EGA60 Series, Model EGA61
Multi-Sample CO_2/H_2O Analyser

Technical Manual
ADC BioScientific Ltd.

L.MAN-EGA61
Manual issue 11 29/12/22 Software issue 1.14 onwards

Contents

2 DESCRIPTION OF INSTRUMENT

The EGA61: Designed as a compact and portable CO_2 and H_2O analysis system for bench or laboratory operation, with integral gas multiplexer (also known as a Gas Handling Unit, GHU).

The front panel: Comprises a soda lime column, a backlit LCD display with a proportionally spaced font and 5 keys, a SD card connector and a USB socket.

Analyser: Comprises a CO_2 analysis cell, a water vapour sensor and a mass flow meter. The analyser has a sampling pump in each incoming line.

Integral gas multiplexer: Available with up to 25 channels. 24 are to be considered as analysis channels, labelled 1-24 on the front panel. Channel 0 is considered as the 'zero channel'. The cell is kept hot by thermostatic control to prevent condensation of water vapour and for measurement stability.

Channels (one channel per sample): The multiplexing valves are mechanically fitted at the factory in groups of 5, and are offered so that there are 5, 10, 15, 20 or 25 channels. Channels that are unavailable are not shown on the display.

Pumps: Each channel has its own pump, being powered all the time to maintain constant flow.

Flow: While a channel is selected for analysis, its flow is measured with the flowmeter, and the corresponding pump drive for that channel is adjusted so the achieved flow equals the set flow. The achieved flow is remembered and displayed even when that channel is not selected.

Usual setup: A single channel of the EGA61 is selected for gas to be sent to the analysis cell while all the others maintain their usual gas flow to waste. This ensures that there is no stagnant air in any gas lines, and that any biological experiments in circuit have a constant flow regardless of whether the lines are being measured or not.

Channel zero: For the user to externally connect soda lime or other conditioning chemical, for periodic switching into the sequence, either after every selection, or once for every cycle of all available channels (see 'configure' menu featured in section 17.8).

Input/Output Features:

- SD card to allow a data or control sequence to be saved and loaded.
- Configurable serial port.
- USB port for connection to a PC when the analyser looks like a storage device.
- Two voltage free relays which can be used to indicate when data is valid, or when the gas channel is changing, or for alarms.
- One analogue output (voltage or current) which can be related, by the user, to any of the measured or calculated parameters.
- Seven 12 bit analogue inputs.

3 SWITCHING ON AND OFF (SEE ALSO QUICK START GUIDE)

Connect the nominal 12V supply, provided, then press the **page**  **button** (far right) for at least 2 seconds. The following style of message will be shown:
EGA Software PRD-1063 Ver 1.0
©1999-2014 ADC Bioscientific Ltd
EN11 0NT www.adc.co.uk
Instrument Serial Number 33650 SW V1.03

The serial number and software version number should be quoted in any correspondence to us.
Immediately after switch on, the analyser will cycle all the inlet solenoid valves, also it will be warming up and unable to display CO_2 or H_2O readings. During this time, a status bar message 'Instrument is warming up' will be displayed.
If the left hand button is momentarily pressed immediately when the introductory message is displayed after turn-on, the warm-up timer will be bypassed. If this is the case, a popup message will inform the user accordingly, and there will be a message on the rolling message bar and the inlet valves will not be cycled. Alternatively, pressing the second button from the left during the time the introductory message is displayed, will disable gas corrections and the warmup timer. A message will be displayed to this effect also.

The EGA61 can be switched off by pressing the **page button** continuously until the power off page is reached (alternatively, pressing the page button several times leads you back to the power off page).

4 ELECTRICAL CONNECTIONS

The front panel has a USB socket which allows an external PC to access the SD card for data download.

The rear panel (shown in fig1) has:
An external DC power socket, fuse protected with a car type fuse
One M3 stud for electrically grounding the chassis. This is necessary for safety if either of the relay outputs are connected to mains power.
RS232 serial connector
12 way pluggable connector strip for connecting:

- Two single pole changeover relays
- Up to 7 12 bit analogue input channels
- 2 relay outputs.
- An analogue out of 0-5V or 4-20 mA.

