Turnkey Instruments Ltd

Osiris

Operating Instructions

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OSIRIS KEYPAD QUICK REFERENCE

KEY-PRESS	FUNCTION
[ON]	to switch on
[RESET]	to quit editing to see battery condition & location
[EDIT]	to select the OSIRIS Editor
[ENTER]	to select an operation or confirm a response to enter the changes made during editing
[START]	to start or stop sampling
[STOP]	to clear memory to review stored results to clear a value during editing
[↑]	to increase a value to say YES
[↓]	to decrease a value to say NO
[←]	to move display cursor left to go to previous display
[→]	to move display cursor right to go to the next display

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OSIRIS AND AIRQ FOR WINDOWS

The OSIRIS environmental monitor can be supplied with AirQ32 Windows software. This enables results stored in the OSIRIS memory to be uploaded into your PC when you have completed sampling. Additionally your PC can be used to control and collect results from the OSIRIS sensor in real time.

AirQ is designed to collect, manage and display data from a range of environment sensors, either as individual sensors or in real-time when connected to a sensor network. The sensors can be used to measure a whole range of environmental quantities such as PM10 particles, airborne fibres, VOCs and pollutant gases. Meteorological signals can also be recorded as an aid to determining the source of the pollution. For example, a live on-screen Pollution Rose can be created which plots pollutants against wind heading on a polar chart.

AirQ is provided with extensive on-line help with hypertext links, clicking an on-screen button with a blue question mark will automatically open the relevant help page.

INSTALLATION OF AIR32Q AND AIR32Q-LITE

The program is supplied on CD and requires Windows 95 or above to operate. An un-installer is provided with the program. Approximately 20 MB of free disk space is required on drive C: to complete the installation

To install in Windows: Insert the CD it should launch automatically if not run **setup.exe,** then follow the on-screen instructions.

AirQ32 will be installed in C:\Airq32. Sample results which can be imported, if required, are to be found in C:\Airq32\Examples.

GETTING STARTED WITH OSIRIS

SWITCHING ON: To turn the instrument on, press and release the switched marked **[ON]**. After a short self test (see below) the display will show ***"OSIRIS ready"***, together with the time and date. If the battery needs re-charging, the display will show ***"OSIRIS paused"*** and continuously flash ***"Charge battery".***

The battery must be fully re-charged as soon the ***"Charge battery"*** warning appears.

Fit the Automatic Power Key into the Local Interface connector if you wish the instrument to switch itself on when power is applied.

SWITCHING OFF: Providing the instrument is not sampling it will switch itself off automatically if no buttons have been pressed for 4 minutes. To manually switch off the instrument press **[STOP]** and **[←]** together. The OSIRIS will not switch off while on-line to AirQ.

DISPLAY CONTRAST: To adjust the contrast of the display press and hold **[RESET]** as the instrument is switched-on until the display goes black after about 3 seconds. Then use the **[↑]** or **[↓]** buttons to darken or lighten the display respectively. Press **[ENTER]** when the required contrast is obtained. OSIRIS will automatically remember this setting and use it each time it is switched-on. The contrast can only be adjusted as you switch the instrument on, and once set to suit you it should not normally need re-adjusting.

SELF TEST: As OSIRIS is switched on it carries out certain self tests to make sure it is working correctly. At the end of the self test the display will show ***"Last Serviced at"***, this is the time and date when the instrument was serviced. If this is more than a year ago, the display will show ***"PLEASE HAVE ME FACTORY SERVICED"*** instead.

If the instrument detects a fault with its memory during the self test the display will show ***"MEMORY ERROR".***

If the instrument has a potential fault the display will show ***"INSTRUMENT FAULT".***

In both of the above cases, the instrument will automatically revert to its default settings and may still be usable – albeit with reduced accuracy. After the error message, the display will show ***"PLEASE HAVE ME FACTORY SERVICED"***. In this case please contact the factory as soon as possible.

MEMORY: If you press **[RESET]** while the display shows ***"OSIRIS ready"*** or during sampling, the display will switch to indicating the battery voltage, the internal case temperature and the percentage of memory used. Release **[RESET]** to revert to the normal display. During dust sampling, when **[RESET]** is released, the display will first show the sample number and instrument location.

The fully charged battery voltage is about 6.4 volts (charger disconnected). It is suggested that the battery is recharged if its voltage drops below 5.9 volts. Sampling will cease automatically and the display will indicate ***"OSIRIS paused"*** if the battery drops below about 5.8 volts. Sampling will also cease if the case temperature exceeds 50 C.

As the percentage of memory used approaches 100% you should cease sampling soon as possible and transfer your results to a PC. There is some leeway here, for the memory is only truly full when the indicator shows 120%. Sampling will cease automatically and the display will indicate ***"OSIRIS paused"*** if the end of the memory is reached.

The battery charger should be connected to the ***Power & Telemetry Connector.*** When the battery charger is connected the battery voltage will eventually rise to about 7.25 volts.

OSIRIS EDITOR

The OSIRIS Editor allows some of the instrument settings and parameters to be changed. To select the editor press **[EDIT]** while the display shows **"*OSIRIS ready*"** or during dust sampling, then use **[←]** or **[→]** to select what to edit followed by **[ENTER]** to select. Note that during dust sampling the number of items which can be edited is restricted.

