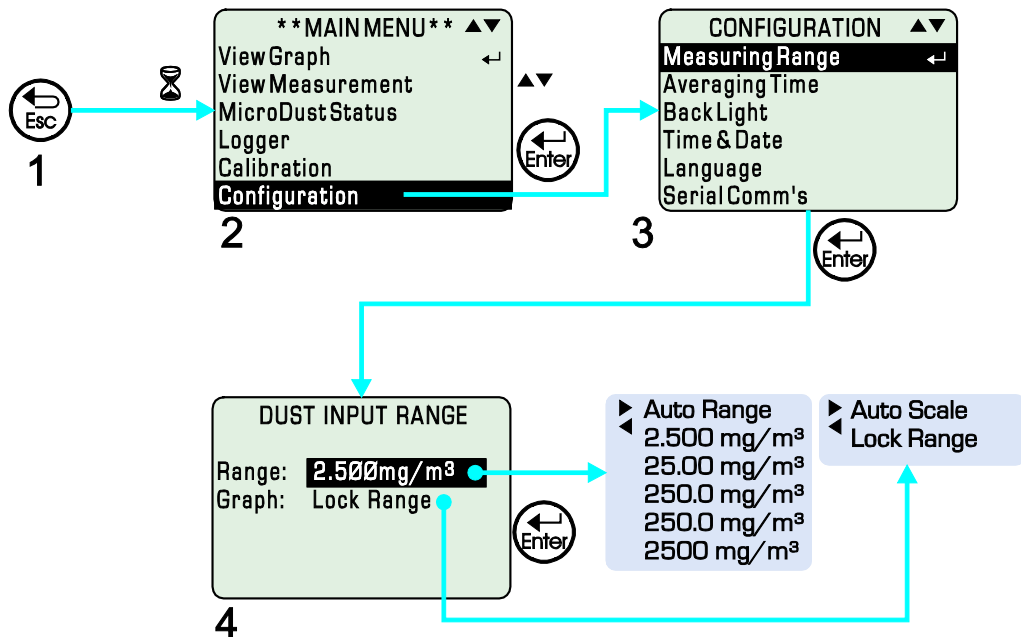
The scale used for the displayed graph can be changed. Set the Graph option to **Lock Range** to fix the scale to be the same as the fixed measurement range. Set the Graph option to **Auto Scale** to display only the range between the current maximum and minimum measurements.

Setting the Averaging Time

You can set the averaging time that the instrument uses on measurements, and the analogue output.

Figure 10.   **Setting the Averaging Time**
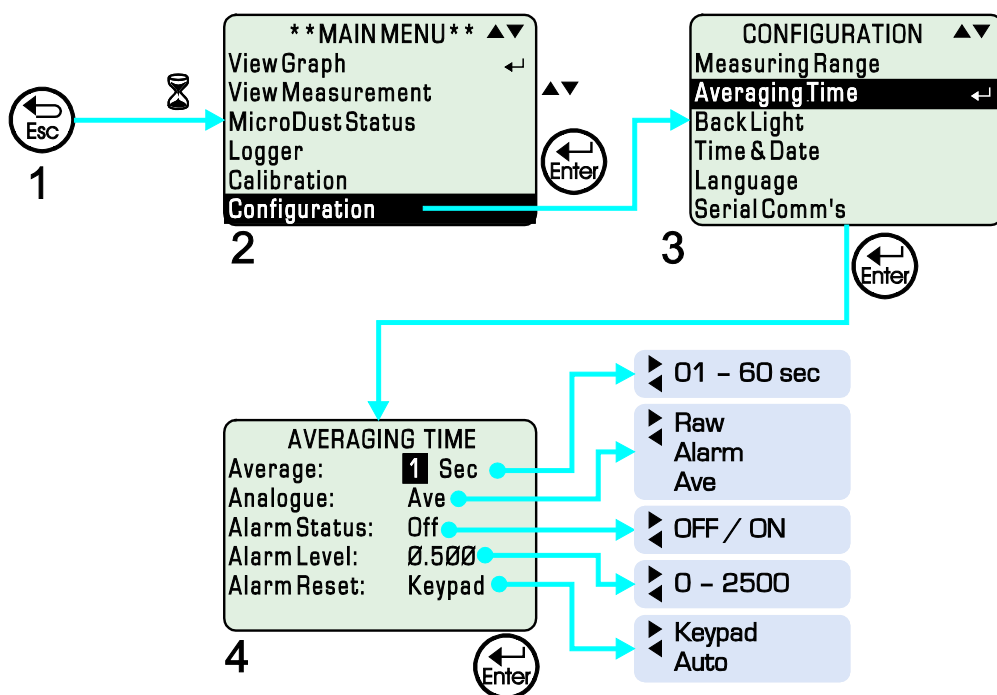
The displayed particulate concentration is a rolling average of measurements taken over the averaging time that you set. In some applications, where aerosol concentrations change rapidly, you can improve measurement stability by setting a longer averaging time.

Analogue output type

The analogue output type is optional. Choose from the following options.

Raw	The analogue output is taken directly from the signal conditioning circuit and is normalised to match the instrument's measurement range.
Average	The analogue output is calculated using the averaging time you have set for the instrument.
Alarm	The output voltage represents a set digital value where 2.5 V is Alarm ON and 0 V is Alarm OFF.

Alarm

If you set the Alarm option to ON, you can set the following options.

Alarm Level	Set the alarm trigger level as xxx.xx mg/m³.
	Press and hold the ▶ or ◀ key to change the setting quickly.

Press the keys briefly to make small changes.

This mass concentration level is taken from the Average reading you have selecting in this menu. When the concentration level is equal to or greater than the alarm level, the instrument triggers the alarm.

Alarm Reset   **Auto** resets the alarm when the concentration falls below the alarm level for longer than 5 seconds.

Keypad resets the alarms when you press any key.

Setting the Backlight and Buzzer

Figure 11.   **Setting the backlight and buzzer options**
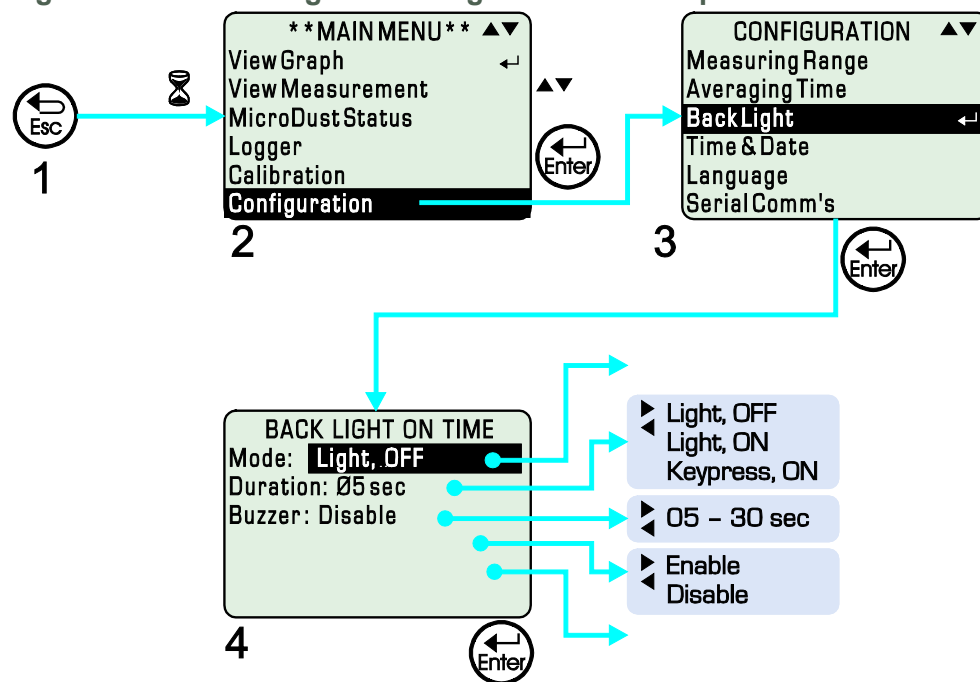
Mode   **Light, ON** switches the backlight ON. The backlight remains ON until you switch it OFF.

Light, OFF switches the backlight OFF. In this mode, the backlight remains OFF until you select a different mode.

The **Keypress** option switches the backlight ON for a short duration when you press any key.

Note that using the backlight reduces the battery life.

Duration   Set the backlight's duration after each keypress.

Buzzer   Enable the buzzer to hear a short tone when you press any key.

Setting the serial communications

Connection between the MicroDust Pro instrument and a PC is through a serial (RS232) communications link.