Note that the screws of the connector strip make electrical contact only when they are tight.

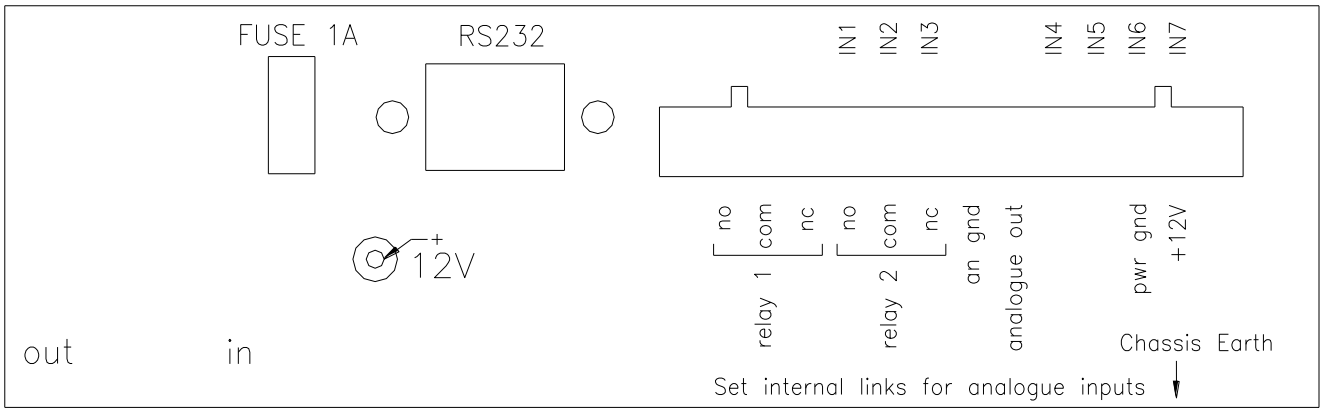


Fig. 1 Rear Panel Connections

5 GAS CONNECTIONS AND FILTRATION

The analyser has Luer tapered gas input connections on the front panel. The Luer taper has the advantage of easy fitting of flexible tubing and the possibility of fitting a range of readily obtained moulded plastic fittings.

It is better to try to minimise restrictions in the sample piping. This is because restrictions will force the pumps to work harder, reducing their life and consuming power, and because restrictions can increase the possibility of water dropout at the high pressure points when the air stream is near to dew point.

The instrument is supplied with push-on PVC caps on all the gas connections to protect against dirt during transit and storage. These must all be removed before it is turned on.

Filters
Hydrophobic filters of 50mm effective diameter (M.630-976) are supplied for all gas channels, to protect against water droplets entering the EGA61 analyser.

If there is a risk of water condensing in the sample tubing and entering the EGA61 analyser, please fit one filter (M.630-976) to every channel. Filters require a short length of adaptor tubing (706-100) at either side, to allow connection to the standard tubing between a channel and a column.
To fit filters to all the connections, it is necessary to fit the filters hanging below/away from the EGA61 front panel, because the spacing of the gas entries is less than the diameter of a filter.

Outlets There are two outlets on the bottom left of the front panel, for the outlet of the analysis cell, and for the outlet of backflush. Restrictions in the backflush out line will cause the inlet flow on any channel to drop when it is switched to backflush, so if a pipe is fitted to this port it should be as short as possible.

Soda Lime Column Connections There are two plug-in gas connections on the top left of the front panel for the soda lime column. The OUT connector for the soda lime should normally be linked with a short pipe to the zero in so that the instrument can establish the CO_2 zero. We advise lengthening the tubing from the soda lime column to zero input so that it loops downwards to reduce the possibility that condensed water droplets enter the analyser.

When the instrument is not being used for an extended period of time, for example a week or more, the soda lime life will be extended by moving the link pipe so it connects the IN and OUT together, thereby sealing the soda lime loop.

6 GAS HANDLING SYSTEM

The Gas Handling Unit (GHU) has up to 25 channels, the first of which is for zero (channel 0) leaving 24 to be considered as analysis channels, labelled 1-24. The valves are mechanically fitted in groups of 5, so it is available with 5, 10, 15, 20 or 25 channels (the first of which is zero). The solenoid valves are of a low power latching type, which maintain their state without power.

