ISSUE 1.07

Raising gas analysis to new levels

SERIES 4

SOLAR

HEATED FID VOC ANALYSER

OPERATING MANUAL

SIGNAL GROUP
www.signal-group.com

Signal Group Ltd
Standards House, Doman Road, Camberley, Surrey GU15 3DF
United Kingdom

Tel: +44 (0)1276 682841 Email: sales@signal-group.com

DOCUMENT HISTORY

ISSUE	AMENDMENT	DATE
1.02	DRAFT	February 2015
1.03	Added wiring info	August 2015
1.04	Formatting, correct fig 8, added sample and air pressures to spec, added more calibration detail	October 2018
1.05	Reformatted, added additional figures and tables, Flow schemes updated	February 2020
1.06	Front cover, Relay and Chart Output Pinouts updated	August 2020
1.07	Front cover update, MCERT-related updates	April 2021

Table 1 : Document history table

Contents

1 What's in the box

- Signal Series 4 SOLAR analyser
- Signal Series 4 Wireless Tables (Optional)
- Signal USB Drive containing:
    - Operating Manuals
    - S4i installation (Optional)
    - Datasheet
    - Test Reports
- Shipping kit containing – Signal Part No. 3000/370010:
    - 2m Mains lead cable
    - Sample filter key (MC/318011)
    - 9/16" Wrench
    - 7/16" Wrench
    - USB drive with related documents
- Analogue output connection cable – Signal Part No. MI/995 (Optional)
- Relay output connection cable – Signal Part No. MI/996 (Optional)

⚠ 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.

2 Important safety instructions

2.1 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.

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

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

– 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 to any local or national standards.

2.2 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 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°C (125°F), or a naked flame or incandescent material.

– Do not place cylinders where they could become part of an electric circuit.

2.3 Operation and Maintenance

On leaving the Signal Group Ltd factory, this product conformed to all applicable safety directives. The operator must take care to follow the instructions given in this manual 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 unit's 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 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.

2.4 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.

3 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.

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

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

Gas	Tube	Pressure
Air (not required for internal air pump option)	1/4" PTFE or similar	0.75Bar ±0.25Bar
Separate FID Air (Optional)	1/4" PTFE or similar	0.75Bar ±0.25Bar
Fuel (H_2He or H_2 - refer to analyser configuration to ensure that correct fuel is used)	1/8" PTFE or similar	1.5Bar ±0.5Bar
Calibration gas (CH_4, C_2H_6,C_3H_8)	1/8" PTFE or PFA	0.4Bar ±0.2Bar
Sample	1/4" PTFE or similar (Heating to 200°C optional)	-0.6 to 0.4Bar (with internal sample pump) or 0.2 to 0.5Bar (without internal sample pump)

Table 2 : Quick-start setup

– 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;

– Your instrument is now powered up and ready for general use. The various internal heated components 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;

– The following options will initiate warmup:

Standby – the unit will go to a state ready for measurement. No gas valves will be open.

Zero – the unit will automatically initiate ignition, and once the flame is lit, open the zero valve to begin measuring zero gas.

Span – as Zero but for Span. Dual FIDs may use Span 1 or Span 2.

Sample – as Zero but the unit will begin measuring Sample gas once lit.

Pause – as Zero but the Span, Zero and Sample Solenoids will all be closed.

– For optimal performance you need to calibrate your instrument. (It is recommended to do this daily) You can calibrate from the following modes:

Zero – calibration in this mode will adjust the zero offset only.

Span – calibration in this mode will adjust the span coefficient only.

Sample – calibration in this mode will adjust the zero offset, followed by the span coefficient.

NOTE – it is advisable to leave your instrument lit for at least an hour before first calibration.

Further details regarding calibration can be found in Section 7 (Including calibration through the sample port).

– 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.

Front Panel Light codes

Light	Status
Red Blink	Heating
Purple	Loading Config File
Yellow	Standby
Yellow Blink	Purge
Green	Measurement Mode
White	No Config
Red/Blue	Alarm
Blue	Sleep

4 Introduction

The Signal SOLAR range of gas analysers uses reference-method Flame Ionisation Detector (FID) technology to determine the Total Hydrocarbon (THC) content of gas samples.

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 SOLAR 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 SOLAR analysers allow optional:
- Measurement ranges as low as 1ppm CH_4 equivalent up to as high as 10% C_3H_8 equivalent;
- Heating (to 200°C);
- Internal combustion and zero air generation;
- Hydrogen or mixed hydrogen/helium fuel;
- Fully automated calibration and flame optimisation;
- Internal heated sample pump;
- Continuous measurement of Total Hydrocarbons (THC), methane (CH4) and Non-Methane Hydrocarbon (NMHC) using dual detectors;
- 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;
- Remote control and data logging over Ethernet or RS232;
- On-board data logging;
- 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 or one of their local representatives to discuss your application further.

5 The Principle of Flame Ionisation

The detector in this instrument ionises carbon atoms in a hydrogen flame. Normally a hydrogen flame produces very few ions. Any carbon-hydrogen bonded molecules carried into the flame results in the formation of carbon ions. The detector can measure most compounds with a carbon-hydrogen bond provided that they are in gaseous form.

Because the detector responds to carbon ions, a mixture of hydrocarbon compounds results in an output proportional to the carbon count. 10 ppm CH_4 mixed with 10 ppm C_3H_8 results in an output of 40 ppm Methane equivalence (ppm), or 13.33 ppm Propane equivalence. These are two of the ways that the hydrocarbon concentration can be expressed. The Signal Dual FID SOLAR will always output methane equivalence.

Combustion exhaust gases normally contain some hydrocarbons that are liquid at ambient temperatures. A heated sample system is necessary to maintain the sample at an elevated temperature.

5.1 Sample System

The compact 3U 19" rack unit includes a 191 °C heated sample handling module which houses the FID, a sample particulate filter, a sample selection solenoid, sample and fuel capillaries, and connections to the zero and span selection valves.

The sample handling module allows the connection of a heated sample line directly to the rear panel preventing cold spots where sample condensation may occur. It uses the well proven make-up air bypass system to prevent sample condensation problems at the regulator. Make-up air is added to the sample path from the bypass air supply at a point down-stream of the sample extraction point. This creates a constant flow at the sample dump port. The sample is never in contact with the control components.

Optional internal pumps provide sample flow and/or bypass air. Alternatively, externally pressurised sample and air supplies may be used.

A portion of the bypass air may be passed through an optional, internal catalytic purifier to provide FID combustion air and zero grade air for calibration.

The dual FID uses a sophisticated and delicate air-bleed system to provide a very fast response time for real time CH_4 and NMHC measurement and ensures that enough oxygen is available for the necessary catalytic oxidation of non-methane hydrocarbons (NMHCs) even with low-oxygen sample gas.

6 Flow Schemes

It is important to use the correct flow scheme for your analyser, there are nine variations to the Solar analyser, five single channel analysers (HFID-THC) with differing pump configurations and four Dual channel analysers (HFID-DNMHC) with differing pump configurations.

The flow schemes can be found below in the following order;

- Figure 1 : THC flow schematic (with air and sample pumps)
- Figure 2 : THC flow schematic (without pumps)
- Figure 3 : THC flow schematic (with an air pump and no sample pump)
- Figure 4 : THC flow schematic (with no air pump and a sample pump)
- Figure 5 : THC MCERT flow schematic (separate burner bulkhead with no air pump and a sample pump)
- Figure 6 : NMHC dual FID flow schematic (with pumps)
- Figure 7 : NMHC dual FID flow schematic (with no pumps)
- Figure 8 : NMHC dual FID flow schematic (with an air pump and no sample pump)
- Figure 9 : NMHC dual FID flow schematic (with no air pump and a sample pump)

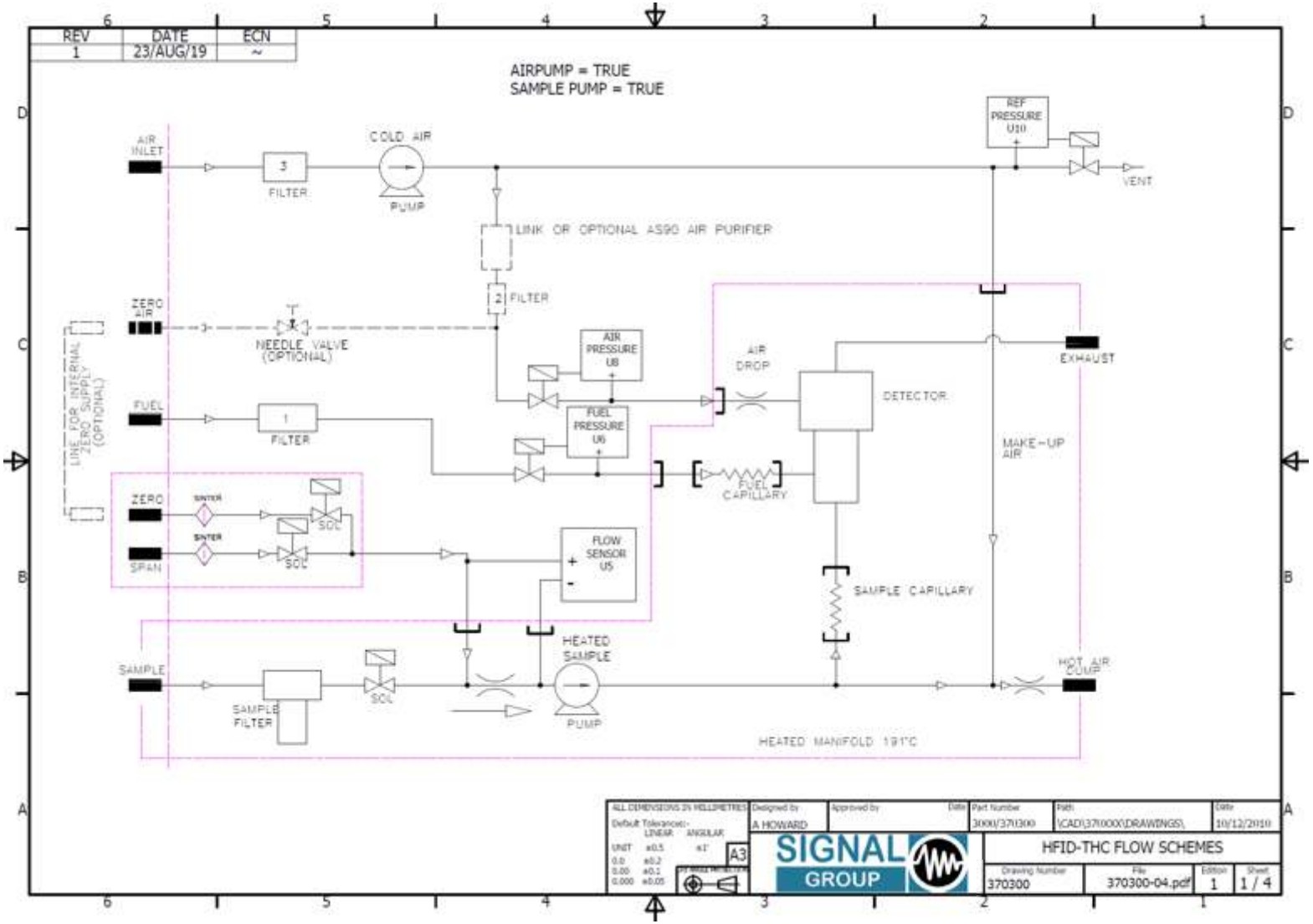


Figure 1 : THC flow schematic (with air and sample pumps)

