User Manual for 1303 Multipoint Sampler and Doser

BE1085-13

Index

1303 Multipoint Sampler and Doser

August 2008

Safety Considerations

SAFETY CONSIDERATIONS

PLEASE READ THESE SAFETY CONSIDERATIONS CAREFULLY AND MAKE SURE YOU UNDERSTAND THEM PROPERLY BEFORE YOU START OPERATING THE MULTIPOINT SAMPLER AND DOSER TYPE 1303.

EXPLOSION HAZARD

⚠ **THE MULTIPOINT SAMPLER AND DOSER TYPE 1303 IS NOT DESIGNED FOR USE IN POTENTIALLY EXPLOSIVE ENVIRONMENTS.**

This means that the instrument must **not** be placed and operated in an area with a potentially explosive atmosphere.

When monitoring potentially flammable or toxic gases it is essential that:

1) the instrument itself is placed in a well-ventilated area **outside** the potentially hazardous zone; and

2) that a sufficiently long tube is connected to the “Sampler Waste Air Outlet” so that the sampled gas is carried **away** to the open air or to an extraction and/or filtration unit.

TO AVOID THE POSSIBILITY OF AN EXPLOSION, MONITORING OF FLAMMABLE GASES **IN EXPLOSIVE CONCENTRATIONS** MUST NEVER BE ATTEMPTED.

⚠ **AVOID WATER CONDENSATION IN THE INSTRUMENT.**

Liquids must be prevented from entering the instrument. It is therefore important that warm humid gases are not drawn into a cold instrument because condensation will take place. If such a situation is likely to occur you should ensure that the gases are drawn through a water-trap filter before they enter the sampler channels of the 1303. This will condense out water vapour in the gases and thus prevent condensation within the instrument. The water-trap filter should be used in the immediate environment of the instrument so it maintains either the same temperature, or a lower temperature than the instrument.

Note: that some gases may be absorbed by the water trapped in the filter. This will reduce the gases’ concentration.

SAFETY CONSIDERATIONS

The Type 1303 Multipoint Sampler and Doser complies with EN61010-1 (1993) and IEC 1010-1 (1990): Safety requirements for electrical equipment for measurement, control and laboratory use. To ensure safe operation and retain the Type 1303 in safe condition, note the following:

APPLYING POWER

Before using the Type 1303, check that it is set to match the available mains voltage and that the correct fuse is installed.

SAFETY SYMBOLS

⚠ The apparatus is marked with this symbol when it is important that the user refer to the associated warning statements given in the Instruction Manual.

⊥ Chassis terminal ⏚ Safety earth terminal ϟ Hazardous Voltage

WARNINGS

Before connecting or disconnecting interface cables, switch off the power to all instruments.

If the correct function or operating safety of the Type 1303 is impaired, secure the instrument against further use until the fault is repaired.

Any adjustment, maintenance or repair of the internal parts of the Type 1303 under power must be avoided as far as possible; if unavoidable, it must only be done by qualified service personnel.

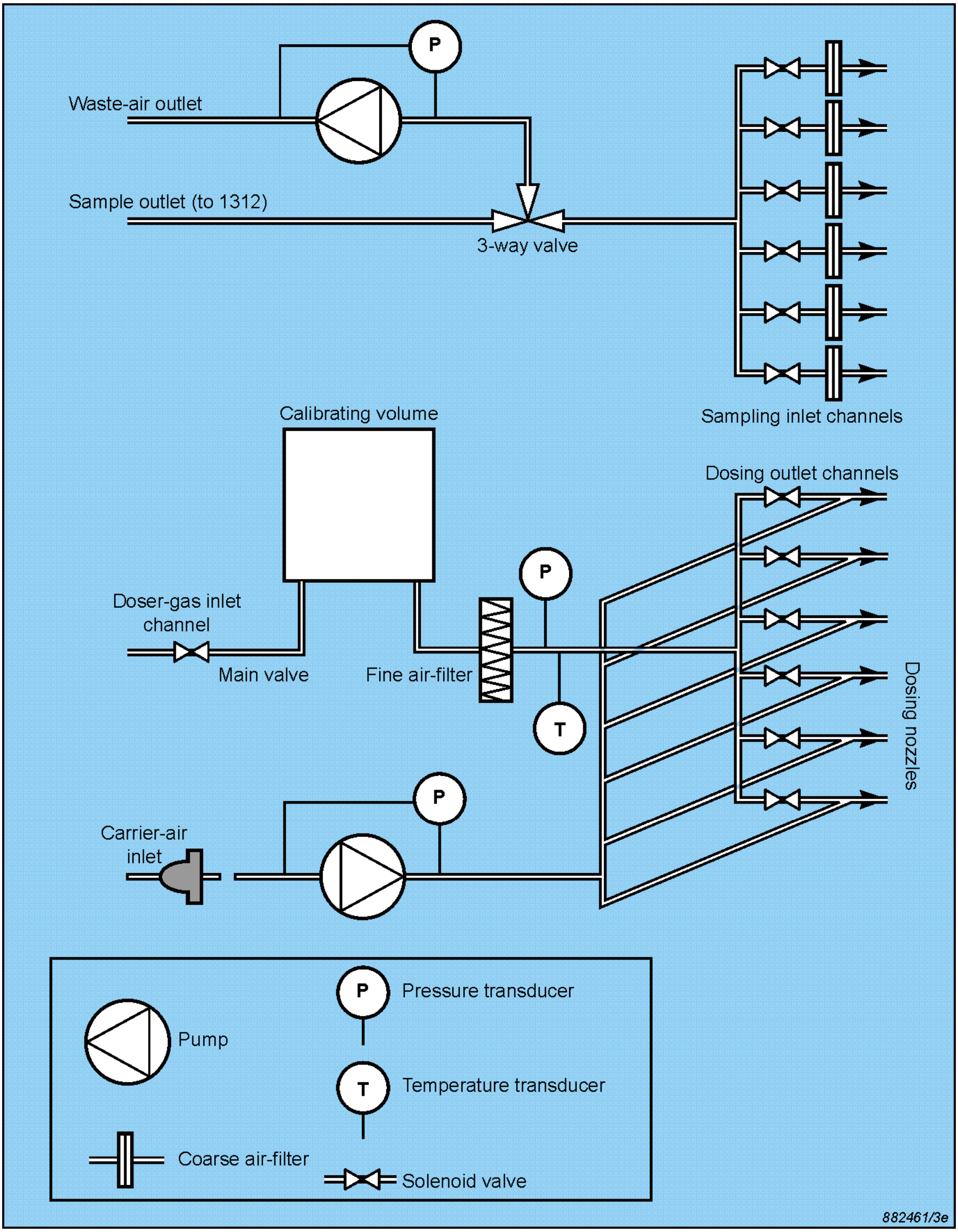
Chapter 1

Description and Functions

August 2008

1.1 Description and Functions

Fig.1.1 The pneumatic system of the 1303



1.1.1 The Sampler System

The pneumatic system of the 1303 is shown schematically in Fig. 1.1. The sampler system is constructed of 316 stainless steel and PTFE (polytetrafluoroetyhlene) tubing to minimize adsorption of samples. The system has 6 inlet channels, each with a solenoid valve. Each inlet channel has a tube-mounting stub on the front-plate of the 1303; 6 tubes of up to 50m length connect each channel to the respective sampling point. The 6 inlet channels converge into one; a three-way valve can then direct the gas sample to the Gas Monitor for analysis, or through the pump to the waste-air outlet on the 1303's back-plate. A pressure transducer checks the efficiency of the sampling pump and allows checks for blocked airways.

An air-filter is attached to the end of each sampling tube to keep the samples free of particles.

1.1.2 The Doser System

The doser system has 6 outlet channels, see Fig. 1.1, each with a solenoid valve. Each channel has a nozzle which reduces the internal diameter of the channel. The nozzles ensure that the rate of flow of tracer-gas to the dosing points is dependent only upon the tracer-gas supply pressure and temperature, and is unaffected by the pressure in the dosing tubes or at the dosing point itself. Three different nozzle sizes are used: four medium, one large and one small. Each size gives a different volume flow rate so that the amount of tracer-gas delivered to a particular dosing point can be matched to the requirement at that point by using the outlet channel which has the appropriate nozzle.

Each of the 6 dosing outlet channels has a tube-mounting stub on the frontplate of the 1303. 6 tubes of up to 50m length connect each stub to the respective dosing point.

2 separate inlet channels mounted on the backplate of the 1303 serve the dosing channels: the tracer-gas inlet, and the carrier-air inlet.

The doser-gas inlet channel is pressurized by the tracer-gas supply cylinder, which is connected to the inlet on the 1303's backplate by tubing. A pressure and a temperature transducer give information on the tracer-gas supply; a fine filter ensures that the dosing channels are particle-free. The main valve on the tracer-gas inlet channel is used to enclose a volume of tracer-gas between itself and the dosing valves. This volume is used when calibrating the doser system.

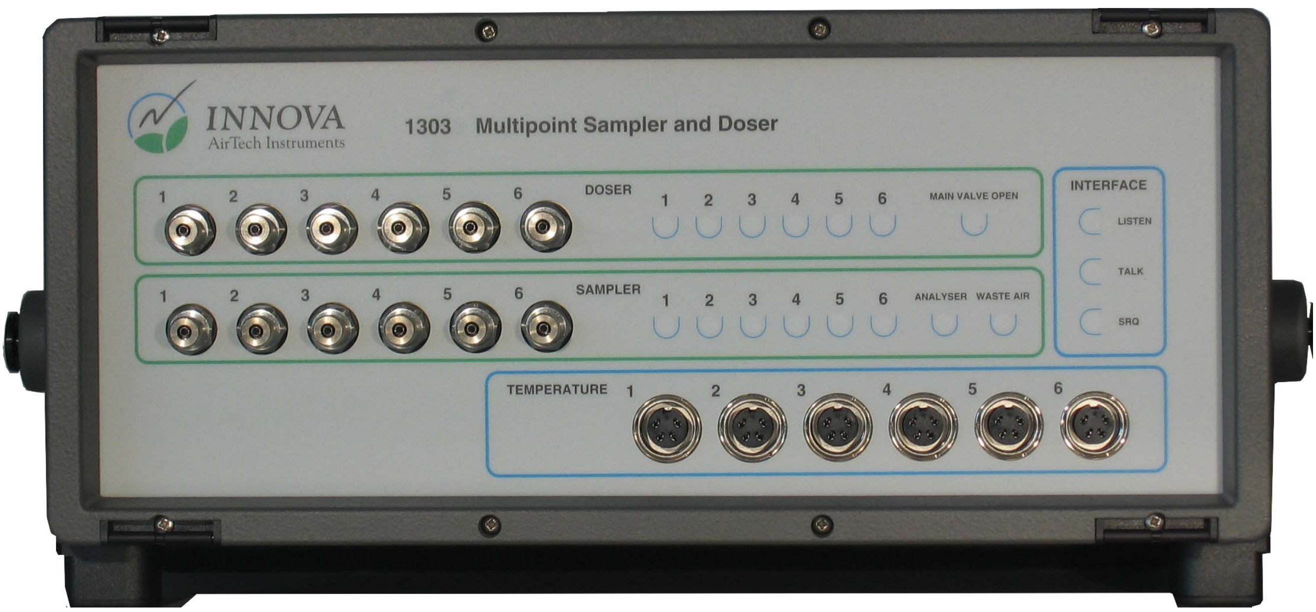
The carrier-air inlet pumps extra air to the dosing outlets to speed delivery of the tracer-gas to the dosing point. This inlet has a coarse air-filter, a pump, and a pressure transducer for checking the efficiency of the pump. Delivering a dose of tracer-gas to a dosing point 50m distant takes 1 minute.