When your instrument is connected to your PC, the settings and parameters can also be changed via the AirQ Configuration Window. Please refer to the next section for details.

Operator ID allows the user to change the name identification of the instrument operator. Up to 16 alphanumeric characters can be entered. Press (and hold to speed up) **[↑]** or **[↓]** to change the flashing character then **[←]** or **[→]** to move on to the next character position. Press **[ENTER]** to quit and save the revised entry. Press **[RESET]** to quit without saving. Press **[START]** to clear the whole entry to underscores.

Location allows the user to change named location of the instrument. The characters are edited in the same fashion as OPERATOR ID.

OSIRIS Settings: the instrument is provided with several settings which can changed by the user . Press **[↑]** to say YES to a particular setting, **[↓]** to say NO. Then press **[ENTER]** to save the revised entry and move on to the next. Press **[RESET]** to return to the editor.

Differential Mode: select YES to allow the instrument to measure differences between TSP and PM2.5, or PM10 and PM2.5. **This option is only available when memory has been cleared.** AirQ will automatically sense if the mode has changed and upload the new settings describing the differential channels PM10-PM2.5 and TSP-PM2.5 etc.

Workplace Mode: select YES to measure and record the workplace size fractions of Inhalable, Thoracic and Respirable; NO to measure and record the environmental size fractions of Total Particles (TSP), PM10, PM2.5 and PM1. The option to change modes is only available after the sample memory has been cleared. See ***How Does it Work?*** and Appendix D for additional information on size selection and measurement ranges.

Telemetry Mode: select YES for 1200 baud communications, select no for 9600 baud. Any change will not be implemented until the instrument is switched off and switched on again. If the telemetry mode is selected the serial communications are directed via the Telemetry Connector, if not via the PC Link Connector (refer to Appendix A).

Total Particles: select YES to allow the instrument to measure and record the particle concentration during sampling based on all the particles physically entering the inlet without additional electronic selection. Environmental mode only.

Measure in µg/m³: select YES to cause the instrument to measure and record the *total particle concentration in micrograms per cubic metre* with a resolution of 0.1 up to a maximum of 6000 µg/m^3. Otherwise results are measured in *milligrams per cubic metre* with no electronic size selection (i.e. PM10, PM2.5 and PM1 not available) up to a maximum of about 60 mg/m3.

PM10 Particles: select YES to allow the instrument to measure and record PM10 particles electronically selected from those physically entering the inlet. Environmental mode only.

Measure in µg/m³: select YES to cause the instrument to measure and record the *PM10 particle concentration in micrograms per cubic metre* with a resolution of 0.1 up to a maximum of 6000 µg/m³. Otherwise results are measured as *number > 10 micron diameter per cubic centimetre.*

PM2.5 Particles: select YES to allow the instrument to measure and record PM2.5 particles electronically selected from those physically entering the inlet. Environmental mode only.

Measure in µg/m³: select YES to cause the instrument to measure and record the *PM2.5 particle concentration in micrograms per cubic metre* with a resolution of 0.01 up to a maximum of 600 µg/m³. Otherwise results are measured as *number > 2.5 micron diameter per cubic centimetre.*

PM1 Particles: select YES to allow the instrument to measure and record PM1 particles electronically selected from those physically entering the inlet. Environmental mode only.

Measure in µg/m³: select YES to cause the instrument to measure and record the *PM1 particle concentration in micrograms per cubic metre* with a resolution of 0.01 up to a maximum of 600 µg/m³. Otherwise results are measured as *number > 1 micron diameter per cubic centimetre.*

Inhalable Particles: select YES to allow the instrument to measure and record the particle concentration according to the Inhalable Convention electronically selected from those physically entering the inlet. Workplace mode only.

Measure in µg/m³: select YES to cause the instrument to measure and record the *Inhalable particle concentration in micrograms per cubic metre* with a resolution of 0.1 up to a maximum of 6000 µg/m³. Otherwise

results are measured in *milligrams per cubic metre* with no electronic size selection up to a maximum of about 60 mg/m3.

Thoracic Particles: select YES to allow the instrument to measure and record Thoracic Convention particles electronically selected from those physically entering the inlet. Workplace mode only.

Measure in µg/m³: select YES to cause the instrument to measure and record the *Thoracic particle concentration in micrograms per cubic metre* with a resolution of 0.1 up to a maximum of 6000 µg/m³. Otherwise results are measured as *number >10 micron per cubic centimetre.*

Respirable Particles: select YES to allow the instrument to measure and record Respirable Convention particles electronically selected from those physically entering the inlet. Environmental mode only.

Measure in µg/m³: select YES to cause the instrument to measure and record the *Respirable particle concentration in micrograms per cubic metre* with a resolution of 0.01 up to a maximum of 600 µg/m³. Otherwise results are measured as *number > 4 micron per cubic centimetre.*

PM2 Particles: select YES to allow the instrument to measure and record PM2 particles electronically selected from those physically entering the inlet. Workplace mode only.