Figure 12.   **Setting the serial communications**
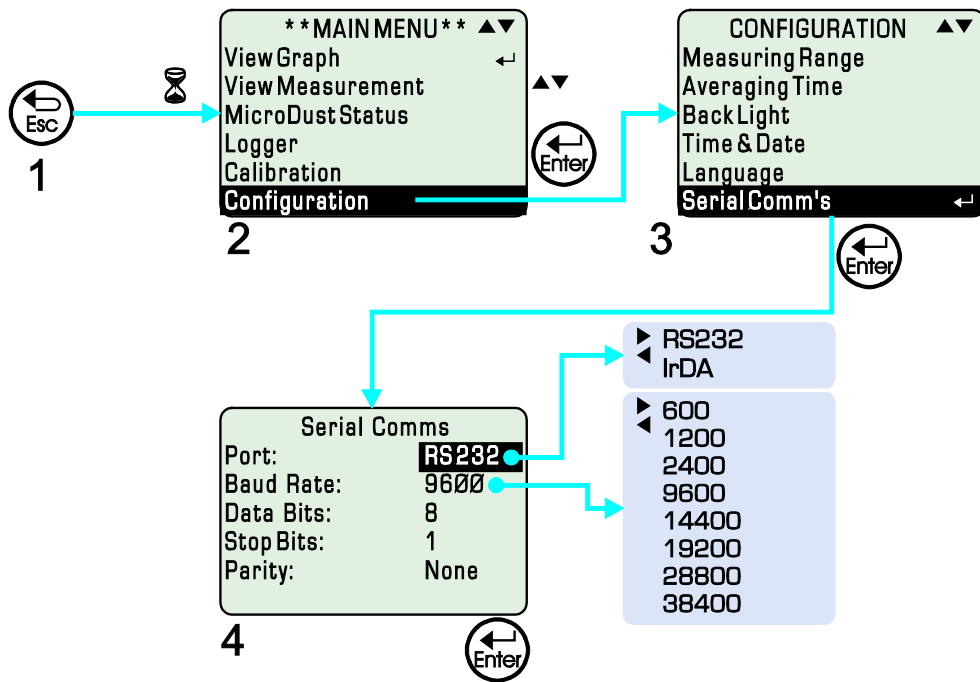
3.3 Calibration

Before you make any measurements with the MicroDust Pro you should confirm that it is set correctly for zero and that its span control (sensitivity) is adjusted correctly.

To gain optimal measurement accuracy you should also perform a user calibration to correct the instrument for the type of particulates to be measured.

Adjusting the zero and span settings

Figure 13.   Adjusting the zero span settings
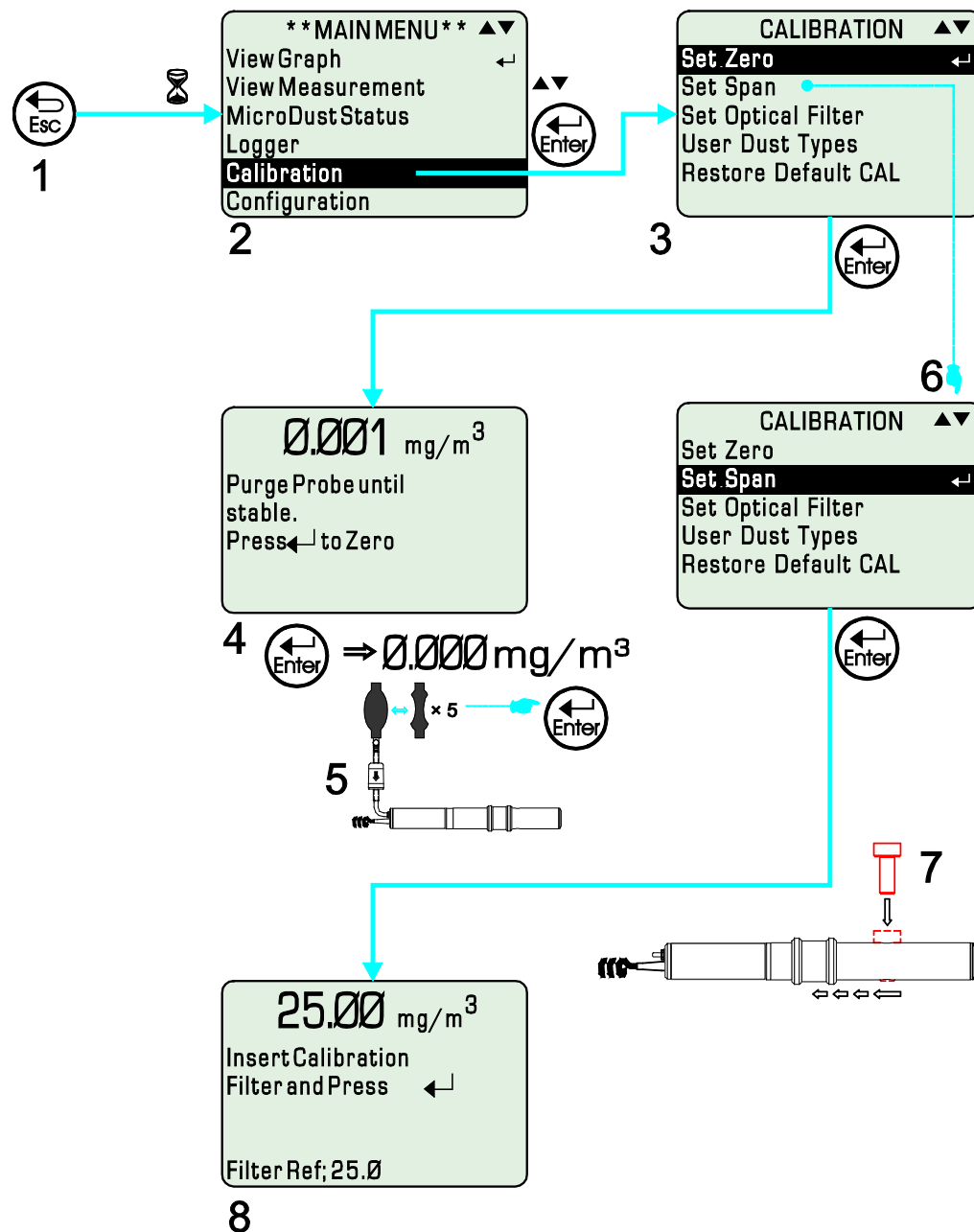
Refer to "Calibrating the instrument for a specific type of particulate" on page 25 for instructions to calibrate the instrument for a specific type of particulate.

Zero adjustment

For sensitive measurements that will use the 0 to 2.5 mg/m³ or the 0 to 25 mg/m³ ranges, it is important to purge the probe with clean air before making zero adjustments or measurements. Fine dust particles in the probe assembly may never settle, even when the probe collar covers the inlet chamber.

Step 5 of Figure 13 shows how to purge the probe with clean air.

Slide the collar over the probe inlet, leaving only a small hole from which the air can escape. Attach the purge bellows to the probe, and rapidly squeeze the bulb five or six times.

This action injects clean air into the chamber and removes possible contamination that may have settled on the optical components inside the probe. When you perform this operation, you may see the indicated concentration increase, and then decrease towards zero.

Allow a few seconds for automatic ranging and for the reading to stabilise. If the reading does not stabilise, squeeze the bulb five or six times and try again.

Press the Enter key ⊕ when the reading is stable. This sets the reading to zero, ± one digit. If the reading is not zero, wait a few seconds and then press the Enter key again until it is zero.

IMPORTANT
If the instrument cannot zero itself in the range 0 to 2.5 mg/m³, it displays a 'Contamination Warning' message and selects the 0 to 25 mg/m³ range. This becomes the lowest usable range that the instrument makes available until the probe is cleaned. For accuracy and stability, you should arrange for cleaning to be done by Casella CEL.

After you have set the zero, make sure you fit the rubber cap on the probe' purge inlet.

Span adjustment

The basic settings for span (or sensitivity) for the MicroDust Pro instrument are set at the factory using ISO (Fine 12103-1 A2) calibration dust.

Each probe is supplied with its own calibration filter, which creates a fixed optical scattering effect in the sampling space. This fixed reference can be used to confirm the factory calibration point for the instrument and probe.

It is important to use only the optical filter supplied for use with the specific probe.

IMPORTANT
It is important to use only the optical filter supplied for use with the specific probe.

The reference value for the calibration filter supplied for the probe is shown on the filter, and is displayed at the bottom of the Set Span screen.

