Venus Solo

Operation Manual

Commercial in Confidence

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Warnings, Cautions and Notes

Warnings and Cautions are used in this Manual to highlight potential hazards and safety risks. Notes are used to provide supplementary information that is not hazard-related.

WARNING: **THIS INDICATES A POTENTIALLY HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY.**

CAUTION: **THIS INDICATES A POTENTIALLY HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN EQUIPMENT DAMAGE OR LOSS OF DATA.**

NOTE: **THIS INDICATES INFORMATION THAT IS CONSIDERED IMPORTANT BUT IS NOT HAZARD RELATED.**

1 Introduction

1.1 About the Sensor

The Venus Solo OEM sensor is a self-contained unit designed for integration into other manufacturers equipment and provides a measurement of gas concentration according to specific user requirements.

These GFC (Gas Filter Correlation) sensors generate a signal proportional to the infrared absorption of the measured gas. Providing the gas concentration lies within the designed range of the sensor, the signal is periodically compared with reference gas.

Gas concentrations are indicated through the non-linearised analogue signal output

Gas connections to and from the sensor are via suitable fittings on the gas measuring cell.
The Venus Solo OEM Series sensors electrical supply is designed to accept 24V DC at 3amp maximum.

1.2 Sensor Identification

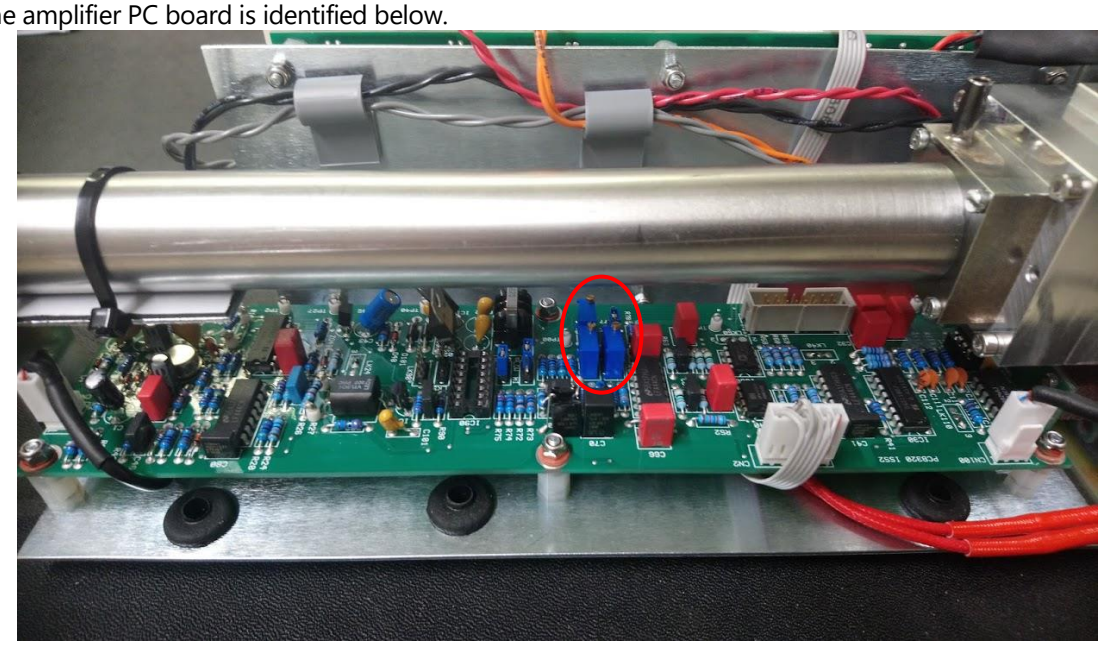
Each sensor is uniquely identified with a serial number. This is located on a label on the base alongside the part number and build date.

NOTE: **PLEASE QUOTE THE SERIAL NUMBER AND PART NUMBER IN ANY COMMUNICATIONS REQUIRING AFTER SALES SUPPORT.**

1.3 Operating Controls

1.3.1 The Operating Controls

Each sensor is supplied with on-board zero and span potentiometers, these are multiturn. The position on the amplifier PC board is identified below.