Measure in µg/m³: select YES to cause the instrument to measure and record the *PM2 particle concentration in micrograms per cubic metre* with a resolution of 0.01 up to a maximum of 600 µg/m³. Otherwise results are measured as *number> 2 micron per cubic centimetre.*

Store in Seconds: select YES for the instrument to save to memory in multiples of one second, NO to save in multiples of one minute. Note memory capacity will be used very quickly if one second storage is used. You cannot use multiples of one second when sampling on-line with AirQ for the program will always reset it to multiples of one minute. However,

you can upload to AirQ off-line samples stored in multiples of one second.

Wind Speed Input: select YES to allow the instrument to measure and record the wind speed during sampling. An external anemometer must be connected. Only available when the instrument is equipped with the meteorological interface.

Wind Heading: select YES to allow the instrument to measure and record the wind direction during sampling. An external wind vane must be connected. Only available when the instrument is equipped with the meteorological interface.

Password Protect: select YES to force a password to be required to access the OSIRIS Editor or the Sampling Mode. The entry password is **[←] [ENTER] [ENTER] [➔]**, a * will appear on the display as each key is pressed. Prevents un-authorised tampering with the instrument settings.

Automatic Start: select YES for the instrument to start sampling immediately power is turned on. Only to be used when sampling off-line from AirQ and you wish the instrument to restart sampling itself automatically when power is restored (Autostart link must be connected) or if the instrument pauses sampling due to a low supply voltage or over temperature. Set to NO if you are using AirQ to control the instrument for on-line sampling, AirQ will restart the instrument when conditions are right. In fact the Automatic Start setting is always off and not shown when the Telemetry Mode is selected.

New Sample Daily: select YES for the instrument to automatically start a new sample at midnight each day. You must also select automatic start otherwise the instrument will just stop sampling at midnight and not restart a new sample.

Inlet Heating: select YES for the instrument to always heat the inlet when sampling with the Heated TSP inlet option. The NO setting reduces power consumption.

Alarms Enabled: select YES to cause the alarm output to activate when the dust concentration exceeds the specified alarm level. Select NO to disable the alarm. The concentration integration time to assess the alarm state is equal to the storage interval and this value will not necessarily be equal to the instantaneous or average values shown on the display.

Mass Calibration: allows you to change the calibration factor for each of the size fractions in terms of concentration in mass per volume of air. This calibration cannot be altered while the instrument is sampling dust.

The default setting is 01.00, allowing an adjustment range of 990%. For a given dust, the calibration factor is equal to the gravimetric mass obtained from a filter weighing divided by the OSIRIS Mean reading taken over the same period. There is a separate calibration factor for each of the size fractions.

Press **[↑]** or **[↓]** to change the flashing digit then **[←]** or **[➔]** to move on to the next digit position. Press **[ENTER]** to quit and save the revised entry. Press **[RESET]** to quit without saving. Press **[START]** to reset the calibration factor to 1.00.

Storage Interval: allows the user to select the intervals in time at which results are stored in memory. The range is 1 minute to 60 minutes if ***Store in Seconds*** is OFF, 1 to 240 seconds if ON. The value stored is the average reading taken over the storage interval.

Press (and hold to speed up) **[↑]** or **[↓]** to change the interval then press **[ENTER]** to save the revised value. The storage interval cannot be changed when sampling.

You cannot *save in seconds* when sampling on-line to AirQ, AirQ will always turn it off when sampling starts. However, you can upload to AirQ off-line samples which have been "saved in seconds".

Autostop Counter: allows the duration of the sample to be set. If set to zero, the instrument will sample until stopped manually. The instrument will cease sampling after the indicated number of saves to memory (i.e. the sample duration will be Autostop Count times Storage Interval). Use **[↑]** or **[↓]** to change then **[ENTER]** to save the new value. If ***Automatic Start*** is ON, the instrument will automatically start a new sample of the same duration.

Adjust Clock: allows the time to be changed to compensate for daylight saving. On selection, the minutes value will flash to indicate it can be adjusted, use **[↑]** or **[↓]** to change then **[ENTER]** to save the new value, the hours value will then flash and can be adjusted likewise. The date can only be changed at the factory. The time and date are set by AirQ to the PC time when on-line sampling starts.

Filter & (Man or Aut) Flow: pressing **[ENTER]** shows the time and date the filter was last changed, and the sampling time in minutes it has been used up to a maximum of 65536 minutes (45.5 days).

Press **[RESET]** again to display the total mass of dust the instrument (based on its current calibration factor and a flowrate of 600ml/min) thinks it has accumulated (over all samples) on its filter. This is a useful aid to calibration - see Appendix.

Press **[RESET]** to display the total operating time for the pump in hours.

Press **[RESET]** again and you are prompted to change the filter, press **[ENTER]** followed by the password **[START] [START] [START]** to do

so. The filter timer and filter mass accumulator (but not the pump time accumulator) will be automatically reset at this time.

If you do not wish to change the filter, just press **[RESET]**.

You will then be prompted to set the sample airflow to its correct value. Connect a 4 mm OD plastic tube and flow meter to the inlet Luer fitting on top of the instrument. **The correct sample flow during is 600 cc/min.** Use **[↑]** or **[↓]** to change then **[ENTER]** to save the new value.