6.1 Flow

Each channel has its own diaphragm pump, which is set to be running all the time unless that channel has been permanently turned off. This ensures that air for analysis is not old, and that any experiments or sample chambers connected to the inlets have a continuous steady flow.

The processor reads the mass flowmeter and continually adjusts the pump drive to achieve the set flow. Flow is set and displayed in µmol per second.

The mass flowmeter precedes the analysis cell; when a channel is selected for analysis its gas flow is measured and its pump drive is adjusted to achieve the set flow for that channel. When the channel is no longer selected the achieved flow is remembered and displayed in a table, and the drive to achieve that flow for that pump is maintained constant.

At low flows, < 60 µmol/sec, the pumps produce noticeable flow pulses, which cause instability in the measured flow. This effect can be significantly reduced by increasing the impedance of the supply pipes that are connected to the low flow channels, for example by using a 5 meter length of 1.5mm bore pipe.

6.2 Timing ('on time' and 'data valid')

In Auto mode, the analysis cell is connected in turn to the inlets. The **'on time'** for each channel can be set at a minimum of 2 seconds and a maximum of 999 minutes.

At the last part of the 'on time', a **'data valid'** period can be individually set for each channel with a minimum of 1 second and maximum value equal to the 'on time' set. This is used to operate one of the relays and log the data.

Note that these two settings interact: If the 'on time' is adjusted to less than the current 'data valid' time, then the 'data valid' will be reduced to match it and a pop up message to that effect will appear. Similarly, if the 'data valid' time is adjusted to be greater than the current 'on time', the 'on time' will be increased. A message will appear, informing the user.