The dosing system can deliver a continuous dose, that is, an uninterrupted flow of tracer-gas over a period of time; or a discontinuous dose, in which the amount of tracer-gas delivered is reduced by interrupting the flow at regular intervals during the dosing period.

The doser system is set up for use by specifying a dosing time-out such that the 1303 will stop any current dosing procedure after a given time has elapsed without instruction from the controlling computer. This value is specified form the controlling computer.

1.1.3 Front Panel

Fig.1.2 The front panel of the 1303



Doser: 6 mounting stubs for connection of tubing (AF0005, red) to dosing points. Each stub is numbered, and has a correspondingly-numbered lamp. When the lamp is lit, it indicates that the corresponding dosing valve is open, see section 3.6.3. When the **Main Valve Open** lamp is lit, it indicates that the main dosing valve is open, see section 3.6.2.

Sampler: 6 mounting stubs for connection of tubing (AF0006, green) to sampling points. Each stub is numbered, and has a correspondingly-numbered lamp. When the lamp is lit, it indicates that the corresponding sampling valve is open, see section 3.5. The **3 Way Valve to Ana-**

lyzer / Waste Air lamps indicate which way the internal 3 way valve is set, see section 3.5.

Temperature Sensors Input: 6 inputs suitable for use with the INNOVA Air Temperature Transducer Type MM0034 or Operative Temperature Transducer MM0060.

Interface: 3 lamps which indicate the function of the IEEE interface. If the **Listen** lamp is lit, the 1303 is receiving instructions or data from the system controller. If the **Talk** lamp is lit, the 1303 is outputting data. If the **SRQ** lamp is lit, the 1303 has generated a Service Request, see section 4.1.1 and 4.2.6. Full details of the IEEE Interface are given in Chapter 4.

1.1.4 Rear Panel

Fig.1.3 The rear panel of the 1303

AC Mains: A 3-pin connector accepting Power Cable for connection to a single phase AC mains supply.

Mains Voltage: Two-position switch for adjustment according to the local mains supply. Before connecting the 1303 to a mains supply, the mains voltage setting and fuse ratings must be checked in accordance with the instructions given in section 2.1.

Dosing Gas Inlet: Mounting stub for connection of a tracer-gas supply to the 1303 using tubing AF0008. See section 2.3.3.

Outlet to Analyzer: Mounting stub for connecting the sampler system of the 1303 to the inlet of an INNOVA Gas Monitor via tubing. See section 2.3.4. Usable models are Type 1302, 1312 or 1412. In the following referred to as “Gas Monitor”.

Waste Air Outlet: Mounting stub for tubing to exhaust air from the 1303’s sampler system. See section 2.3.5.

Interface IEEE-488: Digital interface designed in accordance with IEEE 488-1978. The IEEE interface is identical in use to that described in IEC 625-1; full compatibility is only a matter of using the correct cables and connectors. For more detail about the IEEE/IEC interface, refer to Chapter 4.

Device Address: Bank of 8 switches which decide the 1303’s interface address. See section 2.2.1 for details of how to set the interface address.

Air Inlet: The dosing pump inside the 1303 supply all dosing channels with carrier air for the tracer-gas, when the dosing pump is running.

Chapter 2

Preparing to Use the 1303

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2.1 Preliminary

2.1.1 Environment and Handling

The Type 1303 Multipoint Sampler and Doser is designed for use in environments with temperatures between +5°C and +40°C (+41°F and +104°F) and with up to 90% relative humidity (non-condensing) at 40°C. Other than ensuring correct connection of the mains supply, no special handling precautions are necessary.

2.1.2 Connecting the Mains Supply

The 1303 is operated from a 50 to 400 Hz single phase AC mains supply. Before connecting the mains supply, the following checks and adjustments should be performed to ensure safe operation of the 1303.

Mains Voltage Setting

Ensure that the **Mains Voltage** switch on the rear panel is set to the local supply voltage.

To change the **Mains Voltage** setting, use a small flat-bladed screwdriver to turn the switch to the voltage you require. Now check that correctly rated fuses are fitted to the 1303.

Checking Fuse Rating

Use a small flat-bladed screwdriver to prise open the flap surrounding the **AC Mains** switch. See Fig. 2.1.

Fig.2.1. Accessing the 1303's fuses

Again using the screwdriver, gently lever the fuse-holders out from their slots. See Fig. 2.2.

Fig.2.2. Inserting the fuses into the 1303's fuse holder

For use from a 100-127V supply, use two 1,25A slow-blow fuses (LumaSense No. VF0027); for use from a 200-240V supply, use two 630mA slow-blow fuses (LumaSense No. VF0032). Both types of fuse are supplied with the instrument.

When replacing the fuse-holders, ensure that the direction of the white arrows on each holder matches the arrows marked on the covering flap.

Supply Connection

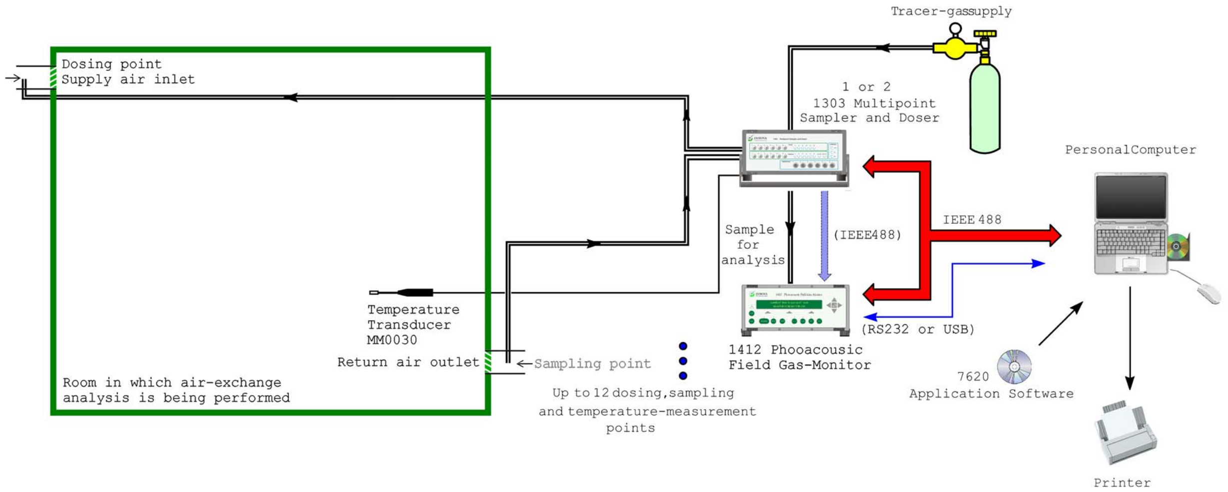
Once the mains voltage setting and fuses have been checked, connect the **Mains Input** connector to the mains supply using Power Cable (supplied with the 1303).

2.2 System Use

The 1303 combines with the Gas Monitor and a controlling computer to provide a system which offers wide-ranging monitoring capabilities. The 1303 makes it possible to perform multi-point air-exchange analyses and multi-point monitoring tasks in many different situations and environments, without changing the system components.

An example air-exchange analysis system is shown in Fig. 2.3. In such a system, the doser/sampler systems of the 1303 are used as follows. The doser system marks the supply-air of the room with a known amount of tracer-gas. The sampler system then takes a sample of the return-air from the room, and delivers the sample to the Gas Monitor for analysis. While the Gas Monitor performs one analysis, the 1303 takes the next sample for analysis from the room. As the amount of tracer-gas delivered to the room is known, and the remaining concentration of tracer-gas in the samples is determined by the Gas Monitor, the ventilation-system performance can be calculated.

Fig.2.3. A typical air-change analysis system, shown with an application example. In this case, the aim of the analysis is to determine the size of the air-change in the mechanically ventilated room. The diagram shows only one dosing and sampling point, for clarity. Up to 6 similar analyses can be performed simultaneously using one 1303. 7620 Application Software gives control of all the functions of the system.



2.2.1 Connecting the 1303 to the System Controller

The 1303 is connected to the computer by the IEEE interface bus, over which the 1303 receives the commands and data which control it. Further information about the cables available from LumaSense to connect the 1303 onto the IEEE interface bus, and about the IEEE interface of the 1303, are given in section 4.1.

2.2.2 Setting the Interface Address of the 1303

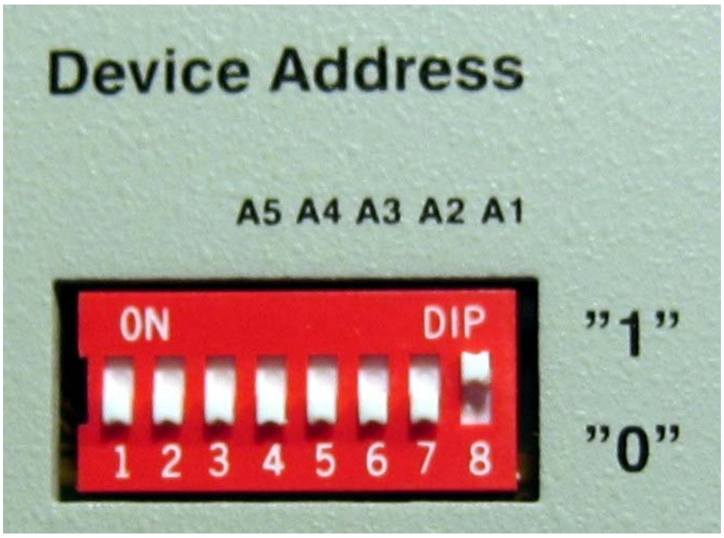
The 1303 uses a single interface address. The address is set using the bank of eight switches on the rear panel of the 1303. The last five switches on the bank decide the interface address. These switches are marked A1 (the least significant bit) to A5 (the most significant bit). The switches represent binary values, as follows:

If the switch is down, it represents a binary “0”. See Fig. 2.4.

Fig. 2.4. Dipswitch settings binary "0"

If the switch is up, it represents a binary "1". See Fig. 2.5.