Insert the calibration filter into the measurement chamber with the arrow pointing towards the probe's handle.

```
25.00 mg/m³
Insert Calibration
Filter and Press   ↵


Filter Ref; 25.0
```
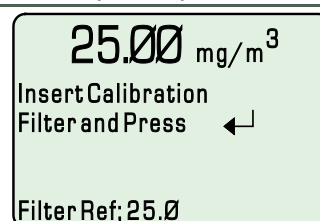
Press the Enter key ⟳ and wait a few seconds to allow the reading to stabilise. The display should show a reading within ± 1 digit of the value shown on the calibration filter to confirm that the factory-set sensitivity of the instrument has not changed.

If the correct value is NOT shown (for example because the instrument was last used with a different probe and filter), follow the steps in Figure 14 to set the optical filter.

The span adjustment calibration described here is an absolute calibration of the instrument. It remains valid when a correction factor is applied. If the probe becomes heavily contaminated after calibration, the instrument displays a warning message and disables the contaminated measurement ranges.

Setting the optical filter

Figure 14.   **Set the Optical Filter**
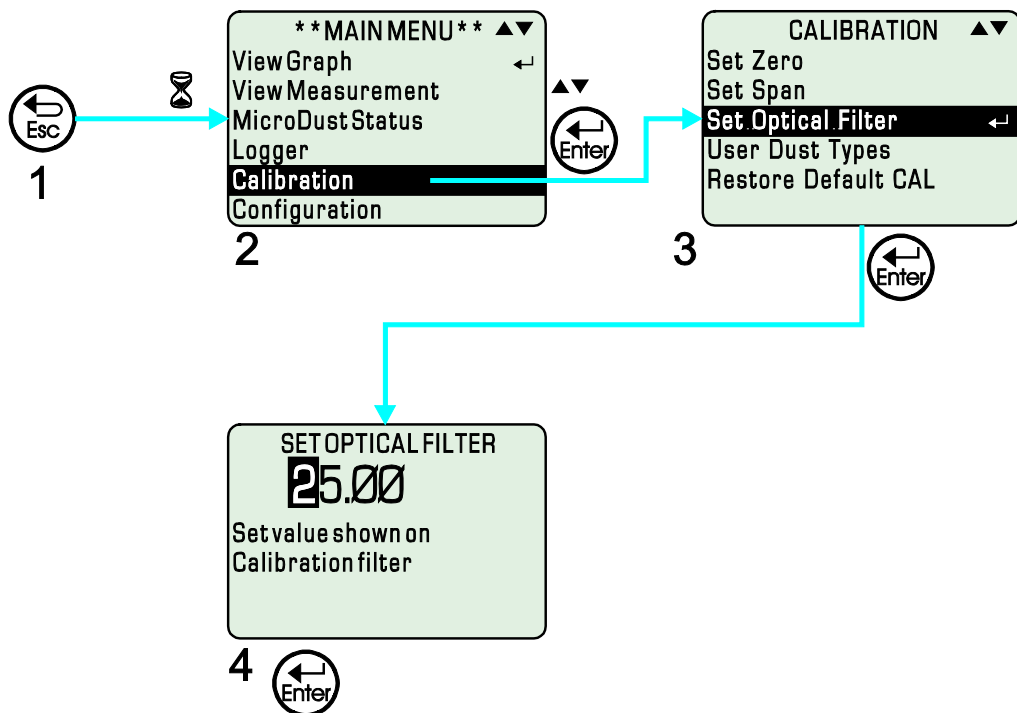
Calibrating the instrument for a specific type of particulate

Gravimetric calibration

The measurement sensitivity of the MicroDust Pro varies according to the properties of different types of particulate that it is measuring. This is a common characteristic of all instruments that use light scattering methods for measuring particulate concentration.

The MicroDust Pro instrument's use of a narrow forward scattering angle minimises these effects, but for optimal accuracy when measuring a specific particulate type, you should perform gravimetric calibration.

Optional gravimetric and respirable adapters incorporate 25 mm or 37 mm filter cassettes and provide a convenient method of gravimetrically calibrating the MicroDust Pro instrument. Refer to section 6.1 "Gravimetric adapters" on page 37 for information about these adapters.

Standard gravimetric techniques can be used to provide a cross-check between readings of the MicroDust Pro and a weighed example. This is achieved by collecting two average measurements over the exposure period – one from the filter (the gravimetric value) and the other from the instrument's averaging function. If there are differences between the gravimetric value and the instrument's reading, a user-defined correction factor can be entered for the relevant particulate type. This correction factor can then be applied automatically to any measured values to provide optimal measurement accuracy.

Calibration procedure

During the calibration, you must use the MicroDust Pro instrument's logging feature to record the particulate concentration measured by the instrument.

1. Adjust the instrument's zero and span settings as described in "Adjusting the zero and span settings" on page 23.

    This returns the instrument to the default calibration set by the factory so that all user-defined calibrations are relative to this setting. This is an absolute calibration that is not affected by changes to the correction factor.

2. Fit the gravimetric or respirable adapter onto the instrument's probe and load a pre-weighted filter into the cassette holder.

    See section 6.1 "Gravimetric adapters" on page 37 for a description of the optional gravimetric or respirable adapters.

3. Adjust the sampling pump to provide the appropriate flow rate.

    - The respirable adapter requires a flow rate of 2.2 litres/minute.
    - For isokinetic sampling, the flow rate is calculated from the sample velocity and cross-sectional area of the gravimetric inlet tube (200 mm²).
    - For general Total Suspended Particulate (TSP) measurements, the actual flow rate is not critical, but will affect the mass of the

collected sample.

4. Start gravimetric sampling and start the instrument's internal data logger (refer to section 3.5 "Data logging" on page 30 for instructions to use the instrument's data logging feature).

    This resets the Time Weighted Average (TWA) value.

5. Continue sampling for a period that is long enough to collect a sufficient sample mass.
6. At the end of the sampling period, stop the data logger and stop the sampling pump.

    The average real-time measurement is available on the display and is stored in an internal data file.

7. Write down the TWA value.
8. Condition and weight the filter to measure the collected mass.
9. Calculate the gravimetric concentration during the sampling period as follows:

$$\text{Gravimetric concentration} = \frac{\text{Mass increase}}{\text{Total sampled volume}}$$

10. Calculate the calibration correction factor as follows:

$$\text{Correction factor} = \frac{\text{Gravimetric concentration}}{\text{Instrument's TWA reading}}$$

Example

Filter mass increase   = 3.21 mg

Volume sampled   = 0.75 m³ (calculated from the flow rate and sample time)

Gravimetric concentration $= \dfrac{3.21}{0.75} = 4.28$ mg/m³

TWA reading   = 3.45 mg/m³ (meaning the instrument in this example gives readings that are low)

Correction factor $= \dfrac{4.28}{3.45} = 1.24$

Applying the correction factor

Adjust the instrument's zero and span settings as described in "Adjusting the zero and span settings" on page 23, and then follow the steps in Figure 15.