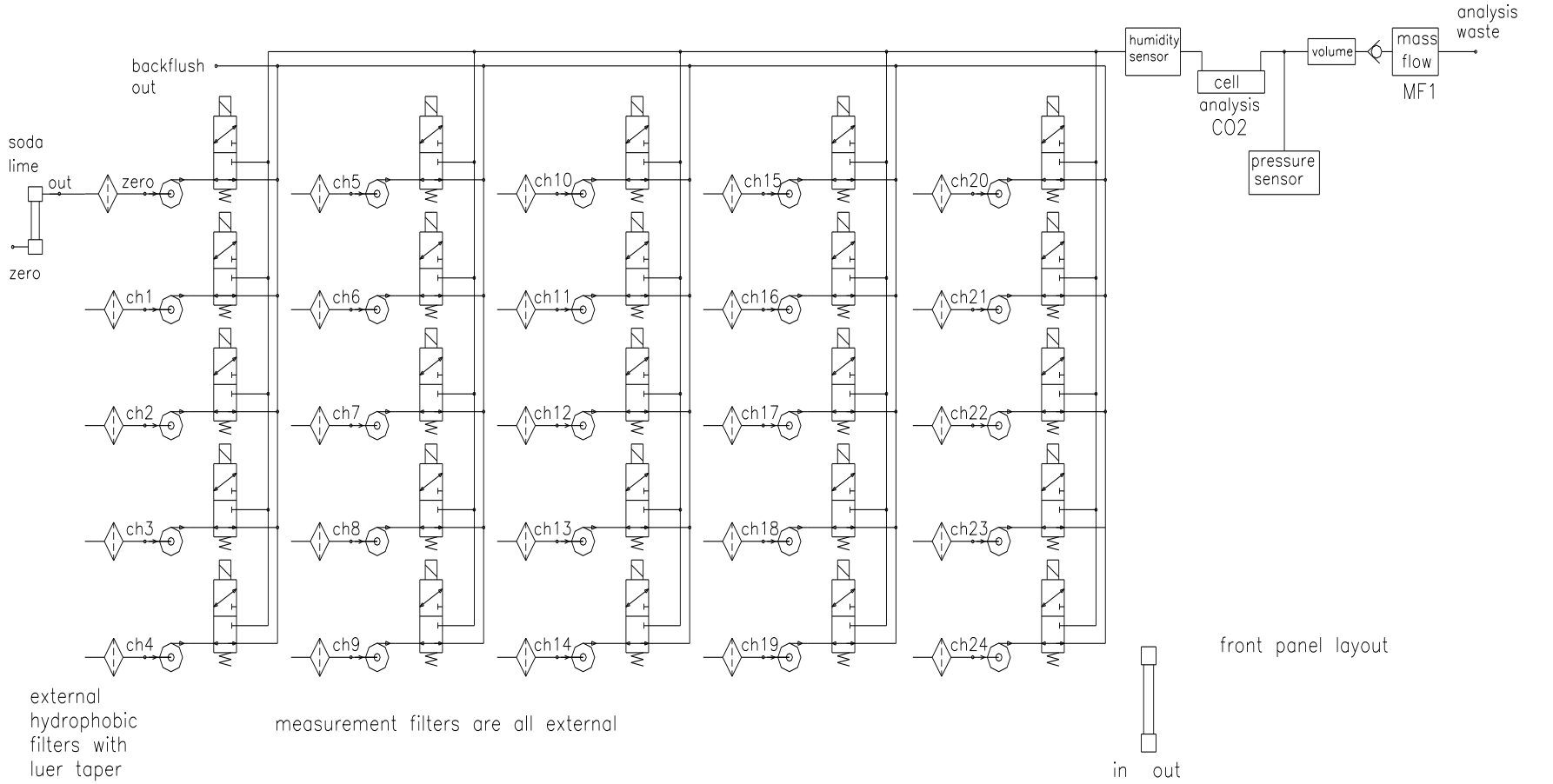


Fig 2. The Gas Circuit.

Soil respiration analyser with gas handling
with individual pumps

7 GAS ANALYSIS SYSTEM

The EGA61 has one CO_2 analysis cell and a humidity sensor to determine H_2O concentration [see Fig 2]. A column of soda lime on the front panel is used to provide air stripped of carbon dioxide as a zero reference for the analysis cell. Gas connections to the column are made by the operator using lengths of PVC tubing (M.706-050), between the connection ports. Typically the output of the soda lime column is linked to the filter connected to the zero input.

In Auto mode, stripped air is supplied to the analysis cell by the zero channel solenoid valve. When the measurement of the stripped air is complete, the measurement value air is stored as the zero reference for all the other CO_2 measurements. To ensure that the zero reference is good, the zero channel flow and the zero channel 'on time' must both be high enough to completely purge the analysis cell of CO_2. E.g. at a flow of 250 µmol/sec, the 'on time' should be at least 90 seconds. The user can check the validity of the zero reference by watching the Can value drop to zero when the zero channel is selected.

If the instrument is in manual mode and set to channel zero, the software will allow the 'on time' that has been set for the zero channel, then it will set the zero reference. This zero process must be done before any CO_2 measurements are meaningful.

The analyser has an atmospheric pressure sensor to calculate a pressure compensation factor for the gas measurement. The gas temperature is taken as that of the gas analysis cell which is temperature controlled by the microprocessor.

8 TUBESET TEMPERATURE CONTROL

The microprocessor controls the cell temperature which is fixed at 45°C to eliminate the possibility of water condensation in the analysis cell and to improve analyser stability. Other temperatures can be set at the factory. Control is to within ±2ºC.

9 DATA LOGGING

Data points (records) can be logged at set time intervals, minimum every 2 seconds, by either:

- Manually pressing a record button
- On 'data valid'
- Relay 1 operation
- A high level on the CTS line of the RS232 connector.

The log due to 'data valid' occurs 1 second before the end of 'data valid'. If, for example, 'data valid is 2 seconds, the log will occur 1 second after the start.

To obtain a high level on the CTS line (which is pin 8 on the 9 pin D type connector), connect it to 12V via a 1800 ohm resistor or connect it directly to the adjacent pin 7 which is internally connected to 12V via a 1800 ohm resistor.

Data can be logged either to the SD card or the serial port.

The data logged to the SD card appears in a spreadsheet with a main title of the instrument type and serial number. Each column has a title for the parameters with the appropriate units.