Fig. 2.5 Dipswitch settings binary "1"

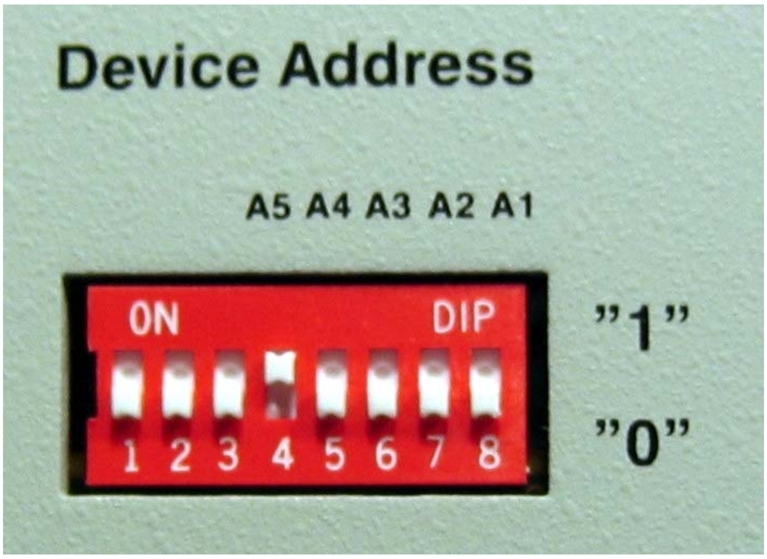


The interface address of the 1303 is set at the factory to 01111 (decimal value 15), see Fig. 2.6. If this is not suitable for your system, use the switches to set an address appropriate to your system.

Fig. 2.6. Interface address 15

If the system comprise two 1303 instruments the standard interface address of the second 1303 should be 16, see Fig. 2.7.

Fig. 2.7. Interface address 16



2.3 Connecting Tubing to the 1303

The 1303 is connected via tubing to:

the sampling points;
the dosing points (if dosing is required);
to a suitable tracer-gas supply;
to the Gas Monitor being used to analyze the gases that are sampled;
to a suitable exhaust for gases purged from the sampler system.

Note: the performance of the 1303's sampling and dosing systems are specified for sampling and dosing tubing of maximum 50m in length.

Tubing for use with the 1303 is available from LumaSense, as follows:

Sampler tubes, green nylon, LumaSense accessory number AF0006 or polytetrafluoroethylene (PTFE), LumaSense accessory number AF0614.

Doser tubes, red nylon, LumaSense accessory number AF0005 red tubing for dosing.

Tracer-gas supply tubing, nylon, LumaSense accessory number AF0008.

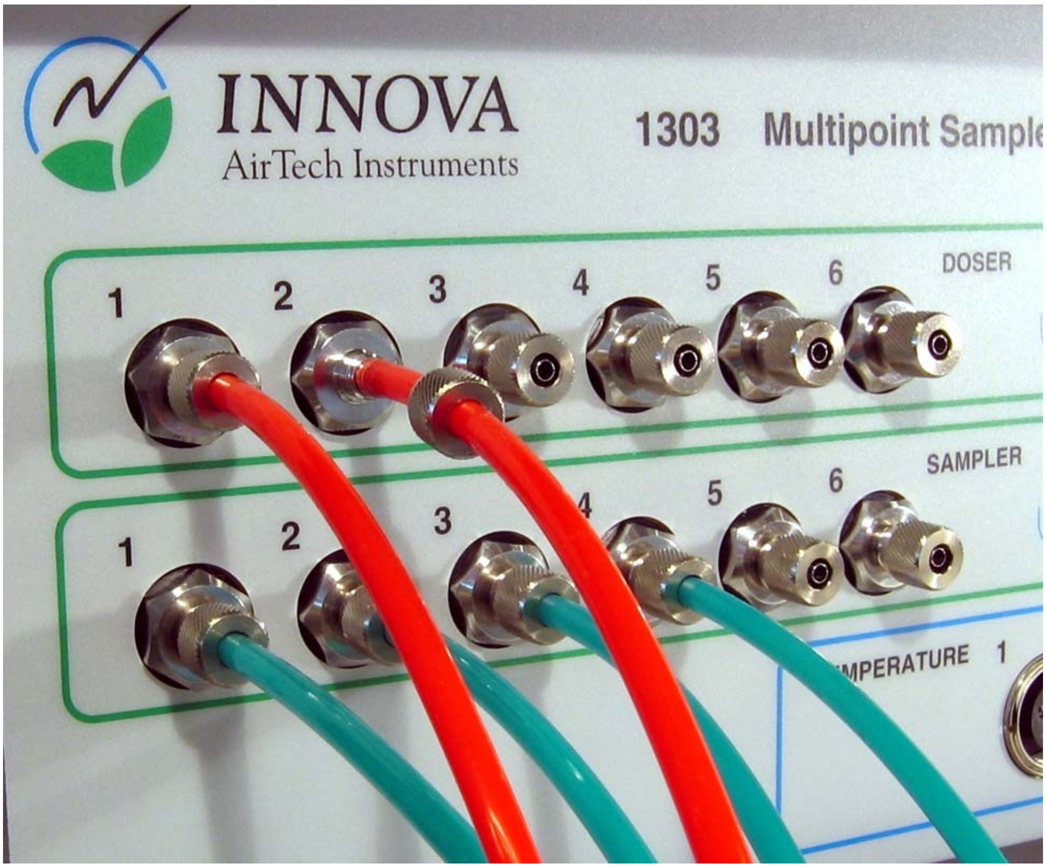
Using these tubing materials minimizes the risk of gases being adsorbed onto the tube's surface, which would result in inaccurate measurements.

2.3.1 Connecting Sampling and Dosing Tubing

Before connecting sampling and dosing tubing to the 1303, you should know approximately where the sampling and dosing points will be in the area to be monitored. This will allow you to estimate the length of tubing you need to connect to the mounting-stubs of the 1303.

To connect sampling tubing, see Fig.2.8.

Fig.2.8. Attaching sampling and dosing tubing to the 1303's mounting stubs



1. Remove the knurled nut from the mounting stub of the sampler channel you wish to use, on the front panel of the 1303.

2. Push one end of the length of the nylon AF0006 or polytetrafluoro-ethylene PFTE AF0614 tubing through the non-threaded end of the nut.

3. Push the end of the tubing onto the mounting stub as far as it will go, and secure the tube by re-tightening the knurled nut onto the threads of the mounting stub.

To connect dosing tubing:

Proceed as described above, using the nylon tubing AF0005.

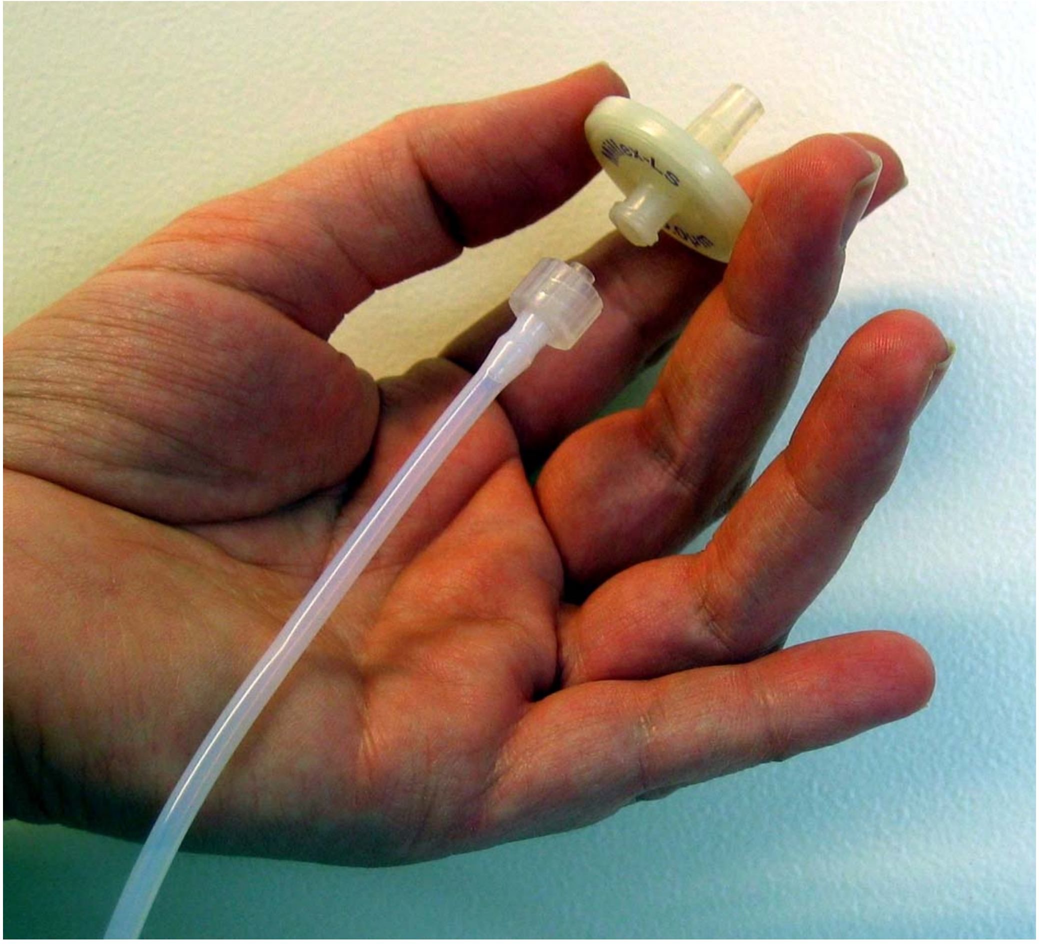
2.3.2 Connecting External Filters to the Sampling Tubes

The external filters, comprising filter, LumaSense accessory number DS2306, and fitting, LumaSense accessory number UD5041 (optional accessories), protect the 1303's sampling airways from airborne particles such as dust, thus helping to prevent blockage of the airways.

Also, if the Gas Monitor is measuring in the parts-per-billion range, it is recommended that the external filters are always used to prevent degrading of the tubing's internal surface.

The filter unit is attached to the tubing as follows, see Fig.2.9.

Fig.2.9. Attaching Fitting UD5041 and Filter DS2306 to sampling tubing



1. Push the Fitting UD5041 into the tubing.

2. Screw the short stub of the Filter DS2306 into the Fitting.

2.3.3 Connecting a Tracer Gas Supply

Tracer gases for use with the 1303 must be supplied from a pressurized cylinder fitted with a suitable pressure-regulator. The regulator ensures that the tracer-gas pressure is constant.

Warning! Do not attempt to connect a tracer-gas cylinder without a pressure-regulator directly to the 1303. Doing this can damage the 1303's internal airways.