Display Refresh: allows the user to select the time interval at which results display is updated. The range is 1 second to 240 seconds. The value displayed on the LCD will be the average reading taken over this interval. Press (and hold to speed up) **[↑]** or **[↓]** to change the interval then press **[ENTER]** to save the revised value.

Results Display: allows the user to select which results will be displayed on the LCD during sampling. The selection can be changed during sampling. The available options are:

Backlighting: select YES to turn on the display backlight for viewing in poor light. The extra power used will reduce the total sampling time on internal batteries by about 30%. Note backlighting can also be controlled via AirQ.

Display Cycling: select YES if you want the display to automatically scan around the available results channels. If you select NO then, during sampling, the results channel shown on the LCD can be changed manually using **[←]** or **[→]**.

Latest Dust: select YES if you want the display to show the latest particle concentration. This will be the time weighted average over the Display Refresh interval.

Average Dust: select YES if you want the display to show the average particle concentration since the sampling started. Note that average results are only available after the first results have been saved in memory (i.e. after the storage interval).

Latest Wind: select YES if you want the display to show the latest wind speed and direction. This will be the time weighted average over the Display Refresh interval. The average direction is taken as the most frequent direction over the interval. Only available if meteorological interface fitted.

Average Wind: select YES if you want the display to show the average wind speed and direction since the sampling started. Note that average results are only available after the first results have been saved in memory (i.e. after the storage interval). Only available if meteorological interface fitted.

Latest External: select YES if you want the display to show the latest external input readings. This will be the time weighted average over the Display Refresh interval.

Average External: select YES if you want the display to show the average external input readings since the sampling started.

Zeroing Interval: allows the user to select the time intervals when autozeros will carried out. The range is 0 hour to 240 hours. The instrument automatically zeros itself when starting to sample and thereafter "*on-the-hour*" at the interval shown on the LCD.

If the interval is set to 0 hours, no further zeroes are carried out. Autozeros last for about 5 seconds during which time the pump is switched off. The default interval is 1 hour. The previous reading is held during autozeros.

If the instrument cannot find a stable zero after seven attempts it will revert back to the zero value it used previously.

Press (and hold to speed up) **[↑]** or **[↓]** to change the interval then press **[ENTER]** to save the revised value.

Anemometer cal: allows you to change the calibration factor for the anemometer in pulses per metre per second wind speed. This factor cannot be altered while the instrument is sampling.

The default setting is 02.00, that is two pulses for each metre per second of wind speed (roughly one pulse per knot).

Press **[↑]** or **[↓]** to change the flashing digit then **[←]** or **[→]** to move on to the next digit position. Press **[ENTER]** to quit and save the revised entry. Press **[RESET]** to quit without saving. Press **[START]** to reset the calibration factor to 1.00.

Invert Windgauge: allows you to compensate for the potentiometer wiring in your wind vane by swapping the apparent East and West directions. To confirm the setting is correct, start the instrument sampling and move the wind vane manually while viewing the wind heading display.

Set Dust Alarm: allows you to set the particle concentration at which the alarm will operate. The alarm operates on the average reading on the Total Particles (Inhalable) channel during the storage interval and is expressed as a percentage of the instrument's alarm scale.

On the microgram range the alarm scale is 1000 micrograms, so a 10.00% alarm corresponds to 10 micrograms per cubic meter dust concentration.

On the milligram range the alarm scale is 10 milligrams, so a 10.00% alarm corresponds to 1.0 milligrams per cubic meter dust concentration.

The default alarm setting is 01.00% of scale. Press **[↑]** or **[↓]** to change the flashing digit then **[←]** or **[→]** to move on to the next digit position. Press **[ENTER]** to quit and save the revised entry. Press **[RESET]** to quit without saving. Press **[START]** to reset the calibration factor to 1.00.

EDITING WITH AIRQ

From the AirQ Configuration Window the following OSIRIS sensor settings and parameters can be altered.

Location: the instrument's location, with AirQ the operator is always ***"Remote Control"***

Integration Time: the OSIRIS storage interval.

Alarms ON at: the OSIRIS alarm level as % of alarm range

Mass Calibration: the OSIRIS mass calibration factors

Measure TSP/Inhalable/TSP-PM2.5: set OSIRIS to measure TSP/ Inhalable/TSP-PM2.5

Measure PM10/Thoracic/PM10-PM2.5: set OSIRIS to measure PM10/ Thoracic/PM10-PM2.5

Measure PM2.5/Respirable: set OSIRIS to measure PM2.5/Resp.

Measure PM1/PM2: set OSIRIS to measure PM1/PM2

Measure Wind Speed: set OSIRIS to measure wind speed

Measure Wind Heading: set OSIRIS to measure wind direction

Alarms Enabled: set the alarm to operate if exceeded.

Continuous Heat: set the inlet heater to be on permanently

AirQ Controlling: allow AirQ to control the heater etc., not OSIRIS

Password Protect: password required for OSIRIS keypad.