Figure 15. Applying the correction factor

Note: The correction factor for limestone should not be taken as 1.000. It is shown here for illustration purposes only.
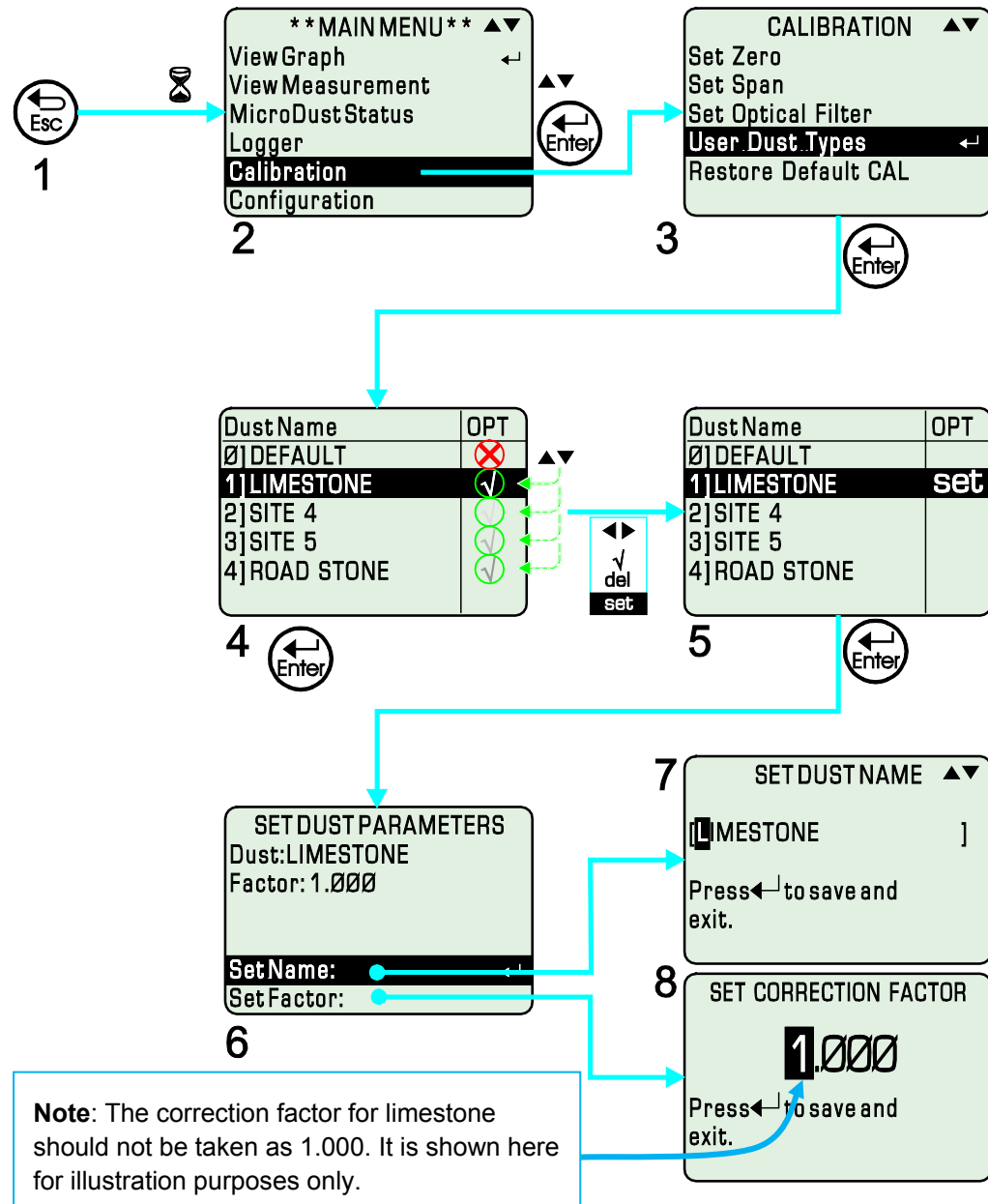
The Default particulate type (shown as item 0 in the list) is a factory calibration that you cannot edit or delete. Select any of the other entries in the list (items 1 to 4) to add the new type of particulate.

You can enter a name for the particulate, and you can enter the correction factor that you have calculated for this type of particulate.

When you use the instrument to measure this type of particulate again, select the appropriate type from the list so the stored correction factor is applied automatically to the measured values.

3.4 Making measurements

Before you make a measurement, perform the following tasks:

- Adjust the instrument's zero and span settings (refer to "Adjusting the zero and span settings" on page 23)
- Apply the appropriate correction factor (refer to "Applying the correction factor" on page 28)
- Set an appropriate averaging time for the application (refer to "Setting the Averaging Time" on page 19)

1. Open the probe collar fully to expose the measuring chamber.
2. Move the probe slowly through the aerosol, or rely on natural air movement to allow the aerosol into the measuring chamber.

   You can make measurements with the probe clipped to the control unit, or you can unclip the probe to allow easy access to confined spaces.

   For static monitoring applications, use an aspirator system if possible (refer to section 6.2 "Aspirator unit" on page 41 for information about the optional aspirator systems).
3. Make the required measurements for the application (refer to "Measurement types" below).

Measurement types

In addition to the basic real-time measurements of particulate concentration, the MicroDust Pro instrument can also calculate and display other useful data.

Maximum value (Max)

This represents the maximum particulate concentration that has occurred in any 1 second period since the instrument was switched ON, since the instrument was reset (by pressing the ◀ key), or since logging started.

You cannot reset the maximum value while logging is active.

Average (Ave)

The average value represents the average particulate concentration since the instrument was switched ON, since the instrument was reset (by pressing the ◀ key), or since logging started.

You cannot reset the Average while logging is active.

3.5 Data logging

Configuring the data logging function

You should configure the instrument for the measurement application before you begin making measurements.

Figure 16. Configuring the data logging function
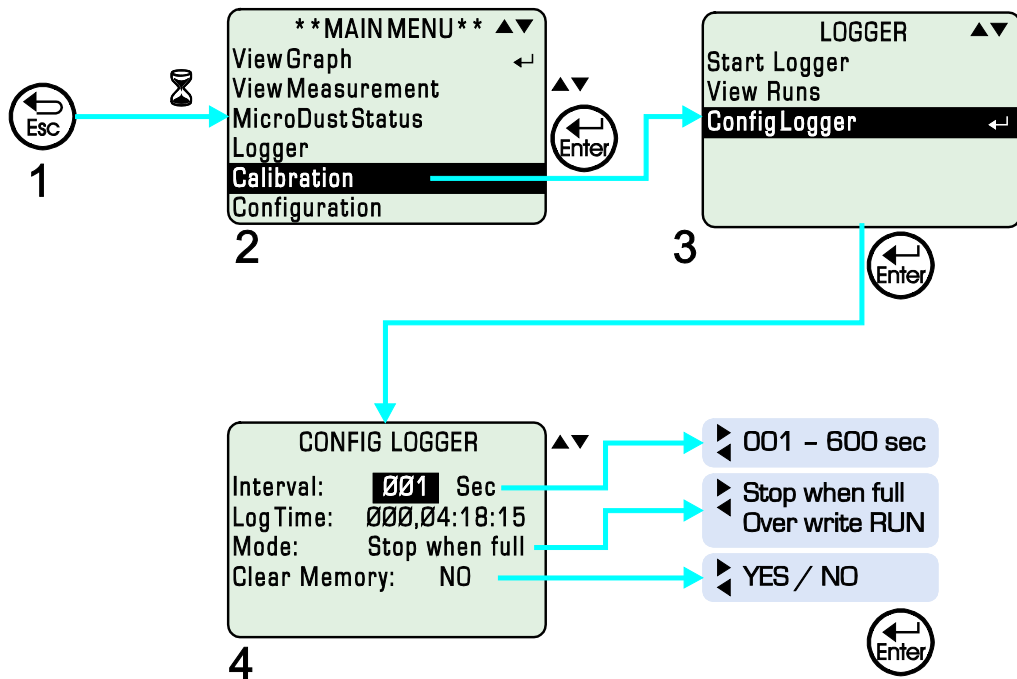
Interval	The logging interval is the time between each recorded data point.
Mode	The logging mode determines what happens when all empty memory locations have been filled with data:

- When set to **Over write RUN**, logging continues and over writes the oldest record with the newest record.
- When set to Stop when full, logging stops automatically when the memory is full.

Clear Memory	To clear the memory manually, select YES and press the Enter key. The instrument displays a warning message to confirm the deletion. Press the Enter key again to confirm the operation and clear the memory.

Note that this operation deletes all the stored runs.

Start logging

Configure the data logging function and, if necessary, clear the memory before you start logging.

Figure 17.   **Start logging**
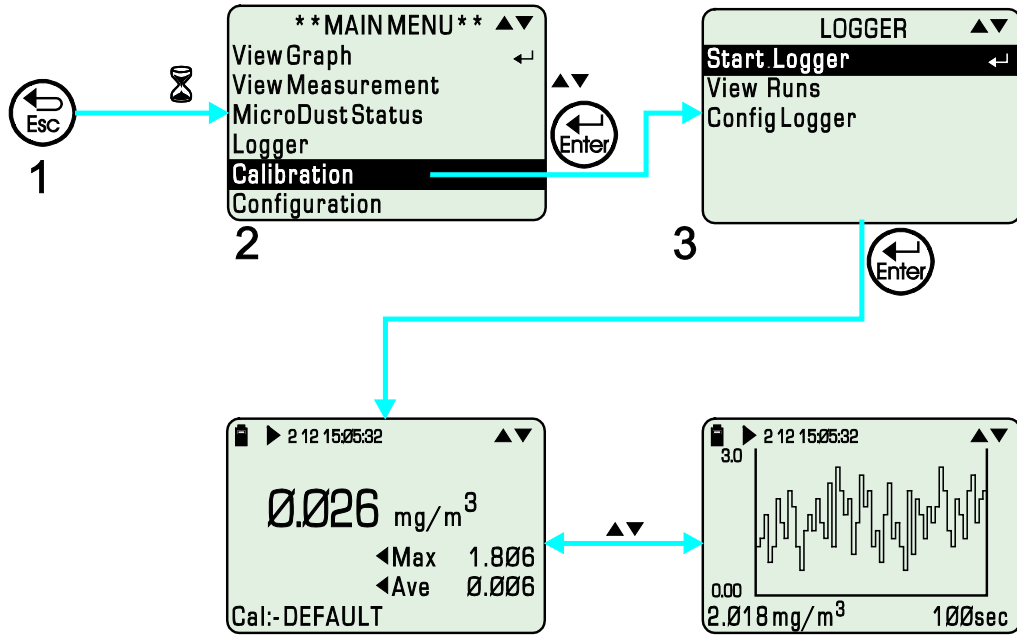
After you start logging, the instrument shows a measurement screen or a measurement graph. Press the ▲ or ▼ keys to switch between these screens.