The tracer-gas supply cylinder is connected to the **Dosing Gas Inlet** on the rear panel of the 1303 using nylon tubing. This tubing is available from LumaSense, accessory number AF0008.

To connect the tracer-gas supply:

1. Attach one end of the tubing AF0008 to the outlet of the pressure-regulator as recommended by the regulator manufacturer.

2. Push the other end of the tubing into the **Dosing Gas Inlet** stub on the rear panel of the 1303.

After connection, slowly open the regulator's valve and allow the pressure to rise. The tracer-gas supply pressure must be within the following range to ensure efficient dosing:

Minimum: 300 kPa (~ 3 bar) absolute
Maximum: 450 kPa (~ 4,5 bar) absolute

If you are using a pressure-regulator which displays pressure relative to atmospheric pressure (101 kPa or 1 bar), the pressure reading should be within the range 200 kPa to 350 kPa (2 bar to 3,5 bar).

The tracer-gas supply tubing is removed from the **Dosing Gas Inlet** stub by pushing on the flange at the end of the stub, and simultaneously pulling the tubing gently.

2.3.4 Connecting the Sampler Outlet to the Gas Monitor

This connection uses the same tubing (PTFE, LumaSense No. AF0614) as for the sampling tubes, section 2.3.1. The tubing is connected to the **Outlet to Monitor** stub on the rear panel of the 1303, and to the **Air Inlet** stub on the rear panel of the Gas Monitor. The tubing is connected as described in section 2.3.1.

2.3.5 Waste Air Outlet

The **Waste Air Outlet** stub, next to the **Outlet to Monitor** stub on the rear panel of the 1303, exhausts waste air from the 1303's sampler system as a new sample is collected. If you do not wish the waste air to mix with the air in the room where the 1303 is positioned, connect a length of PTFE tubing (LumaSense No. AF0614) to the **Waste Air Outlet** stub and direct the tubing to a suitable exhaust-point: for example, out of a window.

2.4 Connecting Temperature Transducers to the 1303

The 1303 has 6 temperature-sensor inputs mounted on its front panel, suitable for direct use with the INNOVA Air Temperature Transducer MM0034 or Operative Temperature Transducer MM0060.

The measurement range and accuracy of these transducers are given in the 1303 specifications in the Product Data.

Chapter 3

Operation

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All tasks performed by the 1303 are controlled over the IEEE/IEC interface from a computer; there is no other control possibility. This chapter deals with the control of the 1303 from the user's point of view; for details of the IEEE/IEC interface specifications, refer to Chapter 4 of this manual.

Sections 3.1 and 3.2 deal with switching-on and the general principles of controlling the 1303. Sections 3.2 to 3.8 deal with the specific commands and requests, known as *interface jobs*, which set-up and control the 1303. Each interface job is dealt with by giving an example which states the effect of the job. For quick reference, an overview of all interface jobs is given in section 4.2 of this manual.

3.1 Switching-On

After ensuring that the 1303 has the correct fuses installed and is set for the appropriate mains voltage (section 2.1.2), the 1303 can be switched on using the **AC Mains** switch on the back-plate. After switching-on, the 1303 is set as follows:

All dosing- and sampling-valves closed;

Internal three-way valve set to **Waste Air Outlet**;

Both pumps stopped;

Main dosing valve closed.

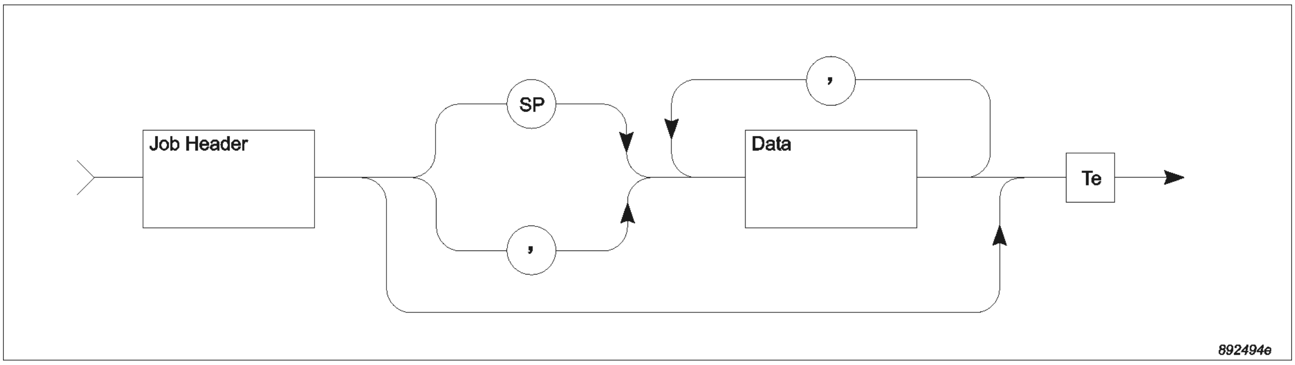
3.2 General Principles of Controlling the 1303

The 1303's functions are controlled over the IEEE/IEC interface using a repertoire of commands and data requests, each of which is specific to a particular function or item of data. These commands and requests are known as *interface jobs*. This section describes the structure of the interface jobs used to control the 1303. Further details about the IEEE/IEC interface of the 1303 are given in Chapter 4 of this manual.

3.2.1 Syntax for Interface Jobs

Fig.3.1 shows a diagram representing a single interface job, sent from the system controller to the 1303. Each constituent part of the interface job is explained below.

Fig.3.1. General syntax diagram for interface jobs



Job Headers

The job header specifies the function you want the 1303 to perform. It consists of one or more words. The ASCII underline character "_" is used to separate individual words in the job header. For example:

OPEN_SAMPLING_VALVE

A hyphen "-" or a full stop"." can also be used to separate words in the job header.

The words making up the job header do not need to be sent in full to the 1303; they can be shortened to a code-form, for example:

OP_SA_VALVE

O_S_V

The minimum code for each job header is usually the first character of each word in the job header. This is written in bold characters in the list of interface jobs given in section 4.2 of this manual. The 1303 accepts job headers in both upper- and lower-case characters.

The Data Field

The data field contains further information specific to the interface job defined by the job header. The data field is separated from the job header by a space character ("SP"), or a comma ",". In the following examples, the separator will always be the space character, represented by the symbol "␣". The data field will normally contain a numerical value. For example:

OPEN_SAMPLING_VALVE␣2

Some jobs may require more than one item of data. In this case, the data is given item by item, separated by commas. For example:

OPEN_SAMPLING_VALVE␣2,3,4

Numerical data for interface jobs sent to the 1303 can be in NR1, NR2 or NR3 form. This is a format for describing how the numerical data is represented, for example:

NR1 data: 250 (number without decimal-fraction or exponent)

NR2 data: 249.85 (number with decimal fraction, without exponent)

NR3 data: 2.499E-2 (number with fraction and exponent).

Generally, any of these data formats can be used, unless specifically stated otherwise in the interface job overview given in section 4.2. The number of characters in the non-exponent part of the data field must not be greater than 8.

Job Terminators

Each interface job must have a *terminator* (signified by T_e in Fig.3.1) which tells the 1303 that it has received the complete interface job. When the 1303 receives the terminator, it checks the whole job and, if it is a valid job, carries it out.

The terminator for communication with the 1303 is an ASCII control character, such as "LF". This is the default terminator character used in communication with the 1303. The terminator character can be changed, as follows.

To select a terminator character other than the default, use the interface job **D**efine_**T**erminator, followed by the decimal value of the character you wish to use. The possible terminator characters, with the corresponding decimal values, are shown in Table 3.1.

DEF_TERMINATOR␣3<LF>	Selects the control character ETX (decimal value 3) as the terminator character.

All of the following interface job examples assume the use of "LF" as the terminator character.

Table 3.1. The range of ASCII terminator-characters which can be used in communication with the 1303

ASCII Char-acter	Decimal Code	ASCII Char-acter	Decimal Code
SOH	1	DC1	17
STX	2	DC2	18
ETX	3	DC3	19
EOT	4	DC4	20
ENQ	5	NAK	21
ACK	6	SYN	22
BELL	7	ETB	23
BS	8	CAN	24
HT	9	EM	25
LF	10	SUB	26
VT	11	ESC	27
FF	12	FS	28
SO	14	GS	29
SI	15	RS	30
DLE	16	US	31

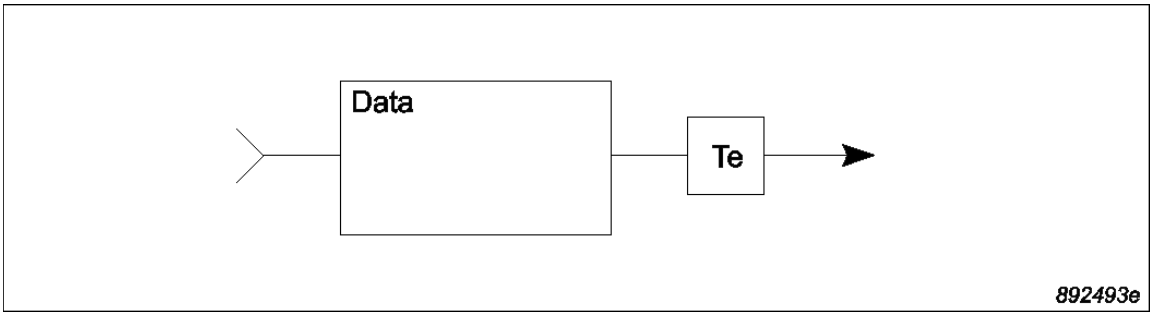
3.2.2 Output Jobs – Requesting Information from the 1303

Interface output jobs request specific data from the 1303. The output jobs allow checks of the 1303's functions and set-up parameters. Output jobs consist of a job header followed by a question-mark; more specific information is requested by including a data field. An example of an output-job is:

SAMPLING_PUMP_PRESSURE?<LF>

To which the 1303 responds with the required data. The general syntax for data output from the 1303 is shown in Fig.3.2.

Fig.3.2. General syntax diagram for data-output from the 1303



Generally, numerical data output from the 1303 is in NR2 form unless specifically stated otherwise in the interface job overview given in section 4.2. The default terminator character used is the control character "<LF>". The terminator character can be changed, as described in section 3.2.1.

Re-usable Jobs

The 1303 interface jobs **C**alibration_**D**ata**?**, **D**osing_**T**ime_**O**ut**?**, **M**olecular_**W**eight**?** and **G**as_**C**onstant**?** are *re-usable* jobs; that is, when the data requested by this job is read-out from the 1303, the same job can be sent back to the system controller so that a different value for this parameter can be read-in to the 1303. For example:

CALIBRATION_DATA?˽1<LF>

Is sent to the 1303. The 1303 reads-out the calibration data for dosing nozzle 1, with the minimum code for the job header, as follows:

C_D˽1,37,45

The job can then be sent again to return the data to the 1303.