Note you cannot change in or out of ***Workplace Mode*** using AirQ, but it will sense which mode you are in and get the appropriate descriptions from the sensor. Please refer to the AirQ online help for further information.

OSIRIS MANUAL SAMPLING MODE

The Sampling Mode allows you to manually tell OSIRIS to start or stop dust sampling and to review the sample results stored in its memory. To select the Sampling Mode press **[START]** when the display shows **"*OSIRIS ready*"**. You will then be prompted with various questions:

RESET MEMORY?: Select YES if you wish to set the instrument memory back to the beginning and the sample number back to 1. You must do this before changing to or from the Workplace Mode. Make sure you have uploaded all the results you wish to keep before doing this as they will be lost irretrievably when the memory reset. Press **[ENTER]** to execute the selection. As a precaution, if you have said YES, the instrument will prompt you with:

ARE YOU SURE ?: select YES to confirm the memory reset and then **[ENTER].**

START SAMPLE nn: where nn is the identification number (between 1 and 85) of the sample you are about to start. It will be Sample 1 if you have just reset the memory. Select YES if you wish to start sampling and press **[ENTER]** to execute. The pump will turn on and dust sampling will commence. If you select NO the review results option appears (providing some results are already in memory).

REVIEW RESULTS: select YES if you wish to review the results saved so far, then **[ENTER]** to execute. The review will show on the LCD. For each completed sample, the sample identification number, its start and stop time, its location and the mean dust concentration over the sampling period will be displayed. Press **[←]** or **[→]** to move on to the next or previous sample. Press **[RESET]** to quit.

You can also select the Sampling Mode whilst OSIRIS is sampling. In this case only one option is available:

STOP SAMPLE nn: where nn is the identification number (between 1 and 85) of the dust sample currently being taken. Select YES if you wish to stop sampling and press **[ENTER]** to execute. The pump will stop and sampling will cease. Providing the sampling duration was long enough to have saved results in memory, when you next start sampling the sample identification number will automatically increase by one. If no results were saved, the sample number will not change. If Sample 85 is reached you will be invited to reset the memory to Sample 1.

The present time and date, the time the sample started and the sample number can also all be displayed on the LCD whilst OSIRIS is sampling by pressing and releasing **[RESET]**. Note that the time the sample started is recorded as when the first result is stored.

REMOTE SAMPLING WITH AIRQ

AirQ can be used to start and stop sampling and continually gather results remotely when the OSIRIS is connected to a PC. Please refer to the AirQ on line help for instructions on how to do this.

Note that if the sampling is started in this way, the operator will automatically be called **"Remote Control"**. In addition the internal memory of the OSIRIS will not be used (and the internal sample number will not be incremented) as the results are continually being transferred to the PC.

However, if for whatever reason, the PC looses communications with the OSIRIS for more than about 4 minutes, the OSIRIS will automatically cease sampling and restart a new sample using its next internal sample number with results being stored in its internal memory for uploading later to the PC. In other words just like the manual sampling mode described in the previous section.

If communications are subsequently recovered, AirQ will attempt to start a new on-line sample and, if successful, results from this new on-line sample will not be stored internally in the OSIRIS memory. The measurements taken when the OSIRIS was off-line will, however, be retained and should be uploaded to the PC if required. This can be done even when the sensor is sampling on-line.

Do not select ***Automatic Start*** in the ***Osiris Settings*** menu if you are sampling on-line with AirQ, it will prevent AirQ taking proper control of the sensor. When you start sampling on-line the OSIRIS clock is automatically synchronised with that of your PC.

SAMPLING WITH OSIRIS – HOW DOES IT WORK?

Do not sample with the instrument if the ambient temperature is above 40 C, or if the instrument is in direct sun such that the case temperature will rise above 40 C. Doing so will shorten the life of the laser and invalidate the product warranty. The instrument will automatically pause sampling and turn the laser off if the case temperature exceeds 50 C. Please see Appendix C.

OSIRIS uses a light scattering technique to determine the concentration of airborne particles and dust in the size range from about 0.4 microns (1 micron = 10^{-6} metre) to about 20 microns in diameter. Above 20 microns, all particles are sized as 20 microns.

The air sample is continuously drawn into the instrument by a pump with a flow rate set by the microprocessor at 10 cc per second (600 cc/min). The incoming dusty air passes through a laser beam in a photometer and then through a filter to remove the particles before reaching the pump.

On the microgram per cubic metre ranges, the instrument sizes individual particles as they pass thorough the laser beam. Over 20,000 particles a second can be sized before coincidence (two particles in the beam at once) effects occur. This typically corresponds to a concentration of much greater than 6000 micrograms per cubic metre.

The light scattered by the individual particles of dust is converted into a electrical pulse which is proportional the size of the particle. A unique feature of the Turnkey photometer is that only light scattered through very narrow angles is measured. This narrow angle scatter is virtually the same for black or white particles of the same size. That is, it doesn't depend on the material composition of the particle; on the other hand, the easier to measure right angle scatter is highly dependant on material composition.

The intensity of the light pulse is therefore an indicator of particle size and from this the microprocessor is able to calculate the expected mass of the particle. It actually assumes the material density of the particle is 1.5 and this is where the mass calibration factor comes in to play. However, for most airborne dusts a density of 1.5 grams/cc is a good approximation.