Both screens show the run and the current interval number.

You can view data stored for the current run (or for other stored runs) while the instrument continues to log data. Refer to "Viewing stored runs" on page 32 for instructions to view runs stored in the instrument's internal memory.

Stop logging

Figure 18.   **Stop logging**
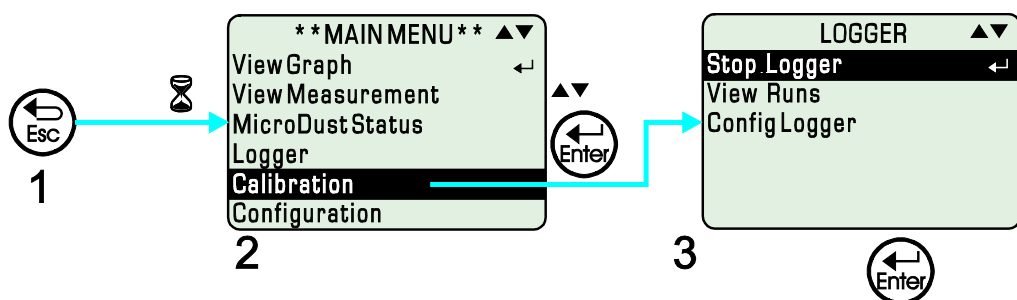
When you stop logging, the instrument saves data up to the last completed interval. Each saved record includes a reading of the average concentration

measured during the relevant logging interval, and the date and time when it was saved.

At the end of each logging run (that is, when logging stops or the instrument is switched OFF, the instrument also saves a summary record. The summary record identifies the average, the maximum and the minimum particulate concentrations that the instrument has measured during the entire run. It also shows the date and time when the maximum measurements were recorded.

Data stored in the instrument's internal memory can be downloaded to a PC running the Casella Insight data management software. Refer to the software's on-line help system for full instructions to use the Casella Insight data management software.

Viewing stored runs

Figure 19.   Viewing stored runs
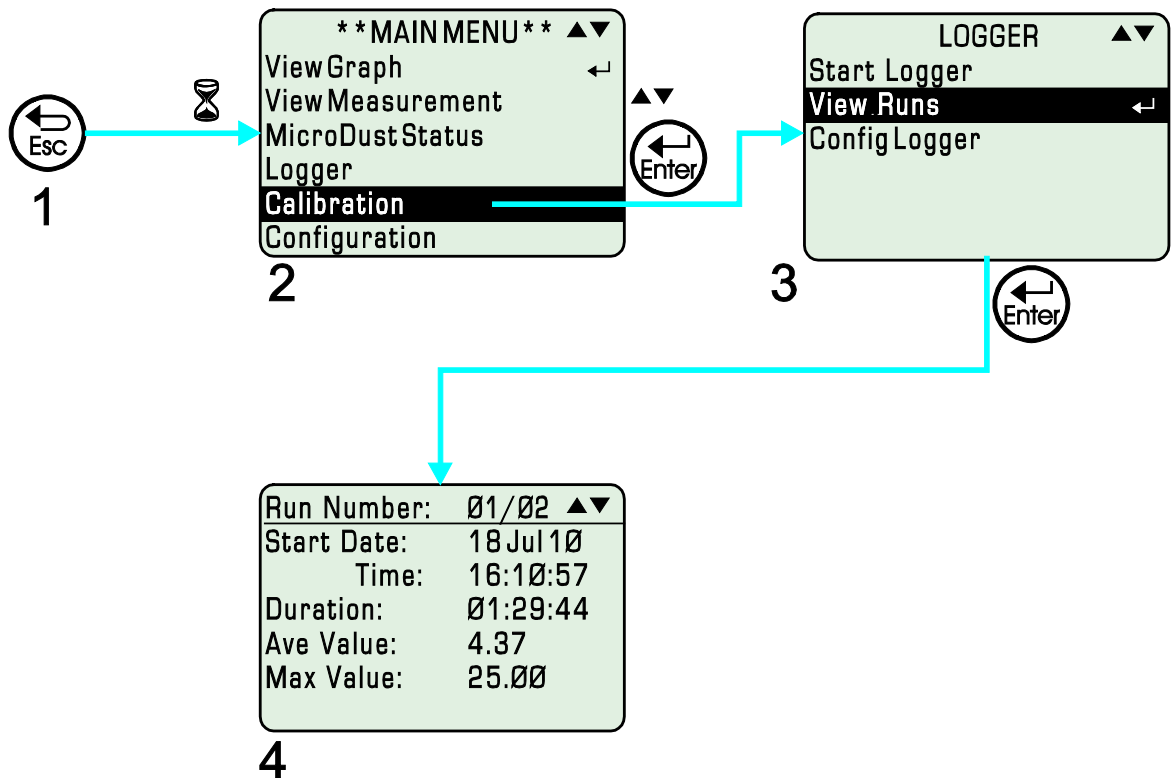
You can view stored runs while you are logging the current run. Use the ▲ or ▼ keys to cycle through and display the stored runs.

4 Casella Insight data management software

Casella CEL's Insight data management software includes a plugin for the MicroDust Pro instrument family. The Casella Insight data management software supports the following:

- Instrument configuration
- Data downloading
- Data management and analysis
- Reporting functions

The software runs on a PC that meets the following minimum specification:

- Operating System: Processor: 1.3 GHz
- Windows XP (Service Pack 2) RAM: 1GB
- Windows Vista (Service Pack 1) Free Disk Space: 1GB
- Windows 7

Refer to the Casella Insight data management software's on-line help for a complete description of the various features of the software can display, and for instructions to use the software with the MicroDust Pro instrument.

This section of the manual explains how to do the following tasks:

- Install the Casella Insight data management software on a PC
- Start the Casella Insight data management software
- Access the on-line help system

4.1 Installing and starting the software

Note
You should perform the installation procedure while operating the PC under administrator privileges.

1. Insert the CD that holds the software into the PC's CD-ROM drive.
2. If the software does not start to install automatically, use Windows Explorer to display the contents of the CD and double-click the Insight folder then double-click the **setup.exe** file on the CD.
3. Wait until the Casella Insight Welcome screen is displayed, and then follow the on-screen instructions.

    When the installation process gives you an option, choose the default settings.

    When the installation finishes, a new 'Insight' icon is displayed on your PC's desktop.

    Double-click the Insight icon to start the software.

Press the PC's **F1** function key to display the software's on-line help system, which tells you how to use the software with the MicroDust Pro instrument. You should refer to the on-line help for all instructions to use the software.

5 Command set for remote control

The MicroDust Pro instrument can be controlled remotely from a PC that is running a simple terminal emulation program, for example HyperTerminal.

Connection between the instrument and the PC is through the serial data cable supplied with the instrument. Refer to "Signals" on page 10 for information about the instrument's serial connection port.

Communication occurs using a baud rate that can vary from 600 baud to 38400 baud. The RS232 serial communication parameters are fixed at using 8 data bits, 1 stop bit and no parity.

You can use a range of single-letter command to control the instrument. These commands mimic the action of the keypad buttons, allowing remote access to the entire menu structure.

5.1 Command X – Start real-time output

The instrument transmits the average particulate measurement as it is displayed on the screen. The measurement updates at intervals of 1 second.

Each transmission terminates with the carriage-return line-feed characters (ASCII characters 0x0A 0x0D).

Example

```
2.87<CR><LF>
2.55<CR><LF>
2.60<CR><LF>
```

5.2 Command Z – Stop real-time output

The instrument stops transmitting the real-time data output.

5.3 Command I – Interrogate target

The instrument transmits a comma-delimited string of characters that contain two ID strings.

- The first ID string is the number of records stored in the logger.
- The second ID string is the firmware version of the instrument.

Example

```
CasellaCEL,(01234) 844100,K, 11,80-176087AXX<CR><LF>
```

5.4 Command T – Download records stored

The instrument downloads all records stored in its internal memory to the PC.

