GCEM 40 Series TUV

Operating & Maintenance manual

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CODEL International Ltd is a UK company based in the heart of the Peak District National Park at Bakewell, Derbyshire. The company specialises in the design and manufacture of high-technology instrumentation for the monitoring of combustion processes and atmospheric pollutant emissions.

The constant search for new products and existing product improvement keeps CODEL one step ahead. With a simple strategy, to design well-engineered, rugged, reliable equipment, capable of continuous operation over long periods with minimal maintenance, CODEL has set standards both for itself and for the rest of the industry.

All development and design work is carried out ‘in-house’ by experienced engineers using proven state-of-the-art CAD and software development techniques, while stringent assembly and test procedures ensure that the highest standards of product quality, synonymous with the CODEL name, are maintained.

High priority is placed upon customer support. CODEL’s dedicated team of field and service engineers will assist with any application problem to ensure that the best possible use is derived from investment in CODEL quality products.

If you require any further information about CODEL or its products, please contact us using one of the numbers below or alternatively visit our web site.

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Contents

IMPORTANT

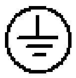
The warning signs (and meanings) shown below, are used throughout these instructions and are intended to ensure your safety while carrying out installation, operation and maintenance procedures. Please read these instructions fully before proceeding.


Caution, risk of electric shock.


Caution, risk of danger.


Caution, hot surface.


Earth (ground) terminal.


Protective conductor terminal

1. CODEL G-CEM40 Series In-Situ Stack Gas Analysers

1.1. Basic Principles

The G-CEM40 Series analysers use an in-situ probe set into the flue gas duct or stack to measure the emission levels of selected gases within the flue. The probe includes a measurement cell that allows flue gases to diffuse into the optical measurement path of the analyser.

A transceiver unit mounted on the probe transmits a beam of infrared energy down the probe through the measurement cell to a reflector that directs the beam back to the transceiver. Analysis of the received energy beam by NDIR technology provides a continuous measurement of the levels of selected emissions within the flue gas.

This in-situ technology enables accurate measurement to be obtained without the problems of sample gas treatment and will operate with over 95% measurement availability even in areas of extreme levels of dust content such as a pre-electrofilter. There are no routine maintenance requirements.

The integral temperature-controlled weather cover enables operation over a 70^{o}C ambient temperature range.

1.2. The G-CEM40 Series Range

The multi-gas analyser can provide channel measurements of NO, SO2 and CO coupled with the additional normalisation channels CO2 and H2O, as follows:

		Output Units
-	NO	ppm, mg/m3 & mg/Nm3
-	CO	ppm, mg/m3 & mg/Nm3
-	SO2	ppm, mg/m3 & mg/Nm3
-	H2O	%
-	CO2	%
-	Temperature	^{o}C
-	Pressure	kPa

Figure 1 shows the complete operating system configuration. The components that make up the complete system are:

- **Probe and Sensing Head** - mounted on the stack or duct.

- **Data Display Unit (DDU)** - that connects to the sensing head via a 4-core cable to provide power and communications for the DDU. This may be mounted up to 1km from the sensing head. A second optional DDU may be slaved from the first DDU enabling display devices to be provided at the analyser point of installation and remotely, for example in the control room.

- **Pneumatics Panel –** connects to the GCEM 40 Series head and probe via 2 core coloured cables. The panel must be mounted within 5 metres of the head and probe.

- **Configurator Software** - a software suite that enables all analyser output and diagnostic data to be accessed and logged on a laptop pc.

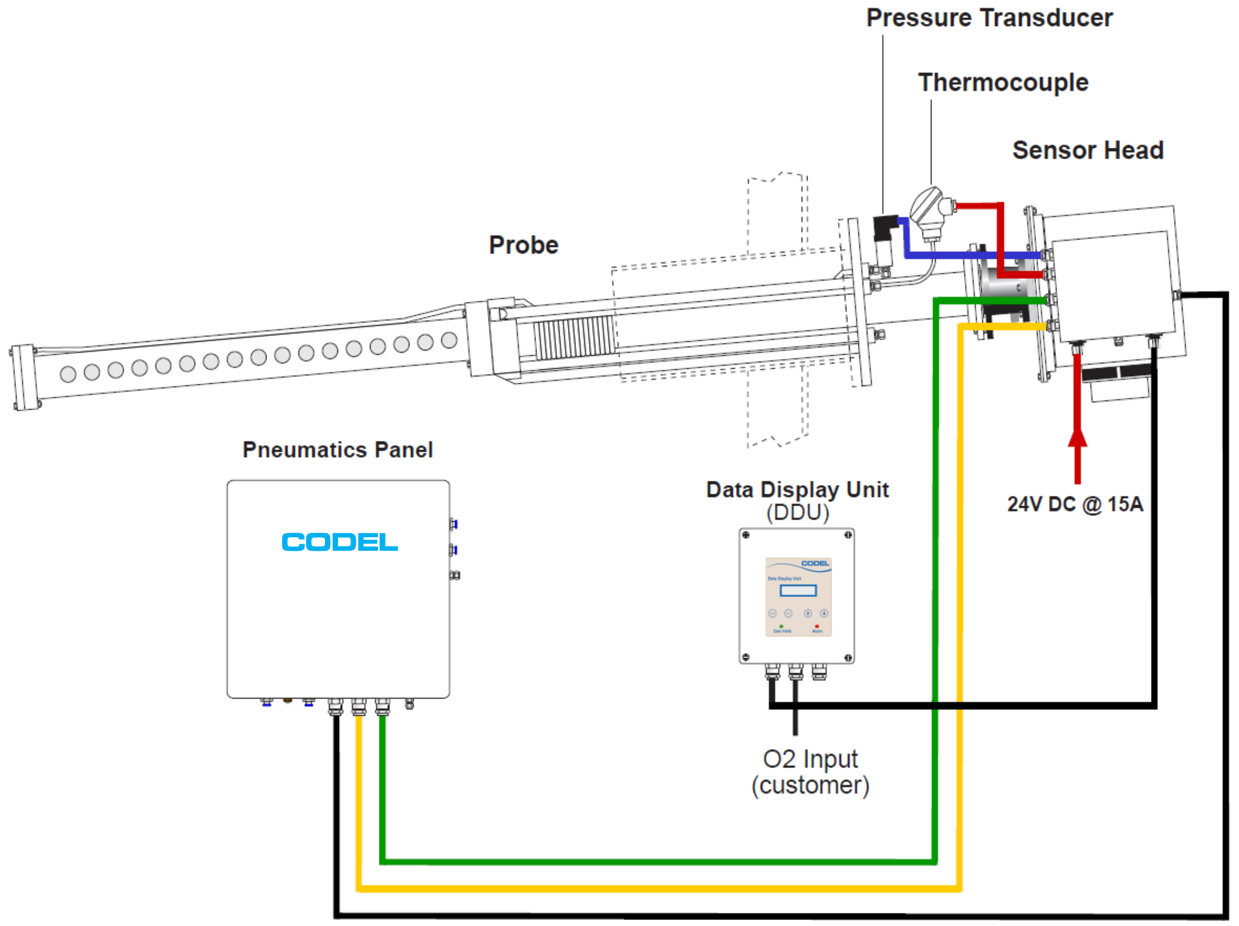


Figure 1: GCEM 40 Series TUV system

1.3. Power Provision

The analyser system operates from 24V DC power. A 24V DC supply at 15A must be provided (by others). This delivers the power for the complete analyser system.

1.4. Compressed Air Provision

The probe requires a source of compressed air for purging and calibration purposes. This air should be dry and oil free. Consumption is 20litre/min @ 5bar during calibration and 2litre/min @ 5bar continuously for normal operation. For analysers configured for fully normalised emissions monitoring a dedicated compressed air filter/drier unit is housed inside the pneumatics panel to ensure continuous air quality.

1.5. Probe and Sensing Head

The probe and sensing head is factory assembled, tested and calibrated. They are packed and transported as a single item. No adjustments or alignment operations are necessary after installation. Simply connect the compressed air line to the probe, connect the DDU communication cable and 24V DC power and switch on. The analyser will immediately switch to a warm-up and calibration mode before automatically dropping into its normal measurement mode after its internal temperatures have stabilised.

There are two probe lengths available (1.8m & 1.0m) as illustrated in Figure 2.