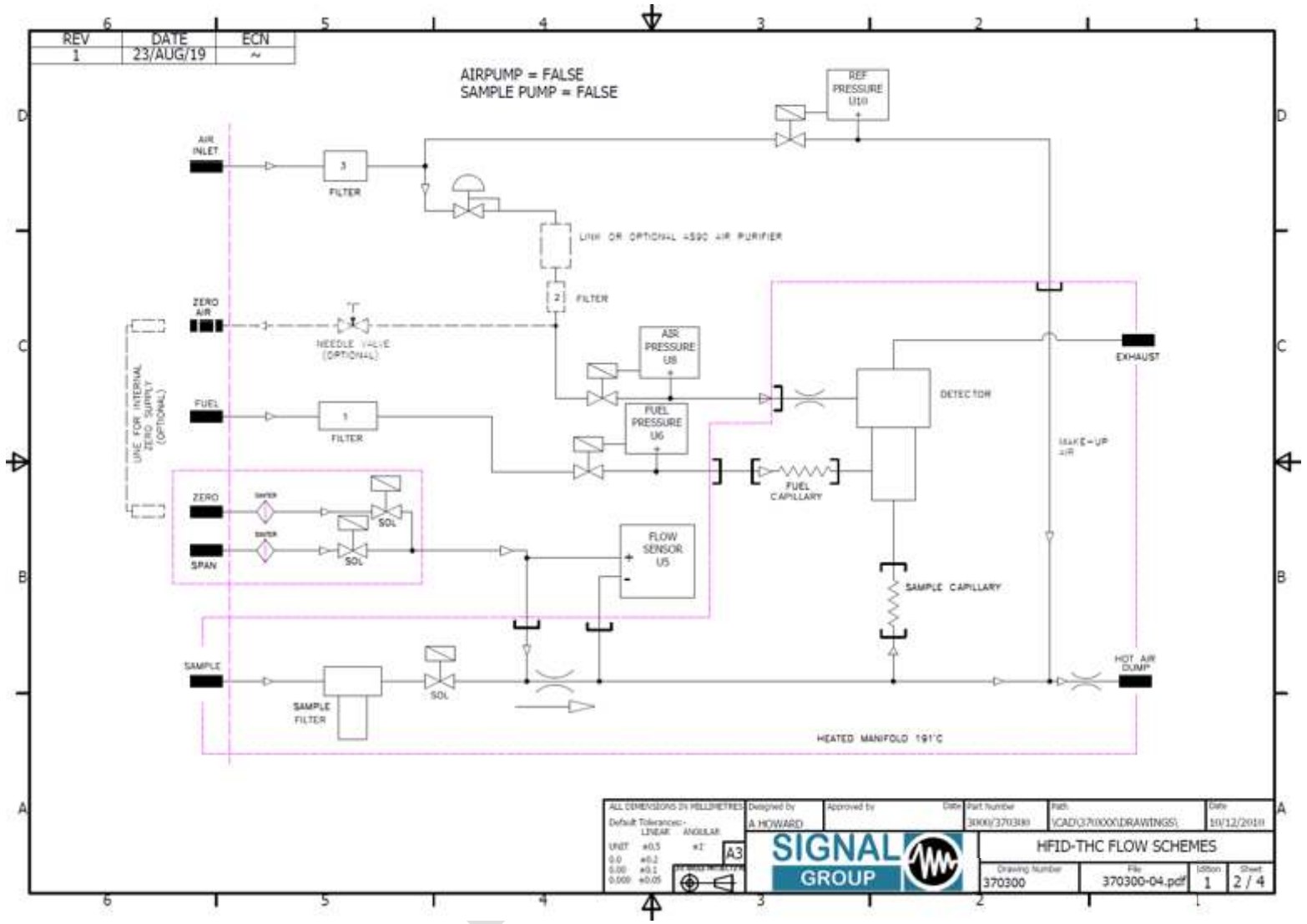


Figure 2 : THC flow schematic (without pumps)

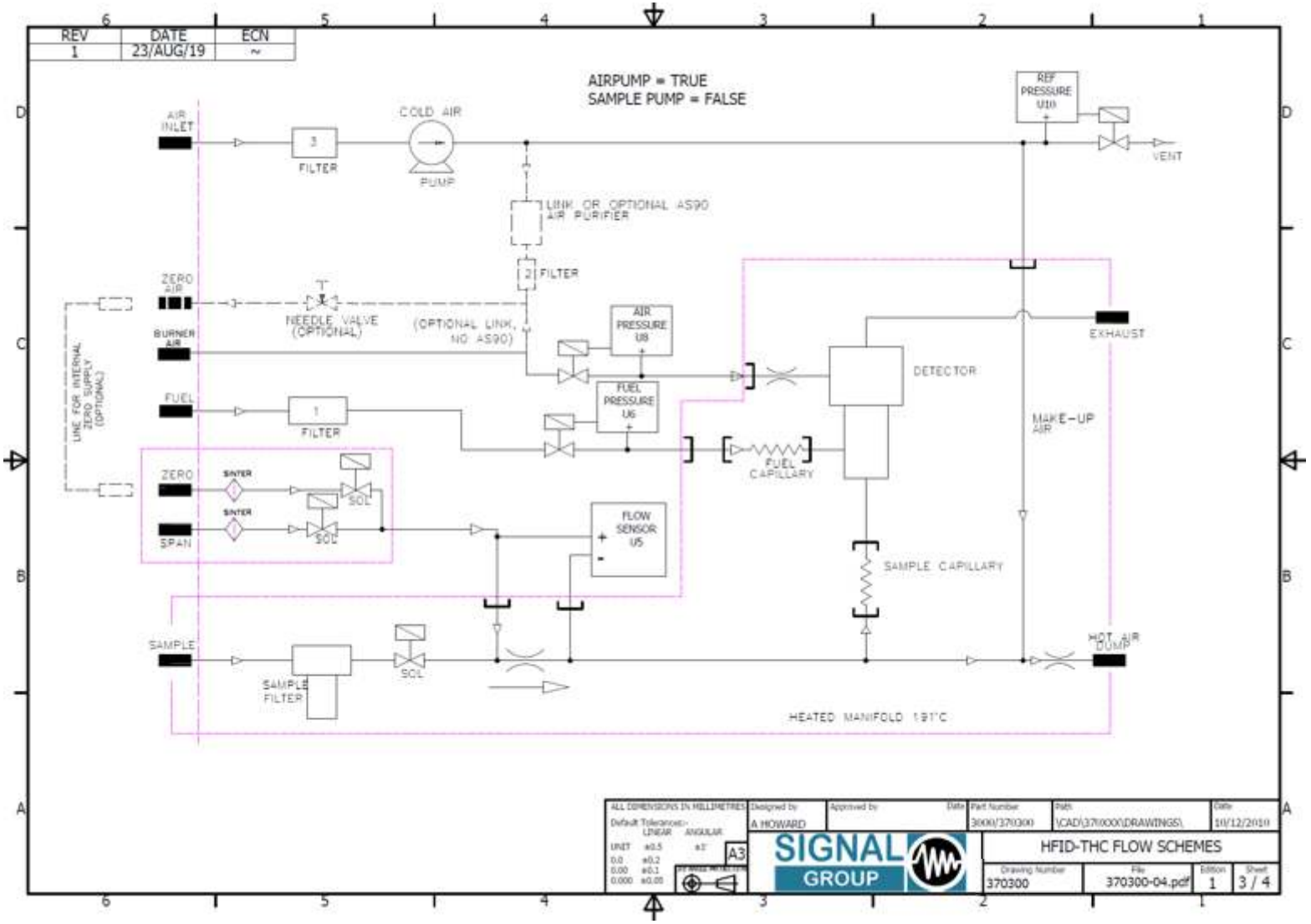


Figure 3 : THC flow schematic (with an air pump and no sample pump)