Having evaluated the mass of the particle, the microprocessor then evaluates the likely chance of deposition of the particle according to the sampling convention being used. These sampling conventions are reproduced in Appendix D. Thus for the Thoracic Convention a 6 micron particle has a 80.5 % of chance of deposition, hence only this percentage of its evaluated mass is accumulated.

Over the course of the sample integration period this mass accumulation continues as more and more particles pass through the laser beam. A calibration factor to compensate for material density is applied to the final accumulation to produce a mass concentration reading for the dust being sampled. The shortest accumulation period is one second.

When properly calibrated, results are expressed in micrograms per cubic metre with a resolution down to 0.01 microgram. The average and latest concentrations can be shown on the display provided they have been selected in the *Results Display* portion of the Editor.

The milligram range is activated by selecting NO for ***Measure in µg/m³*** for Total Particles, or Inhalable in Workplace Mode. If the milligram range is selected all the electronic size selection options are automatically disabled.

Note that the milligram range is for indication purposes only, since at these high concentrations several particles may be present in the laser beam at the same time. Accurate sizing therefore proves impossible and the reading is based on the statistical fluctuations in the signal. For this reason the milligram range may show some statistical scatter at low concentrations. However, it is proportional to the dust concentration and sufficient to show if remedial action is working.

The instrument is normally fitted with a heated TSP inlet which should be cleaned periodically.

Various size selective inlets are also available for the instrument. These are the PM10, PM5 and PM2.5 impactors and a PM10 vertical elutriator. These can be used to collected a size selected gravimetric sample on the instrument's filter. Of course if

a size selective inlet is used, the electronically size selected mass calculated by the instrument no longer strictly valid (for example, PM10 would become PM10 squared with a PM10 inlet), but the Total Particle channel will represent the particle mass seen on the instrument's filter.

For sampling in very wet conditions or long term sampling outdoors it is recommended the Weather Shield is fitted in place of the M8 stainless steel set screws in the instrument lid. The Weather Shield is available from the manufacturers and can incorporate a heated TSP inlet which can be used in place of the standard inlet.

The exhaust port is located in the base of the instrument. It is important that water is prevented from entering the instrument case via the exhaust. When not sampling, the port can be sealed with an M5 screw and viton washer. This effectively seals the exhaust port and also prevents the instrument drawing in air through the sample inlet. Closing the exhaust in this fashion can be used to check the instrument zero. With the exhaust closed off, the pump will pressurise the instrument case and the procedure can be used for confirming the water tightness of the case by checking for zero flow into the Luer fitting.

If required a simple 4mm OD plastic tube can be pushed into the Luer fitting. When drawing a sample via a tube in this manner from a pressurised system return the flow by connecting a right angle Banjo fitting and tube to the exhaust port. Failure to do so will result in an incorrect flow rate and imbalance of the clean air flow within the instrument.

Note that OSIRIS will cease sampling and the display will show ***"OSIRIS paused"*** when the battery voltage drops below about 5.8 volts (or if the case temperature rises above 50 C, or if the memory is full). The former may happen if you are doing long term sampling while connected to an intermittent external power source. Before pausing, the instrument will correctly terminate the present results store in memory so that nothing is lost. If you wish the instrument to restart automatically (with a new sample number) when the battery recovers, the **Automatic Power Key** should be fitted to the **Local Interface** connector and **Automatic Start** selected in the *OSIRIS Settings* menu. If Automatic Start is selected, the instrument will restart

itself when an excessive temperature cools.

When sampling off-line, each dust sample taken with OSIRIS is identified by a sample identification number, and optionally the operator and location. A review of the completed sample results can be done by OSIRIS itself or alternatively the stored information uploaded to AirQ for Windows software.

UPLOADING STORED RESULTS

To upload stored results to AirQ connect the PC-Link lead provided with your instrument to the Local Interface connector and to one of the serial ports of your PC. Then refer to the on-line help provided with AirQ. You can upload stored results while OSIRIS is still sampling (although you cannot upload the current sample being taken). If the OSIRIS is not sampling you can also use AirQ to erase its memory and change other settings of the instrument.

MAINTENANCE

The are no user serviceable parts inside the OSIRIS instrument case. The manufacturer's warranty is invalidated if the case seal is broken.

The OSIRIS photometer contains a Class 3B laser which may cause eye damage if the photometer is opened.

CHARGING THE BATTERY: To re-charge OSIRIS battery, connect the charger supplied with the instrument to the **Power & Telemetry** connector on the front panel. Switch on the mains power to the charger. A full charge takes about 8 hours.

With a fully charged battery, OSIRIS can be operated for up to 10 hours. For longer sampling periods you must leave the battery charger (or any other 12 volt dc power supply) permanently connected to the instrument.

Always recharge the battery as soon as possible after the **"Charge Battery"** warning appears on the display.

To get the best performance and battery life out of your OSIRIS it is important that the battery is kept in good condition.

If the battery has gone into deep discharge through neglect or miss-use, it may take up to 72 hours of re-charging to fully recover its capacity.