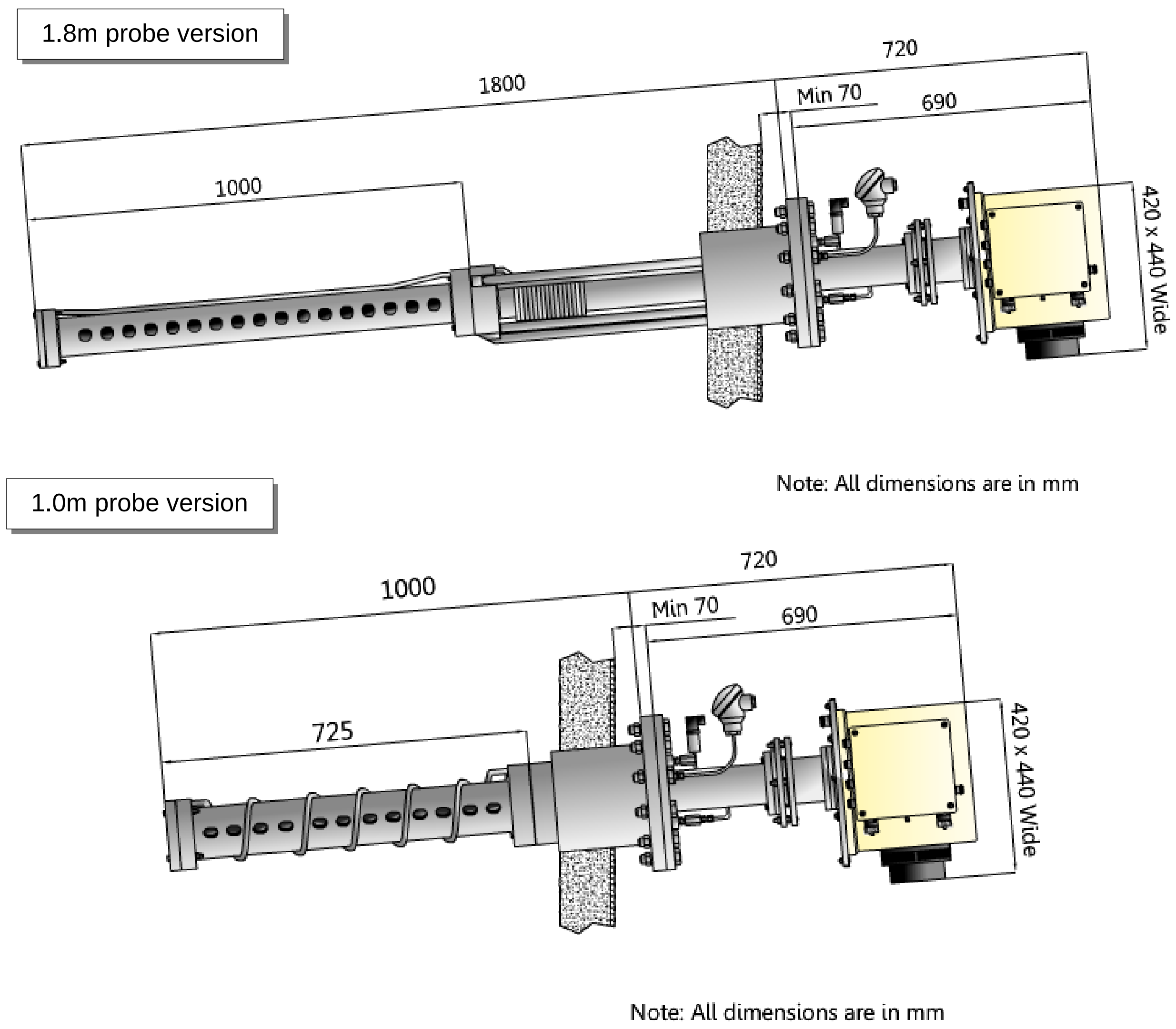


Figure 2: Overall Analyser Dimensions

1.6. Data Display Unit

This device incorporates a 32-character alpha-numeric display and soft-touch keypad enabling all analyser output and diagnostic data to be readily accessed. This may be mounted close to the analyser probe and sensing head or up to 1km away.

1.7. Outputs

The DDU is equipped with five fully isolated 4 to 20mA analogue outputs that are configurable from the keypad and display. Volt-free SPCO contact outputs are also provided in the DDU for Data Valid and Alarm levels.

1.8. Analyser Protection

The analyser is fitted as standard with an integral weather cover providing protection to IP67. The weather cover incorporates a thermoelectric heating/cooling temperature control element which ensures continuous analyser operation over an ambient temperature range of -20 to +50^{o}C.

2. Measurement Principles

2.1. In-Situ Probe

The gas analysis is made within a probe inserted into the flue gas either at the stack or in the flue gas ducting. This avoids the complications of gas sample treatment and accompanying maintenance issues often associated with traditional extractive analytical techniques.

The probe consists of two parts, one being a measurement chamber situated at the end of the probe where the gas analysis takes place and the second being the probe body that supports the measurement chamber and enables it to be easily mounted in the stack or duct.

Measurements are made using NDIR (Non Dispersive InfraRed) technology. A beam of infrared energy is transmitted down the probe from the sensing head to a mirror at the end of the measurement chamber from where it is reflected back to the sensing head where it is spectro-analysed to determine the analysis of the flue gas.

The measurement cell contains an array of stainless steel sintered filters mounted in the wall of the cell. Flue gas molecules will readily diffuse through these filters ensuring that the gas within the measurement cell is the same as that in the flue at all times. Dust particles within the flue gas however cannot pass through these filters ensuring that the measured gas is always clean and that the sensitive optical components within the probe do not become contaminated with dirt.

Because the gas molecule transfer mechanism is natural diffusion and not suction the pores of the filter elements do not become blocked with dust. This probe will operate quite normally in dust loadings of several gr/m3. What is more is that the probe requires no routine maintenance even in high dust conditions.

2.2. Measurement Elements

An infrared beam is generated by a small thermal source within the sensing head. Radiation from this source is focused by a lens onto the mirror mounted at the end of the in-situ probe measurement chamber. The reflected beam is focused by a second lens in the sensing head onto a highly sensitive infrared detector. Immediately in front of the detector is a gas wheel that holds a number of optical filters and gas cells designed to isolate specific infrared wavebands required for the measurement of the defined gas species. This wheel is rotated by a stepper motor at a constant speed of 1Hz. As each filter sweeps through the infrared beam the on-board processor digitises the detector output to produce a detector value ‘D’.

The number and types of optical filter used depends upon the gas species being measured. However each gas species is characterised by two detector measurements one of which is a live or measurement channel uniquely sensitive to the gas being measured (Dmeasure); the other is a reference measurement at a waveband insensitive to the measured gas (Dreference). From these two values, specific to each gas species, the gas concentrations can be calculated.

2.3. Detector Operation

The detector is a lead selenide photoconductive element. To achieve the sensitivity required for accurate gas analysis the element must be cooled to a temperature of -25°C. This is achieved by an encapsulated thermoelectric Peltier cooler with an integral thermistor to monitor the element temperature.

The on-board processor continuously monitors the thermistor temperature and regulates the power to the Peltier cooler to achieve the required stable temperature.

2.4. Stepper Motor Control

The supervisory processor develops a frequency signal which is used to drive the stepper motor and gas wheel. Accurate timing of this signal ensures that the wheel rotates at precisely 1Hz. By counting the pulses in the frequency drive to the motor the processor knows exactly when each optical filter is passing through the infrared beam and can conduct the detector digitisation process to obtain the detector signals necessary for the calculation of the gas species concentrations.

2.5. Calculation of Gas Concentration

Every second, with every rotation of the gas wheel, a series of detector measurements are made resulting in values of Dmeasure and Dreference for each gas species being measured. A parameter which we define as Y is calculated for each gas according to the relationship:

$$Y = 80000 - SC \times Dmeasure/Dreference$$

where SC is a calibration constant designed to make Y = 0 when the gas concentration is zero.

This ‘Y’ value is a unique, but non-linear function of gas concentration.

Having calculated the ‘Y’ value for each required gas the processor then applies a linearising algorithm to the ‘Y’ value to produce a value of gas concentration in ppm (parts per million concentration).

2.6. Effects of Flue Gas Temperature

Gas density and the infrared absorption spectra of the gases are both influenced by flue gas temperature. For an accurate determination of gas concentration it is essential to know precisely the value of flue gas temperature at all times. For this reason the in-situ probe incorporates a thermocouple temperature sensor whose output is monitored continuously by the on-board processor to enable accurate compensation to be made for the effects of gas temperature on the calculated values of gas concentration.

2.7. Output Data Normalisation

For emissions monitoring purposes it is common practice to present gas concentration data not only in ppm, but also in mg/Nm3. For this it is necessary to have knowledge of flue gas temperature, pressure, moisture content and dilution air content. Each of these parameters must be measured and the calculated gas concentration value corrected back to standard gas conditions, normally zero^{o}C temperature, 1 atmosphere pressure, zero moisture content, and a defined level of excess O2 or CO2 (fixed level of dilution air).

When such data presentation is required the in-situ probe is fitted with an integral absolute pressure sensor which is continuously monitored by the on-board processor. The sensing head is further equipped with the additional measurement channels for H2O and CO2 thus enabling complete data normalisation to be provided without the necessity of acquiring additional data from other sensors and analysers.

A 4 to 20mA input is available at the sensing head for the input of O2 data should this be required.

2.8. Analyser Temperature Control

Stable operating temperatures are essential for accurate measurements using infrared technology. The GCEM40 Series sensing head is equipped with state-of-the-art temperature control technology built around the incorporation of an integral fully IP67 sealed weather cover with thermoelectric heating/cooling capabilities.

2.8.1. Auto Weather Cover Control

The auto weather cover AWC enables the sensing head control temperature to be maintained within +/-0.1^{o}C over an ambient temperature range of -20 to +50^{o}C.

2.8.2. Gas Wheel Temperature Control

The gas wheel holds the optical filters and gas cells necessary for the measurements. These items are temperature dependent and must be held at a constant temperature for accurate gas analysis to be made. A heater plate positioned close to the wheel is controlled by the on board processor to ensure a stable operating temperature for the gas wheel.

2.8.3. Thermistor Control

In to achieve the detector sensitivity required for these measurements, the detector element temperature must be maintained at a level of -25^{o}C. This is achieved by incorporating a thermoelectric cooling element and thermistor temperature sensor in the detector package. Power to the cooler is regulated by the processor to maintain a constant detector element temperature, as measured by the integrated thermistor.

2.9. Analyser Calibration

The probe is designed with an inlet port that allows calibration gas to be injected into the measurement chamber thereby flushing out the flue gases and replacing them with calibration gas in order to maintain and verify calibration accuracy. Two solenoid valves operated by the sensing head processor are used to control the flow of zero gas (dry compressed air) and span gas (protocol gas cylinder).