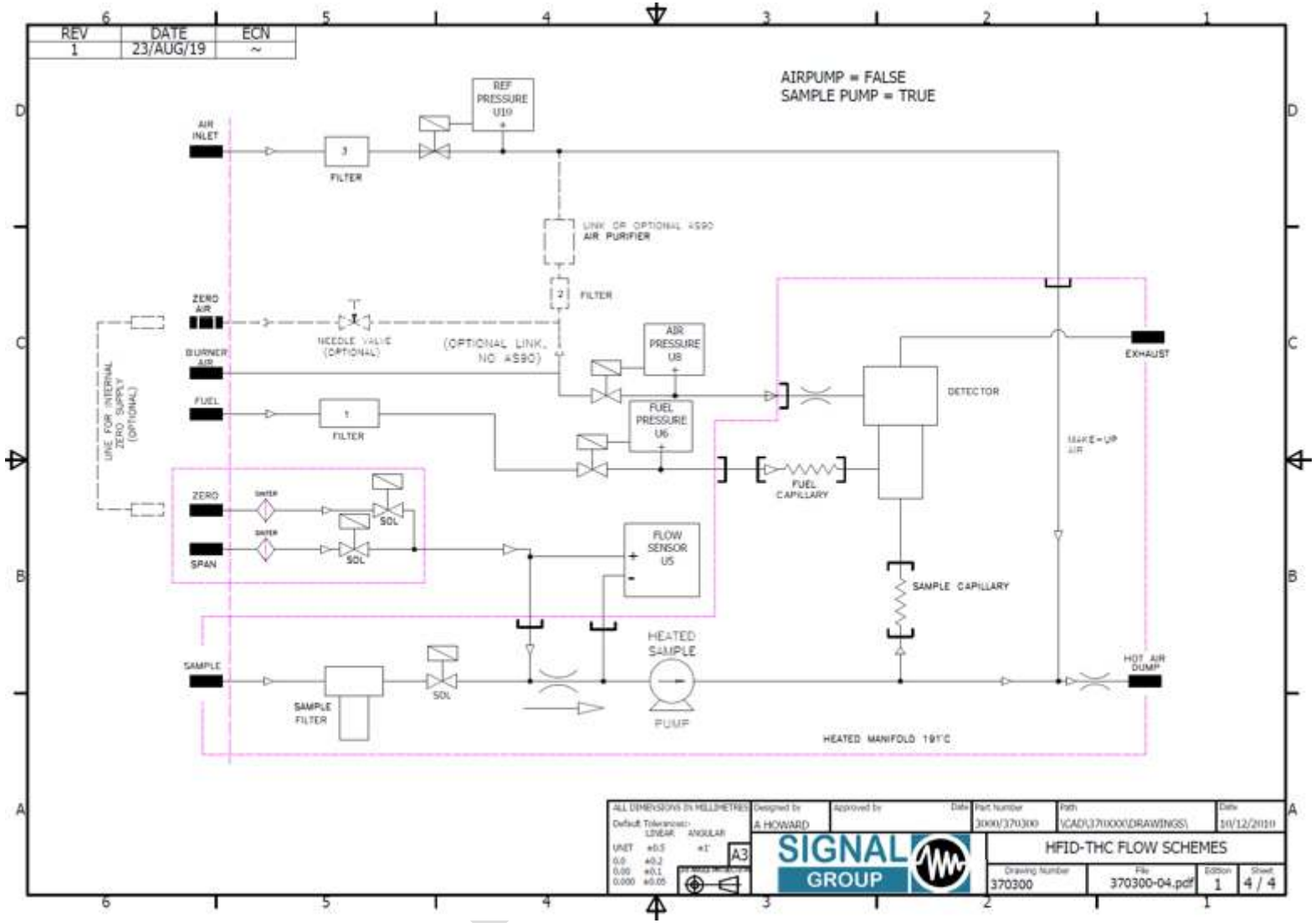
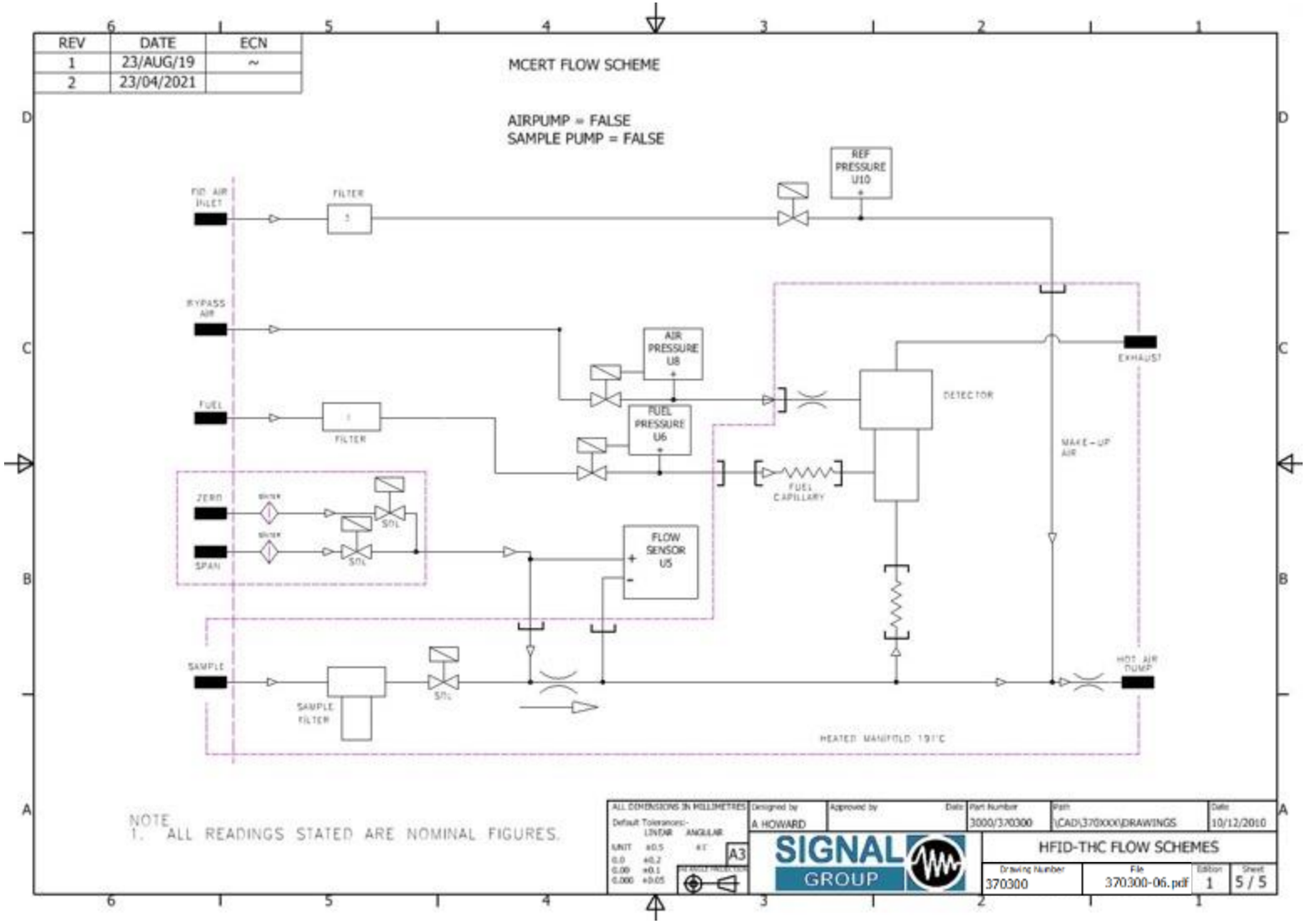


Figure 4 : THC flow schematic (with no air pump and a sample pump)


REV
DATE
ECN
1
23/AUG/19
~
2
23/04/2021
MCERT FLOW SCHEME
AIRPUMP = FALSE
SAMPLE PUMP = FALSE
REF PRESSURE U10
FID AIR INLET
FILTER
BYPASS AIR
AIR PRESSURE U8
EXHAUST
FUEL
FUEL PRESSURE U6
DETECTOR
MAKE-UP AIR
FUEL CAPILLARY
ZERO
SPAN
SOL
FLOW SENSOR U5
SAMPLE
SAMPLE FILTER
HOT AIR PUMP
HEATED MANIFOLD 191°C
NOTE
1. ALL READINGS STATED ARE NOMINAL FIGURES.
ALL DIMENSIONS IN MILLIMETRES
Default Tolerances:-
LINEAR ANGULAR
A3
Designed by
A HOWARD
Approved by
Date
Part Number
3000/370300
Path
\CAD\370000\DRAWINGS
Date
10/12/2010
SIGNAL GROUP
HFID-THC FLOW SCHEMES
Drawing Number
370300
File
370300-06.pdf
Edition
1
Sheet
5 / 5

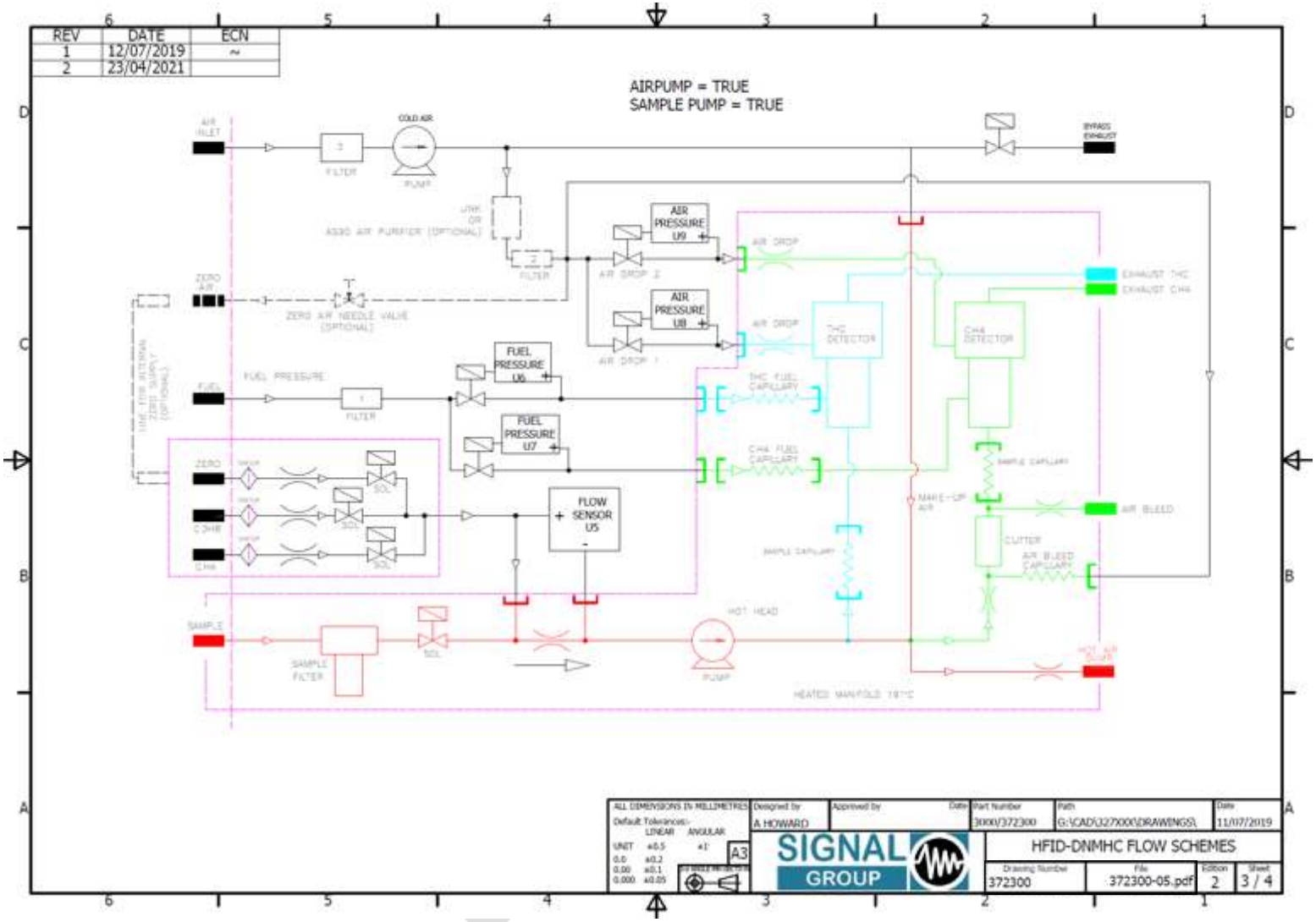


Figure 6 : NMHC dual FID flow schematic (with pumps)