Example

```
Log close, 28/07/03,12:13:48, 129.396,
129.445,28/07/03,12:13:42,
0 [CR][LF]
28/07/03,12:13:48, 129.361, 1 [CR][LF]
28/07/03,12:13:46, 129.387, 2 [CR][LF]
28/07/03,12:13:44, 129.439, 3 [CR][LF]
Log close, 28/07/03,12:11:30, 240.920,
240.947,28/07/03,12:11:22,
4 [CR][LF]
28/07/03,12:11:30, 240.882, 5 [CR][LF]
28/07/03,12:11:28, 240.909, 6 [CR][LF]
28/07/03,12:11:26, 240.897, 7 [CR][LF]
28/07/03,12:11:24, 240.920, 8 [CR][LF]
28/07/03,12:11:22, 240.937, 9 [CR][LF]
28/07/03,12:11:20, 240.935, 10 [CR][LF]
28/07/03,12:11:18, 240.943, 11 [CR][LF]
28/07/03,12:11:16, 240.935, 12 [CR][LF]
```

5.5 Command R – Set instrument ID, time and date

This command enables you to set the time, date and two ID strings remotely. This information is displayed on the instrument's status screen.

⚠️ **CAUTION**

All records stored in the instrument are erased when you use this command.

Transmit the command 'R' and then wait to receive a response 'D' from the instrument before you transmit the data string.

Example

Transmit R

Wait to receive D

Transmit the data string:

```
CasellaCEL,(01234)844100,K,28/07/03,12:30[CR][LF]
```

- The maximum ID string length is 16 bytes.
- The date format is dd/mm/yy.
- The time format is hh:mm using the 24-hour format.

5.6 Commnd B – Upload a bitmap to the instrument

This command enables you to upload a 128 × 64 pixel bitmap that the instrument uses as a 'splash' screen when you switch the instrument ON. You can use this feature to include a special logo or other screen. The first byte of the bitmap forms the top left corner of the screen.

Example

Transmit B

Wait to receive D

Transmit the bitmap string.

5.7 Command C – Clear bitmap

This command restores the instrument's default 'splash' screen.

5.8 Command i - Screen dump

The screen dump tells the instrument to transmit binary data to the PC that represents the screen that the instrument is displaying currently. The first byte transmitted is for the top left corner of the screen.

The screen dump command cannot be used at intervals shorter than 2 seconds. This delay is necessary to allow the data to be transmitted successfully.

6   Sampling Accessories

When you use the MicroDust Pro instrument in static monitoring applications, you should use some form of aspiration with the sampling probe. This can be either a TUFF (or Apex) sampling pump or a fan aspirator.

By maintaining an air flow through the sampling probe you can eliminate possible errors caused by the orientation of the probe's inlet and size selectivity.

The gravimetric and respirable adapters include 25 mm or 37 mm filter cassettes, and provide a convenient method of calibrating the instrument.

6.1   Gravimetric adapters

The gravimetric adapter units draw particulate matter through the sampling probe's measuring chamber and deposit it on a 25 mm or a 37 mm filter. There are three gravimetric adapter options available:

- **Total Suspended Particulate (TSP)**
  All sampled particulate is monitored in real time and then deposited onto a sample filter. The design does not allow selection based on particulate size.
- **Respirable (4 µm)**
  The respirable adapter design includes a Cyclone size-selective unit. This means that only respirable particulate passes through the sampling probe and is deposited onto the filter.
- **Polyurethane Foam Filter (PUF)**
  The PUF gravimetric adapter uses foam filter inserts to provide size-selective sampling. Filters are available for PM_{10}, Respirable (4 µm), and $PM_{2.5}$ fractions.

These adapters allow you to use standard gravimetric methods to cross-check readings from the MicroDust Pro instrument against a weighed sample.

All components of these adapters fit together using O-ring seals. You should check these regularly, and you should fit new O-rings if there are any signs of damage. Damaged O-rings can cause measurement errors due to air leakage.

If errors exist between the instrument's measurements and the true gravimetric value, you can determine and apply a correction factor to the instrument's measurements. Refer to "Calibrating the instrument for a specific type of particulate" on page 25 for instructions to do this.

Align and insert the sampling probe into the adapter block. Insert the adapter's locating spigot into the probe's inlet so that the adapter cannot rotate or move on the probe.

TSP and Respirable adapters

Figure 20.   Gravimetric and respirable adapter modules
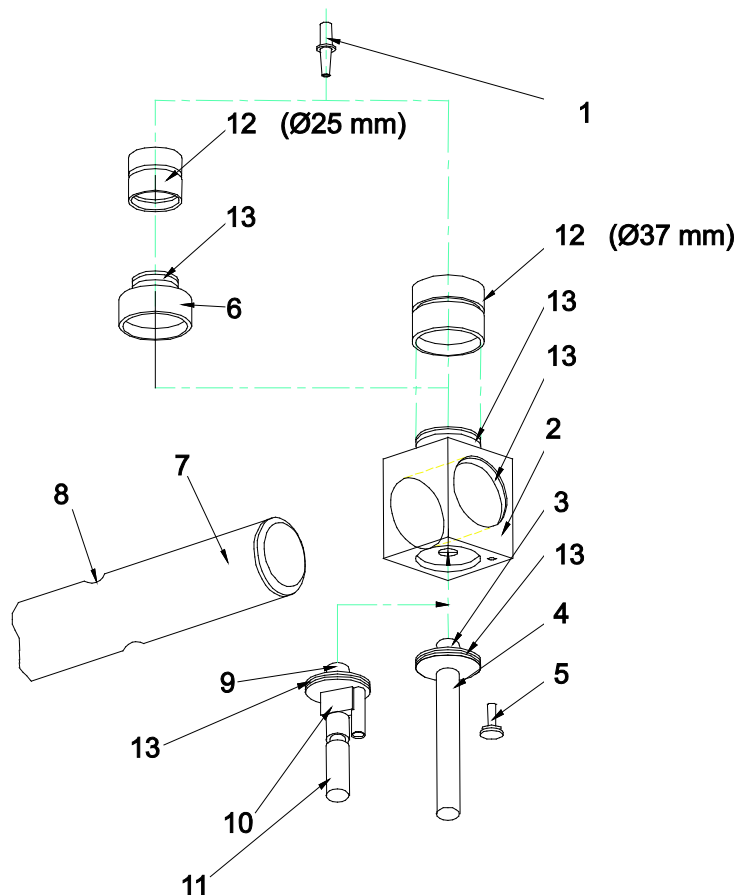
1	Pump connection	8	Measuring chamber inlet
2	Adapter block	9	Locating spigot
3	Locating spigot	10	Cyclone
4	Inlet tube	11	Coarse dust container
5	Thumb screw	12	Filter cassette (25 mm / 37 mm)
6	37 mm-to-25 mm reducer	13	O-rings
7	MicroDust sampling probe		

The basic design of the TSP and respirable adapters is the same, but with different inlet fittings. The respirable adapter is a centrifugal separator that uses the cyclone principle of dust separation. It draws only the respirable fraction of particulate matter through the measurement chamber and onto the filter (D50 cut = 4 μm at 2.2 litres/minute).

The cyclone (10) is fitted to the adapter block (2) using an O-ring seal. A suitable constant-flow pump such as the Casella TUFF or Apex should be connected to the filter cassette (12) through a length of silicone tubing.

It is important that the cyclone must operate in the vertical orientation. You should also clean the coarse dust container (11) and check it for damage at regular intervals.

When you install a new filter in the filter cassette, make sure it is held firmly against the filter support pad. If the filter is loose, the instrument will give incorrect measurements.

When the cyclone is pressed into the adapter block, make sure the cyclone's locating spigot (9) engages the probe inlet so that the adapter assembly cannot rotate or slide on the sampling probe. Use the thumb screw to secure the adapter assembly in position.

PUF filter adapter

The MicroDust polyurethane foam filter (PUF filter) adapter is for use in PM_{10}, respirable and $PM_{2.5}$ sampling applications that have a flow rate of 3.5 litres/minute. The design is based on the Conical Inhalable Sampler (CIS), which is identified in the Health and Safety Executive's publication MDHS14.

For monitoring applications, the adapter is fitted to the sampling probe as shown in Figure 21.

The air sample is drawn through the PUF filter and then into the MicroDust Pro measuring chamber before being deposited onto the filter (25 mm or 37 mm).

The type of foam filter loaded into the adapter determines the size of particulate matter being monitored by the MicroDust Pro and being collected on the filter.

The PUF filter inserts have been designed as size-selective filters to capture particles that are larger than a specified mean aerodynamic size. However, it is also possible to pre-weigh and post-weigh the PUF inserts to determine the total inhalable size dust fraction value and the desired size fraction.

PUF filters should be stored in a clean and, preferably, air-conditioned environment.

If used without PUF filters the CIS adaptor will provide the total inhalable size dust fraction into the MicroDust for real-time measurement.