A zero calibration is performed automatically every 24 hours and on demand manually from input via the DDU. This ensures control and correction of any long term calibration drift.
Span verification checks can be activated on demand from input via the DDU after ensuring that the correct protocol gas cylinder is connected to the span input solenoid on the probe.

2.10. Condensation Protection

In order to prevent blockage of the sintered filters it is important to ensure that condensation is not allowed to develop on them. The probe is not suitable for use in wet scrubbing applications when liquid water droplets can be present in the flue gas.

It is also important to protect the probe during the period of initial start up of the combustion system when hot combustion gases come into contact with a cold probe. Until the probe temperature increases beyond the dewpoint temperature of the flue gases condensation is likely to deposit on the probe resulting in blocked filters.

The analyser is equipped with a simple but effective defence mechanism to prevent filter blockage from condensation. When the flue gas drops below a set temperature (typically 10^{o}C above dewpoint temperature), indicative of a boiler shut-down condition, the analyser automatically applies compressed air-purging to the probe measurement chamber thereby preventing build-up of condensation on the sintered filters. The purging air is applied until the probe temperature increases above the set temperature value on recommencement of boiler operation.

2.11. Normal Operation

The analyser is designed to be self-sufficient, any power interruptions will be detected and the analyser will trigger an automated routine to ensure all opacity parameters are achieved before returning to normal operation. Zero calibrations are automated and are carried out each day as well as after plant start up or power up conditions.

Correct operation can only be maintained if the air supply is oil free, dry and of sufficient pressure. The analyser will automatically detect failures in air supply and become data invalid. Any calibrations will also be inhibited.

3. Specification

3.1. Measurements

-	Operating Principle	:	NDIR gas filter correlation
-	Span	:	0 to 6000ppm (CO, NO, SO2)
			0 to 25% (CO2, H2O)
-	Certified Ranges	:	0-300ppm, 0-1000ppm for CO,NO & SO2
-	Response Time	:	<200secs
-	Accuracy	:	+/-2ppm or +/-2% of span
-	Resolution	:	1ppm
-	Calibration	:	zero - automatic every 24 hours
			span - manually on demand

3.2. Compliances

-	EMC	:	EN50270:2006,EN61000-3-2+A1&A2:2009,EN61000-3-3:2008
-	Low Voltage	:	61010-1 (Edition 3)

3.3. Outputs DDU

-	Analogue	:	5 x 4 to 20mA isolated, 500Ω load, fully configurable from keypad
-	Logic	:	5 x volt-free SPCO contacts, 50V, 1A max, configurable as alarms
			1 x volt-free SPCO contact, 50V, 1A max, for data valid
-	Serial	:	RS485 modbus configured

3.4. General

-	DDU Display	:	32-character alpha-numeric back lit LCD
-	Keypad	:	4-key soft-touch entry
-	Construction	:	probe - 316L stainless steel
			Head & DDU - epoxy coated aluminium (IP66)
-	Ambient Temperature	:	-20 to +50^{o}C
-	Flue Gas Temperature	:	300^{o}C (standard probe)
		:	400^{o}C (high-temperature probe)
-	Power Requirements	:	24V DC @ 15A
-	Compressed Air Requirements	:	dry & oil free, 20 litre/min @ 4bar for calibration and purging; 2 litre/min @ 4bar normal operation

4. Data Display Unit (DDU) Operation

4.1. Introduction

After the instrument has been commissioned it will measure the concentration of gases within the probe measurement chamber and produce outputs proportional to those concentrations. The Data Display Unit (DDU) has an integral 32-character alpha-numeric display and four-element keypad that may be used to scroll through a variety of menus for data display and analyser configuration and set-up.

4.1.1. Measurement Mode

During normal measurement mode the instrument measures the various detector levels and computes for each gas channel the value 'Y' from which the gas concentrations can be derived. Data is refreshed every second and the gas concentration can be viewed on the DDU alpha-numeric display.

4.1.2. Calibration Mode

In calibration mode the analyser switches on purging air to the measurement chamber to produce a zero gas condition against which the analyser can be zero calibrated. In this mode of operation the analyser measures the detector levels in order to compute the calibration values (Kcal values) required to set the 'Y' values and calculated concentration values to zero.

Note: **In order to be able to monitor negative output excursions 10,000 is added to the calculated 'Y' values so that Y = 10,000 corresponds to zero gas concentration. A value of 'Y' less than 10,000 corresponds to a negative output value**.

4.2. Power Up

Immediately after power-up the DDU display will show the analyser type number and gas species measured:

GCEM 40 Series
< < GAS MONITOR > >

After 5 seconds the display will automatically switch to the main display mode Mode 1.

Until the various temperature controllers have achieved a stable temperature for the various sensor components, the analyser will suffer from shifts in zero. For this reason immediately upon power up the analyser will switch to a zero purge condition until the temperature controllers have stabilised. In this condition the data valid LED on the display panel will be OFF and the display caption will read as below. When the temperatures have stabilised the analyser will immediately perform a zero calibration after which the purge switches OFF and the analyser reverts to a normal measurement mode of operation and the data valid LED will illuminate.

1 SO2	**0000 vpm**
Power Up Purge	

4.3. Operation of Display Modes

The analyser has six modes of display operation identified by a number in the top left-hand corner of the display.

MODE 1	-	Normal Operating Mode	-	displays gas concentrations
MODE 2	-	Parameter Mode	-	displays operating parameters
MODE 3	-	Normalisation Mode	-	displays normalisation data
MODE 4	-	Diagnostic mode	-	displays analyser diagnostic data
MODE 5	-	Set-Up Mode	-	sets operating parameters. These must be entered correctly for the analyser to function successfully. This mode can only be accessed using a security code.

The output data of the analyser is unaffected by keypad operations in all operating modes except MODE 5 Set Up.

4.4. Keypad Operation

The keypad contains just four keys that enable navigation through the various display menus and screens. The four keys are:

Mode Key	-	pressing the **MODE** Key will scroll the display to the next mode of display, or back to the operating mode (Mode 1) if pressed from within a mode menu.
Arrow Up/Down	-	pressing the **ARROW** keys will do one of two things depending upon the status of the display. They will step through the available options within a mode or sub-mode or, if in Mode 5, they can be used to increase ↑ or decrease ↓ a displayed value.
Enter	-	pressing the **ENTER** key will do one of two things depending upon the status of the display. It will select the displayed mode or option from a sub-mode or, if in Mode 5 it can be used to enter a selected parameter value.

Allow approximately 1 second for the display to respond to a key instruction otherwise a double-key entry may be recorded.

4.5. Program Tree

Figure 3 illustrates the main program of the instrument.

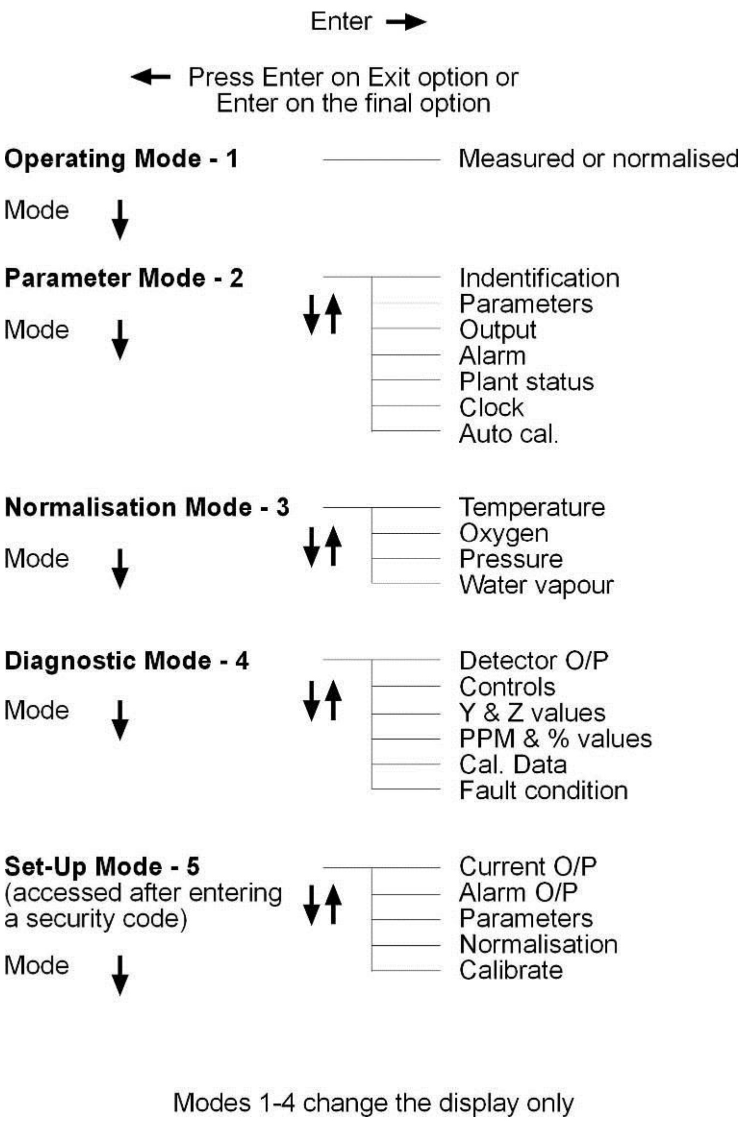


Figure 3: Program Tree

4.6. Normal Operating Mode

The display defaults to this mode, MODE 1, after power-up. To select this mode from another display setting simply press the **MODE** key until the mode number 1 appears in the top left of the display.