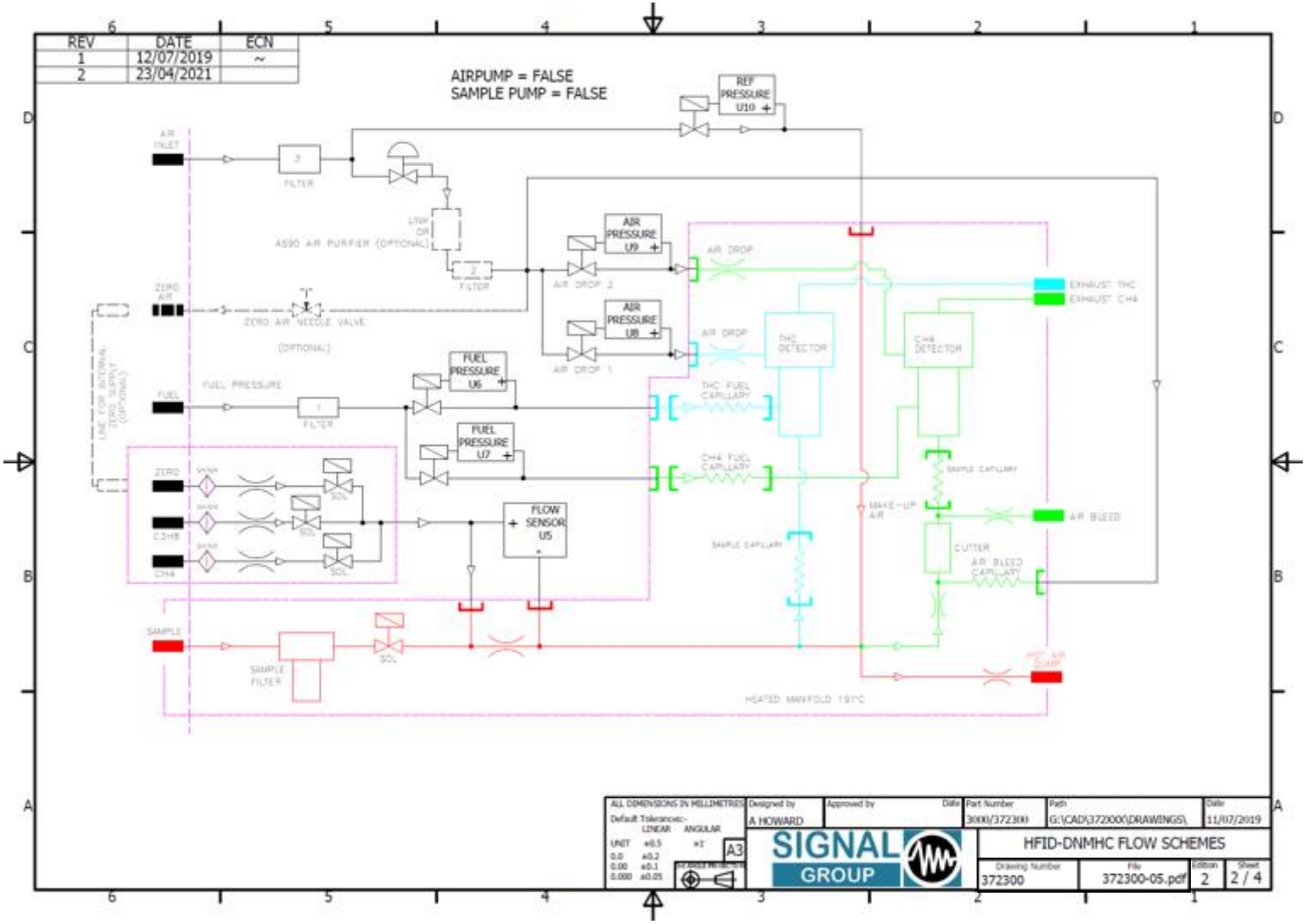


Figure 7 : NMHC dual FID flow schematic (with no pumps)

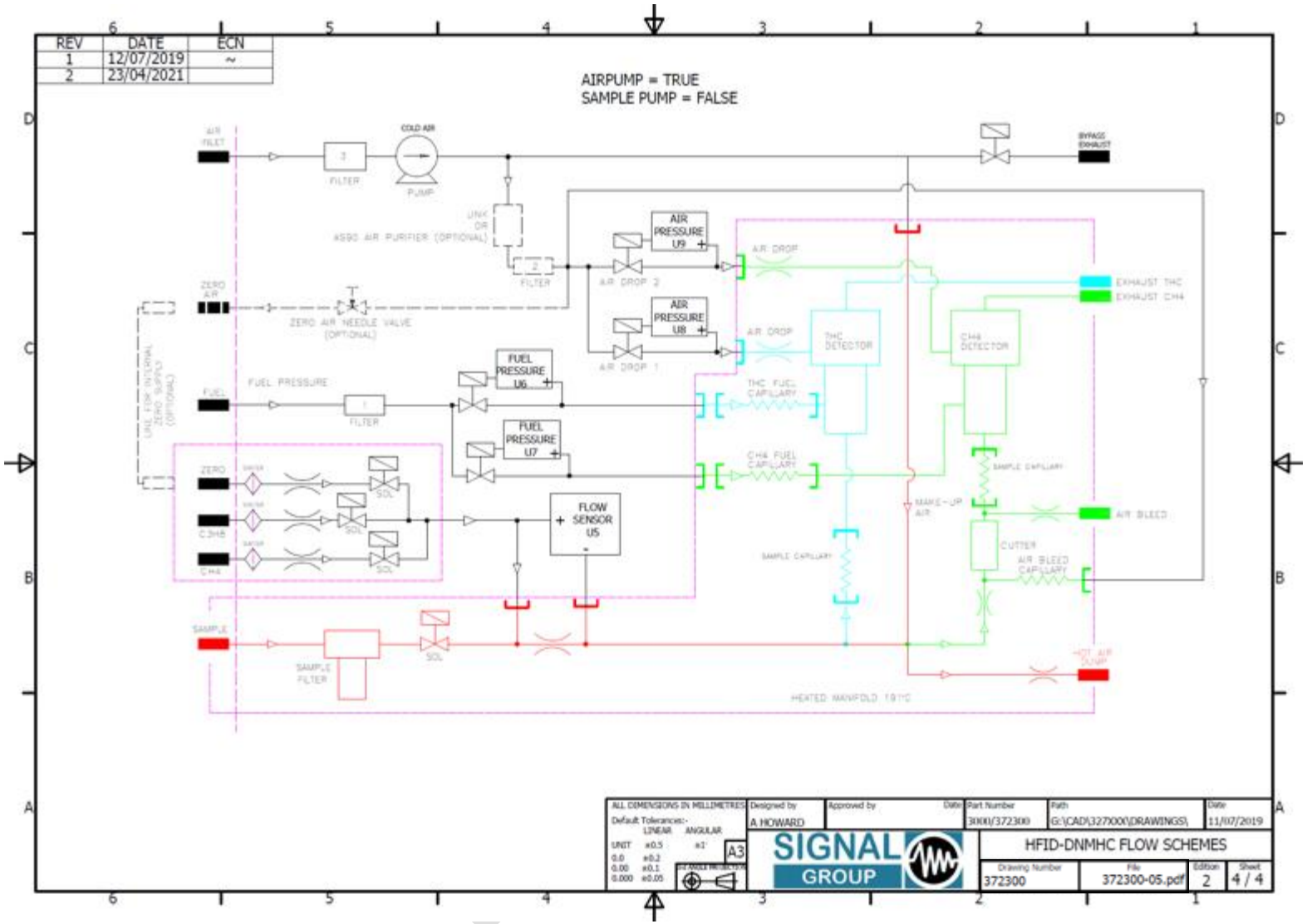


Figure 8 : NMHC dual FID flow schematic (with an air pump and no sample pump)