Controls	RV77(upper left)	SPAN SET to 5 volt full scale
	RV95(bottom left)	ZERO SET to 0 volt
	RV55 (bottom right)	Coarse balance (only fitted for 3 eyed gases)

1.4 Electrical Outputs

1.4.1 Analogue Outputs

All external connections are on a 14 pin DIL header, see the electrical schematic in **Figure 2Error! Reference source not found.**, section 5. The unit is shipped with a default output of 0-5.0V full scale.

1.4.2 Analyser Fail, and MonitorSignals

As external connections on 14 pin DIL header, see the electrical schematic in **Figure 2Error! Reference source not found.**, section 5. Output signal is 5V high for analyser fail.

1.5 Operating Principles

1.5.1 Infrared Absorption

The sensor measures gas concentrations using the effect of infrared absorption.

All heteroatomic gases absorb (or transmit) light energy in the infrared region at specific wavelengths that are dependent upon the chemical composition of each type of gas.

The sensors incorporate a source of infrared energy (usually in the form of a heated filament), which is then optically filtered to reduce the radiation spectrum to that of the absorption band of the gas being measured.

1.5.2 The Optical Sensor in use

In order to obtain and maintain the optimum performance from the sensor, follow the below guidelines.

The GFC sensor is an optical system and can suffer some deterioration in the performance if it is internally contaminated by the condition of the incoming gases.

The gas sample should be non-condensing at room temperature.

It is recommended that the sensor is continuously switched 'ON' to prevent condensation.

The flow rate of the gas sample affects the response time of the measurement. A sample flow rate of nominally 500 ml/min is recommended.

Generally, the sample gas will be pumped to achieve the required flow rate.

The installation of pressurised cylinders must include suitable pressure regulators and carefully controlled to avoid damage to any pump due to over-pressure. Max pressure is 0.2 BarG.

The sensor must be allowed to 'temperature stabilise' after first being switched on. The users enclosure affects the temperature control as well as providing protection. Operating temperature should be maintained between 10-45 degrees C.

Unless the sensor is only used occasionally it is advisable to leave the sensor switched on, particularly over-night when reduced temperatures may result in condensation. When the unit is not in operation any sample pumps should be switched off.

1.6 Installation Arrangement

The sensor size will vary dependent upon the range of gas measurement required. It is mounted on a base plate for easy integration into your system. The main PC board is also mounted on this base plate.

Power input and signal output are via connectors identified in the electrical schematic as shown in **Figure 2**, section 5. Gas connection details are shown in Section 1.9.

CAUTION: **NOTE THAT THE SENSOR IS SENSITIVE TO ELECTROSTATIC DISCHARGE, WHICH MAY CAUSE SERIOUS DAMAGE. ENSURE THAT ESD PROECAUTIONS ARE OBSERVED AT ALL TIMES WHEN HANDLING THE SENSOR OR WHEN WORKING ON THE SENSOR**

1.7 Location & Ambient Conditions

The location must provide firm support of the sensor when the sensor is mounted in the normal attitude on its base.

It is not necessary to force ventilate the OEM enclosure to cool the unit, but free circulation of air is necessary for accuracy and reliability.

A stable ambient temperature gives best performance results, sudden changes in temperature will disturb the GFC sensor causing a shift in readings until the compensation recovers.

NOTE: **IN ALL CASES THE AMBIENT CONDITIONS MUST COMPLY WITH THE SPECIFICATIONS DETAILED IN THE DATASHEET. HIGH AMBIENT CONDITIONS WILL AFFECT PERFORMANCE.**

1.8 Power Supply Setting & Connections

1.8.1 Power Supply Setting

The sensor operates from 24V nominal +/-10%, at 3amp maximum.

1.8.2 Power Supply Connections

See the electrical schematic in section 5.

CAUTION: **POWER SHOULD NOT BE APPLIED TO THE SENSOR UNLESS THE MOTOR HAS STOPPED.**

1.9 Gas Arrangements

1.9.1 The Gas Circuit

WARNING: **ALL GASES ARE POTENTIALLY TOXIC AND HAZARDOUS TO HEALTH**

WARNING: **EXHAUST LINES MUST BE PROPERLY VENTED AND ARRANGED TO PREVENT BLOCKAGE**

WARNING: **VENTILATE THE ENCLOSURE TO PREVENT A BUILD_UP OF GAS IN THE EVENT OF A LEAK**

1.9.2 The Sample Gas

The sample gas supplied to the sensor must be relatively clean, cool and of low moisture content. Samples containing dust or particulates must be filtered externally and the filters serviced at regular intervals.