1 NO	**0348 vpm**
Measured	

1 CO2	**09.7 %**
Measured	

1 CO	**0150 vpm**
Measured	

1 SO2	**0275 vpm**
Measured	

1 H2O	**11.6 %**
Measured	

In this mode the gas species name, output value and analyser response time are displayed. Each gas measured by the analyser can be displayed individually in this mode. The standard output value for each gas is vpm (volume parts per million). This value is fully compensated for the effects of temperature and pressure. In the case of CO2 and H2O measurements the units are simply %.

Output data for all gases, other than CO2 and H2O can be presented in mg/m3 at the temperature and pressure at the point of measurement or in mg/Nm3. Mg/Nm3 is a fully normalised output using the normalisation reference values for temperature, pressure, CO2 or O2, and H20 set in Mode 5.

To change the data displayed press the **ENTER** key and a flashing cursor will appear at the position of the display gas species name. The **ARROW** keys enable the displayed gas species data to be scrolled through.

Pressing the **ENTER** key again will shift the flashing cursor to the beginning of the output value units (vpm, mg/m3 or mg/Nm3). The **ARROW** keys will now scroll through the unit options. Pressing the **ENTER** key one more time will cancel the flashing cursor and the arrow keys will become inoperative.

1 SO2	**0275 vpm**
Measured	

1 SO2	**0346mg/m3**
Measured	

1 SO2	**0346 mg/Nm3**
Normalised	

1 CO2	**09.7 %**
Measured	

1 H2O	**11.6 %**
Measured	

The bottom line of the display identifies the mode of measurement, either as measured (vpm or mg.m3) or normalised (mg/Nm3) and the selected response time in minutes.

This bottom line display is also used to identify when the purge air is applied to the probe.

4.7. Parameter Mode

In this mode the parameters set up in mode 5 set-up mode may be examined, but not changed. Press the **MODE** key until the number 2 appears in the top left hand corner of the display. The display will be as shown below.

2 PARAMETERS

Press the **ENTER** key to view the display option menu. The **ARROW** keys will now scroll through the available display options. To select a particular option select using the **ARROW** keys and press **ENTER**. To exit an option and return to the parameter menu press **ENTER** again.

4.7.1. Identification

This option is used to identify the analyser type and gas species measured, the Eprom number used, and the analyser identity number used for serial communication purposes. Use the **ARROW** keys to scroll between these displays.

2 PARAMETERS
Identification

2 GCEM 40 Series	
Gas Analyser	

2 GCEM 40 Series	
EPROM	**D07 . 107B**

2 GCEM 40 Series	
IDENTITY	**# 001**

Note: **The analyser identity number is set via the rotary switch on the processor card in the lid of the DDU**.

4.7.2. Parameters

Use the **ARROW** keys to scroll between the following displays:

Pathlength - the measurement cell pathlength. This depends upon the probe used. The 1.8m probe has a measurement path length of 2000mm and the 1.0m probe a pathlength of 1450mm.

O/P Fault - the 4 to 20mA output condition in the case of a data invalid (fault) condition. There are four options, set in mode 5, for the output fault condition. ZERO, FULL SCALE (FS), HOLD (output holds at last valid reading) or MEAS (output continues to measure).

Protocol - the serial output protocol. This may be set as Codel, which enables the analyser to be connected to a Codel SmartCem emission data acquisition system, or Modbus which provides a serial Modbus output.

Baud Rate - the serial output baud rate. Codel comms requires 4800 baud, Modbus normally requires 9600 baud.

2 PARAMETERS
Parameters

2 PARAMETERS	
Pathlength	**1000 mm**

2 PARAMETERS		**2 PARAMETERS**	
Protocol	**Codel**	**Protocol**	**Modbus**

2 PARAMETERS	
Baud Rate	**4800**

2 PARAMETERS		
O/P 1	**Fault**	**ZERO**

4.7.3. Output

The configuration of the two analogue outputs may be viewed in this option. The zero, full scale value and the output units for each output are displayed.

2 PARAMETERS
Output

2 O/P 1 (4mA)	**NO**
0000 ➔ 0500 mg/Nm3	

2 O/P 2 (4mA)	**CO2**
0000 ➔ 25%	

2 O/P 3 (4mA)	**CO**
0000 – 1000 vpm	

2 O/P 4 (4mA)	**SO2**
0000 – 1000 vpm	

2 O/P 5 (4mA)	**H2O**
0000 - 25%	

4.7.4. Alarm

The alarm threshold level and units configuration of the volt-free contact alarms are viewed in this option.

2 PARAMETERS	
Alarm	

2 Alarm 1	**NO**
Level	**0300 mg/Nm3**

2 Alarm 2	**CO2**
Level	**15%**

2 Alarm 3	**CO**
Level	**0500 vpm**

2 Alarm 4	**SO2**
Level	**0500 vpm**

2 Alarm 5	**H2O**
Level	**15%**

4.7.5. Plant Status

Plant Status ON or OFF is displayed in this option. There are two sources of information that can be used to determine plant status. One is the probe temperature. A temperature threshold may be set in Mode 5 below which the plant is considered to be in the OFF condition. The second is the input of a plant status logic signal from some other data source. Use of the **ARROW** keys will enable the current plant status and the data source to be examined. During plant OFF conditions the analyser automatically switches purging air onto the probe to prevent condensation forming on the probe optical components during the subsequent plant start up.

2 PARAMETERS	
Plant Status	

2 PARAMETERS	
Plant Status	**ON**

2 PARAMETERS	
Plant Status	**OFF**

5 Plant St.	**I/P**
Temperature	

2 Plant St.	**I/P**
Logic	

5 Plant St.	**I/P**
Temp. th'd	**080 C**

4.7.6. Clock

The real time clock is displayed in this option.

2 PARAMETERS	
Clock	

2 time	**13* 10* 34**
date	**29/04/09**

4.7.7. Auto Cal

The parameters that control the operation of the automatic zero calibration system are displayed here.

Interval	-	displays the interval in hours between auto calibrations.
Logic	-	the plant status logic input can be reconfigured to act as an external calibration input. This display shows the status of the logic selection.
Cal Alarm	-	alarm 1 can be configured to act as a Cal in Progress alarm. This display shows the status of that alarm.
Next Cal	-	if the timer is being used to trigger the automatic calibrations the time at which the next calibration is scheduled to occur is displayed here.

This data may be viewed by scrolling through using the **ARROW** keys.

2 PARAMETERS
Auto Cal

2 PARAMETERS **timer - inhibited**	**2 PARAMETERS** **Interval 024hrs**
2 PARAMETERS **Logic ON**	**2 PARAMETERS** **Logic OFF**
2 PARAMETERS **Cal Alarm OFF**	**2 PARAMETERS** **Cal Alarm ON**
2 PARAMETERS **timer - inhibited**	**2 Next Cal 0200h** **on 30/04/09**

2 PARAMETERS
EXIT

4.7.8. Exit

Pressing the **ENTER** key when the EXIT caption is displayed returns to the PARAMETERS display. Pressing the **MODE** key will then scroll the display through to Mode 3 Normalisation.

4.8. Normalisation

The normalisation input and reference values may be viewed in this mode.

3 NORMALISATION

After pressing the **ENTER** key to access the mode the **ARROW** keys can be used to scroll through the normalisation menu, Temperature, Oxygen/Carbon Dioxide, Pressure and Water Vapour.

3 NORMALISATION
Temperature

3 TEMP	**Deg C**
St 000 IP (a)	**127**

3 NORMALISATION
Carbon Dioxide

3 CO2	**%DRY**
St 09 IP (m)	**09.3**

3 NORMALISATION
Oxygen

3 OXYGEN	**%DRY**
St 06 IP (a)	**06.8**

3 NORMALISATION
Pressure

3 PRESSURE	**kPa**
St 101 IP (a)	**102**

3 NORMALISATION
Water vapour

3 WATER VAPOUR	**%**
St DRY IP (m)	**11.6**

3 NORMALISATION
EXIT

After selecting one of the four sections press ENTER to access the data. In each display the top line provides the units of measurement, while the bottom line gives the standard value for the normalisation, the measured value and method of measurement (m = measured by the analyser, a = analogue input, k = keypad input).

The standard or reference value is that value which is normally specified by the local Environmental Agency to which the gas channel output data should be normalised. For temperature this is usually zero Celcius, for pressure 101KPa and for water vapour 0%.

Flue gas dilution effects are corrected by measuring the excess oxygen level in the flue gas and normalising the gas channel data to a standard value of oxygen. The standard level usually depends upon the fuel being used. It is also possible to normalise for dilution effects using CO2 measurements in the flue gas. Either method may be used with this analyser. Oxygen or CO2 normalisation can be selected in mode 5.

To leave a display and return to the normalisation menu, press the **ENTER** key.

4.9. Diagnostic Mode

Access Mode 4 Diagnostics by scroll using the **MODE** key until the display DIAGNOSTICS appears.

4 DIAGNOSTICS

Access the diagnostic menu by pressing the **ENTER** key.

4.9.1. Detector Outputs

Select Detector Outputs using the **ARROW** keys and access via the **ENTER** key. The selected gas channel will be identified at the top left of the display, followed by the measure (Dm) and reference (Dr) detector levels for that channel. All detector values should be within the range 10,000 to 20,000.