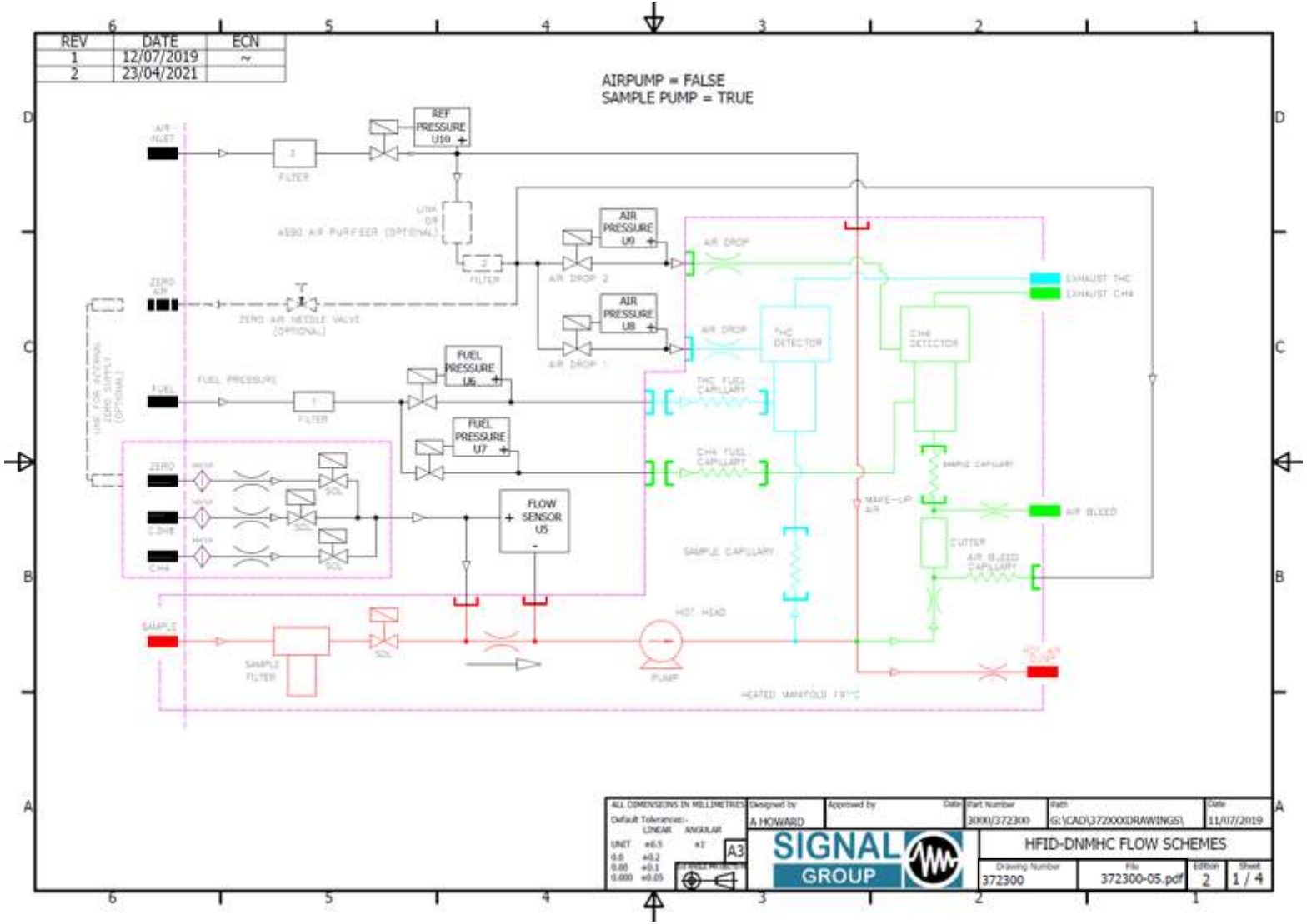


Figure 9 : NMHC dual FID flow schematic (with no air pump and a sample pump)

7 Operation

7.1 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 SOLAR analyser, you will need the following services:

– **Power:** SOLAR's standard universal power supply allows operation from 100Vac to 250Vac at 50 to 60Hz. 600W maximum.

24DC operation is available on request. Please ask for details.

– **Fuel:** Hydrogen or mixed 40% Hydrogen/60% Helium (depending on chosen option) – If in doubt, ask!

– **Air:** Depending on your chosen options, you may need zero-grade compressed air. If you have chosen to use the internal air generator then shop air is appropriate for most applications. For applications where accuracy under 1ppm CH4-equivalent are required, you should use zero-grade air or an external air purifier such as Signal's model AS80 air purifier.

– **Calibration Gases:** CH4, C2H6 or C3H8 may be used (CH4 and one other are required for Dual FIDs). Signal recommends a gas concentration close to the expected measurement level. For greatest accuracy, the balance gas should contain a similar Oxygen concentration to the sample gas.

CAUTION: CH4, C2H6 or C3H8 levels close to or above their respective Lower Explosion Limit (LEL) should use Nitrogen balance to avoid risk of explosion.

7.2 Start

– 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;

– 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;

Figure 10 : Dual FID rear panel

– Ensure that the correct fuses are in place within the integrated IEC socket on the rear panel. Figure 11 below shows the rear panel layout of a Dual FID;

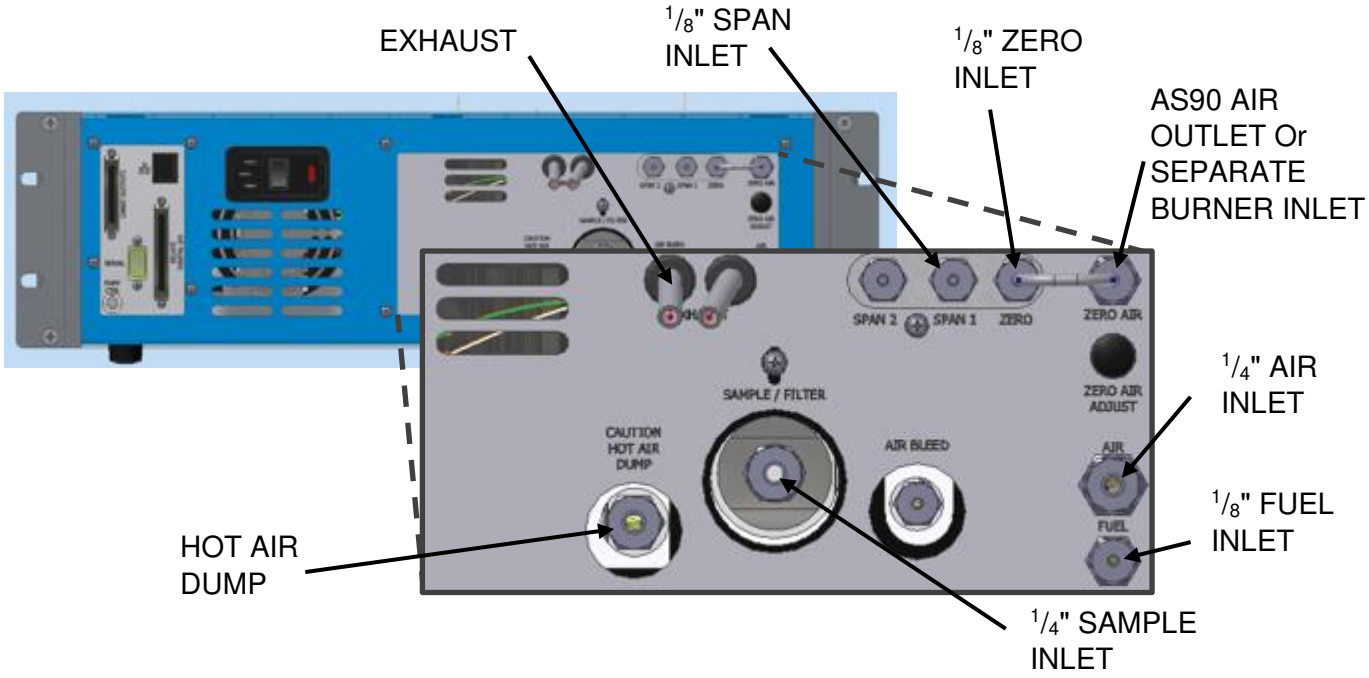


Figure 11 : THC FID pneumatic connections

– **FUEL**

  – Attach the appropriate fuel gas (pure, hydrocarbon-free hydrogen or hydrogen/helium mix. 5.0 grade recommended. Confirm your chosen option before use) to the FUEL port on the rear panel (see picture below) at 1.5±0.5bar (150±50kPa, 22±7.25psi);

– **AIR** : Ensure that the correct air supply is available for your chosen option: -

  – For instruments with an internal air pump, you should ensure that the air inlet is clear and free from blockages.

  – For instruments without an internal air pump, a continuous supply of pressurised air is required, at 0.75±0.25bar (50±25kPa, 7.25±3.6psi).

  – For instruments without internal air purifier, zero-grade air must be provided for accurate readings. Some applications may require an external air purifier to achieve best performance. Consult your local Signal Group Ltd representative for further advice.

  – Connect your chosen air supply to the AIR port on the rear panel.

  – For instruments with a separate FID AIR bulkhead, air must be connected to this as well as the AIR port.

  – For instruments without internal air purifier, your chosen zero-grade air must additionally be connected to the ZERO port.

  - For MCERT certified units the zero calibration gas must enter through the SAMPLE port at -0.6 to 0.4Bar (for units fitted with internal sample pump), or 0.2 to 0.5Bar (for units without internal sample pump).

- **SPAN**
  - Connect your chosen span calibration gas to the SPAN port on the rear of the analyser (for THC FIDs, you may use either CH4 or C3H8, for CH4 only FIDs you must use CH4, for Dual FIDs you must use both CH4 [Span1] and C3H8 or C2H6 [Span2]), at 0.4±0.2Bar (40±20kPa, 6±3psi). It is recommended that the concentration value of your span gas should be between 40% and 80% of your chosen measurement range.
  - For MCERT certified units the span calibration gas must enter through the SAMPLE port at -0.6 to 0.4Bar (for units fitted with internal sample pump), or 0.2 to 0.5Bar (for units without internal sample pump).
- **SAMPLE**
  - Connect your sample supply to the SAMPLE/FILTER port on the rear panel at -0.6 to 0.4Bar (for units fitted with internal sample pump), or 0.2 to 0.5Bar (for units without internal sample pump).
  - It is recommended that the sample gas temperature be maintained at a level above the dew point of the measurand(s), e.g. 191°C, using a heated sample line obtainable from Signal Group Ltd.
  - For MCERT certified units the ZERO and SPAN calibration gases must enter the analyser through the SAMPLE port at -0.6 to 0.4Bar (for units fitted with internal sample pump), or 0.2 to 0.5Bar (for units without internal sample pump).
- **EXHAUSTS**
  - Connect the HOT DUMP and AIR BLEED (Dual FID only) to a well-ventilated area, ensuring that the connection is free from obstruction that could cause restrictions.

CAUTION: The gases emitted from the HOT DUMP and AIR BLEED (Dual FID only) will be hot and may contain sample gas. Care must be taken to avoid risk of burning or local build-up of sample gases.

  - Connect the exhaust tubes to a well-ventilated area, ensuring that the connection tubing always remains at a downward angle. Failure to do this could cause water build-up which could disable the FID flame and prevent proper use of the instrument.

- 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.
- 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 6.5Amps (for 115VAC), if switching the primary side of an AC-DC transformer.
- The front panel Status LED should now be illuminated solid blue. This indicates that the unit is in Sleep mode.

7.3 Control

Once the analyser is powered on it may be controlled using either the wireless tables or optional S4i for computer use. (See the appropriate User Guide for further information.