DO NOT CHARGE THE BATTERY IF THE INSTRUMENT EXHAUST PORT IS CLOSED.

CHANGING THE CALIBRATION FILTER: The calibration filter is designed to collect dust particles for calibration purposes and to protect the pump and photometer. It is located on the bottom of the instrument directly beneath the sample inlet.

The recommend filter type is Whatman GF/A 25mm fibre glass circles.

To change the filter, remove the 3 thumbscrews securing the filter cap to its base. The cap contains the filter circle secured by an O-ring. Check the O-ring is in good condition when replacing the filter. Check too the smaller O-ring for the off-centre exhaust tube on the base. Proper sealing cannot be obtained unless both O-rings are fitted. Make sure the small O-ring is aligned with the exhaust tube in the base before refitting the filter cap. To do this, the small O-ring should be to the rear when the filter cap is refitted.

Never run the instrument without the calibration filter. There is a high capacity secondary filter tube near to the pump which protects the pump and photometer but this will eventually become clogged too, necessitating replacement.

CALIBRATION: To calibrate the instrument divide the weight of dust on the filter (in micrograms) by the volume of air passed through it. This is the ***Filter Concentration*** and the Calibration Factor should be adjusted by the ratio (Filter Concentration)/(Average Dust Reading). For a single sample the accumulated dust reading is equal to the average dust reading for that sample. See below for calibrations over multiple samples.

As an aid to calibration Osiris will automatically record the number of minutes the filter has been used for, up to a maximum of 65536 (about 45 days). It will also record the *Accumulated Dust Mass* in milligrams it has seen (over all samples) using its old calibration factor and assuming a flow rate of 600 ml/min. See the ***Filter and Airflow*** section of the Editor. In this case, the Calibration Factor should be adjusted by the ratio (Increase in Filter Mass)/(Accumulated Dust Mass).

Because the instrument cannot determine the material density, the calibration factors may change depending on the type of dust.

CLEANING THE INLET: Before sampling begins make sure that the **TSP Inlet** is clean. The inlet is a push fit into the metal Luer fitting on the instrument lid. Remove the inlet by gently pulling and twisting to leave the Luer fitting in the lid.

Do not remove the four Allen button screws on the instrument lid which hold the Luer fitting in place.

When replacing the impactor make sure the Luer fitting is pushed down hard.

The Luer Inlet can itself be remove for cleaning by gently pulling and twisting. Replace by carefully pushing and twisting.

CORRECT FLOW RATE: To provide the correct particle size selection characteristic the instrument the flow rate must be set to 600 cc/min. It is recommended that the instrument flowrate is checked and adjusted periodically using a rotameter or other type of flowmeter.

ZERO CHECKING: The instrument zero can be checked for value and stability by inserting the supplied GF/A syringe filter into the Luer inlet while sampling

ALWAYS REMOVE THE INLET FROM THE LUER FITTING BEFORE PLACING THE INSTRUMENT IN ITS YELLOW CARRYING CASE. FAILURE TO DO SO MAY DAMAGE THE INLET WHEN THE LID IS CLOSED. MAKE SURE THERE ARE NO OTHER ITEMS NEAR THE INLET WHEN THE LID IS CLOSED.

It is recommended that OSIRIS be serviced once per year or earlier if the instrument self test warns of an instrument fault.

Turnkey Instruments Ltd and its distributors can offer a Service Contract for your OSIRIS which includes a lifetime guarantee for your instrument. Please contact your supplier for details.

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If you need assistance please contact:

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APPENDIX A

Connector Pin Connections

Connector type is Bulgin Mini Buccaneer with either pin or socket contact carriers.

Power and Telemetry (8 way pin carrier on case)

Pin L (3)	+12 volt DC external power supply
Pin N (2)	0 volt external power supply. Connected to instrument case.
Pin GND	0 volt return circuit for heaters and alarm. Connect to power supply 0 volt near to power supply.
Pin 1	Telemetry Wire 2 Opto-isolated digital telemetry (1200 baud). Connect to black terminal on telemetry control unit. Conect to REMOTE LOOP 2 on TIM Radio Modem.
Pin 2	Telemetry Wire 1 Opto-isolated digital telemetry(1200 baud). Connect to red terminal on telemetry control unit. Connect to REMOTE LOOP 1 on TIM Radio Modem.

Pin 4	Inlet Heater -ve side of inlet heater. Driven by 60 volt 1 amp MOSFET. Pulled to 0 volts when heater is on. Use diode protection when driving inductive loads. Connect +ve side of inlet heater to power supply +ve, make sure 0 volt return (Pin GND) is connected to power supply -ve.
Pin 5	Alarm -ve side of alarm circuit. Driven by 60 volt 1 amp MOSFET. Pulled to 0 volts when Alarm is on. Use diode protection when driving inductive loads. Use relay to drive high power loads. Connect +ve side of alarm circuit to power supply +ve, make sure 0 volt return (Pin GND) is connected to power supply -ve.
Pin 7	Inlet Fan or Gauge Heater -ve side of inlet fan or rain gauge heater. Driven by 60 volt 1 amp MOSFET. Pulled to 0 volts when on. Use diode protection when driving inductive loads. Connect +ve side of inlet fan to power supply +ve, make sure 0 volt return (Pin GND) is connected to power supply -ve.