To enable the 1303 to respond to the jobs listed above with a job header, use the **O**utput_**H**eader˽**I**nclusive as follows:

OUTPUT_HEADER˽INCLUSIVE<LF>

This is disabled using the following job:

OUTPUT_HEADER˽EXCLUSIVE<LF>

3.3 Installing Set-up Parameters

The 1303 stores in its memory 3 set-up parameters. These are the *dosing time-out*, the *gas constant* and the *calibration data*. Each parameter is dealt with in turn below. The *dosing time-out* has a default value of 60 s. The *gas constant* must be installed into the 1303 before calibrating the 1303's doser system. The *calibration data* must be installed before using the doser system of the 1303 – see section 3.4.

Note: after switching-off, the 1303 will revert to the default values for each parameter. It is recommended that you read-out and note down the current set-up parameters for future reference in the event of loss of set-up data from the 1303. The procedure for reading-out the set-up parameters is described in the following sections. The values for each parameter can then be re-inserted using the jobs described in the following text.

3.3.1 The Dosing Time-out Parameter

This value specifies the maximum time for which the 1303 will deliver tracer-gas without receiving further instructions about the dosing task from the system controller. When the time period specified by the dosing time-out is exceeded, the 1303 stops delivering tracer-gas, and sets the Dosing Nozzle Flag in the Warning Flags byte (section 3.8.5).

The range of possible values is from 10s to 3600s. If you do not specify a value for this parameter, the 1303 uses the default value of 60s.

The dosing time-out is changed as follows.

Examples:

DOSING_TIME_OUT␣30<LF> Changes the dosing time-out to 30s.

The current dosing time-out value can be checked using the following job:

DOSING_TIME_OUT?<LF> Outputs the current dosing time-out value from the 1303.

3.3.2 The Characteristic Gas Constant Parameter

This value is the ratio, $^{R}/_{M}$, of the universal gas constant (R=8314 J kmol^{-1} K^{-1}) and the molecular weight (kg kmol^{-1}) of the tracer-gas being used. This is used in the calculation of the calibration data for each dosing nozzle, and must therefore be changed before calibrating the 1303 with a different tracer-gas from the one previously used.

Note: calibration of the doser system is not possible if no value is given for this parameter.

The range of values is from 0 to 10 000. There is no default value.

Example:

SF_6 Tracer gas: SF6 molecular weight: M = 146,05 kg/kmol = 146,05 g/mol.
The Characteristic Gas Constant Parameter $^{R}/_{M}$ = 8314/146,05 = 56,92

GAS_CONSTANT␣56.92<LF> Sends the gas constant value 56.92 (for SF_6) to the 1303.

Alternatively, the gas constant can be expressed in terms of the molecular weight of the gas:

MOL_WEIGHT␣146,05<LF>	Sends the gram molecular weight 146,05 (for SF_6) to the 1303.

The current characteristic gas constant or molecular weight value (depending on how you have previously expressed the gas constant to the 1303) can be checked using the following jobs:

GAS_CONSTANT?<LF>	Outputs the current gas constant value from the 1303.
MOL_WEIGHT?<LF>	Outputs the current molecular weight value from the 1303 in kg $kmol^{-1}$ (equivalent to g mol^{-1}).

Table 3.2. Molecular weight of commonly used Tracer-gases

Tracer Gas	**M**	**R/M**
	Molecular Weight g/mol = kg/kmol	Characteristic Gas Constant
SF_6	146.05	56.92
Freon 134a	102.03	81.49
Freon 152	66.05	125.87
CO_2	44.01	188.91
N_2O	44.01	188.91

3.3.3 The Calibration Data Parameter

This specifies the effective outflow area (in $m^2 \times 10^{-9}$) of a specific dosing nozzle, thus allowing the 1303 to automatically calculate the amount of tracer-gas delivered during a dosing procedure. The 1303 is able to calculate these values automatically for each dosing nozzle when calibrating itself – see section 3.4 for further information. A dosing nozzle cannot be used until it is calibrated with the tracer-gas to be used.

The range of values is from 0,1 to 100,0; there is no default value for this parameter.

If the calibration data for each specific nozzle and for the tracer-gas currently being used is known, it can be sent directly to the 1303 using the following job, without calibrating the 1303. Note that the 1303's doser nozzles must still be calibrated with each change of tracer-gas, so that the 1303 is able to calculate the amount delivered.

Example:

CALIB_DATA␣1,1.25<LF>	Sets the calibration data of number 1 dosing nozzle to 1.25.

To avoid having to calibrate each dosing nozzle after each time the 1303 has been switched off, it is recommended that the calibration data for each nozzle is read-out and noted for future reference. The calibration data for a specific nozzle can be checked using the following job.

CALIBRATION_DATA?␣1<LF>	Outputs the calibration data for dosing nozzle number 1.

3.4 Calibrating the Doser System

Each of the nozzles in the 1303's doser system must be calibrated so that the amount of tracer-gas delivered during a given dosing procedure can be accurately determined. The 1303's doser system must be calibrated before performing any dosing tasks, and also every time you use a different tracer-gas from the one used previously.

A volume of tracer-gas is enclosed between the main valve and the dosing valves; this volume is then released through the nozzle to be calibrated. As the internal volume of the airways are known, the effective outflow area for each nozzle is calculated from the rate of pressure-decrease measured in the dosing airway. The amount of tracer-gas delivered can then be calculated from the *effective outflow area*, the tracer-gas supply pressure and temperature, and the dosing time-period.

Once started, using the appropriate interface job, the 1303's calibration procedure is fully automated.

Note: ensure that a tracer-gas supply is connected to the 1303 as described in section 2.3.2 before starting calibration, otherwise calibration cannot be performed.

If you do not want the tracer-gas used for calibration to mix with the air in the room in which you are performing the calibration, attach tubing to the dosing nozzle (section 2.3.1) to direct the tracer-gas out of the room.

Important! To ensure accurate calibration of the 1303, observe the following points before performing the calibration procedure.

1. The 1303 must be placed in the area in which it will be used, with power on, at least 10 minutes before calibrating. This allows the

1303's temperature to stabilize in relation to the temperature of the area in which it will be used.

The main dosing valve and each dosing valve must be opened to allow tracer-gas to flow into the 1303's dosing manifold, for 5 minutes before calibrating. This ensures that the temperature of the dosing system will stabilise relative to the temperature of the tracer-gas. The procedures for opening the main dosing valve and the dosing valves, to allow flow of tracer-gas through the dosing system, are described in section 3.6.2 and 3.6.3 respectively. To ensure that the tracer-gas does not flow into the room in which you will be performing measurements, direct the outlets of the doser tubing to a suitable exhaust – for example, out of a window. After flushing is complete, wait for 15 minutes before proceeding with the calibration.

2. If you are to use a different tracer-gas from the one used previously, you must first flush the doser system with the new tracer-gas, before calibrating with the new tracer-gas. Flushing is done as described above. Once flushing is completed, remember to change the characteristic gas-constant value stored in the 1303 to that for the new tracer-gas before performing the calibration. This procedure is described in section 3.3.2.

Examples:

CALIBRATE_NOZZLE␣1<LF>	Starts the 1303's self-calibrating procedure for dosing nozzle number 1. Each nozzle calibration takes approximately 5 minutes. If no dosing nozzle number is given, the 1303 will calibrate all the dosing nozzles.

Each of the dosing nozzles that you wish to use must be calibrated in this way. Once the procedure is complete, the new calibration data for each nozzle can be read-out using the following job:

CALIBRATION_DATA?␣1<LF>	Outputs the calibration data for dosing nozzle number 1. If no nozzle number is given, the calibration data for all 6 nozzles is output.

Note: the 1303 does not maintain the calibration data in its memory after switching-off. It is recommended that you read-out and note down the current calibration data for each nozzle, for future reference in the event of loss of calibration data from the 1303. The calibration data can then be re-installed using the **C**alibration_**D**ata job, section 3.3.3.

3.5 Using the Sampler System

Using the 1303's sampler system (see Fig. 1.1), to deliver a sample to the Gas Monitor is a 3-stage process:

1. The required sample valve is opened; all other sample valves are closed automatically. The sampling pump starts.

2. The sample valve is connected to the sampling pump via the 1303's internal 3-way valve, allowing the waste air to be exhausted from the sample channel (via the **Waste Air Outlet**, section 2.3.5) and drawing the new sample.

3. When the new sample has been drawn to the 1303, the internal 3-way valve is set to direct the sample to the Gas Monitor. The sampling pump stops, and the Gas Monitor's pump draws the sample for analysis.

While the Gas Monitor is analyzing this sample, the next sample can then be drawn ready for the next analysis.

Three interface jobs control the sampling process.

Examples:

OPEN_SAMP_VALVE␣1<LF>	Opens sample valve 1, closes all other sample valves and starts the sampling pump. If no sample valve is specified, all sample valves are closed.
CONNECT_SAMP_VALVE␣TO_SAMPLING_PUMP<LF>	Connects the sample valve to the sampling pump, and exhausts the waste air from the sample channel.
CONNECT_SAMP_VALVE␣TO_MONITOR<LF>	Stops the 1303's sampling pump, and directs the new sample to the Gas Monitor for analysis.

The time taken to draw a sample depends upon the length of the sampling tube. The gas-transport speed in a tube of internal diameter 3mm is 2m s^{-1}, assuming that the sampling pump is working within its design limits. The pressure across the sampling pump can be checked to ensure efficient gas-transport; see section 3.8.1 for details.

The sampling pump can be controlled using the following jobs:

SAMPLING_PUMP˽ON<LF>	Starts the sampling pump.
SAMPLING_PUMP˽OFF<LF>	Stops the sampling pump.

3.6 Using the Doser System

The 1303 can perform two types of dosing tasks: *continuous*, which gives an uninterrupted flow of tracer-gas over a period of time; or *discontinuous*, where the flow of tracer-gas is interrupted at regular intervals during a given dosing time. These tasks are dealt with in turn below.

Before starting any dosing tasks, the 1303's doser system (see Fig.1.1) must be calibrated with the tracer-gas to be used – see section 3.4 for details of how to do this. The 1303 cannot open a dosing valve for which calibration data does not exist.

To ensure efficient dosing, the tracer-gas pressure must be in the range 300 kPa to 450 kPa absolute.

3.6.1 The Dosing System

Flushing Recommendation

After the Type 1303 has been used for dosing, it should be flushed through with nitrogen gas. This can be done using the "Flush Function" featured in Type 7620 Application Software.

Releasing the Pressure

The pressure inside the 1303 must be released before storage. This can be done by closing the valve to the dose-gas bottle, or by removing the tube supplying the dose gas to the 1303 while it is dosing.

Failure to release this pressure can result in the piston inside the dosing outlet valve(s) becoming stuck to the rubber seal. This can result in the valve having difficulty opening the next time the instrument is used.

