SERIES 4

PULSAR

NDIR/PARAMAGNETIC MULTI-GAS ANALYSER
OPERATING MANUAL

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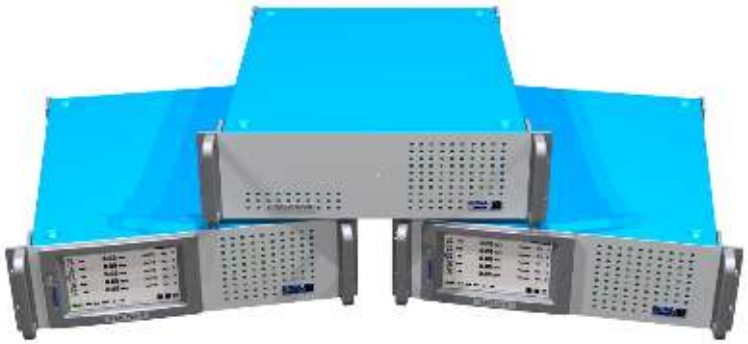


NOTE: Due to the capability of separate calibrations for each range, it may appear that one range measures differently to another. In this case it is necessary to recalibrate in order to realign the measurements. Always apply the calibration to all ranges to avoid inter-range differences.

3.4 Remote Control

Consult the S4i User Guide (available to download at www.signal-group.com) for detailed remote control operational guidance.

- *Measurement*

  Once the unit is stable and fully calibrated, accurate measurements can be taken.
  Select Sample mode to energise the heated internal sample valve and allow sample gas to flow.
  You may check the calibration at any time by switching to Zero or Span gas paths and monitoring the measurements.

- *Ranges*

  Each gas measurement channel within the instrument may have a single, or two hardware ranges, depending on your selected options. Extra ranges are generated by the instrument software. It is standard practice (and often dictated by regulations) to choose a suitable range for measurement. For this reason consult your local regulations for further guidance on the use of ranges.

  To enable compliance with various regalutory standards, 5 ranges are provided, together with an auto range facility. Each of these ranges is programmable by the user, apart from the maximum range and the (optional) second hardware range which are fixed.
  Four of the five ranges are standard *0-n* type, with a fixed lower end, but the fifth is *m-n*, which means that it has a programmable lower end allowing the expansion of the specific range of measurement. For example, if the expected range of measurement is 11 to 18ppm, an instrument range of 5 to 25ppm may be chosen. The main benefit of this facility is that it allows for greater resolution on the analogue outputs.

  NOTE: Each range uses separate calibration curves and coefficients. Ensure that all the ranges that will be in use are properly calibrated before taking measurements.

DOCUMENT HISTORY

ISSUE	AMENDMENT	DATE
1.01	DRAFT	09/16

WHATS IN THE BOX

- ✓ Signal Series 4 PULSAR analyser
- ✓ Signal USB Drive containing:
  1) Operating Manual
  2) S4i User Guide
  3) S4i installation
  4) Datasheet
  5) Test Reports
- ✓ 9/16" Wrench
- ✓ 7/16" Wrench
- ✓ Analogue output connection cable (Optional)
- ✓ Relay output connection cable (Optional)
- ✓ Power cable (UK)

activated. There are many reasons that a stable reading would not be found. It is advisable to contact your local Signal Service representative for advice if this occurs.

- *Coarse zero/Span Calibration*

It may be necessary, from time to time, to initiate a coarse calibration. This is a fully automated procedure which adjusts the amplifier hardware for optimum performance. The process may take up to 10 minutes to find the appropriate settings so this should not be performed regularly.
Coarse calibration can be initiated from the same states as the standard calibration above.
Reasons that coarse calibration may be required include, but are not limited to:

- Partial blockage or contamination of sample filters;
- Component degradation (some components such the IR sensor and IR source degrade over time. If you suspect this to be the case then contact your local Signal service representative);
- Particulate obstruction of the IR light path (it is advisable to follow a strict maintenance regime for all analytical instrumentation to ensure a robust and reliable measurement is always available);
- Degradation of sample pump;
- Significant change in ambient conditions (pressure, temperature, etc)

It is advisable that you contact your local Signal Group Ltd representative if you suspect a requirement for coarse calibration.

they have become stable enough to use as a reference for calibration. Once stability is achieved, the unit will monitor the measurements for a short period before setting the correct values.