Meteorological Inputs (8 way socket carrier on case)

Pin L	+ 5.0 volt regulated output current limited to 100 mA. Use to supply meteorological instruments
Pin N	Analogue common 0 volts
Pin G	Instrument case
Pin 1	wind direction potentiometer. Recommended value 5k to 10k Ohm Analogue input signal, 0 volt to +5 volts generated by 360 degree continuous rotation potentiometer, typical electrical rotation 340 degrees or better. We provide 0 volt and +5 volt voltage drive for potentiometer. Input bias current from wiper is less than 20 micro Amperes. 0.0 volts due North (0 degrees) 1.25 volts reads due East (90 degrees) 2.5 volts reads due South (180 degrees) 3.75 volts due West (270 degrees) 5.0 volt due North (360 degrees) West and East can be interchanged by selecting Inverted Windgauge

Pin 2	wind speed pulses. Terminal is biased at +5 volt. Pulse counting input to be driven by open collector transistor or reed relay. We provide +5 volt bias and 0 volt common. Pulses should pull the input below +1 volt to be registered. De-bounced in software to maximum count rate of 100 pulses per second. Pulse calibration adjustable in software.
Pin 4	External 2 voltage input 0.0 to 5.0 volts, 12 bit resolution 200 kilo-ohm input impedance
Pin 5	External 1 voltage input 0.0 to 5.0 volts, 12 bit resolution 200 kilo-ohm input impedance
Pin 7	External 3 pulse counting input for traffic counting (option only) Terminal is biased at +5 volt Pulse counting input to be driven by open collector transistor or reed relay. We provide +5 volt bias and 0 volt common. Pulses should pull the input below +1 volt to be registered. Maximum count rate 1000 pulses per second.

Local Interface (8 way pin carrier on case)

Pin L	Automatic power-up when connected to 0 volt
Pin N	analogue PM10 output (optional only) 0 to 4 volts, 12 bit resolution 100 ohm output impedance 0 to 4000 micrograms/cubic metre 0 to 40 milligrams per cubic metre
Pin G	future expansion
Pin 1	PC-Link serial transmit (9600 baud)
Pin 2	PC-Link serial receive (9600 baud)
Pin 4	0 volt
Pin 5	+ 5.0 volt regulated output current limited to 100 mA.
Pin 7	future expansion

APPENDIX B

Table of Recording Times

The instrument is fitted as standard with a 128 k byte memory. The recording duration will be reduced slightly if a large number of separate samples recorded. The memory is full when the indicator shows 120%.

Particles only (4 channels)

Save Interval	Recording duration
1 minute	5.5 days
5 minutes	28 days
15 minutes	85 days

Particles (4 channels), wind (2), external (2)

Save Interval	Recording duration
1 minute	3 days
5 minutes	14 days
15 minutes	42.5 days

APPENDIX C

Technical Specification

Measuring Ranges (with unity calibration factor)	(i) zero to > 6000.0 micro-grams per cubic metre with a resolution of 0.1 or 0.01
	(ii) zero to > 60 milli-grams per cubic metre with a resolution of 0.001
Calibration Filter	Whatman GF/A 25 mm circle
Operating Time	10 hours from fully recharged internal battery
External Power Source	10 to 12 volts at 150 mA (250 mA with backlight)
Operating temperature	-5 C to +40 C. Must be sampling prior to excursions below freezing.
Humidity	up to 100%. Water must be prevented from entering the inlet or exhaust
Particle size range	0.4 to 20 microns diameter
Pump flow rate	600 cc per minute
Dimensions	260 x 160 x 190 mm

APPENDIX D

Collection Efficiencies in % for Particle Size Conventions

Aerodynamic Diameter µ	Inhalable EN481	Thoracic EN481	Respirable EN481	PM10 EN12341
0.0	100	100	100	100
1.0	97.1	97.1	97.1	100
2.0	94.3	94.3	91.4	94.2
3.0	91.7	91.7	73.9	92.2
4.0	89.3	89.0	50.0	89.3
5.0	87.0	85.4	30.0	85.7
6.0	84.9	80.5	16.8	81.2
7.0	82.9	74.2	9.0	75.9
8.0	80.9	66.6	4.8	69.7
9.0	79.1	58.3	2.5	62.8
10	77.4	50.0	1.3	55.1
11	75.8	42.1	0.7	46.5
12	74.3	34.9	0.4	37.1
13	72.9	28.6	0.2	26.9
14	71.9	23.2	0.2	15.9
15	70.3	18.7	0.1	4.1
16	69.1	15.0	0	0
18	67.0	9.5	0	0
20	65.1	5.9	0	0

Taken from BS EN481: 1993 and EN 12341: 1997

Total Particles	100% for all diameters
PM2.5	100% for diameters less than 2.5 micron 0% for diameters greater than 2.5 micron
PM2	100% for diameters less than 2 micron 0% for diameters greater than 2 micron
PM1	100% for diameters less than 1 micron 0% for diameters greater than 1 micron

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