3.6.2 Opening the Main Dosing Valve

The main dosing valve (see Fig.1.1), which isolates the tracer-gas supply from the internal airways of the 1303, must first be opened.

Example:

MAIN_DOS_VALVE˽OP<LF>	Opens the main dosing valve to allow the flow of tracer-gas to the dosing valves.

The main dosing valve will close automatically to protect the doser-system airways if the tracer-gas pressure in the dosing manifold is above 550 kPa absolute.

3.6.3 Starting Continuous Dosing

Using the interface job described below starts an uninterrupted flow of tracer-gas through the specified dosing valves. Any number of the dosing valves can be opened simultaneously. The valve specified in the interface job will be opened; those not specified are closed. The 1303's doser system is also equipped with a pump which pumps *carrier-air* through the dosing valves to accelerate delivery of the tracer-gas to the dosing points. The dosing pump is controlled separately from the dosing valves.

Note: the carrier-air inlet on the rear panel of the 1303 must not be blocked.

Example:

OPEN_DOSING_VALVE␣ 1,2<LF>	Opens only dosing valves 1 and 2. If no dosing valves are specified, all dosing valves are *closed*.

The dosing pump must then be started. The pump is controlled using the following commands.

DOSING_PUMP␣ON<LF>	Starts the carrier-air pump.
DOSING_PUMP␣OFF<LF>	Stops the carrier-air pump.

If no further instructions are sent to the 1303, the dosing procedure will be stopped automatically when the time-period specified by the *Dosing Time-out* parameter, section 3.3.1, has elapsed. To continue the task in progress, the same job should be sent again to the 1303 before the dosing time-out period has elapsed.

The carrier-air pump can be used to effect air-change in the casing of the 1303, to prevent a build-up of the concentration of tracer-gas in the casing of the 1303. This is done using the interface job **D**OSING_**P**UMP␣**A**UTO. When sent to the 1303, this job causes the doser pump to start automatically whenever the pressure in the 1303's doser system is higher than 125kPa. The pump operates for one minute, then stops for one minute, then operates for one minute, and so on.

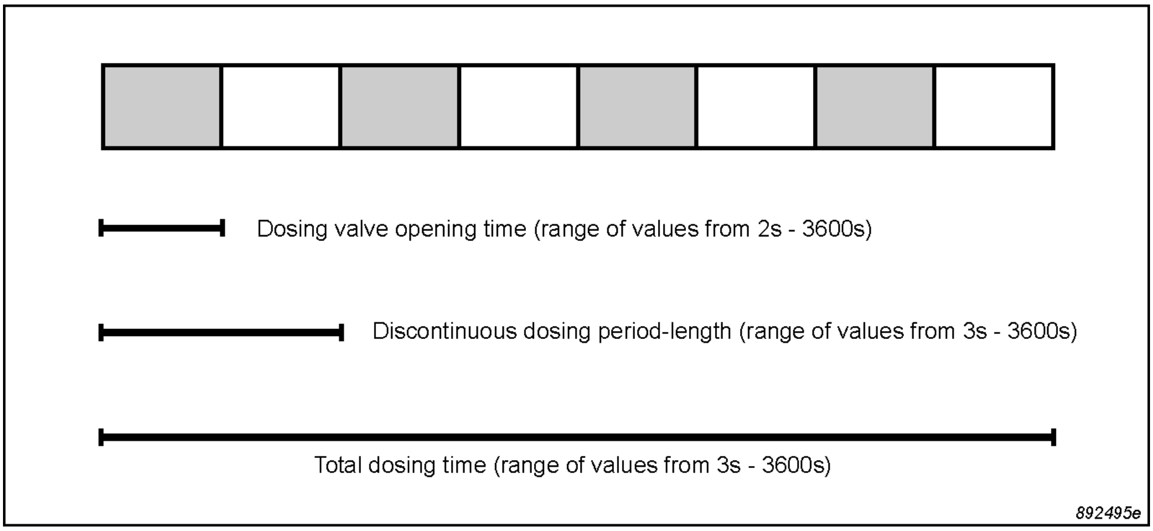
Example:

DOSING_PUMP˽AUTO<LF>	Runs the carrier-air pump for one minute, at one minute intervals, whenever the pressure in the 1303's doser system rises above 125kPa.

3.6.4 Starting Discontinuous Dosing

This interface job starts a flow of tracer-gas which is interrupted at regular intervals during a given total dosing time – see Fig.3.3. The discontinuous dosing job comprises four data elements: the dosing valve number; the total dosing time; the discontinuous dosing period-length; and the dosing valve opening period, see section 4.2.3.

Fig.3.3. Representation of the 1303's discontinuous dosing function



Example:

DIS_DOSING˽1,20,5,3<LF>	Starts a discontinuous dosing procedure through dosing valve number 1 for a total time of 20s. The discontinuous dosing period-length is 5s, during which the dosing valve is open for 3s.

DIS_DOSING␣3,60,6,2<LF>	Starts a discontinuous dosing procedure through dosing valve number 3 for a total time of 60s. The discontinuous dosing period-length is 6s, during which the dosing valve is open for 2s.
DIS_DOSING␣1,20<LF>	Starts a dosing procedure in which dosing valve number one is open continuously for 20s.
DIS_DOSING␣1<LF>	Stops any current discontinuous dosing procedure through dosing valve number one.

3.6.5 Calculating the Dosage Delivered

When each dosing-nozzle is calibrated with the tracer-gas being used (section 3.4) the 1303 is able to calculate the delivered dosage automatically. The delivered dosage is read-out from the 1303 as follows:

Example:

DOSAGE_GIVEN?␣1<LF>	Outputs from the 1303 the dosage (in mg) delivered through dosing valve number 1 *since the last time the dosage was read-out*. If no dosing valve is specified, the 1303 reads-out the dosages delivered through each of the 6 dosing valves.

3.7 Temperature Measurement

The temperature measured by the Air Temperature Transducers MM0034 and MM0060 is read out from the 1303 as follows:

Example:

SENSOR_TEMP?␣1<LF>	Reads-out the temperature data in °C from the temperature transducer connected to input number 1. If no transducer is connected to the particular input, -100°C is output by the 1303.

3.8 Checking the 1303

These interface jobs are for checking the various functions of the hardware and software components of the 1303, and help to identify faults in the 1303.

3.8.1 Sampling_Pump_Pressure? Interface Job

This job reads-out the pressure-difference across the sampling pump. The pressure across the pump can be measured with the sampling valves either open or closed. The internal 3-way valve must be set to **Waste Air Outlet**.

Example:

SAMP_PUMP_PRESS?<LF>	Measures and outputs the pressure-difference across the sampling pump, in kPa. With all sampling valves closed, the pump should generate a pressure-difference greater than 40kPa. With the sampling valves open, the pressure-difference should be less than 25 kPa.

3.8.2 Dosing_Pump_Pressure? Interface Job

This job reads-out the pressure-difference across the dosing pump, which supplies the carrier-air for dosing.

Example:

DOS_PUMP_PRESS?<LF>	Measures and outputs the pressure-difference across the dosing pump, in kPa. This value should be at least 10kPa.

3.8.3 Status? Interface Job

This job reads-out the 1303's current mechanical condition. The 1303's current condition is shown as a "flag", i.e. a word-value comprising 16 bits, each of which represents a specific mechanical component. If a bit is set, the 1303 is currently using the corresponding component. The flag is output from the 1303 as the total of the decimal equivalents of the binary values of the bits which are set. See Table 3.3 for the components represented by each bit in the Status flag, and their corresponding decimal values.

Table 3.3. The 1303's Status Flag. Each bit represents a particular 1303 component; when set, the 1303 is currently using that component.

Status Flag			Current function when set
Bit no.	**Dec. value**	**Bit name**	
1	1	Dosing valve 1	Dosing valve 1 open
2	2	Dosing valve 2	Dosing valve 2 open
3	4	Dosing valve 3	Dosing valve 3 open
4	8	Dosing valve 4	Dosing valve 4 open
5	16	Dosing valve 5	Dosing valve 5 open
6	32	Dosing valve 6	Dosing valve 6 open
7	64	Main dosing valve	Main dosing valve open
8	128	Dosing pump	Dosing pump on
9	256	Sampling valve 1	Sampling valve 1 open
10	512	Sampling valve 2	Sampling valve 2 open
11	1024	Sampling valve 3	Sampling valve 3 open
12	2048	Sampling valve 4	Sampling valve 4 open
13	4096	Sampling valve 5	Sampling valve 5 open
14	8192	Sampling valve 6	Sampling valve 6 open
15	16384	3-way valve	3-way valve set to analyzer
16	32768	Sampling pump	Sampling pump on

Example:

STATUS?<LF>	Outputs the Status flag of the 1303 as described above. Refer to Table 3.3 for the decimal values of each bit. Refer also to the examples given below.

If the 1303 outputs 33024, using Table 3.3 shows that 33024 = 256 + 32768. Therefore, bits 9 and 16 are set. The mechanical condition of the 1303 is: sampling valve number 1 open, and the sampling pump running.

If the 1303 outputs 199, using Table 3.3 shows that 199 = 1 + 2 + 4 + 64 + 128. Therefore, bits 1, 2, 3, 7 and 8 are set. The mechanical condition of the 1303 is: dosing valves 1, 2 and 3 open; main dosing valve open; dosing pump running.

3.8.4 Check_System Interface Job

This job starts a self-test sequence. This test sequence checks the functions of the 1303's sampler system with a two-part test, as follows.

1. **Check of the sampling pump efficiency and air tightness:** all 6 sampling valves are closed, the internal 3-way valve is set to **Waste Air Outlet** and the sampling pump started. If the pressure difference across the pump is less than 40kPa, either the sampling pump is not operating efficiently, or there is an air-leak around the pump. This sets the Sampling System Flag in the Warning Flags byte – see section 3.8.5.

2. **Check of blocked sampling channels:** all 6 sampling valves are closed, the internal 3-way valve is set to **Waste Air Outlet** and the sampling pump started. One by one the sampling valves are opened. If the resulting pressure difference across the pump (with open sampling valves) is greater than 25 kPa, then the sampler system airways are blocked. This sets the Sampling Channel Flag in the Error Flags byte – see section 3.8.6.

If the above conditions cannot be met, the setting of the corresponding Error flag causes a Service Request to be generated, if enabled – see section 4.1.1 and 4.2.6.

Example:

CHECK_SYSTEM<LF>	Starts the 1303's self-test sequence as described above.

3.8.5 Reset_System Interface Job

This interface job restarts the 1303. This job does *not* reset the 1303's set-up parameters or calibration data. The 1303 restarts as described in section 3.1. Resetting the 1303 cancels any task which the 1303 was performing prior to the reset.

Example:

RESET_SYSTEM<LF>	Resets the 1303.