Figure 21.   PUF adapter installation
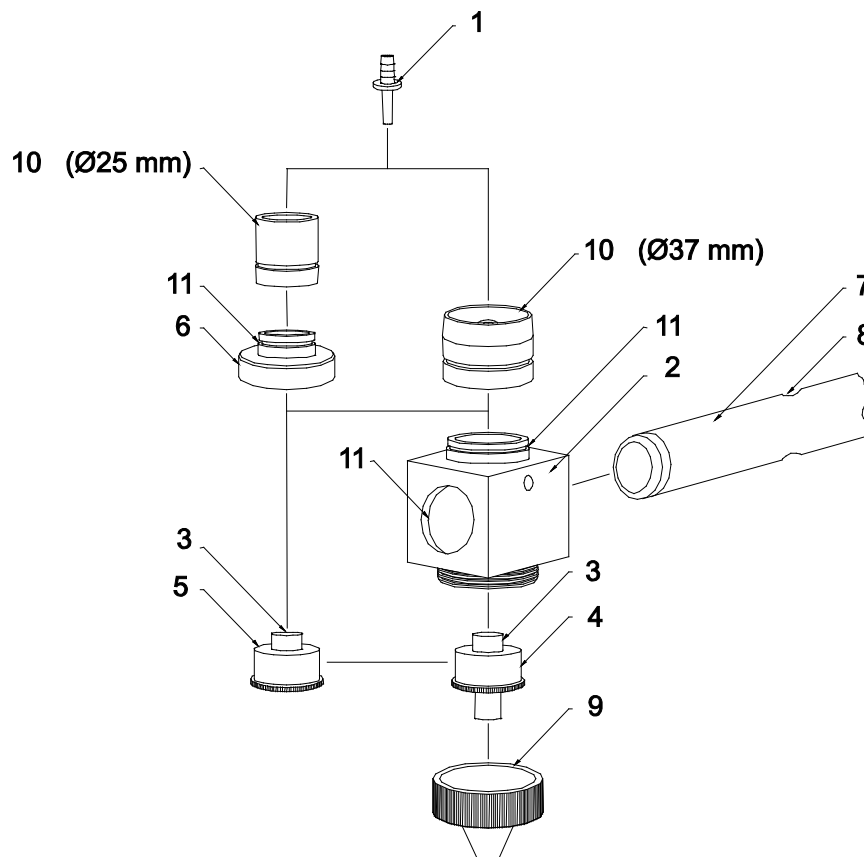
1	Pump connection	7	MicroDust sampling probe
2	Adapter block	8	Measuring chamber inlet
3	Locating spigots	9	PUF filter head cap
4	PUF filter holder $PM_{2.5}$	10	Filter cassette (25 mm / 37 mm)
5	PUF filter holder PM_{10}/Respirable	11	O-rings
6	37 mm-to-25 mm reducer		

To insert or remove PUF filters from their filter cassettes, use clean tweezers and vinyl gloves. Do not allow the filters to become damaged, creased or folded in any way.

Spare PUF filters are available from Casella CEL:

- PM2.5 foams (packs of 10)   P/N P118204
- PM10 foams (packs of 10)   P/N P118206
- Respirable 2 foams (packs of 10)   P/N P118208

6.2 Aspirator unit

The fan-driven aspirator unit, shown in Figure 22, can be used to draw all suspended particulate matter through the probe, provided there is no back pressure.

Figure 22.   Aspirator unit
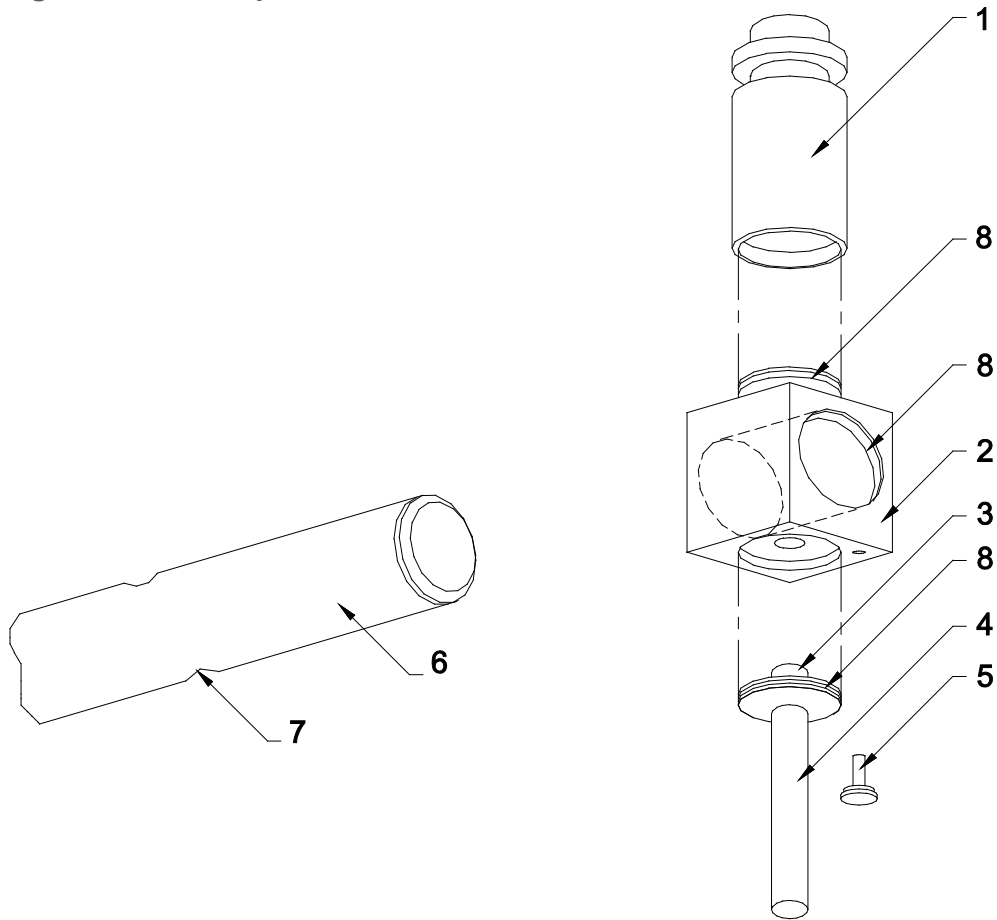
1	Fan aspirator	5	Thumb screw
2	Adapter block	6	MicroDust sampling probe
3	Locating spigot	7	Measuring chamber inlet
4	Inlet tube	8	O-rings

The fan aspirator (1) and the inlet tube (4) are push-fitted into the adapter block (2). When assembling these units, it is important to prevent damage to the O-rings.

The complete aspirator unit is located and secured to the sampling probe (6), with the locating spigot (3) engaging the measuring chamber inlet (7).

The aspirator fan operates from a 5 V DC power supply, which can come from a suitable mains DC adapter or from a battery supply.

You should clean the aspirator regularly to make sure there is no accumulation of dust, which can cause measurements errors or mechanical seizure of the fan.

7 Specifications

7.1 Instrument specification

Measurement

Sensing technique	Forward light scattering (12° to 20°) using infrared source (wavelength 880 nm)
Measuring range	0.001 to 2500 mg/m³ over four ranges:

- 0 to 2.5 mg/m³
- 0 to 25 mg/m³
- 0 to 250 mg/m³
- 0 to 2500 mg/m³

The active range can be fixed or auto ranging.

Resolution	0.001 mg/m³
Zero stability	Typically <2 µg/m³/°C
Span stability	±0.7 % of reading/°C

Temperature:

Operating	0 °C to 55 °C (non-condensing)
Storage	−20 °C to +55 °C (non-condensing)

Power supply

Power consumption	Approximately 100 mA at 6 V
Battery	Four AA / MN1500 cells Alkaline or rechargeable NiMH

Operating run time on batteries:

Alkaline (2700 mAh)	Typically >20 hours
NiMH (950 mAh)	Typically >9 hours

Battery charging	Internal NiMH fast-charging circuitry. Charge termination based on Negative Delta V detection with additional time-out protection.
Important:	The charger MUST be disabled when operating from non-rechargeable batteries. See "Setting the DIP switches" on page 12.