NOTE: For best accuracy, allow the instrument to stabilise for at least 1 hour after warmup before attempting to calibrate.

NOTE: Before attempting any calibration, ensure that the correct gases are connected.

NOTE: Before attempting a Span calibration, ensure that the span gas table is complete with the correct gas values, as described on the gas cylinder certificate. Failure to do this may result in large errors in measurement and/or unexpected readings.

NOTE: Each measurement range has its own individual zero offset and span coefficient. Select Apply Calib. To All Ranges before any calibration if you wish to use the same offset and coefficient for all ranges.

You may begin a Calibration from any of the following modes:

ZERO – only the zero offset is adjusted.

SPAN – only the span coefficient is adjusted.

SAMPLE – First the zero gas path is automatically selected and the zero offset adjusted, then the adjustment of the span coefficient is performed with the span gas path selected.

- *Calibration Failure*
  The calibration routine automatically waits for a stable reading before applying the results. If a stable reading cannot be found within the built-in time limit, then the calibration will fail and an alarm will be

□Read This First□

Signal Group Ltd designs, manufactures and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you MUST properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions MUST be adhered to and integrated into your safety program when installing, using and maintaining Signal Group Ltd products. Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.

• Read all instructions prior to installing, operating, and servicing the product.
• If you do not understand any of the instructions, contact your Signal Group Ltd representative for clarification.
• Follow all warnings, cautions, and instructions marked on and supplied with the product.
• Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
• Install your equipment as specified in the Installation Instructions of the appropriate Instruction Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
• To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
• When replacement parts are required, ensure that qualified people use replacement parts specified by Signal Group Ltd. Unauthorised parts and procedures can affect the product's performance, place the safe operation of your process at risk, and VOID YOUR WARRANTY. Substitutions may result in fire, electrical hazards, or improper operation.
• Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

IMPORTANT
SAFETY INSTRUCTIONS

Wiring and Installation

The following safety instructions apply to all EU member states and should be followed according to Low Voltage Directive. It is recommended that non-EU areas should also comply with these instructions unless superseded by other local or national standards.

1. It is essential that suitable grounding connections be made at all connectors provided for this purpose.

2. All safety covers and grounding connections must be properly reinstated after maintenance or troubleshooting. The integrity of all earth terminals must be maintained at all times.

3. To ensure safe operation of this equipment, connection to the mains supply should be made through a circuit breaker which will disconnect all circuits carrying conductors in the case of a fault. These circuit breakers should comply with a recognised standard such as IEC947. All wiring must conform with any local or national standards.

Handling and Storing Pressurised Gases

This instrument requires pressurised gases for use. Some general safety precautions are outlined below, however it is advisable that operators are properly trained in the handling and storage of pressurised gas containers:

- Never drop cylinders or permit them to strike each other violently;
- Cylinders may be stored in the open, but in such cases should be protected against extremes of weather and, to prevent rusting, from the dampness of the ground. Cylinders should be stored in the shade

3.3 Control

Once the analyser is powered on it may be controlled using either the bundled S4i program (See the S4i User Guide for further information), or the optional front panel display.

- *Password Protection (front panel display only)*

  To prevent inadvertent changes to the operational status of the analyser, any keys that affect gas path, mode, range, and configuration can be disabled and password protected. Refer to the front panel display user guide for instructions. Make sure that you keep a record of chosen your password.

- *Warmup*

  It is possible to select gas paths using the front panel display or the S4i interface program. This may be done by pressing the SAMPLE, SPAN or ZERO buttons.

  Once STANDBY or one of the gas paths listed above have been selected, the front panel LED will flash rapidly, indicating instrument warmup. The heated components within the instrument will warm up to their set temperatures before gas path opening will occur. You can monitor these temperatures on the front panel display or using the S4i. If the instrument is already up to temperature (i.e. it has already been set to Standby), then it will proceed directly to the next stage:

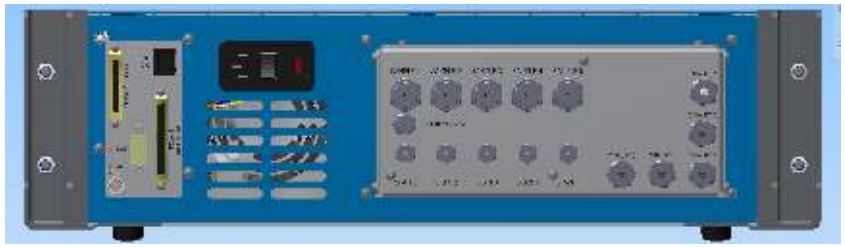
  If an integrated sample pump is fitted, this will start when a gas path is open.