Column Order and Titles:
a) Record number
b) Date
c) Time
d) Current gas channel (zero, 1,2,3… on auto or M1, M2,… if manually selected)
e) CO_2 Analysis
f) H_2O Analysis
g) Pressure
h) Air flow (For the current channel)
i) Temperature
j) Relays status (bit 0 =relay1, bit 1=relay2)
k) Supply voltage
l) Analogue input 1
m) Analogue input 2
n) Analogue input 3
o) Analogue input 4
p) Analogue input 5
q) Analogue input 6
r) Analogue input 7

Data output through the Serial RS232 Port is output in the same order but without titles.

10 RELAY OUTPUTS

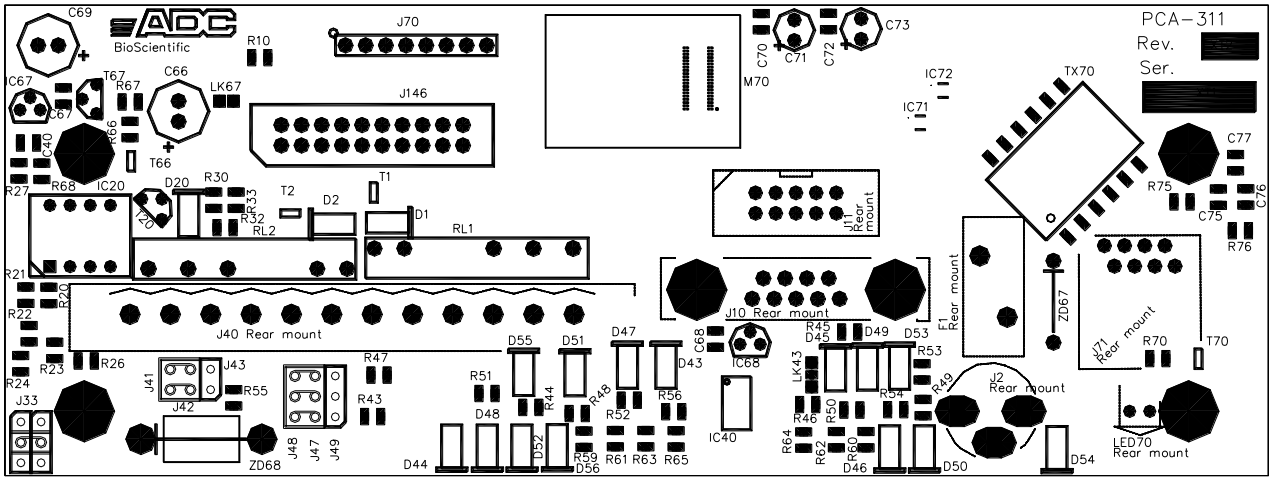
Relay 1	**Relay 2**
6A 250V AC rating	0.7A 110 V AC rating
Default activated on 'data valid pulse'	Default activated on 'zero valid'
The factory default is that Relay 1 energises for 1 second, 1 second before a channel change. This is called the data valid pulse	Relay 2 closes for 1 second, 1 second before the zero channel changes.
User options: Increase the on time of relay 1 to make it closed for up to as long the channel is selected. Configure as an alarm for any of the analogue inputs or CO_2 or H_2O level. Configure to activate on : gas level analogue input level 'data valid'	**User options:** Configure as an alarm for any of the analogue inputs or CO_2 or H_2O level. Configure to activate on : gas level analogue input level 'data valid'
SAFETY If either relay is connected to a mains power system, you must provide external fuse protection in the relay circuit and also earth the analyser. Earth using the M3/4 earth stud on rear panel. The attached earth cable must have a sufficient current rating to blow the fuse in the event of a fault.	