Samples above ambient temperature with high moisture content should be passed through a water trap or desiccator after cooling.

Samples may contain other gases which 'interfere' with the gas being measured. The extent to which known interferents can affect the measurement are defined on your calibration certificate.
Sample gas pipes shall be non-reactive to and shall not contaminate the gas. See **Table 1**.

The response time will be affected by the sample flow rate. Sensor response times are normally quoted for the recommended 500ml/min flow rate, ignoring the effect of sample pipe volume. The volume of the sample piping will also affect the response time.

Take care to not to over pressurise the sensor as this may cause damage or measurement errors.

If it is necessary to draw higher flows than recommended (e.g. due to long sample gas lines), a means of bypassing the excess flow to exhaust must be included in the OEM enclosure.

Piping and Component Materials: The guidelines below are based gas wetted components used. Please consult Analox Ltd on materials for use with other gases

Table 1 Piping variants

	Polymer	PTFE	Brass	SS316
carbon dioxide	YES	YES	YES	YES
carbon monoxide	YES	YES	YES*	YES
methane	YES	YES	YES	YES
Nitric oxide	NO	YES	NO	YES
Nitrous oxide	YES	YES	YES	YES

- Except very low range

1.9.3 The Span Gas

The span gas is used for calibration and is a known concentration of the measured gas - usually between 50% and 100% of the full-scale range of the sensor. We recommend a certified span gas is used and the cylinder is fitted with a 2-stage pressure regulator with an output pressure indication of 0-0.3 Bar (0-5psig).

The regulator should be set to give a nominal output pressure of 0.2 Bar (3psig).

CAUTION: APPLICATION OF GAS PRESSURES ABOVE 0.2 BAR G / 3PISG WILL DAMAGE THE SENSOR AND VOID ANY REMAINING WARRANTY

1.9.4 The Zero Gas

The zero gas is used to check/set the reading from the optical sensors in the zero-concentration condition. 100% nitrogen is the preferred zero gas as it is low cost and readily available.

For some gases fresh/certified air may be used (for example on high concentration CO and CO_2 sensors). When fresh air is used, ensure it is drawn from outside and away from any possible contamination from such as exhaust ducts, chimneys, etc.

In most respects fresh air should be treated in the same way as the sample gas with regards to filtering, moisture content etc. See sample gas section 1.9.2.

1.9.5 The Exhaust Gas

Exhaust gas is the sample (or zero/span) gas that has passed through the analyser. For hazardous gases (high concentrations, flammable or poisonous), exhaust gas must be carefully routed to a safe venting point.

It is important to minimise 'back pressure' at the EXHAUST port, as this will affect readings and reduce the efficiency of the sample pump. Where long runs of pipe are necessary, larger bore pipe should be used via a suitable adapter. Where the exhaust pipe is connected to a forced air extraction duct, make sure that any suction is minimal.

1.10 General Safety Advice

1.10.1 Use of Gas Cylinders

WARNING: **BEFORE USE GAS CYCLINERS MUST BE CHECKED TO ENSURE:**
The cylinders are securely located.
The cylinders are fitted with a two stage regulator.
The cylinders contain the correct gas mixture for use.
The cylinders are connected to the correct 'entry' of the sensor.
The cylinder's output pressure regulator is set to OFF.

WARNING: **DURING USE, CHECK:**
The output pressure regulator is set to below 0.2 Bar.

WARNING: **AFTER USE, CHECK:**
The output pressure regulator is turned OFF.
The cylinder valve is turned OFF.

1.10.2 Gas Leaks

All external-piping connections must be checked for gas leaks, to ensure that no gases are leaking to the local area (which may be a health hazard), and that no uncontrolled air or gas is drawn into the sensor (and so affect the measurement).

Do not increase the pressure to check for leaks (or for any other reason), as this may damagethe sensor.

1.10.3 Exhausting & Ventilation

Because any gas is potentially toxic, and, some may be inflammable, the gas must be exhausted to where it will be rapidly dispersed. For the same reasons, the sensor and its environment including the location of gas cylinders must be properly ventilated to minimise the dangers of gas leaks.

In all cases the local safety regulations must be consulted and followed.

2 Calibration

Gas readings made using GFC optical sensors are relative rather than absolute. Before precise gas readings can be obtained, the analyser must be adjusted so that it reads zero when there is no trace of the measured gas present, then, when a known concentration of the gas is applied, the reading is adjusted to agree with this concentration. These adjustments are known as 'zero' and 'span' respectively.