3.9 Error Conditions and Service Requests

If an error arises in the 1303's hardware, processor system or software, the 1303 can signal the system controller by generating a Service Request. The exact nature of the error condition can then be investigated by using the **W**arning**?** or **E**rror**?** interface jobs.

3.9.1 The Status Byte

The status byte is an eight-bit byte, read out by the system controller as part of the serial poll sequence. The status byte gives the first indication of the cause of the service request. The status byte for the 1303 is shown in Table 3.4.

Table 3.4 The 1303's Status Byte, showing the error conditions which result in the individual bits being set.

Status Byte		**Error Condition**
Bit no.	**Dec. Value**	
1	1	Not used
2	2	Set when the 1303 has completed a reset
3	4	Set when the 1303 has completed an interface job
4	8	Not used
5	16	Set when the 1303 has not completed the previous interface job when a new job is read-in
6	32	The 1303 is in an abnormal condition. The interface jobs **W**arning**?** or **E**rror**?** give more information about the abnormal condition – see section 3.9.4 and 3.9.5
7	64	Indicates the 1303 has set the interface *SRQ* line. This bit cannot be disabled
8	128	Set when the time period given in the dosing time-out set-up parameter (section 3.3.1) has elapsed

For an error to generate a Service Request, the corresponding bit in the status byte must be enabled to request service. The procedure for this is described in the following section.

When a service request is enabled, all bits in the status byte *except* bit 6 are reset by a serial poll read-out or resetting the status byte. Bit 6 is only reset when the abnormal condition of the 1303 (identified by the **W**arning**?** or **E**rror**?** interface jobs, sections 3.9.4 to 3.9.5) is corrected. When a service request is generated, bit 7 of the status byte is always set; it cannot be disabled.

3.9.2 Enabling Service Requests

The Specified bits in the status byte are enabled using the interface job **S**ervice_**R**equest_**E**nable. The required bits are specified by using the decimal equivalent of their binary value, as shown in Table 3.4. See also the job examples below for further clarification.

Note that the relevant bits are always set whenever the corresponding condition occurs; this job only enables or disables the generation of a service request by that condition.

Examples:

S_R_E˽32<LF>	Service request is generated by the setting of bit 6 (bit pattern 00100000 = 2^5 = 32 decimal) in Table 4.3.
S_R_E˽160<LF>	Service request is generated by the setting of bit 6 and bit 8 (bit pattern 10100000 = 2^5 + 2^7 = 32 + 128 = 160 decimal).
S_R_E˽0<LF>	All bits are disabled (except bit 7).

The bits which are enabled in the status byte can be read-out using the **S**ervice_**R**equest_**E**nable**?** interface job:

S_R_E?<LF>	Outputs the sum of the decimal values of the bits which are enabled. For example, if the decimal read-out is 48, the enabled bits are bit 5 and bit 6 (bit pattern 00110000 = 2^5 + 2^6 = 16 + 32 = 48 decimal).

3.9.3 Resetting the Status Byte

The job **R**eset_**S**tatus_**B**yte is used for this task.

Example:

R_S_B<LF>	Resets the bits in the status byte to zero.

3.9.4 The Warning? Interface Job

This job reads-out an 8-bit byte (the Warning Flags) which gives information about error conditions which affect the efficient operation of the 1303. The 1303 is still able to operate, but the error should be rectified as soon as possible. The Warning Flag byte is shown in Table 3.5.

Table 3.5. The 1303's Warning Flags byte

WARNING FLAGS		
Bit no.	**Dec. Value**	**Flag Description**
1	1	Reset Done Flag
2	2	Temperature Flag
3	4	Power Fail Flag
4	8	Sampling System Flag
5	16	Dosing Filter Flag
6	32	Dosing Nozzle Flag
7	64	Dosing Pump Flag
8	128	Calibration Flag

Warning Flags are set when either the 1303's self-check procedures or the **C**heck_**S**ystem interface job identify an error condition. This in turn sets bit 6 of the Status Byte (generating a service request, if enabled) to indicate that an error condition exists. The **W**arning**?** job can then give more information about the cause of the error condition.

Example:

Warning?<LF>	Outputs the Warning Flags from the 1303. A "1" indicates that the flag is set; a "0" indicates the flag is not set.

The conditions which causes the Warning Flags to be set, and the appropriate action to take, are dealt with in turn below.

Reset Done Flag

Indicates that the 1303 has completed a reset, following either the **R**eset_**S**ystem interface job (section 3.8.5) or switching-on the 1303. This flag is reset when the Warning Flags are read-out from the 1303.

Temperature Flag

Is set when the internal temperature of the 1303 is outside the range +2°C to +60°C. The 1303 must not be used until the internal temperature is within the normal operating limits of +5°C to +40°C. This flag is reset when the internal temperature is again within the normal operating limits, or by resetting the 1303, or switching the 1303 off/on.

Power Fail Flag

Is set if the power from the 1303's transformer to the 1303 is outside the range 13,25V to 15,75V. This flag is reset when the voltage is back within the above range, or by resetting the 1303, or switching the 1303 off/on. If the error is persistent, have the 1303 serviced.

Sampling System Flag

Is set if, during the self-test specified in test 3 of the **C**heck_**S**ystem job (section 3.8.4) the pressure across the pump is less than 40kPa. This indicates that either the sampling pump is not working correctly, or that the sampler system is not sufficiently air-tight. This flag is reset by the next **C**heck_**S**ystem job (if the results of the check are satisfactory), or by resetting the 1303, or switching the 1303 off/on. If the error is persistent, have the 1303 serviced.

Dosing Filter Flag

Is set with the **C**alibrate_**N**ozzle job (section 3.4) if the rate of pressure-increase in the doser system during a calibration is too slow. This indicates either a blocked dosing-filter or the tracer-gas supply bottle is empty. If the tracer-gas supply bottle is empty, replace it with a full bottle. If the tracer-gas bottle is not empty, the dosing-filter is blocked, and the 1303 must be serviced. This warning can also be caused by the regulator on the dose-gas bottle reacting too slowly. The flag is reset by the next calibration, or by resetting the 1303, or switching the 1303 off/on.

Dosing Nozzle Flag

Is set with the **C**alibrate_**N**ozzle job (section 3.4) if the newly-calculated nozzle area is 2-times larger or smaller than the existing largest and smallest nozzle. This indicates that the calibration procedure was not performed correctly. The calibration procedure must then be repeated. This flag is also set when the time specified by the *dosing time-out* set-up parameter has been exceeded (section 3.3.1). The flag is reset by the next calibration, or by resetting the 1303, or switching the 1303 off/on.

Dosing Pump Flag

Is set if the pressure generated by the carrier-air pump is less than 10kPa above ambient pressure. This indicates that the carrier-air pump is not working correctly. The flag is reset when the pressure generated by the pump is over 15kPa above ambient pressure, or by resetting the 1303, or switching the 1303 off/on. If the error persists, have the 1303 serviced.

Calibration Flag

Is set when a dosing procedure is attempted through a dosing channel which has not been calibrated, or if no characteristic gas-constant (or molecular weight) has been read-out to the 1303 before starting the dosing procedure. A non-calibrated dosing channel cannot be used for dosing. Dosing procedures cannot be performed without reading-in a characteristic gas-constant. The flag is reset by calibrating the dosing channel (section 3.4) or reading in the characteristic gas-constant for the tracer-gas being used (section 3.3.2). Resetting the 1303 or switching the 1303 off/on also resets the flag.

3.9.5 The Error? Interface Job

This job reads-out an 8-bit byte (the Error Flags) which gives information about errors which cause the 1303 to stop working. If any of these errors exist, the 1303 is unable to function until the error is rectified. The Error Flag byte is shown in Table 3.6.

Table 3.6 The 1303's Error Flags byte

ERROR FLAGS		
Bit no.	**Dec. Value**	**Flag Description**
1	1	ADC Flag
2	2	RAM Flag
3	4	PROM Flag
4	8	Sampling Channel Flag
5	16	Dosing-pressure Flag
6	32	Job Specification Error
7	64	Software Error Flag
8	128	Set-up Error Flag

Error Flags are set when either the 1303's self-check procedures or the **C**heck_**S**ystem interface job identify an error condition. This in turn sets bit 6 of the Status Byte (generating a service request, if enabled) to indicate that an error condition exists. The **E**rror**?** job can then give more information about the cause of the error condition.

Example:

Error?<LF>	Outputs the Error Flags from the 1303. A "1" indicates that the flag is set; a "0" indicates the flag is not set.

The conditions which cause the Error Flags to be set are dealt with in turn below.

ADC Flag

Is set when the ADC (analogue-digital converter) develops an error. This results in a software-error, which automatically resets the 1303. The flag is reset by reading-out the Error Flags, or by switching the 1303 off/on. If the error persists, have the 1303 serviced.

RAM Flag

Indicates that the RAM (random access memory) of the 1303, which stores the 1303's set-up data, has been corrupted. The flag is reset by switching the 1303 off/on. If the error persists, have the 1303 serviced.

PROM Flag

Indicates that the CRC (cyclic redundancy check) for the PROM (programmable read-only memory) has identified incorrect data. The flag is reset by switching the 1303 off/on. If the error persists, have the 1303 serviced.

Sampling Channel Flag

Is set during the self-test specified in the **C**heck_**S**ystem job (section 3.8.4), or when drawing a sample with the 3-way valve set to **Waste Air Outlet**, if the pressure across the sampling pump is above 25kPa. This indicates that the sampler-system airways may be blocked. The flag is reset by reading-out the Error Flags, or by switching the 1303 off/on. If the error persists, have the 1303 serviced.

Dosing-pressure Flag

Is set when calibrating the dosing nozzles, or when performing a dosing task if the tracer-gas pressure in the dosing manifold is outside the range 295kPa to 455 kPa absolute. Calibration cannot continue if the tracer-gas pressure is outside of this range. The flag is also set if the tracer-gas pressure rises above 550kPa when the Main Dosing Valve is open; the Main Dosing Valve closes automatically at this pressure. The flag is reset when the tracer-gas pressure is within the specified limits; or by resetting the 1303, or switching the 1303 off/on.

Job Specification Error

Is set if an interface job sent to the 1303 is not recognised. This can be due to an incorrect job header, incorrect syntax, or incorrect or missing data. This flag is also set when calibrating the dosing nozzles, if no characteristic gas-constant (or molecular weight) has been read-in to the 1303 (section 3.3.2). A job cannot be carried out by the 1303 if this flag is set. The job's syntax should be checked carefully and the job sent again. The flag is reset by reading-out the Error Flags, or by switching the 1303 off/on.

Software Error Flag

Is set when the 1303's software develops an error when running. When this flag is set, the 1303 is reset automatically. The flag is reset by reading-out the Error Flags, or by switching the 1303 off/on. If the error persists, have the 1303 serviced.