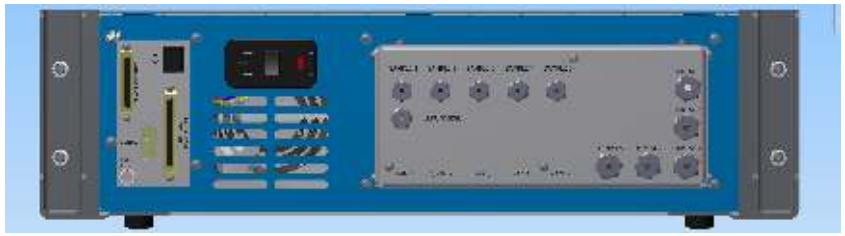
- *Zero/Span Calibration*

  The procedures for calibration of the zero offset and span coefficient are fully automated. Simply select Calibrate while the unit is lit and stable to initiate the process. The analyser will start by choosing the correct gas path (if not already selected), to allow the calibration has to flow. It will then monitor the measurements to determine the point at which

6.5Amps (for 115VAC), if switching the primary side of an AC-DC transformer .

10. The front panel Status LED should now be illuminated solid blue. This indicates that the unit is in Sleep mode.





The following section of this manual describes the expected behaviour of the instrument in various cases, and some common operational controls. Use the appropriate user interface guide for more detailed information on how to connect with and use the instrument further.

when located in areas where extreme temperatures are likely;

- The valve protection cap should be left on each cylinder until it has been safely secured against a wall or other solid structure, or placed is dedicated cylinder stand;
- Avoid dragging, rolling or sliding cylinders, even for a short distance – they should be moved using a suitable transportation device (e.g. Bottle trolley);
- Never tamper with the safety devices in valves or cylinders;
- Avoid storage of full and empty cylinders together. Serious suck-back Can occur when empty cylinders are attached to pressurised systems;
- No part of a cylinder should be exposed to a temperature higher than 52℃ (125℉), or a naked flame or incandescent material;
- Do not place cylinders where they could become part of an electric circuit.

Operation and Maintenance

On leaving the Signal Group Ltd factory, this product confirmed to all applicable safety directives. The operator must take care to follow the instructions given in this manual in order to preserve this condition.

Before switching on the instrument, ensure that the local supply voltage is within the limits indicated in this manual.

Any interruption of the protective earth connections, whether inside or outside of the unit, or removal or interruption of its ground line connection, may result in reduced instrument performance and exposure to the risk of electrocution. It is therefore strictly forbidden to deliberately disconnect the protective earth.

The removal of covers and panels may expose electrical components. Connectors may also be energised even if no mating connector is present. The unit should therefore be disconnected from All electrical supplies before any kind of maintenance or repair is carried out. Only

trained personnel who are aware of the risk are permitted to energise an open unit.

Fuses may only be replaced with identical items. It is forbidden to use repaired fuses or to bypass fuses.

Substances hazardous to health may escape from the units gas outlets. It is advisable to exhaust the gas outlets to a safely ventilated area.

The safety of the personnel operating this equipment is paramount. All efforts should be taken to ensure their protection.

Our analysers are checked and tested using state of the art equipment and techniques. Despite this, an element of risk remains to the user when using any gas analyser. Even when operated as intended and observing all applicable safety instructions and standards, some risks remain, including but not limited to the following:

- An accidental interruption of the protective earth line, e.g. In an extension cable, may result in a risk to the user;
- Electrically live components may be exposed if operating the instrument with covers removed;
- The emission of hazardous gases may be possible even if all connections have been made correctly and according to the manufacturers' instructions.

Avoid exposure to the dangers of these residual risks by taking particular care when installing, operating, maintaining and servicing the analyser.

If unsure about anything in this manual, please contact your local Signal Group Ltd representative for further guidance.