Ignition

- The ignition procedure of the FID Hydrogen flame is fully automated. Simply select a gas path when in Sleep or Standby mode to initiate the sequence.
- 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 (1 or 2) or ZERO buttons.
- Once the ignition sequence is initiated, the front panel LED will flash red rapidly, indicating instrument warmup. The heated components within the instrument will need to warm up to their set temperatures before ignition 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:
- Once the instrument is up to its necessary temperature, the pumps (if fitted) will switch on and the bypass pressure will come under control to its set point (usually 200mBar). After a short time, the fuel and combustion air regulators will begin to control, and the glow plugs will momentarily energise. You can monitor the various pressures on the front panel display or S4i. The S4i will also indicate when the glow plugs are being energised.
- The combustion air will drop from its initial set point by 1mBar upon each failed ignition attempt, until a flame is detected. It will do this until it reaches near 0mBar, then wait for a short period and begin the sequence again. Three sets of failed attempts will occur, after which, and without successful ignition, failure is reported.

Zero/Span Calibration

- The procedures for calibration of the zero offset and span coefficient are fully automated. The process is as follows:
  - Enter the span gas bottle concentration values as described in your chosen interface guide
  - 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 gas to flow.
  - It will then monitor the measurements to determine the point at which 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.
- Dual FIDs use a proprietary algorithm to determine the carbon content of the sample, taking into account the relative responses of each detector to the chosen calibration gases.For best accuracy, allow the instrument to stabilise for at least 1 hour after ignition before attempting to calibrate.
- Before attempting any calibration, ensure that the correct gases are connected.

- 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.
- 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 Through Sample Port

- If required, the analyser may be configured so that calibration is performed through the SAMPLE port instead of the separate SPAN and ZERO ports.
- In this case the procedure is the same, ZERO and SPAN modes can still be selected but when calibration starts, the sample solenoid will open.
- If calibration is selected in SAMPLE mode a zero and span calibration will still be performed consecutively but the gases must be switched over manually.

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 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, air and/or fuel filters;
  - Mild instrument contamination;
  - Restricted sample and/or fuel capillary (and/or air-bleed capillary in Dual FIDs) (due to e.g. Partial blockage);
  - Replacement of sample or fuel (or air-bleed for Dual FIDs) capillary;
  - Degradation of sample or air pump;

  - Recent service of sample or air 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.

Measurement

- Once the unit is lit 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

- The instrument has a single hardware range (one for each channel on Dual FIDs), allowing accurate measurement from zero to full scale of the instrument at all times, regardless of selected user range. However, 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 regulations, 5 ranges are provided, together with an auto range facility. Each of these ranges is programmable by the user, apart from the maximum range which is 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.
  - 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.

7.4 Remote Control

Consult the S4i User Guide or Tablet Software User Guide (if applicable) for detailed remote-control operational guidance.

7.5 Connectivity

Relays

– The Analyser can be fitted with up to 35 contact closure output relays which can be configured to operate when in alarm states, or to actuate valves for a particular detector, range and gas path.

– The following output relays are available depending on your selected option:

- Standard IO – 3 (non-configurable)
- Extended IO – 23 (20 configurable)
- Special Extended IO – 35 (32 configurable)

– I/O cables, MI/1020 can be ordered separately to connect to the Relay outputs. (Previously, MI/996)

Relay specification

- Load: Resistive load (cosφ = 1)
- Rated Load: 0.5 A at 125 VAC; 1 A at 24 VDC
- Contact Material: Ag (Au alloy)
- Rated Carry Current: 2 A
- Max. switching voltage: 125 VAC, 60 VDC
- Max. switching current: 1 A
- Max. switching power: 62.5 VA, 30 W
- Failure rate (reference value): 1 mA at 5 VDC

– P level: λ60 = 0.1 x 10-6/operation. This value was measured at a switching frequency of 120 operations/min and the criterion of contact resistance is 100. This value may vary depending on the operating environment. Always double-check relay suitability under actual operating conditions

MI/1020 (Δ1.06)

Relay No/Digital IO	Pin	Colour		Relay No/Digital IO	Pin	Colour
1	1	Brown		18	18	LightGreen
	68	White/Red			51	Pink/Black
2	2	Brown/Green		19	19	LightGreen/Brown
	67	Purple/Green			50	White/Black
3	3	Red		20	20	LightBlue
	66	LightBlue/Gray			49	Gray/Green
4	4	Orange		22	21	Green/White
	65	Pink/Gray			48	Gray/Black
5	5	Orange/Brown		GLB ALB23 (NO)	22	Yellow/Red
	64	Purple/Yellow		GLB ALA23 (Com)	47	Purple/White
6	6	Yellow		GLB ALC23 (NC)	23	Blue/Red
	63	Yellow/Gray		GND Power	46	Purple/Black
7	7	Green		+24V Fused Output	24	LightBlue/Red
	62	Green/Brown		TTL Sleep	45	Blue/Black
8	8	Pink/Green		NC	25	Green/Red
	61	Yellow/White		TTL CAL	44	LightBlue/Yellow
9	9	Blue/Green		GND POWER	26	Green/Orange
	60	Orange/White		GND POWER	43	Pink/Blue
10	10	Green/Yellow		DIO1	27	yellow/Gray
	59	Red/White		DIO9	42	Pink/Red
11	11	Blue		DIO2	28	LightGreen/Green
	58	LightBlue/Green		DIO10	41	Green/Black
12	12	Purple		DIO3	29	Yellow/Brown
	57	Blue/Orange		DIO11	40	Yellow/Black
13	13	Purple/Red		DIO4	30	Brown/Yellow
	56	Yellow/Blue		DIO12	39	Orange/Gray
14	14	Gray		DIO5	31	Brown/Pink
	55	Blue/White		DIO13	38	Orange/Black
15	15	Gray/Red		DIO6	32	LighBlue/Brown
	54	LightBlue/Black		DIO14	37	Red/Black
16	16	White		DIO7	33	Gray/Brown
	53	LightGreen/Gray		DIO15	36	Brown/White
17	17	Pink		DIO8	34	Black
	52	LightGreen/Black		DIO16	35	Brown/Black

Table 3 : Relay wiring table - Colours refer to Signal output cable MI/1020

MI/996 (Previous data cable) (Δ1.06)

Relay No/Digital IO	Pin	Colour		Relay No/Digital IO	Pin	Colour
1	1	Pink		18	18	Grey
	68	Black			51	Black
2	2	Pink		19	19	Grey
	67	Pink			50	Pink
3	3	Pink		20	20	Grey
	66	Blue			49	Grey
4	4	Pink		22	21	Grey
	65	Green			48	Purple
5	5	Pink		GLB ALB23 (NO)	22	Grey
	64	Yellow		GLB ALA23 (Com)	47	Blue
6	6	Pink		GLB ALC23 (NC)	23	Grey
	63	Orange		GND Power	46	Green
7	7	White		+24V Fused Output	24	Yellow
	62	Red		TTL Sleep	45	Orange
8	8	White		NC	25	Grey
	61	Brown		TTL CAL	44	Red
9	9	White		GND POWER	26	Purple
	60	Black		GND POWER	43	Brown
10	10	White		DIO1	27	Purple
	59	Pink		DIO9	42	Black
11	11	White		DIO2	28	Purple
	58	Purple		DIO10	41	Green
12	12	White		DIO3	29	Purple
	57	Blue		DIO11	40	Green
13	13	White			30	Purple
	56	Green		DIO12	39	Yellow
14	14	White		DIO5	31	Purple
	55	Yellow		DIO13	38	Orange
15	15	White		DIO6	32	Purple
	54	Orange		DIO14	37	Red
16	16	White		DIO7	33	Purple
	53	Red		DIO15	36	Brown
17	17	Grey		DIO8	34	Blue
	52	Brown		DIO16	35	Black

Table 4 : Relay wiring table - Colours refer to Signal output cable MI/996

Analogue Outputs

– Five 0-10Vdc analogue outputs are included as standard. These may be used for chart recordings, to connect to an external datalogger, or to operate external alarms. Ten analogue outputs are available with extended and special extended IO options. Up to ten isolated 4-20mA outputs are also optionally available. (MI/995)

– These outputs are typically configured to provide measurements from each gas detector channel (scaled to the range in use), and to indicate the range in use. For range indication, 1V = range 1 (lowest range), 2V = range 2, etc.

– The outputs may also be configured by users to provide outputs of internally measured temperatures and pressures. This can be useful for fault finding as well as tracking sample flows

MI/995 (Δ1.06)

Ch number	Pin Number	Old Pin Colour	New Pin Colour
1	1	Pink	Brown
	26	Black	White
2	2	Pink	Yellow
	27	Brown	Green
3	3	White	Pink
	28	Black	Grey
4	4	White	Red
	29	Brown	Blue
5	5	White	Violet
	30	Red	Black
6	6	White	Red/Blue
	31	Orange	Grey/Pink
7	7	White	White/Pink
	32	Yellow	Brown/Green
8	8	White	White/Green
	33	Green	Grey/Brown
9	9	White	White/Yellow
	34	Blue	White/Grey
10	10	White	Yellow/Brown
	35	Purple	Pink/Brown

Table 5 : Chart Output Pinout Colour

8 Routine Maintenance

8.1 Introduction

The analyser requires little routine maintenance to keep it in good working order.

If the analyser is used infrequently, check the filter and Zero/Span calibration every time it is used. Check the catalytic air purifier efficiency every six months.

If the analyser is used continuously, check the filter and Zero/Span calibration once per week or as experience dictates.

The filter may need to be checked at different intervals depending on the particulate content of the sample gas.

Zero/span calibration may need to be checked at different intervals depending on the local variations in ambient temperature and/or atmospheric pressure.

8.2 Sample Filter

CAUTION

If the analyser has been switched on, the filter housing may be too hot to touch. The filter replacement tool provides a method for changing hot filter elements.

Dirty Filters may contain corrosive compounds. Use gloves. Obey local safety measures.

Signal recommends and supplies PTFE filters (Part number FILT/023) for use as internal Sample filter in all Solar and Quasar instruments. These PTFE filters may be cleaned and re-used.

Glass fibre filters are not recommended for use in our heated analysers. They can be damaged during installation into the heated manifold and fibres can become detached and block critical sample paths.

Removal/Replacement

Before filter removal, ensure that the Sample gas line has been shut off using an external valve, or that the process has been paused to allow for safe servicing of the analyser.