The first display shows the instantaneous detector values refreshed every second. Pressing the **ARROW** keys will scroll the display to the smoothed detector values (Dms and Drs) for that same gas channel. Pressing the **ARROW** key again will scroll the display to ‘Select Channel’. To switch to another gas channel press the **ENTER** key. The display will now indicate the selected gas channel. To change the displayed gas channel use the **ARROW** keys to scroll through the gas channels in use. Press **ENTER** to switch to the selected channel.

The display will revert to the Diagnostic menu. Press **ENTER** again to reselect Detector Outputs. The display will now show the detector values for the new selected channel.

To exit these displays pressing the **ENTER** key will return to the Diagnostic menu.

4 DIAGNOSTICS
Detector Outputs

NO	**Dm**	**=**	**15632**
	Dr	**=**	**14871**

NO	**Dms**	**=**	**15654**
	Drs	**=**	**14866**

4 DIAGNOSTICS
Select Channel

4 DIAGNOSTICS	
Channel	**NO**

4 DIAGNOSTICS	
Channel	**SO2**

4.9.2. Controls

Select Diagnostic Controls using the **ARROW** and **ENTER** keys. The four sections of this sub menu Thermistor, Automatic Weather Cover Temperature, Gas Wheel Temperature and Detector Case Temperature are accessed by scrolling the display using the **ARROW** keys. Pressing the **ENTER** key at any time will return the display to the Diagnostic menu.

Thermistor	-	the first display within this section shows the thermistor control data. The thermistor value represents the detector element temperature which needs to be accurately controlled by the Peltier cooler within the detector casing to a temperature of -25^{o}C. The thermistor measured value appears on the top line and the Peltier control current on the bottom line. The control target value is set at 12288, which represents -25^{o}C temperature, and the displayed value should be within +/-4 of this value for correct operation.
Automatic Weather Cover (AWC)	-	the weather cover is integral to the analyser design. Sealed to IP67, it provides full protection from the elements and enables the temperature of the analyser to be accurately controlled over an ambient temperature range of -20 to +50^{o}C. The analyser measured temperature is displayed on the top line of the display; the power delivered to the weather cover control element is shown on the bottom line expressed as a percentage of available power. The control element can provide heating or cooling. Heating/cooling modes are identified by a '+' or '-' sign in front of the % power value.
Gas Wheel Temperature (GW)	-	the gas wheel within the analyser holds all the critical optical filters and gas cells necessary for the gas measurements. This wheel is controlled to a temperature 2^{o}C higher than the analyser temperature set point (set by the AWC control). Temperature is displayed on the top line and control power on the bottom line of the display.

4 DIAGNOSTICS

Controls

4 Therm	**=**	**12288**
C Ma	**=**	**0547.1**

4 AWC T	**=**	**30.06^{o}C**
Power	**=**	**23.1%**

4 GW T =	**32.01^{o}C**	
Power	**=**	**15.8%**

4.9.3. Y & Z Values

Select ‘Y’ & ‘Z’ values using the **ARROW** keys and access via the **ENTER** key. The selected gas channel will be identified at the top left of the display followed by the Y(0) and Z(0) values for that channel.

4 DIAGNOSTICS	
Y & Z values	

NO	**Y (0)**	**=**	**10157**
	Z (0)	**=**	**10284**

NO	**Y (s)**	**=**	**10152**
	Z (s)	**=**	**10278**

4 DIAGNOSTICS	
Select Channel	

4 DIAGNOSTICS	
Channel	**NO**

4 DIAGNOSTICS	
Channel	**SO2**

Y(0) is the instantaneous ‘Y’ value measured over the previous one second of analyser operation. ‘Y’ is a unique, but non-linear function of gas concentration calculated from the detector levels Dm and Dr for that channel. Zero gas concentration is represented by a ‘Y’ value of 10,000. Z(0) is the ‘Y’ value compensated for the cross-sensitivity effects of other gases. These compensations, designed to maintain specified accuracy under all operating conditions, are updated every second by the analyser processor.

Pressing the **ARROW** keys will scroll the display to the smoothed ‘Y’ & ‘Z’ values [Y(s) and Z(s)] for that same gas channel. Pressing the **ARROW** key again will scroll the display to ‘Select Channel’. To switch to another gas channel press the **ENTER** key. The display will now indicate the selected gas channel. To change the displayed gas channel use the **ARROW** keys to scroll through the gas channels in use. Press **ENTER** to switch to the selected channel. The display will revert to the Diagnostic menu. Press **ENTER** again to reselect ‘Y’ & ‘Z’ values. The display will now show the ‘Y’ & ‘Z’ values for the new selected channel.

To exit these displays, pressing the **ENTER** key will return to the Diagnostic menu.

4.9.4. PPM & % Values

Select PPM & % values using the **ARROW** keys and access via the **ENTER** key. The selected gas channel will be identified at the top left of the display, followed by the ppm or % values for that channel. CO2 and H2O are displayed in % concentration, all other gas species are displayed in parts per million (ppm).

4 DIAGNOSTICS
PPM & % values

4 NO	**=**	**0172ppm*m**
NO	**=**	**0086ppm**

4 DIAGNOSTICS
Select Channel

4 DIAGNOSTICS	
Channel	**NO**

4 DIAGNOSTICS	
Channel	**SO2**

The analyser responds to the total number of molecules of gas within the measurement cell path and therefore measures the product of gas concentration multiplied by the optical pathlength. The basic measurement units for the analyser are therefore ppm x m or % x m. To obtain values in ppm (or %) this basic measurement must be divided by the measurement cell pathlength. Both ppm.m (or %.m) and ppm (or %) values are displayed.

Pressing the **ARROW** key will scroll the display to 'Select Channel'. To switch to another gas channel press the **ENTER** key. The display will now indicate the selected gas channel. To change the displayed gas channel use the **ARROW** keys to scroll through the gas channels in use. Press **ENTER** to switch to the selected channel. The display will revert to the Diagnostic menu. Press **ENTER** again to reselect PPM & % values. The display will now show the PPM & % values for the new selected channel.

To exit these displays, pressing the **ENTER** key will return to the Diagnostic menu.

4.9.5. Cal Data

Select Cal Data values using the **ARROW** keys and access via the **ENTER** key. The selected gas channel will be identified at the top left of the display.

4 DIAGNOSTICS	
Cal Data	

NO	**K cal**	**=**	**78929**
	K wkg	**=**	**78929**

NO	**D mc**	**=**	**15733**
	D rc	**=**	**14914**

4 DIAGNOSTICS	
Select Channel	

4 DIAGNOSTICS	
Channel	**NO**

4 DIAGNOSTICS	
Channel	**SO2**

During a zero calibration a calibration factor Kcal is determined which is used to set the 'Y' value for that channel to 10,000 when the measured gas concentration is zero. This is done by recording Dm and Dr values during the calibration process and using the values obtained, Dmc and Drc, to calculate the calibration factor Kcal. A second calibration factor Kwkg is derived from Kcal after compensation for temperature variations within the analyser. Since however the analyser temperature is accurately controlled the values of Kcal and Kwkg should be the same.

On selecting this menu item the first display will show the values of Kcal and Kwkg currently in use for that gas channel. Pressing the **ARROW** keys will scroll the display to the calibration detector values Dmc and Drc, derived from the last calibration, for that same gas channel. Pressing the **ARROW** key again will scroll the display to 'Select Channel'. To switch to another gas channel press the **ENTER** key. The display will now indicate the selected gas channel. To change the displayed gas channel use the **ARROW** keys to scroll through the gas channels in use. Press **ENTER** to switch to the selected channel. The display will revert to the Diagnostic menu. Press **ENTER** again to reselect Cal Data values. The display will now show the Cal Data values for the new selected channel.

To exit these displays, pressing the **ENTER** key will return to the Diagnostic menu.

4.9.6. Fault Condition

The analyser operates a continuous assessment of all diagnostic data to ensure that all elements of operation are within specification. Any deviation from this operation specification will be identified as a fault condition.

Analyser fault condition status can be viewed from the fault condition display.

4 DIAGNOSTICS
Fault Condition

4 Zero Purging
OFF

4 Zero Purging
ON

4 DIAGNOSTICS
Fault Condition

4 Fault Status
D → C Comms Fault

4 Fault Status
D → C Comms Fault

4 Fault Status
C → M Comms Fault

4 Fault Status
Cooling Fan Failure

4 Fault Status
Air Supply Failure

4 Fault Status
Temp > Range <

4 Fault Status
Tx IR → Failure

4 Fault Status
Rx _ C → High

4 Fault Status
Therm > Range <

4 Fault Status

Detector > Range <

4 Fault Status

*** All Clear ***

4 DIAGNOSTICS

EXIT

When no faults are detected the display will show the condition ‘Fault Status’ * All Clear *. The fault conditions which are tested for are as follows:

D→C Comms Fault	-	a communication failure between the DDU and the analyser control processor.
C→M Comms Fault	-	a communication failure between the analyser control processor and the master processor in the sensing head.
Cooling Fan → Failure	-	Loss of rotation of the analysers cooling fan.
Air Supply → Failure	-	Loss of compressed air to the analyser.
Temp >Range<	-	a fault in the probe mounted flue gas temperature sensor.
Press >Range<	-	a fault in the probe mounted flue gas pressure sensor.
Tx IR → Failure	-	a failure of the infrared source unit.
Rx^{o}C > high	-	receiver temperature too high.
Therm >Range<	-	the thermistor control out of range.
Detector >Range<	-	one or more detector values are out of range.

Additional to these fault conditions are the status of the measurement cell zero purge that is also displayed here.

While not an analyser fault the application of the zero purge will cause the Data Valid relay to de-energise in the same way as a fault condition does.