11 ANALOGUE OUTPUT

There is one analogue output **'an.out'** of either 0-5V or 4-20 mA which is hardware selectable with an internal link. The factory default is 0-5V representing the channel number that is currently selected: 0V=ch0, 200mV=ch1, 400mV=ch2, 600mV=ch3, 800mV=ch4, 1V=ch5 etc, or 4mA=ch0, 20mA=ch24 etc.
The software allows adjustment of the FSD (Full Scale Deflection) to a scale factor as low as 0.904. The span and zero has a software adjustable range of +/-5% for span and zero. So full digital scale of analogue out represents 5.25 +0.25, and the software allows subtraction of up to 0.5 for zero and a scale factor as low as 0.904.
The analogue output has a default range out of 0-5V which can be changed to 0-2.5V by asking your dealer to remove surface mount resistor R20 (10k) on the rear interface board or to 0-10V by changing R21 from10k to 30k. The 4-20 mA option is internally link selectable on the same circuit board, and there is a further option of 5V DC for powering any external sensors which might be connected to the analogue inputs

12 ANALOGUE INPUT

There are up to 7, 12 bit analogue inputs **'an.in'** nominally 5V maximum, allowing the EGA61 to act as a data logger e.g. collecting the data from an attached analyser. The connections for the inputs are shared on the back panel with other electrical connections e.g. relays; the analyser is shipped with a factory default of two channels available. If additional inputs are required they can be specified at the time of ordering, or user-selected by removing the rear panel and moving links. The impedance of each input is 4100 ohms and there is a 5% attenuation due to the overvoltage protection network. These inputs are displayed as 0 – 5.00V.



Relay2 in 1,2,3 5VDC out 5V an. out 4-20mA out pwr,gnd an 6,7

Fig. 3 PCA-311 layout. To show position of user-selectable links

13 INTERNAL LINKS

There are not enough connections on the rear panel connector plug for all the analogue in, out and relay lines simultaneously, so the required connections are link selectable internally. See [Fig. 3] above.
The 2 pin link on J33 determines what is connected to the Analogue Output screw terminal of the connector shown in Fig. 1. In the top position it selects constant 5VDC, which can be used for a constant power for energising external sensors. In the middle position, it selects 0 to 5V. In the lower position, it selects 4-20mA. The factory default position is the middle position.

If the 6 way block on J48, J47 and J49 is fitted between J48 and J47 then the screw terminals are selected for connection to Relay 2. If the block is fitted between J47 and J49 then these screw terminals are used for IN1, IN2, and IN3. The factory default position is the right hand position, i.e. IN1, IN2, and IN3.

If the 4 way jumper block on J41, 42, 43 is fitted between J41 and J42 then12VDC power and power ground are selected. If this block is fitted between J42 and J43 the IN6 and IN7 is selected. The factory default position is the left hand position i.e. power and ground.

14 SERIAL PORT

The serial port on the rear panel allows for logging to a remote destination.
The baud rate defaults to 115200 and can also be programmed by the user.

15 POWER SUPPLY

The analyser is supplied with a universal voltage mains power to 3A 13.8V DC converter with regulated output. Note that it will run from an unregulated supply but the performance will be reduced, particularly pump flow stability. A 12V regulated supply is also OK.
The processor monitors the supply voltage and displays a condition bar.
Power is most conveniently connected with a coaxial type power plug which has a body diameter of 5.5mm and central hole of 2.5mm. Power may also be applied via the 12 way removable screw terminal connector on the back panel provided the internal links LK40 and 41 on circuit board PCA-311 have been correctly set. The factory default is that they are set to enable external power on the connector.

16 REAL TIME CLOCK

The EGA61 has a real time clock to time and date stamp records. The clock will continue to keep good time from an internal rechargeable battery for up to 4.5 weeks. The internal battery needs to have external power connected for about 27 hours to fully recharge, but the instrument does not need to be switched on.

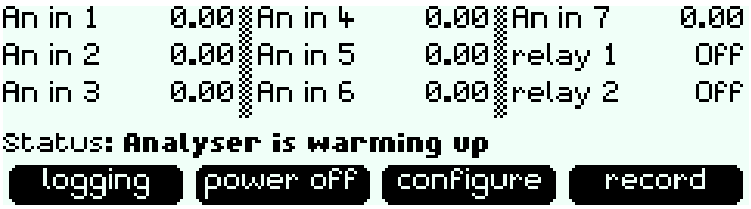
17 MENU STRUCTURE

The display has a proportionally spaced font, and 4 ‘soft’ keys below the display which are configured according to the menu page that is displayed.
Caution: If the left button (number 1) and number 4 are pressed at the same time, the instrument will perform a software reset.