Routine calibration is important, not only to verify measuring accuracy, but also to spot changes over time that may indicate maintenance is required.

2.1 Initial Checks

Once the sensor is fully installed ensure all gas connections are correctly connected.

As one of the first operations concerns zeroing and spanning the sensor, ensure that external zero and span gas supplies are available for connection to the sensor. If gas cylinders are used, check the pressure regulators are set correctly.

2.2 Warm Up

Switch on the Sensor and allow the sensor to warm up for 30-90 minutes. *

Do not attempt to take readings during the warm up time.

*refer to technical specification for time

2.3 Calibration Procedures

Calibration can either be carried our manually or automatically through the comms link to the OEM analyser.

2.3.1 Manual with D.V.M (Digital Volt Meter)

A simple volt meter is used to show the gas readings. The span and zero potentiometers are fitted as shown on the circuit diagram **Figure 2**. Calibration can be performed by adjustment of the potentiometer. If required the client can fit external potentiometers according to the circuit diagram **Figure 2**

2.3.2 Setting Zero

With zero gas flowing the zero control should be adjusted to provide an output of 0V.

2.3.3 Setting Span

It is recommended that zero adjustment is done immediately prior to adjusting span.

With span gas flowing adjust the span control to the required output of 5.0V.

3 Maintenance

3.1 Routine Checks

Regular maintenance is essential to ensure accurate measurements and prolong the life of the sensor.

If water traps and/or particulate (dust) filters are included in the installation these must be periodically inspected and maintained to avoid overflows or blockage.

3.1.1 Water Vapour

The system should be checked for water ingress periodically. If transparent piping was used, water can often be seen in droplets on the inside walls or collecting at a low point in the piping arrangement. With opaque or steel pipes, disconnect them at a low point to see if water drips out.

If signs of water are found, it may eventually block the pipes or result in amounts being drawn into the sensor and the optics. It is recommended that some form of water trap be fitted, so that the contents can be easily seen and regularly inspected.

If the sensor or optics have been damaged by water ingress it may require to be returned to Analox Ltd for repair and service.

3.1.2 Dust

We recommend the user fits a 5-micron filter to prevent dust ingress as this can build up over time and affect all parts of the gas path. Dust may also block the particulate filters fitted in the inlets of the sensor and may therefore result in a blockage or a reduction in flow.

If dust has penetrated the sensor it may require to be returned to Analox Ltd for repair and service.

4 Optical Sensor Description

The GFC infrared sensor is a non-dispersive single beam analyser in which the gas to be measured is passed through an optical cell continuously. Although the sensor output is in terms of gas concentration, this type of analyser operates as a comparator.

Its output is not absolute but is established by standardising with a known gas mixture at a point on the calibrated scale.