To exit this display, pressing the **ENTER** key will return to the Diagnostic menu.

4.9.7. Exit

Pressing the **ENTER** key when the EXIT caption is displayed returns to the DIAGNOSTICS display.

Pressing the **MODE** key will then scroll the display through to Mode 5 Set Up Mode.

4.10. Set Up Mode

All operating parameters, averaging times, output settings, normalisation parameters, path length, calibration etc. can all be changed from this display mode. To prevent any unauthorised changes the user must enter a four number code before this mode can be accessed. Once accessed the normal operation of the analyser will cease, the Data Valid LED will extinguish and the Data Valid relay and mA output conditions will all register a **data invalid** condition.

Figure 4 shows the program tree for displays options in Mode 5.

Enter →

← Press Enter on Exit option

Current O/P ↓↑	Channel	1 to 5
	Species	NO, CO2, CO, SO2 or H2O
	Output	0 or 4-20mA
	Units	vpm, mg/m3 or mg/Nm3
	Set Span	0 to 9999 span (units depend on above)
	Fault Condition	Measured, zero mA, FS (20mA) or hold last value
	Set mA O/P	Set up current output levels
Alarm O/P ↓↑	Channel	1 to 5
	Species	NO, CO2, CO, SO2 or H2O
	Units	vpm, mg/m3 or mg/Nm3
	Level	Set alarm level for 1 to 5 (units depend on above)
Parameters ↓↑	Security No.	4-digit code
	Identity	Analyser address
	Protocol	Select Codel or Modbus protocol
	Baud Rate	Select 4800 or 9600 baud
	Plant Status I/P	Select temperature threshold or logic signal
	Display	Select NOx or NO (where applicable)
	Set Clock	Set year, month, day, hour, minute & second
Normalisation ↓↑	Temperature	Set up normalisation I/P & std. levels for temp.
	Oxygen/CO2	Set up normalisation I/P & std. levels for O2/CO2
	Pressure	Set up normalisation I/P & std. levels for pressure
	Water Vapour	Set up normalisation I/P & std. levels for H2O
Calibrate ↓↑	Set Cal Data	Set purge time, number of cycles & post cal delay
	Zero Cal	Conduct a basic calibration
	Zero Purge	Switch on/off zero air purge
	Span Gas	Span calibration check
	Auto Calibration	Configure auto calibration

Exit options not shown

Figure 4: Program Tree for the Set-Up Mode

4.10.1. Security Code Entry

On scrolling to Mode 5 using the **MODE** key the display will appear as shown below. To gain access to the security code press **ENTER**. The security code will appear showing 0000. If no further key-press is made within 5 seconds the display will revert back to the Mode 1 display.

5 SET UP MODE

5 SET UP MODE

Security # 0000

5 SET UP MODE

Security # 6371

5 SET UP MODE

INCORRECT CODE

To enter the security code pressing the **ARROW** keys will scroll the 1st digit through the number 0 to 9. Select the desired number and press **ENTER**. Operation will now switch to the 2nd digit. The 2nd, 3rd and 4th numbers may now be selected in a similar manner. If the security code has been entered correctly the Mode 5 menu will immediately appear. If the security code is incorrect the display will show INCORRECT CODE for a few seconds after which the display will revert back to Mode 1.

The security code will be initially factory by Codel set to the value 0000 to enable initial access by the user. The user is recommended to change this code before completing the commissioning process and beginning measurement operation.

Once successfully accessed the Mode 5 menu can be scrolled through using the **ARROW** keys. Once the required item has been identified on the display it can be accessed by pressing the **ENTER** key.

4.10.2. Configure Outputs 1 to 5

The analogue mA outputs are configured from these modes. Upon entering the mode the sub menu will appear. The various options can be scrolled through using the **ARROW** keys and the required option accessed by the **ENTER** key.

Channel 1 to 2 - select which mA output to set up.

5 CONFIGURE O/P 1
Channel 1

Species - one of the gas channels can now be assigned to the selected output.

5 CONFIGURE O/P 1
Species No.

Output - the mA range can be selected as 0 to 20mA or 4 to 20mA. Pressing the **ARROW** keys will change the output range from 0 - 20mA to 4 - 20mA. Input the required range by pressing the **ENTER** key. The display will immediately revert back to the options menu.

5 CONFIGURE O/P 1
Output

5 CONFIGURE O/P 1	**5 CONFIGURE O/P 1**
Output = 4 to 20 mA	**Output = 0 to 20 mA**

Units - for output of CO_2 and H_2O the only units available are % concentration. For other gas species the choices are vpm (volume parts per million), mg/m3 and mg/Nm3 (for analysers equipped with normalisation data). Select the option required using the **ARROW** keys and **ENTER**.

5 CONFIGURE O/P 1	
Units	

5 CONFIGURE O/P 1	
Units	**vpm**

5 CONFIGURE O/P 1	
Units	**vpm**

5 CONFIGURE O/P 1	
Units	**mg/m3**

5 CONFIGURE O/P 1	
Units	**mg/Nm3**

Set Span - this option defines the range of the analogue output. First the zero value of the output range must be set. Set each of the four digits using the **ARROW** and **ENTER** keys. After entering the 4th digit the display will immediately switch to the span full-scale value. Enter the required span value in the units displayed (set up in the previous option) by setting each of the four digits in turn using again the **ARROW** and **ENTER** keys.

5 CONFIGURE O/P 1	
Set Span	

5 CONFIGURE O/P 1		
Zero	**=**	**0000 mg/Nm3**

5 CONFIGURE O/P 1		
Span	**=**	**1000 mg/Nm3**

Fault Condition - there are four options for the status of the output during an analyser fault condition. They are ZERO (output goes to zero), MEAS (output continues to measure), HOLD (output holds that last value before the fault condition appeared) and F.S. (output drives to 20mA). Each of these options can be scrolled to using the **ARROW** keys and selected by the **ENTER** key.

5 CONFIGURE O/P 1
Fault cond

5 CONFIGURE O/P 1
Fault cond ZERO

5 CONFIGURE O/P 1
Fault cond ZERO

5 CONFIGURE O/P 1
Fault cond MEAS

5 CONFIGURE O/P 1
Fault cond HOLD

5 CONFIGURE O/P 1
Fault cond F. S.

Set mA Output - this option sets the calibration of the mA ouput to ensure an accurate 0.00 and 20.00 mA range. This calibration is factory set and should only be necessary if it is suspected that there is an error in the output calibration. To use this function it is necessary to connect a calibrated mA meter across the appropriate output terminals of the DDU. No other devices should be connected to the output during this procedure.

On entering the routine the display will register the zero calibration setting. Using the **ARROW** keys adjust the 'set zero' factor to increase or decrease the mA output until an output of 0.00mA is achieved on the mA meter. Press **ENTER** to accept this calibration.

The display will then switch to the 'Set span' value. Again increase or decrease the mA output using the ARROW keys until 20.00 mA is achieved. Press enter to accept the setting. The display will now revert to the Configure Output options menu.

Exit - press the **ENTER** key to revert to the MODE 5 menu.

5 CONFIGURE O/P 1
Set mA O/P

5 CONFIGURE O/P 1	**5 CONFIGURE O/P 1**
Set zero (0016)	**Set span (3932)**

5 CONFIGURE O/P 1
EXIT

Repeat this output configuration process for Outputs 2 to 5.

4.10.3. Alarm Outputs 1 to 5

The five alarm output functions are configured in these modes. The volt-free contact relays are Single Pole Changeover and are normally de-energised, energising for an alarm condition. The configuration options are scrolled using the **ARROW** keys and selected by pressing the **ENTER** key.

Channel 1 to 2 - Select which channel output to configure.

Species - Select a gas channel to assign to the Alarm Output.

Units - if the selected gas channel is either CO_2 or H_2O the units will be in % concentration only. For any other gas the selection of vpm, mg/m3 and mg/Nm3 is stepped through using the **ARROW** keys and the units selected by pressing the **ENTER** key.

Level - the output level at which the alarm will trigger is set by adjusting the four-digit value, one digit at a time by use of the **ARROW** and **ENTER** keys.

Exit – Press the **ENTER** key to revert to the MODE 5 menu.

5 ALARM	**O/P 1**

5 ALARM	**O/P 1**
Channel	**1**

5 ALARM O/P 1	
Species	**NO**

5 ALARM	**O/P 1**
Units	

5 ALARM	**O/P 1**
Units	**vpm**

5 ALARM	**O/P 1**
Units	**vpm**

5 ALARM	**O/P 1**
Units	**mg/m3**

5 ALARM	**O/P 1**
Units	**mg/Nm3**

5 ALARM	**O/P 1**
Level	

5 ALARM	**O/P 1**
Level	**0200mg/Nm3**

5 ALARM	**O/P 1**
EXIT	

Repeat this procedure for Alarm Outputs 2 to 5.

4.10.4. Parameters

The analyser general parameters are set in this mode. The option menu is scrolled using the **ARROW** keys and an option is selected by pressing the **ENTER** key.

5 PARAMETERS

Security - to prevent any unauthorised tampering with the set up information it is important that the security code is changed from the factory setting of 0000. Each of the four digits is scrolled in turn using the ARROW keys and the number required selected individually by pressing the enter key. Please ensure that the entered security code is not lost otherwise access to Mode 5 Set up will be denied. In the event of a lost or forgotten code, please contact Codel for instructions on how to unlock the access.

5 PARAMETERS
Security

5 PARAMETERS	
Security #	**2345**

Identity - Address required for use with PC data collection; usually set to 1 for a single system.