- Disconnect the sample gas line from the back of the instrument.
- The filter is immediately behind the pipe fitting. The pipe fitting and filter cap are removed as a single item using a special tool. Identify the filter extraction tool (MC/318011), supplied in the accessory kit. Using the filter extraction tool, release the filter cap by rotating ¼ turn anti-clockwise.
- Reverse the filter extraction tool and screw it onto the pipe fitting.
- Withdraw the housing, taking care not to touch the hot surfaces.

- The filter element will be found protruding from the cap. It will quickly cool and may be removed by hand. Dirty filters can contain corrosive compounds. Use gloves.
- Lightly soiled filters may be cleaned following the guidelines below. Clean the filter or fit a replacement filter element if heavily soiled.
- Re-assemble the filter cap to the analyser using the reverse procedure and reconnect the sample line.

New filter elements are available from Signal with part number FILT/023.

NOTE: If you did not purchase a spares kit with the analyser, consider purchasing one now. Several kits are available which contain items that you will find useful in your servicing and maintenance schedules.

Cleaning

The preferred cleaning method is to immerse the filter in an ultrasonic bath containing a solution of 1 part 'Ardrox® 6333' to 4 parts water at a temperature of 70ºC for a period of 10 minutes or until all surface particles are removed.

Ardrox® is a registered trademark of Chemetall GmbH and is available from them or their distributors. It is an aqueous based liquid concentrate comprising a blend of alkali builders, sequestrants, corrosion inhibitors and biodegradable surfactants.

ARDROX	
Appearance	Pale, yellow liquid
Density	1.07 g/ml at 20ºC
Flash Point	Non-flammable
pH	12.3
Storage requirements	Protect from freezing conditions

Table 6 : Ardrox Information

5.3 Other Filters

The following replaceable filters are located inside the instrument and should be changed at routine service intervals, or when contaminated:

– Air filter: Signal Part Number FILT/029 (see Figure 12- Filter details, detail "A")

– Fuel filter: Signal Part Number FILT/702 (see Figure 12- Filter details, detail "B")

Take care not to damage the plastic filter body when replacing.

A third, air purifier output filter is serviceable by a qualified engineer. Please contact your local Signal representative for further information.

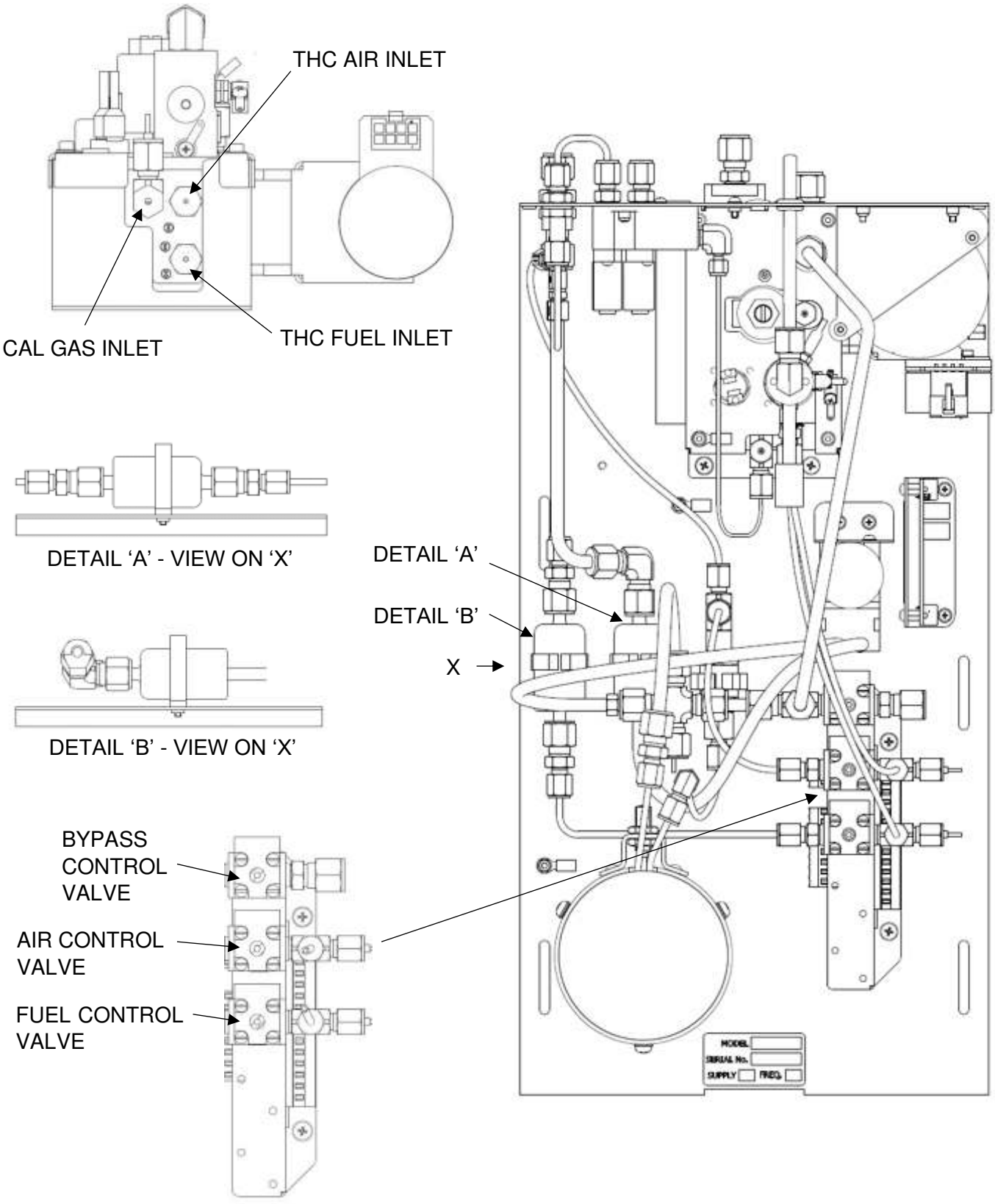


Figure 12 : Filter, Oven inlets and control valve details

8.3 Dual FID Cutter Cartridge Replacement

Dual FIDs contain a porous catalyst which is susceptible to damage due to vibration. This is contained within a conveniently replaceable cartridge, accessible from the rear panel. The cartridge comprises of various components. To replace the cartridge see instructions below utilising Figure 13 : Cutter cartridge details for further clarity;

- Locate the cartridge end cap (Item 4 – MC/371511) and using an 6mm Allen key, unscrew anticlockwise until loose.
- Carefully remove the Compression spring (Item 5 – MI/1000), the Spring cartridge (Part 5 – MC/371652) and the Inlet filter (Item 7 – MC/371612) to reveal the cartridge face.
- Withdraw the cartridge by screwing an M2 bolt into the threaded hole on the face of the cartridge, **only fasten the M2 bolt 2mm deep** as there is a mesh inside the cartridge which can be broken if the m2 bolt is inserted too far. With the bolt in place, use a pair of pliers to pull out the cartridge.
- The old cartridge can either be sent back to Signal for a refurbishment or it can be disposed of (it contains no harmful components so it can be disposed of safely adhering to local requirements).
- Ensure the new cartridge has ‘o’ ring (Item 3 – O’RING/167) before reinserting the cutter body, if not slide over the end on the cartridge into the groove.
- Re-insert the cartridge, into the cutter body following a similar method to its extraction.
- Once the cartridge is in place, replace the Inlet filter (Item 7 – MC/371612)(the filter can block, if this is suspected them replace with a new one), spring cartridge (Part 5 – MC/371652 and spring(Item 5 – MI/1000). Ensure the spring cartridge is in the correct orientation (the tapered end should be on the filter side and the spring placed over the shaft of the flat side).
- Replace the cartridge end cap to complete the cartridge replacement ensuring the cap is tightly fastened to avoid leaks.

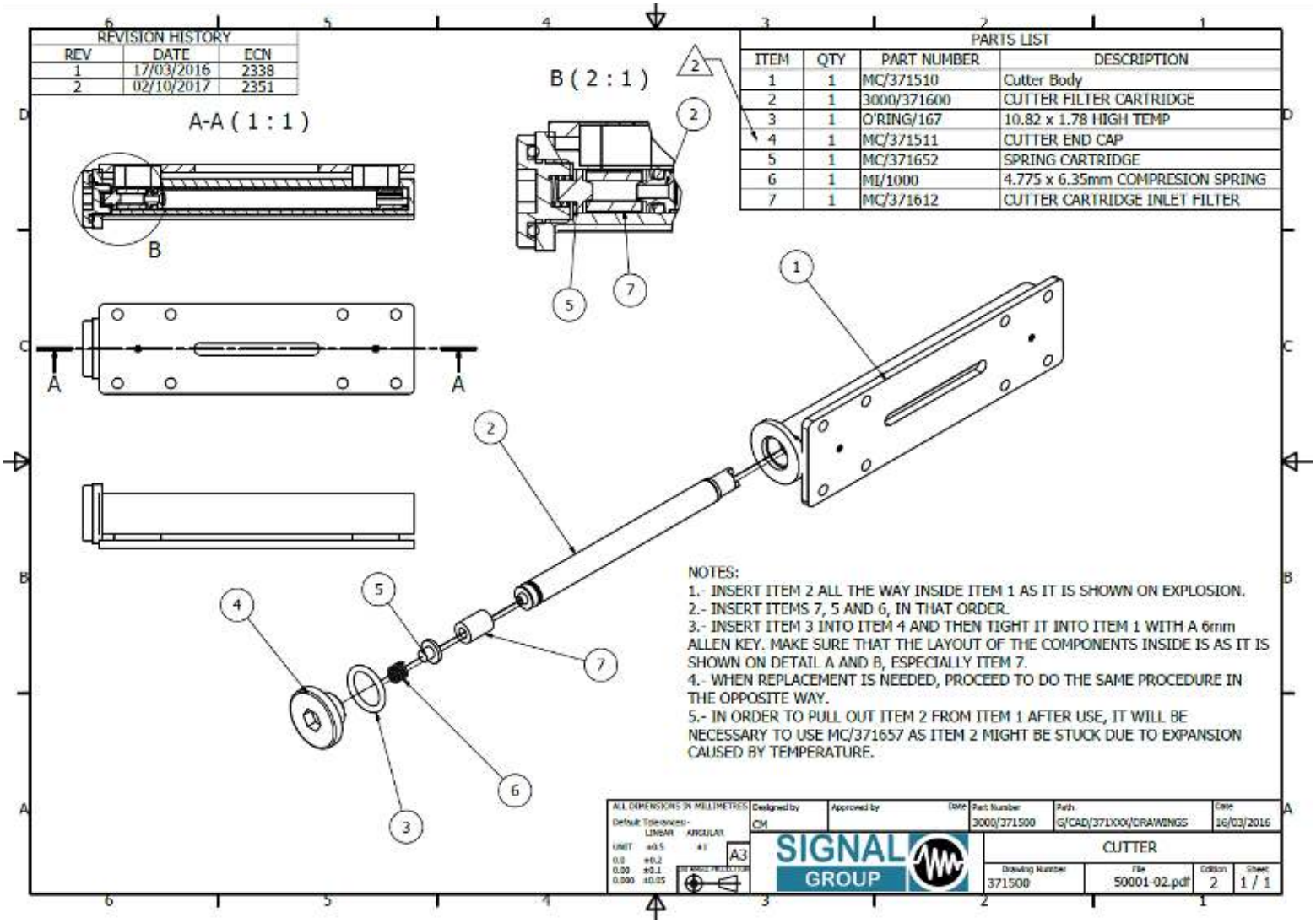


Figure 13 : Cutter cartridge details

9 Routine Servicing

9.1 Schedule

The analyser requires regular servicing to maintain its accuracy and operational status.