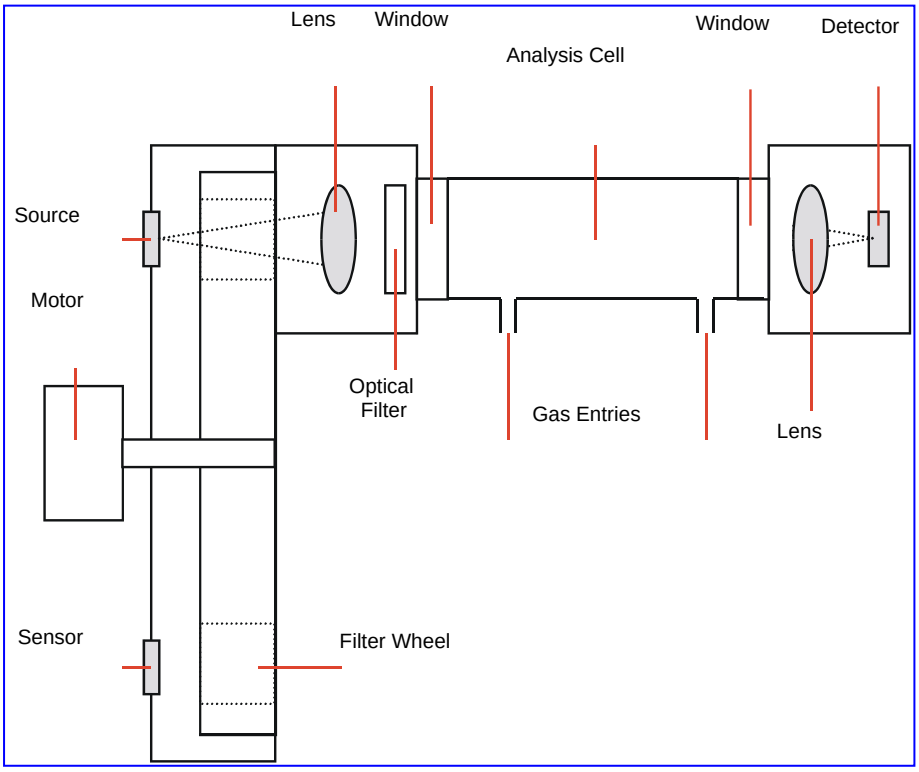


Figure 1 The GFC optical sensor

A typical GFC Sensor layout is shown in **Figure 1**. This reflects a'single' analysis cell.

The length of the cell is dependent on the concentration of the sample measured and may vary from 1mm (at very high concentration) up to about 250mm (at low concentration).

Infrared (heat) radiation from a small source is directed through a rotating filter wheel, a collimating lens, an optical (thin-film) filter, the sample cell, a focussing lens and on to a solid-state detector.

The wheel is rotated at 1100 RPM, to give a modulation frequency of 18.3 Hz. Each cell element is sealed at both ends by awindow that does not optically interfere with the radiation.

The heart of the sensor is the gas filter wheel, which contains a sealed sample of gas of the type to be measured, and a non-absorbing gas. As the wheel rotates it provides a ratio of sample and reference signals, in a sequence detected by a wheel position sensor. The ratio signals, together with the selective transmission of the optical filter, sensitises the sensor to respond to that region of the infrared spectrum corresponding to the measured gas in the sample.

When the gas to be measured enters the sample cell, it absorbs some radiation, and alters the ratio of the sample and reference signals. It is this change in energy level that is amplified to give the output signal.

The optical path between the source and the first cell window, and between the last window and the detector, will normally contain room air, or a gas from which any interfering gases have been stripped. This air is referred to as 'Purge' air, and if a chemical stripper is used, it will be shown on the gas circuit.

5 Using The Venus Solo OEM Sensor

5.1 Introduction

These notes describe the techniques recommended to provide for linearisation and scaling the sensor output for gas concentration display.

5.1.1 Sensor Connections

The sensor is fitted with two connectors for external connection; a three pole 0.156" pitch power connector, and a 2 x 8 way header for signals. The pin connections for the header suit the use of IDC cable for interconnections up to about 500mm. The pin connections are shown in Figure 2.

Note that there are two ground connections for power. Both grounds should be connected back by separate wires to the central 'start' earth point, or to the power supply terminals. 24/0.2 wire is recommended for power connections.

5.1.2 Gas Reading Output

The Venus Solo sensor is designed to provide an analogue and digital output from 0-5V representing zero to full scale gas reading. In practice, the zero and full scale voltages will be approximate, due to various effects that affect both span and zero.

It is important to understand that the output has a working range that covers –10V to +10V, and can reach +/- 12V. During initial warm-up, the output can fluctuate widely as the electronics and optical system stabilises. The measurement electronics used with the Venus Solo sensor must be able to handle these fluctuations.

The user can offset the output above or below zero if required for the measurement electronics.

The basic sensor provides an output that is linearly proportional to the infra-red absorption, not gas concentration. The plot of gas concentration to absorption is a curve which flattens as concentration increases (so, for very low full-scale concentrations, the sensor output is approximately linear). This means that linearisation of the sensor output is usually required.

5.1.3 Instrument Fail Output

This is a logic output which can be used to monitor the 'health status' of the Venus Solo sensor. Once the initial warm-up has complete the instrument fail line will go to logic '1'.

It falls to logic '0' under the following circumstances:

- Wheel not turning (motor fail/jam/driver failure)
- Source failure (or source regulator failure/connection problem)
- Detector failure or connection problem
- Amplifier failure power supply failure

Under certain fault conditions, the instrument fail line may oscillate – anything other than a steady '1' level should be considered a fault condition.

The instrument fail output is driven from a MC14093 CMOS logic gate, working at 5V CMOS logic levels. It does not have sufficient drive to light a LED.