6. **SAMPLE** –
    a. For analysers with Automatic gas handling:
        i. For instruments with integrated sample pump, connect Sample gas to the SAMPLE port on the rear panel at -0.2 to 0.4Bar (-20 to 40kPa, -3 to 6psi);
        ii. For instruments without integrated sample pump, connect Sample gas SAMPLE port on the rear panel, at 0.2 to 1Bar (20 +\-1000kPa, 3 to 14.5psi);
    b. For analysers with Non-Automatic gas handling:
        i. For instruments with integrated sample pump, connect Sample gas to the SAMPLE/SPAN/ZERO port on the rear panel, at -0.2 to 0.4Bar (-20 to 40kPa, -3 to 6psi);
        ii. For instruments without integrated sample pump, connect Sample gas SAMPLE/SPAN/ZERO port on the rear panel, at 0.2 to 1Bar (20 +\-1000kPa, 3 to 14.5psi);
7. **EXHAUSTS** – Connect the exhaust(s) to a well ventilated area, ensuring that the connection is free from obstruction that could cause restrictions.

    CAUTION: The gases emitted from the exhaust(s) may contain sample gas. Care must be taken to avoid risk of local buildup of sample gases.

8. If desired, attach your chosen output cables (analogue/relays/etc) now. Preassembled cables can be purchased separately from Signal Group Ltd. Contact your local representative for details. Alternatively, see the Output Wiring section of this manual for connection information.
9. When all the fittings and cables are secure, you may apply power to the unit by using the switch on the rear panel (this applies to units powered by mains AC only). 24VDC units should use an external switch capable of carrying up to 25Amps if switching 24VDC, 3.15 Amps (for 230VAC) or

3.2 Start

1. Ensure that the analyser is resting on a stable surface or fixed into a rack, or on a wall if the wall-mount option has been chosen;
2. Ensure that the correct fuses are in place within the integrated IEC socket on the rear panel. The diagram below shows the rear panel layouts of 5-channel Automatic and Non-Automatic PULSAR instruments;
3. Connect the included (or equivalent) power cable to the rear panel IEC power socket, ensuring the supply voltage is within the operational limits of the instrument;
4. **PURGE** –
    a. For analysers with Automatic gas handling: Connect pure Nitrogen to the ZERO/PURGE port on the rear panel, at 0.55bar +\-0.45bar (55 +\-45kPa, 8 +\-6.5psi). This will also be the source of your zero gas.
    b. For analysers with Non-Automatic gas handling: Connect pure Nitrogen to the PURGE port as described above.
    NOTE: for Zero, connect your Zero gas to the SAMPLE/SPAN/ZERO port at 0.55bar +\-0.45bar (55 +\-45kPa, 8 +\-6.5psi) when necessary (e.g. For calibration);
5. **SPAN** –
    a. For analysers with Automatic gas handling: Connect Span gas to the SPAN port on the rear panel, at 0.55bar +\-0.45bar (55 +\-45kPa, 8 +\-6.5psi).
    b. For analysers with Non-Automatic gas handling: Connect pure Span gas to the SAMPLE/SPAN/ZERO port when necessary (e.g. For calibration);

    For best results, match your span gas flow to that of your sample.
    It is recommended that the concentration value of your span gas should be between 40% and 80% of your chosen measurement range;

Competent Personnel

Specialist knowledge of this instrumentation is a necessity for working with and on the unit.

Authorised personnel for installing, operating, servicing and maintaining the analyser are instructed and trained personnel of the operating company, Signal Group Ltd or their local representatives.

It is the responsibility of the operating company to:

- Ensure their staff have adequate training;
- Observe safety regulations;
- Follow this instruction manual.

Operators must:

- Have been properly trained;
- Have read and understood all relevant sections of the instruction manual before commencing use of the instrument;
- Know all the applicable safety mechanisms and regulations.

To avoid personal injury and loss of property, do not install, operate, maintain or service this instrument before reading and understanding this manual and receiving appropriate training.

Do not dispose of this instruction manual.

QUICK-START

Please read all safety instructions before operating the analyser.