Protocol - the RS485 output of the DDU may be used to connect to a wider Codel SmartCem Emission Monitoring system in which case the special Codel communication protocol is required. Alternatively the RS485 may be used to connect to another monitoring or control system (e.g. plant DCS). In this case the communication can be switched to a standard ModBus protocol. Select the required protocol using the **ARROW** keys and accept with the **ENTER** key.

5 PARAMETERS
Protocol

5 PARAMETERS	
Protocol	**Codel**

5 PARAMETERS	
Protocol	**Modbus**

Baud Rate - the Codel protocol normally operates from a communication baud rate of 4800, while the Modbus operates at 9600 baud. Select using the **ARROW** and **ENTER** keys.

5 PARAMETERS
Baud Rate

5 PARAMETERS	
Baud Rate	**4800**

5 PARAMETERS	
Baud Rate	**9600**

Plant Status Input - to protect the measurement cell optical components from condensation during plant off and subsequent start up conditions it is important for the analyser to recognise a 'plant off' condition in order to be able to apply purging air to the probe. Plant status can be recognised in one of two ways. Either from detecting that the probe temperature has dropped below a predetermined threshold or from a remote logic signal that signifies plant status. Select between temperature and logic using the **ARROW** and **ENTER** keys.

5 PARAMETERS
Plant St. I/P

5 Plant St. I/P
Temperature

5 Plant St. I/P
Logic

5 Plant St. I/P
Temp. th'd 080 C

If 'Temperature' is selected the analyser will require the temperature threshold for plant ON/OFF recognition to be determined. This temperature value is scrolled up or down by holding down the up or down **ARROW** key. When the required temperature is displayed press the **ENTER** key to accept. The default factory set condition is a threshold of 80^{o}C.

Display NO or NOX - the analyser when configured for NO measurement can display the measured data as either NO or NOX. It is often a requirement of environmental authorities to present NO emission data as NOX, expressed as NO2 equivalent. Either of these display formats can be selected by scrolling with the **ARROW** keys and confirming with the **ENTER** key.

5 PARAMETERS
Display NO or NOX

5 PARAMETERS
Display NOX

5 PARAMETERS
Display NO

Set Clock - the DDU processor contains a real time clock used for initiating automatic calibrations. The clock time and date are set here.

Year - adjust the year by scrolling up or down using the **ARROW** keys and entering with the **ENTER** key.

Month - adjust the month by scrolling up or down using the **ARROW** keys and entering with the **ENTER** key.

Days - adjust the day by scrolling up or down using the **ARROW** keys and entering with the **ENTER** key.

Hours - adjust the hour by scrolling up or down using the **ARROW** keys and entering with the **ENTER** key.

Minutes - adjust the minutes by scrolling up or down using the **ARROW** keys and entering with the **ENTER** key.

Seconds - adjust the seconds by scrolling up or down using the **ARROW** keys and entering with the **ENTER** key.

Exit - press the **ENTER** key to revert to the MODE 5 menu.

5 PARAMETERS	
Set Clock	

5 Set Clock	
Year	**2009**

5 Set Clock	
Month	**04**

5 Set Clock	
Days	**30**

5 Set Clock	
Hours	**09**

5 Set Clock	
Minutes	**27**

5 Set Clock	
Seconds	**42**

5 PARAMETERS	
EXIT	

4.10.5. Normalisation

All of the normalisation inputs and reference parameters are set up from this mode. Each of the four normalising factors, temperature, oxygen/carbon dioxide, pressure and water vapour may be accessed by means of the **ARROW** and **ENTER** keys.

5 NORMALISATION

Temperature - the **ARROW** keys are used to scroll to three options, Set Standard Levels, Set Values and Exit.

5 NORMALISATION
Temperature

5 Temperature
Set std levels

5 TEMP		**Deg C**
Std level	**=**	**000**

5 Temperature
Set values

5 TEMP	**Deg C**
Analogue Input	

5 TEMP	**Deg C**
4 mA = 000	**20 mA = 600**

5 TEMP	**Deg C**
EXIT	

Set Std Levels - select by pressing **ENTER**. The standard temperature level to which data will be normalised is set by adjusting the value with the **ARROW** keys and entering with the **ENTER** key. The standard value is normally set to 0^{o}C.

Set Values - select by pressing **ENTER**. The DDU will specify input via 'analogue input'. Accept by pressing **ENTER** again. This time the display requires the temperature range of the input device to be entered. This is normally the temperature sensor integral with the probe and has a range of 0 to 20mA equivalent to 0 to 600^{o}C. Enter the zero and span values using the **ARROW** and **ENTER** keys.

Exit	-	after entering the analogue span value the display switches to EXIT. Press **ENTER** to revert to the Normalisation menu.
Oxygen/ Carbon Dioxide	-	in Parameter Set Up the normalisation for compensation for flue gas dilution effects has been set for either O2 or CO2 and this display will reflect that set up condition. The **ARROW** keys are used to scroll to three options, Set Standard Levels, Set Values and Exit.

5 NORMALISATION **Oxygen**	**5 NORMALISATION** **Carbon Dioxide**
5 Oxygen **Set std levels**	**5 Carbon Dioxide** **Set std levels**
5 OXYGEN % **Std level = 06**	**5 CO2 %** **Std level = 09**
5 OXYGEN % **Set values**	**5 CO2 %** **Set values**
5 OXYGEN % **Analogue Input**	**5 CO2 %** **Measured**
5 OXYGEN % **Measured DRY**	**5 OXYGEN %** **Measured WET**
5 OXYGEN % **4 mA = 000 20 mA = 20.9**	
5 OXYGEN % **EXIT**	

Set Std Levels	-	select by pressing **ENTER**. The standard O2/CO2 level to which data will be normalised is set by adjusting the value with the **ARROW** keys and entering with the **ENTER** key. The standard value required will depend upon the fuel type and local emission reporting standards.

Set Values - select by pressing **ENTER**. For CO2 the display will automatically select 'measured' and utilise the actual CO2 value measured by the analyser. No further set up is required for CO2. For O2 the display switches to 'analogue input'. Accept by pressing **ENTER** again. This time the display requires the range of the input device to be entered. Enter the zero and span values using the **ARROW** and **ENTER** keys. For O2 it is also necessary to specify whether the measurement is made in a 'dry' or 'wet' gas condition. Select 'DRY' or 'WET' using the **ARROW** and **ENTER** keys.

Exit - after entering the last data the display switches to EXIT. Press **ENTER** to revert to the Normalisation menu.

Pressure - the **ARROW** keys are used to scroll to three options, Set Standard Levels, Set Values and Exit.

5 NORMALISATION

Pressure

5 PRESSURE

Set std levels

5 PRESSURE kPa

Std level = 101

5 PRESSURE kPa

Set values

5 PRESSURE kPa

Analogue Input

5 PRESSURE kPa

4 mA = 000 20 mA = 200

5 PRESSURE kPa

EXIT

Set Std Levels - select by pressing **ENTER**. The standard pressure level to which data will be normalised is set by adjusting the value with the **ARROW** keys and entering with the **ENTER** key. The standard value is normally set to 101kPa.

Set Values - select by pressing **ENTER**. The DDU will specify input via 'analogue input'. Accept by pressing **ENTER** again. This time the display requires the pressure range of the input device to be entered. This is normally the pressure sensor integral with the probe and has a range of 0 to 20mA equivalent to 0 to 200kPa. Enter the zero and span values using the **ARROW** and **ENTER** keys.

Exit - after entering the analogue span value the display switches to EXIT. Press **ENTER** to revert to the Normalisation menu.

Water Vapour - the GCEM40 series analysers are in-situ measurement devices. No sample treatment or conditioning is necessary for the measurement. Consequently the measurements made are 'wet' measurements that often require normalisation to 'dry' gas conditions. This is possible using the measurements of water vapour integral to the analyser. The **ARROW** keys are used to scroll to three options, Set Standard Levels, Set Values and Exit.

5 NORMALISATION
Water Vapour

5 WATER VAPOUR
Set std levels

5 WATER VAPOUR		**%**	
Std level	**=**	**DRY**	

5 WATER VAPOUR		**%**
Std level	**=**	**WET**

5 WATER VAPOUR	**%**
Set values	

5 WATER VAPOUR	**%**
Measured	

5 WATER VAPOUR	**%**
EXIT	

Set Std Levels - select by pressing **ENTER**. The standard level can be chosen to be either 'WET' or 'DRY'. Select using the **ARROW** and **ENTER** keys.

Set Values - the display automatically switches to 'Measured' and the actual H2O value measured by the analyser is used for normalisation. Press **ENTER** to accept.

Exit - after the last **ENTER** the display switches to EXIT. Press **ENTER** to revert to the Normalisation menu.

4.10.6. Calibrate

All calibrations, zero and span, manual or automatic and zero purge control are all managed from this menu option. After accessing via the **ENTER** key the calibrate menu can be viewed using the **ARROW** keys. To exit this menu option press MODE key.

5 CALIBRATE

Set Cal Data - access using the **ENTER** key. Two options are available. Access using **ARROW** and **ENTER** keys.

5 CALIBRATE

Set Cal Data

5 CALIBRATE

Purge time 10 m

5 CALIBRATE

Set C Cycles = 030

5 CALIBRATE

Post Cal Delay 10 m

Purge Time - set the time in minutes that the zero air purge will operate prior to the start of the zero calibration process using the **ARROW** and **ENTER** keys. A period of 10minutes is normally sufficient to ensure complete purging of the measurement cell.