Servicing should be carried out by a qualified service engineer with electrical and pneumatic experience. If you do not have these in-house skills, contact your local Signal representative who will be pleased to assist you.

Item	Frequency
Replace Sample Capillary	When the calibration procedure repeatedly fails.
Electronic Calibration	After changing the sample capillary or if the analyser continuously fails normal calibration.

Table 7 : Servicing frequency

9.2 Service Manual

Full service manuals are normally only issued to distributors and agents. However, they can be purchased by those who wish to carry out their own servicing. Signal recommend attendance of a complete service training course prior to attempting a service.

Note: All warranty will cease if a customer carries out their own servicing during the warranty period unless special arrangements have been made in writing.

9.3 Sample Capillary

CAUTION

The oven is at 191 °C during operation. Allow at least 2 hours for it to cool before attempting capillary replacement.

If the analyser has been used without a sample filter, or with a sample containing compounds that can condense at temperatures lower that 191 °C and the shutdown procedure is not followed, the sample capillary may become blocked.

Removal/Replacement

– Remove the analyser from any rack or housing and place upside down on a firm, clean bench. It is very important that the work surface and all tools are clean to prevent particulate entering the manifold block or sample capillary.

– Locate the access plate on the base of the analyser. Remove the screws, plate, and insulation to reveal the capillaries.

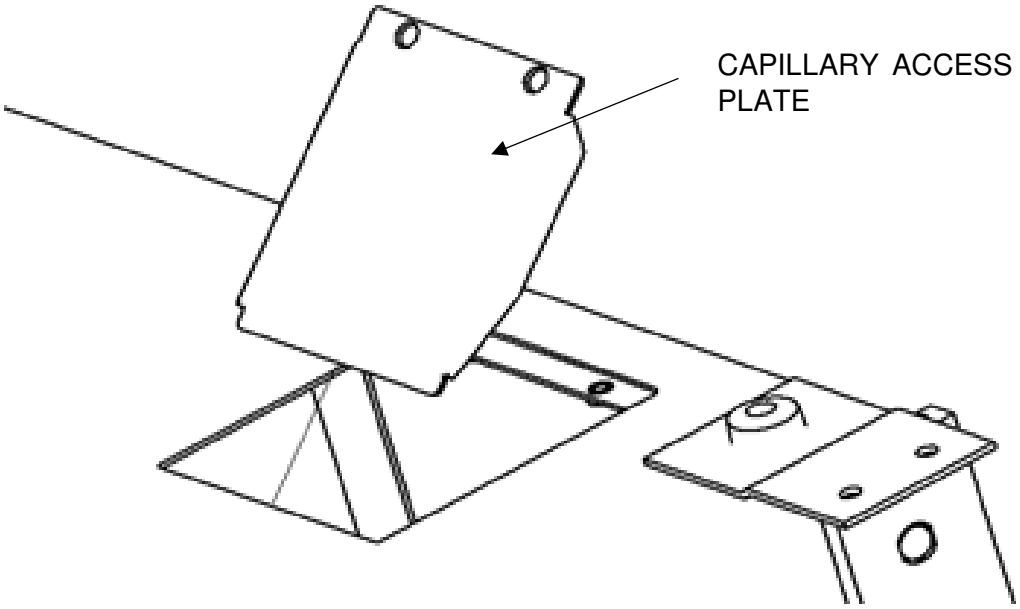


Figure 14 : Capillary access plate

– Using a small brush or vacuum cleaner, remove all particulate from around the capillary
– Disconnect and replace the capillary.

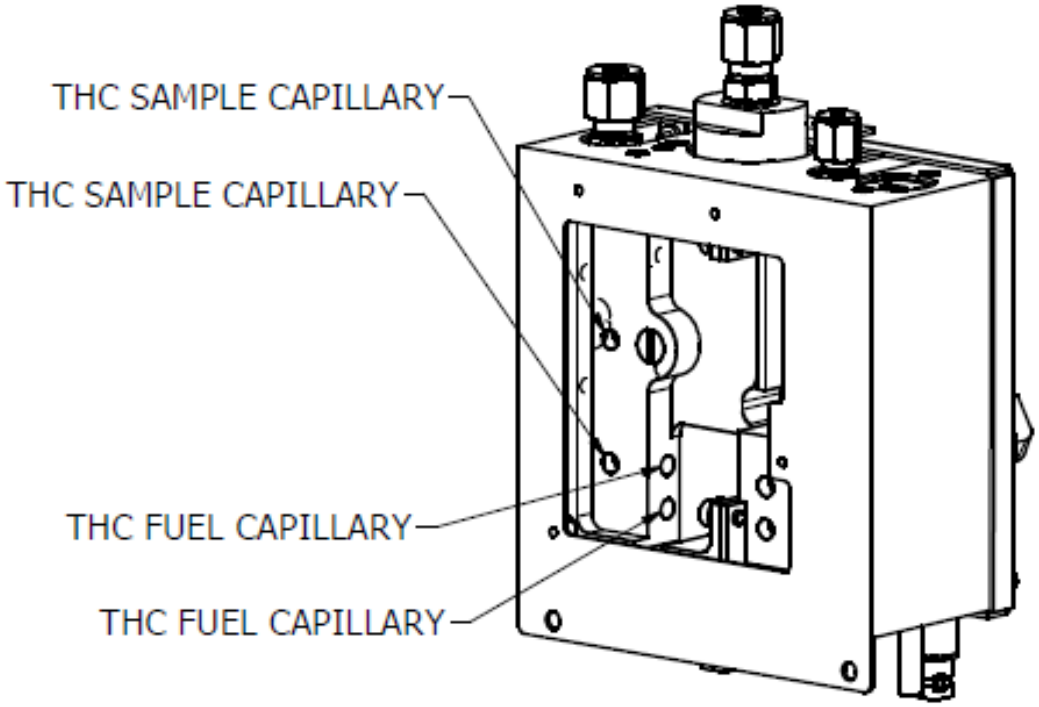


Figure 15 : THC capillary locations

– For a Dual there will be two sample capillaries, it is important to identify which channel has the blockage to ensure the correct capillary is changed.

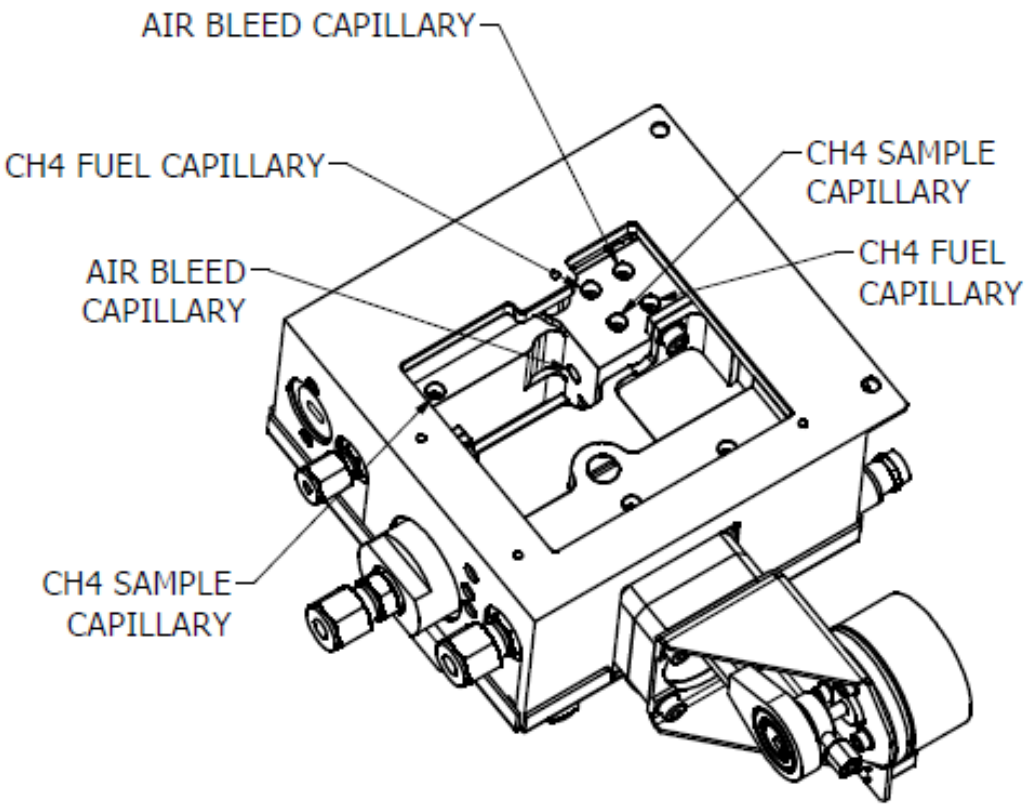


Figure 16 : NMHC and CH4 capillary locations

– Once the capillary has been replaced, insert the insulation and install the access plate.

– Install the analyser and perform a coarse calibration, followed by a standard Zero/Span calibration.

10 Table of Figures

11 Table of Tables