Set-up Error Flag

This flag is set when the 1303's set-up parameters (described in section 3.3 and 4.2.1) are deleted. This happens because either the 1303's set-up memory has been corrupted, or the 1303 has been switched off/on. The 1303's set-up parameters will revert to their default values. This flag is reset by reading-out the Error Flags. If the error persists, have the 1303 serviced.

Chapter 4

The IEEE/IEC Interface and Interface Job Overview

August 2008

4.1 Introduction

The digital interface of the Multipoint Sampler and Doser Type 1303 is designed according to ANSI/IEEE Std 488-1978, “IEEE Standard Digital Interface for Programmable Instrumentation”. The only significant difference between this and the digital interface of IEC Publication 625-1 is in the type of connector specified; a full range of connectors and adaptors from LumaSense ensures compatibility between instruments fitted with either connector.

The 1303 is connected to other instruments with IEEE/IEC interfaces using the following LumaSense cables and connectors.

- Cable AO0265, which has an IEEE standard connector at each end, connects the 1303 to other instruments equipped with the IEEE connector.

- Cable AO0264, with an IEEE connector at one end and an IEC standard connector at the other end, connects the 1303 to instruments which have the IEC connector.

- Cable WL0845, which has IEEE connectors at both ends, is used to connect the 1303 to the IEEE connector of the Gas Monitor.

The codes and formats used in sending and receiving data to and from the 1303 over the IEEE/IEC interface have been designed according to the recommendations of IEEE Std 728-1982, “IEEE Recommended Practice for Code and Format Conventions (For Use with ANSI/IEEE Std 488-1978)”. Note in particular that the 1303 carries out all communications other than defined bus command sequences using ASCII (ISO 7-bit) coded messages.

It is important to note that although the digital interface of the 1303 is designed according to IEEE Std 488 and follows the recommendations of IEEE Std 728, absolute compatibility with IEEE/IEC interfaces designed by other manufacturers cannot be unconditionally guaranteed, since differences can occur within the limits of the specifications. Any problems encountered, however, will be of a software rather than a hardware nature. Where compatibility is in doubt, contact your local LumaSense representative for further information.

4.1.1 IEEE Functions Implemented in the 1303

The interface of the 1303 implements the following functions as specified in IEEE-488. The sections referred to are the relevant sections of the IEEE Std 488-1978 which specify the functions. The equivalent clauses of IEC Publication 625-1 are given in parentheses.

Section 2.3	Source Handshake (SH) Interface Function, (Clause 6) SH 1 – complete capability
Section 2.4	Acceptor Handshake (AH) Interface Function, (Clause 7) AH 1 – complete capability
Section 2.5	Talker (T) Interface Function, (Clause 8) T 5 – basic talker, serial poll, talk only mode, unaddress if MLA
Section 2.6	Listener (L) Interface Function, (Clause 9) L 3 – basic listener, listen only mode, unaddress if MTA
Section 2.7	Service Request (SR) Interface Function, (Clause 10) SR 1 – complete capability
Section 2.9	Parallel Poll (PP) Interface Function, (Clause 12) PP 1 – complete capability
Section 2.10	Device Clear Interface Function, (Clause 13) DC 1 – complete capability
	All other functions – no capability

For further details of the above functions refer to the relevant section of the IEEE or IEC standards.

4.2 Overview of 1303 Interface Jobs

In this section, each 1303 interface job is grouped according to its function, with a short description of its effect. The correct syntax for each job is given, with the minimum code for each job-header, in bold upper-case characters. The data for input jobs can be in NR1, NR2 or NR3 format, unless specifically stated otherwise. The data for output jobs is in NR2 format unless specifically stated otherwise.

4.2.1 Set-up Jobs

These jobs install set-up parameters in the 1303. The set-up parameters must be installed before starting to use the 1303. Further information about the set-up parameters is given in section 3.3.

Table 4.1 The interface jobs which set-up the 1303.

Job Header	Data	Effect on 1303
Dosing_**T**ime_**O**ut	Time interval form 10s to 3600s.	Sends the new value for the Dosing Time-out parameter to the 1303.
Dosing_**T**ime_**O**ut**?**	*No data.*	Reads-out the current Dosing Time-out value from the 1303.
Gas_**C**onstant	Ratio of R (8314 J $mol^{-1}K^{-1}$) and the molecular weight M of the tracer-gas being used.	Sends the new value for the Characteristic Gas Constant parameter to the 1303.
Gas_**C**onstant**?**	*No data.*	Reads-out the current Characteristic Gas Constant parameter from the 1303.
Mol_**W**eight	Molecular weight of the tracer-gas being used.	Sends the new value for the molecular weight of the tracer-gas being used to the 1303.
Mol_**W**eight**?**	*No data.*	Reads-out the molecular weight of the tracer-gas being used from the 1303.
Calibration_**D**ata	Doser-nozzle number and area of nozzle in $m^2 * 10^{-9}$.	Sends the calibration data for the stated doser nozzle to the 1303.
Calibration_**D**ata?	Doser-nozzle number.	Reads-out the calibration data for the stated doser nozzle from the 1303.

4.2.2 Sampler System Jobs

These jobs control the 1303's sampler system. Further information about these jobs is given in section 3.5.

Table 4.2 The interface jobs which control the 1303's sampler system.

Job Header	**Data**	**Effect on 1303**
Open_**S**ampling_**V**alve	Up to 6 sampling-valve numbers.	Opens the specified sampling valves.
Connect_**S**ampling_**V**alve	**T**o_**M**onitor **T**o_**S**ampling_**P**ump	Routes the air-sample either to the Gas Monitor, or via the sampling pump to the **Waste Air Outlet**.
Sampling_**P**ump	**O**n **O**ff	Starts/stops the sampling pump.

4.2.3 Doser System Jobs

These jobs control the dosing function of the 1303. For further information about the calibration of the doser system, refer to section 3.4. For further information about using the doser system, see section 3.6.

Table 4.3 The interface jobs which control the 1303's doser system

Job Header	Data	Effect on 1303
Calibrate_**N**ozzle	Specific dosing-nozzle number.	Starts the automatic calibration of the specified doser nozzle.
Main_**D**osing_**V**alve	**OP**en **CL**ose	Opens/closes the main dosing valve.
Open_**D**osing_**V**alve	Up to 6 dosing-valve numbers.	Opens specified dosing valves.
Discontinuous_**D**osing	Dosing valve number, total dosing time, discontinuous dosing period-length, dosing valve opening period.	Starts a discontinuous dosing procedure through the specified dosing valve.
Dosing_**G**as_**P**ressure**?**	*No data*.	Measures and reads-out the tracer-gas pressure (kPa) in the doser manifold.
Dosing_**G**as_**T**emperature**?**	*No data*.	Measures and reads-out the tracer-gas temperature (°C) in the doser manifold.
Dosage_**G**iven**?**	Specific dosing-valve number. If no number is given, the total dosage through all valves is read-out.	Reads-out the dosage of tracer-gas (mg) delivered through the specified doser nozzle since the last read-out of the dosage delivered.
Dosing_**P**ump	**O**n **O**ff **A**uto	Starts the dosing pump. Stops the dosing pump. See end of section 3.6.2.

4.2.4 Temperature Measurement Jobs

This job controls temperature measurement with the 1303.

Table 4.4 The interface jobs which control the 1303's temperature-measurement function.

Job Header	**Data**	**Effect on 1303**
Sensor_**T**emperature**?**	Specific temperature-sensor number	Reads-out the temperature (°C) at the specified temperature-sensor.

4.2.5 1303 Check Jobs

These jobs check the various functions of the 1303. For further information, refer to section 3.8.

Table 4.5 The interface jobs which check the 1303's functions.

Job Header	**Data**	**Effect on 1303**
Sampling_**P**ump_**P**ressure**?**	*No data*.	Measures and reads-out the pressure (kPa) across the sampling pump.
Dosing_**P**ump_**P**ressure**?**	*No data.*	Measures and reads-out the pressure (kPa) across the dosing pump.
Status**?**	*No data*.	Reads-out the 1303's status-flag.
Check_**S**ystem	*No data.*	Starts a check of the 1303's sampler system.
Reset_**S**ystem	*No data*.	Resets the 1303.

4.2.6 Error Condition and Service Request Jobs

These jobs allow the identification of error conditions in the 1303. For further information, refer to section 3.8.

Table 4.6 The interface jobs which investigate error conditions and allow generation of service requests.

Job Header	Data	Effect on 1303
Service_**R**equest_**E**nable	Decimal value of bits you want to enable	Selectively enables bits in the status byte.
Service_**R**equest_**E**nable**?**	*No data*	Reads-out from the 1303 the enabled bits of the status byte.
Reset_**S**tatus_**B**yte	*No data.*	Resets all the bits of the status byte to zero.
Warning**?**	*No data.*	Reads-out the 1303's Warning flags.
Error**?**	*No data*	Reads-out the 1303's Error flags.

4.2.7 Standardised Jobs

These jobs do not directly affect the operation of the 1303. The **D**efine_**T**erminator job is detailed in section 3.2.1. The **O**utput_**H**eader job is detailed in section 3.2.2.

The jobs with syntax of the type "***RST**" are standardised IEEE 488.2 jobs. Most of these jobs are identical to normal 1303 jobs in operation; the function description refers you to the appropriate 1303 job.

Table 4.7 Standardised interface jobs which perform various secondary functions of the 1303.

Job Header	Data	Effect on 1303
Define_**T**erminator	Decimal value of the ASCII control character	Selects the terminator character for interface jobs.
Identify**?**	*No data*	Outputs **INNOVA 1303**
Output_**H**eader	**EX**clusive **I**nclusive	Disables/enables the 1303 to output the minimum code of the job header with the appropriate data, in response to the output jobs listed, section 3.2.2.
***IDN?**	*No data.*	Outputs **INNOVA,1303,VPXXXX**
***RST**	*No data.*	Identical to the job **R**eset_**S**ystem.
***SRE**	As for **S**ervice_**R**equest_**E**nable.	Identical to the job **S**ervice_**R**equest_**E**nable.
***SRE?**	*No data*	Identical to the job **S**ervice_**R**equest_**E**nable**?**
***STB?**	*No data*	Reads-out the status byte from the 1303.
***TST?**	*No data*	Indicates if the Warning or Error flags are set. The 1303's condition is given as follows: 0: Normal 1: Warning flag(s) set -1: Error flag(s) set The flags can then be read-out using the **W**arning**?** or **E**rror**?** jobs.

Chapter 5

Service and Repair

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The Type 1303 Multipoint Sampler and Doser is designed and constructed to provide the user with many years of safe, trouble-free operation. However, should a fault occur which impairs its correct function and operating safety, then it should be immediately disconnected at the mains source and secured against further operation. For repair contact your local LumaSense Technologies A/S service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

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LumaSense Technologies A/S
Energivej 30
DK-2750 Ballerup, Denmark

Tel.:(+45) 44 20 01 00
Fax: (+45) 44 20 01 01
http://www.lumasense.dk