Set C Cycles - set the number of calibration cycles using the **ARROW** and **ENTER** keys. **Note: - The calibration time in seconds will be 8 times the value entered here. For example a value of 30 will give a calibration time of 240 seconds.**

Post Cal Delay - Set the number of post cal delay minutes using the **ARROW** and **ENTER** keys. Note that it is not recommended to reduce this value below 10 minutes.

Zero Cal - pressing the **ENTER** key will initiate a zero calibration sequence using the calibration parameter data set in the Set Cal Data option.

The display will begin by counting down the zero purge time in seconds. On completion of this purge period the calibration itself will commence and the display will count down the calibration cycles in seconds. When complete the display will show CAL COMPLETE for a period of 5 seconds after which the display will revert to Mode 1 and normal analyser operation will resume.

5 CALIBRATE

Zero Cal

5 Zero Purging

Purge time 0103

5 Cycle #	**0209**
CAL IN PROGRESS	

5 CAL COMPLETE

Zero Purge - this option is used to manually switch on or off the zero air purge. Select YES or NO for the zero purge using the **ARROW** and **ENTER** keys.

5 CALIBRATE
Zero Purge

5 CALIBRATE	
Zero Purge	**NO**

5 CALIBRATE	
Zero Purge	**YES**

Span Gas - manual operation of the span gas solenoid is controlled from here. Also automatic operation of the span check can be configured here. The auto span check will operate immediately after an auto zero calibration routine. If the auto span option is selected ensure that a span gas bottle is connected to the span gas input and is turned ON. Select the span operations using the **ARROW** and **ENTER** keys.

5 CALIBRATE
Span Gas

5 CALIBRATE	
Span Gas	**NO**

5 CALIBRATE	
Span Gas	**YES**

5 CALIBRATE	
Auto Span	**ON**

5 CALIBRATE	
Auto Span	**OFF**

Auto Cal - set up the method of initiating an automatic calibration routine. Press **ENTER** to access.

5 CALIBRATE
Auto Cal

5 Auto Cal
Initiate

5 Initiate
Cal timer

5 Cal timer
Interval

5 Cal timer	
Interval	**024 hrs**

5 Cal timer
Next Cal

5 Cal timer	
Next Cal	**0300 hrs**

5 Cal timer
EXIT

5 Initiate
Logic

5 Initiate via	
Logic Input	**NO**

5 Initiate via	
Logic Input	**YES**

5 Initiate
EXIT

Initiate	-	there are two methods of initiating an automatic zero calibration, by the on board clock or remotely via a logic input. Scroll and select using the **ARROW** and **ENTER** keys
Cal timer	-	having selected Cal timer first set the cal interval by scrolling the 3-digit number in the display using the **ARROW** keys to give an interval between calibrations measured in hours. Save the setting by pressing the **ENTER** key. Setting a value of 000 will inhibit the timed auto cal.
Next Cal	-	using the **ARROW** and **ENTER** keys enter the time in 24-hour clock format at which the next calibration is to be performed, e.g. 0300 is 3:00 am.
Exit	-	after entering the last data the display switches to EXIT. Press **ENTER** to revert to Mode 1 display and normal operation.
Logic	-	this enables the plant status logic input to be configured as an input for calibration initiation. Press **ENTER** to access. Select 'YES' using the **ARROW** keys and press **ENTER** to accept. This will overwrite any configurations previously made for Plant Status input.

5. List of Figures

Appendix 1: Standard MODBUS Communication

Summary

Using standard MODBUS protocol function 03 allows a host to obtain the contents of one or more holding registers in the CODEL DDU.

The request frame from the host (typically a DCS or SCADA) defines the relative address of the first holding register followed by the total number of consecutive registers to be read.

The response frame from the CODEL DDU lists the contents of the requested registers, returning 2 bytes per register with the most significant byte first. A maximum of 125 registers can be accessed per request.

The formats of the request and response frames are detailed below, where ‘X’ and ‘n’ are hexadecimal variables.

An example of a MODBUS register map is shown below:

Host Request Frame

01	Address
03	Function code
XX XX	Address of starting register
00 XX	Number of consecutive registers
XX XX	CRC

Slave Response (from CODEL MODBUS SCU)

01	Address
03	Function code
XX	Byte count
XX XX …to… …to…	Date from starting register
XX XX	Date from nth register
XX XX	CRC

Standard baud rate - 4800 or 9600

Bits per byte - 1 start bit
- 8 data bits (least significant sent first)
- 1 stop bit
- no parity

Data Register Locations at CODEL GCEM40 Series DDU for Interrogation using Standard MODBUS are shown in the following table:

REGISTER FORMAT					CUSTOMER SPECIFIC DETAILS			
Location		Analyser Data	Data	Units	Typical Range	Tag	Value	Description
0070	G-CEM40x0 channel 1	instantaneous	XXXX	1ppm (or 0.1%)	0-3000ppm (0-50.0% if CO2 or H2O)		XXXX	
0071	G-CEM40x0 channel 2	instantaneous	XXXX	1ppm (or 0.1%)	0-3000ppm (0-50.0% if CO2 or H2O)		XXXX	
0072	G-CEM40x0 channel 3	instantaneous	XXXX	1ppm (or 0.1%)	0-3000ppm (0-50.0% if CO2 or H2O)		XXXX	
0073	G-CEM40x0 channel 4	instantaneous	XXXX	1ppm (or 0.1%)	0-3000ppm (0-50.0% if CO2 or H2O)		XXXX	
0074	G-CEM40x0 channel 5	instantaneous	XXXX	1ppm (or 0.1%)	0-3000ppm (0-50.0% if CO2 or H2O)		XXXX	
0075	Not Used	instantaneous	XXXX				XXXX	
0076	Not Used	instantaneous	XXXX				XXXX	
0077	Normalisation Source - Temperature	instantaneous	XXXX	1 degree C	0-300		XXXX	
0078	Normalisation Source Data - Oxygen	instantaneous	XXXX	0.1%	0-25.0		XXXX	
0079	Normalisation Source Data - Pressure	instantaneous	XXXX	1kPa	0-160		XXXX	
007A	Normalisation Source Data - Water Vapour	instantaneous	XXXX	0.1%	0-50.0		XXXX	
007B	Flue Gas Temperature	instantaneous	XXXX	1 degree C	0-300		XXXX	
007C	Data Valid	instantaneous	XXXX	logic	XX00=valid, else=invalid		XXXX	
007D	Purging/Calibration Status	instantaneous	XXXX	logic	00XX=purge off, XX00=Cal off		XXXX	
007E	Plant Status/Head Indentifier	instantaneous	XX0A	logic	000A=plant on, else Plant Off		XX0A	
007F	G-CEM40x0 DDU Comms validation	instantaneous	XXXX	logic	00XX=valid, FFXX=no reply		XXXX	

0400	G-CEM40x0 channel 1	instantaneous	XXXX	1vpm (or 0.1%)	0-3000vpm (0-50.0% if CO2 or H2O)		XXXX	
0401	G-CEM40x0 channel 1	instantaneous	XXXX	mg/m3 (or 0.1%)	0-9999mg/m3 (0-50.0% if CO2 or H2O)		XXXX	
0402	G-CEM40x0 channel 1	instantaneous	XXXX	mg/Nm3 (or 0.1%)	0-9999mg/Nm3 (0-50.0% if CO2 or H2O)		XXXX	
0403	G-CEM40x0 channel 2	instantaneous	XXXX	1vpm (or 0.1%)	0-3000vpm (0-50.0% if CO2 or H2O)		XXXX	
0404	G-CEM40x0 channel 2	instantaneous	XXXX	mg/m3 (or 0.1%)	0-9999mg/m3 (0-50.0% if CO2 or H2O)		XXXX	
0405	G-CEM40x0 channel 2	instantaneous	XXXX	mg/Nm3 (or 0.1%)	0-9999mg/Nm3 (0-50.0% if CO2 or H2O)		XXXX	
0406	G-CEM40x0 channel 3	instantaneous	XXXX	1vpm (or 0.1%)	0-3000vpm (0-50.0% if CO2 or H2O)		XXXX	
0407	G-CEM40x0 channel 3	instantaneous	XXXX	mg/m3 (or 0.1%)	0-9999mg/m3 (0-50.0% if CO2 or H2O)		XXXX	
0408	G-CEM40x0 channel 3	instantaneous	XXXX	mg/Nm3 (or 0.1%)	0-9999mg/Nm3 (0-50.0% if CO2 or H2O)		XXXX	
0409	G-CEM40x0 channel 4	instantaneous	XXXX	1vpm (or 0.1%)	0-3000vpm (0-50.0% if CO2 or H2O)		XXXX	
040A	G-CEM40x0 channel 4	instantaneous	XXXX	mg/m3 (or 0.1%)	0-9999mg/m3 (0-50.0% if CO2 or H2O)		XXXX	
040B	G-CEM40x0 channel 4	instantaneous	XXXX	mg/Nm3 (or 0.1%)	0-9999mg/Nm3 (0-50.0% if CO2 or H2O)		XXXX	
040C	G-CEM40x0 channel 5	instantaneous	XXXX	1vpm (or 0.1%)	0-3000vpm (0-50.0% if CO2 or H2O)		XXXX	
040D	G-CEM40x0 channel 5	instantaneous	XXXX	mg/m3 (or 0.1%)	0-9999mg/m3 (0-50.0% if CO2 or H2O)		XXXX	
040E	G-CEM40x0 channel 5	instantaneous	XXXX	mg/Nm3 (or 0.1%)	0-9999mg/Nm3 (0-50.0% if CO2 or H2O)		XXXX	