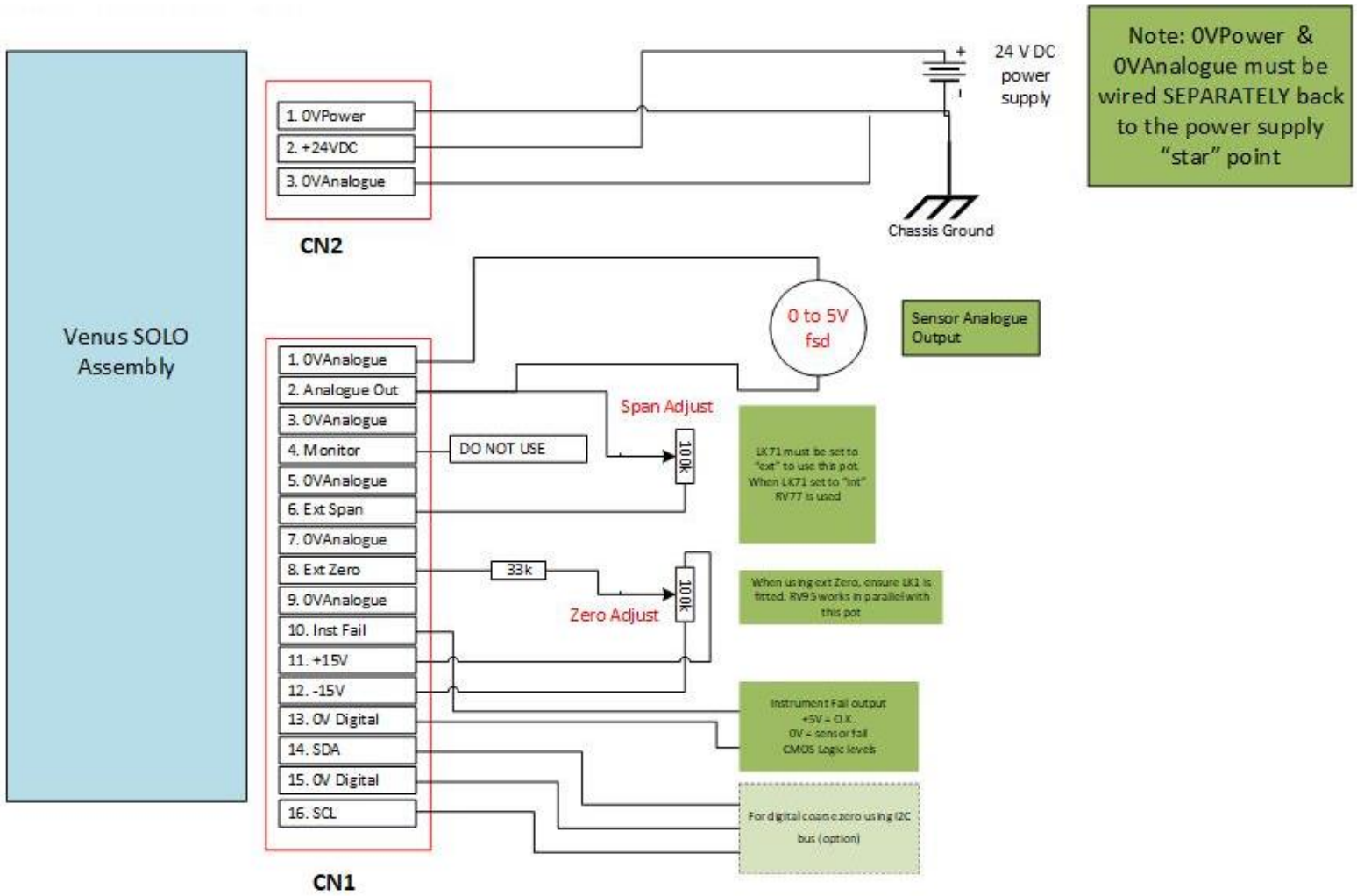


Figure 2 GFC Electrical Schematic

6 Electrical Specifications

6.1 Power Supply

24V DC (± 10%), 3amp maximum

6.2 Analogue Outputs

Non-linear, 0-1v, 0-2v, 0-5V

6.3 Digital Outputs

I2C available as an optional extra.

7 Spare Parts

Analox Ltd can provide spare parts for regular and preventative maintenance. Please contact us for support and pricing.

Please quote the serial number and Part number in any communications requiring spares or after sales support.