This section is intended as a quick guide for trained personnel. See the Operation section for detailed instructions.

a) Connect your power supply to the mains IEC connector on the rear panel (for standard AC operation);

b) Connect your gases to the rear panel at the following pressures, using tubing as indicated below:

Gas	Tube	Pressure
Purge/Zero (Usually N2. Contact Signal if you wish to use a different gas)	1/8" PTFE or similar	0.1bar to 1bar
Calibration gas	1/8" PTFE or PFA	0.55bar ±450mBar (for best results, adjust to match flow to Sample flow)
Sample	¼" or 1/8" PTFE or similar. (6mm metric option also available)	-0.2 to 0.4Bar (with internal sample pump), or 0.2 to 1Bar (without internal sample pump)

c) Switch on the power using the switch on the rear panel (AC operation only). At this stage you should see a solid blue LED on the front panel, indicating that the unit is in Sleep mode. An internal fan may also be audible;

d) Your instrument is now powered up and ready for general use, however, the various internal heated

3 Operation

3.1 Services

Signal Group Ltd assumes that the user has a certain level of understanding of gas analysers. Some aspects of gas analysis can be dangerous without proper training and understanding. Signal and its representatives are able to provide full analyser training on request. Contact your local representative for further information.

To use your PULSAR analyser you will need the following services:

- **Power –** PULSAR standard universal power supply allows operation from 100Vac to 250Vac at 50 to 60Hz.
  24DC operation is available on request. Please ask for details.

- **Purge** – Depending on your chosen options, you may need zero-grade Nitrogen to continuously purge the optics. Some gases do not require Nitrogen, others may use catalytic air purifiers to sufficiently clear the ambient air of any interference. Please consult your local Signal Group representatives for further information regarding your purge options.

- **Calibration Gases** – Signal recommends a gas concentration close to the expected measurement level.
  CAUTION: **CH_4 levels close to or above their respective Lower Explosion Limit (LEL) should use Nitrogen balance to avoid risk of explosion.**

- **Sample** – Sample gases MUST be clean and dry before entry into the PULSAR**.**

  NOTE: Some sample gases require careful preparation before using a PULSAR **for analysis.**
  Failure to adequately condition the sample gas may void your warranty. If in doubt, ask.

2 Introduction

The Signal PULSAR range of gas analysers uses Non-Dispersive InfraRed (NDIR) technology to determine the concentration of gas of interest in a sample gas. There are various NDIR measurement techniques available on the market today. The Signal PULSAR uses Gas Filter Correlation (GFC).
Specifically designed to be versatile and reliable, and function equally well in tough applications such as Continuous Emissions Monitoring (CEM), engine certification and gas turbine research and development, the PULSAR range has the performance to meet your analysis requirements. Proprietary digital flow and temperature control, together with Signal's world-class Series 4 electronics package, provides superior performance across the board.

Standard PULSAR analysers allow optional:

- Measurement ranges as low as 1ppm up to as high as 100%;
- Capability of measuring many gases such as CO, CO_2, CH_4, NO, SO_2, HCl and N_2O;
- PID Temperature controlled critical components;
- Very low purge gas consumption;
- Fully automated calibration;
- Optional integrated sample pump;
- 10 user-programmable analogue outputs for monitoring concentrations, ranges, pressures and/or temperatures;
- Up to 35 user-programmable relay outputs for alarm or external valve operation;
- Optional remote control and data logging over Ethernet or RS232;
- Optional on-board data logging;
- Optional 24VDC power supply.

Signal is renowned for its ability to create instruments for special applications, so if the options above do not cover your specific requirements then contact Signal Group or one of their local representatives to discuss your application further.

components will require time to warm up. Depending on your chosen options, this may be as long as 45 minutes. Use your chosen operating interface (front panel display or S4i. See the appropriate user guide for detailed information) to proceed and initiate the warmup procedure;

e) The following options will initiate warmup:

Standby – the unit will go to a state ready for measurement. No gas valves will be open apart from purge.
Zero – the unit will automatically warm up and begin measuring. The Zero port valve will energise to allow zero gas to flow.
Span – as Zero but for Span.
Sample – as Zero but the unit will begin measuring Sample.

f) You may need to calibrate your instrument on first use. You can select ***Calibrate*** from the following modes:

Zero – this will adjust the zero offset only.
Span – this will adjust the span coefficient only.
(ensure that the correct calibration gas concentration values have been entered into the relevant section of your chosen interface. See the user guide for your chosen interface for further information).
Sample – this will adjust the zero offset, followed by the span coefficient.
NOTE – it is advisable to leave your instrument switched on and warmed up for at least an hour before its first calibration.

g) Once calibrated and stable, your instrument is ready for accurate measurement. Use the relevant user interface guide for further information regarding instrument features such as analogue outputs and data logging, and how to configure and use them.

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