Charge rate:

Fast charge	450 mA
Standby charge	Approximately 55 mA

Power adapter (-PC18):

Type	Universal power supply
Input voltage range	100 V to 240 V AC 47 Hz to 63 Hz
Output	12 V DC at 0.8 A
Connectors	Supplied with connectors suitable for USA, UK, European and Australian mains outlet sockets.
Supply capacity	The instrument can be operated continuously from the -PC18 power adapter

Physical

Display	128 × 64 pixel LCD graphics panel with backlight
Keypad	Seven-key tactile membrane

Weights:

Instrument with probe	0.97 kg
Complete kit in case	4.5 kg

Dimensions:

Instrument	Height:	245 mm
	Width:	95 mm
	Depth:	50 mm
Probe	Diameter:	35 mm
	Total length:	290 mm
Carry case	Height:	135 mm
	Width:	490 mm
	Depth:	370 mm

Displayed values

Current concentration	Represents the rolling average of instantaneous particulate concentration over a user-selectable time period from 1 second to 60 seconds.
Average	Represents the average value since the instrument was switched ON or since the instrument was reset.
Max value	Represents the maximum instantaneous value since the instrument was switched on or since the instrument was reset.
	Instantaneous values are updated at intervals of 1 second.
Scrolling graph	The graph mode proves an indication of variations in particulate concentration over time.
	You can select the timebase for periods of 100 seconds, 200 seconds, 15 minutes or 60 minutes.
	The Y-axis can be set to a fixed range, or can be auto-ranging.
Factory calibration	The instrument is factory calibrated using traceable isokinetic techniques and ISO 12103-1 A2 Fine test dust (Arizona road dust equivalent).
	Four user-defined calibration settings are available to suit specific types of particulate or particular monitoring applications.
Routine calibration	The instrument's software provides an easy calibration routine for zero and span settings.
	The instrument allows confirmation of the factory calibration point by using an optical reference filter.

Data logging

Internal memory	64K EEPROM providing capacity to store more than 15700 data points.
Example capacities:	
Logging every 5 s	21 hours 48 minutes
Logging every minute	10 days 21 hours
Logger interval	Adjustable from 2 seconds to 600 seconds

Recorded values	Average concentration over logging interval
	Maximum and average values for the entire logging period are saved at the end of each logging run.
Serial interface	RS232 in discrete steps up to 38400 baud
	IrDA expansion capability
Analogue output	0 V to 2.5 V DC FSD, 500 Ω output impedance

Digital output (available only when the alarm is selected – refer to "Alarm" on page 20):

Alarm ON	2.5 V
Alarm OFF	0 V

7.2 Maintenance

The instrument requires cleaning by the factory annually, or more frequently under severe measuring conditions.

7.3 Optional accessories

176086B	12 V DC charging lead for use in a car
180043B	Extension cable for sampling probe (10 metres)

7.4 Standards compliance

The MicroDust Pro instrument complies with EMC Directive 89/336/EEC of the European Union. It has been tested according to the standard delivery schedule and complies with the following standards:

EN 50081-1 : 1992 EN 50081-2 : 1993	Generic emission standards for residential, commercial, light industry and industrial environments
EN 50082-1 : 1992 EN 50082-2 : 1995	Generic immunity standards (both for RF fields and for electrostatic discharge) for residential, commercial, light industry and industrial environments
EN 61000-4-2 : 1995 IEC 61000-4-2 : 1995	Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrostatic discharge immunity test.

8   Maintenance and Servicing

Casella CEL has an in-house service department that provides a complete range of repair and calibration services for products manufactured by Casella. Please contact the service department at the Bedford Headquarters for details of the full range of services available.

To return equipment for repair, pack it properly into the original packing materials or a good equivalent and send it fully insured and pre-paid to the following address:

> Casella CEL
> (Service Department)
> Regent House
> Wolseley Road
> Kempston
> Beds MK42 7JY
> United Kingdom

IMPORTANT
Include a letter that gives full list of the package contents, together with details of any repair work needed, fault conditions, or servicing requirements for the instrument.

For servicing outside the United Kingdom, return the instrument to the appointed distributor.

8.1   Lens contamination

In common with all items of optical equipment, the MicroDust Pro instrument's lenses can become contaminated with particulate matter that settles on exposed surfaces. Over time, this can reduce the instrument's accuracy, or can make it difficult for the instrument to give a stable zero reading.

The optical chamber and lens arrangement on the MicroDust Pro have been designed carefully to reduce the need for cleaning. However, to extend the serviceable life of the instrument you should perform this task after each measurement operation.

Cleaning the lens

1. Attach the air purge bellows to the probe's purge inlet.
2. Move the probe collar to open the sampling chamber.
3. Pump vigorously to blow clear any dust or contamination on the lens surface.

Continuous purge technique

For long-term sampling, or where you expect to make measurements in high concentrations of contamination, you should use a continuous source of dry filtered air to purge the measurement chamber. Use one of the pumps from the Casella TUFF or Apex series for this purpose. Maintain a flow rate into the purge inlet at approximately 10 % of the main sample rate.

When you use continuous purging, you must draw the aerosol sample through the measurement chamber by using an aspiration technique. If you do not do this, the clean air used for purging will prevent entry of particulate matter.

If the lens becomes so heavily contaminated that this technique does not clean it, you must return the instrument to Casella CEL for cleaning and re-calibration. Note that the instrument warranty does NOT cover this operation or general servicing of the instrument.

8.2 General maintenance

- Use a clean, slightly damp cloth to wipe the outside of the MicroDust Pro instrument. Do not use abrasive, caustic or solvent materials to clean the instrument.
- Check the condition of the battery compartment when you fit batteries to the instrument. Check for signs of corrosion and arrange any repairs necessary.
- Remove the batteries from the instrument if it will not be used for a long period of time (more than one month).
- Do not allow the instrument to become wet.

8.3 Servicing hints

There are no user-serviceable parts inside the MicroDust Pro instrument or sampling probe. DO NOT open these items. Repairs should be performed only by authorised engineers.

IMPORTANT
If you suspect the instrument has an electrical fault, or if a fault persists after you perform the servicing hint listed below, return the instrument to Casella CEL for repair..

Table 2.   Servicing hints

Fault symptom	Possible cause	Service hint
The instrument does not switch ON	Battery is discharged or does not charge (confirm whether the charge indicator comes on when you connect the charge)	Recharge the batteries or fit new batteries if necessary. Use an external power supply.
The probe always reads zero	A fault may exist on the infra-red transmitter or receiver	Check the probe connection.
There is a continuous 'over range' indication	Optical misalignment due to mechanical shock. Excessive contamination	Return the instrument to Casella for optical alignment, cleaning and re-calibration.
Zero is unstable or drifts when the probe collar covers the sampling chamber	Sample chamber contamination by dust or fibre	Follow the technique in section 8.1 "Lens contamination" to clean the sample chamber. Follow the technique in "Zero adjustment" on page 23.
A probe contamination message is displayed	Optical misalignment due to mechanical shock. Excessive contamination	Purge the probe with clean air from the bellows pump.

9   Servicing and Warranty arrangements

9.1   Inspection and test

To make certain the MicroDust Pro instrument conforms to its publish specification, the instrument is tested thoroughly and its accuracy is verified before shipment from the factory. All technical information about each individual instrument is filed under the instrument's serial number, which you should include in any correspondence concerning this instrument.

9.2   Warranty period

To ensure conformity with the specification, this instrument is thoroughly inspected and its accuracy verified prior to dispatch. All technical information is filed under the instrument serial number, which should be quoted in any correspondence. The manufacturer undertakes to rectify any defect in the instrument directly attributable to faulty design or assembly and which becomes apparent during the warranty period. In order to take advantage of this warranty, the instrument must be returned, carriage paid, to the manufacturer's factory or accredited agent, where necessary repairs will be carried out.

The warranty period runs for 24 months from the date of receipt of goods, with exceptions on certain specialised components supplied by other manufacturers that may be warranted for shorter or longer periods by their actual manufacturers. In all such cases, the benefit of these undertakings will be passed on to the user.

CASELLA CEL's liability is limited to items of their own manufacture, and they do not accept liability for any loss resulting from the operation or interpretation of the results from this equipment.

To obtain repair under warranty, the instrument should be packed and returned in its original packing or an equivalent either to CASELLA CEL's local agent, or in the case of UK domestic sales, to the CASELLA CEL Service Department at Bedford. Please include the following information:

Instrument type(s); Serial number(s) and Firmware version number(s); Customer name and address; Contact name and phone number(s); details of any PC and software involved, including version number(s); Reason for returning the equipment with a detailed description of the fault and a list of any error messages that may have been displayed.

The necessary adjustments will be carried out, and the instrument returned as soon as possible. After the warranty has expired (except on approved accounts) service work is undertaken against quotations and all packing and transit costs are charged extra.

9.3 User servicing

There are no user-serviceable components inside the MicroDust Pro instrument or the sampling probe.

DO NOT open the instrument or the probe to attempt repairs. You will cancel the warranty if you attempt to open the instrument or the probe for any reason.

If you suspect the instrument has developed a fault, contact your local Casella CEL agent to arrange for service and repair.