Button  or ‘page’ button cycles through 3 main menu screens, see below:

17.1 Main Menu 1

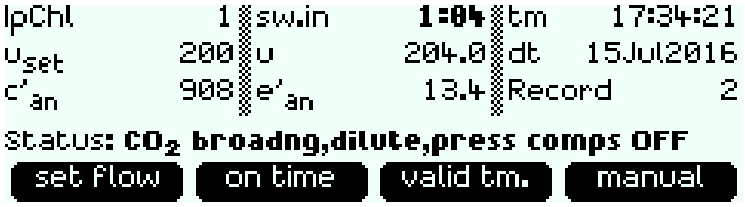
The main menu page 1 shows the currently selected input channel, the corresponding CO_2 and H_2O analysis values, the time, and a bar showing power status.



A full bar indicates 12.8V or more (a nearly empty bar indicates 11V) when a “power low” warning will be shown, and an empty bar occurs at 10.8V when the instrument will turn off after displaying “Switching off”.
The message line above the button labels displays any error or warning notices for 5 seconds. In this example there is a warning that the analyser is warming up. This message line space appears on most menu pages, although it is often blank.
Pressing ‘page’ takes you to main menu page 2

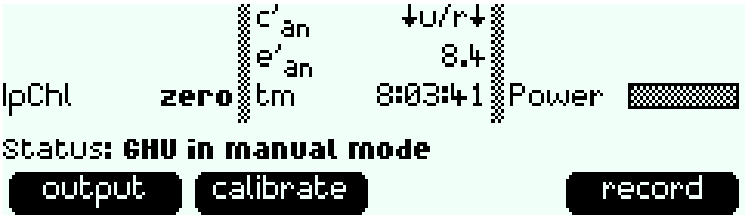
17.2 Main Menu 2

This is a list of the analogue voltage inputs on the rear panel and the status of the relays. Pressing ‘page’ takes you to main menu page 3.



17.3 Main Menu 3

The key labelled ‘manual’ switches between manual and auto [see ‘manual menu’ section]. Pressing ‘page’ returns to main menu page 1, so repeated presses of ‘page’ cycle through the 3 main menu pages.



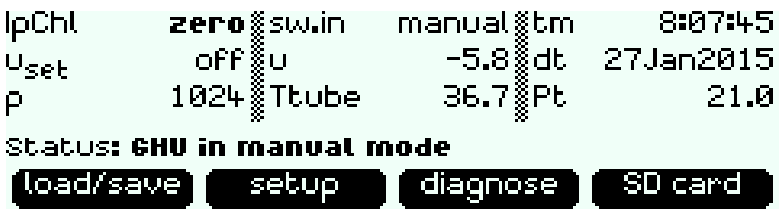
17.4 MANUAL MENU

In manual mode, you can select a channel for analysis (connecting the analysis cell to the input). Manual mode is used when setting up an assay, pausing, restarting or changing between Setup files. (In manual mode, the 'on time' and 'data valid' times are irrelevant because the auto sequence is suspended). All the channels and achieved flows are shown on this screen-shot.
The cursor indicates the selected channel and is moved with the down and right arrows. On entry, the current channel will be selected (black). Pressing 'page' returns to main menu 1.

Auto operation will remain suspended with the channel that has been manually set. Note that this mode of operation may lead to erroneous CO_2 measurements if the zero measurement (which is only performed in auto mode) has drifted.

If manual logging is enabled in the logging trigger conditions, a log can be made by pressing the record key. If it is not enabled, a pop up message to this effect appears.

On return to main menu 1, the key previously labelled 'Manual' will have switched to 'Auto'. **Pressing 'Auto' will then restart the automatic sequencing,** starting at the channel that was on during 'manual'. The key will switch back to manual without leaving main menu 1.
If the instrument is in manual mode, then to change channel it is necessary to go briefly through the auto state before getting to the manual channel selection screen. During manual mode, the status message 'manual mode' will be displayed:



17.5 Set Flow Menu

Pressing 'page' returns to the settings menu 1. This menu shows the available channels in 5 columns of 5, with each having a flow setting. The cursor displays at the same channel that was previously selected. It is possible for a pump to be switched off by pressing on/off. This is a quicker way to turn a pump off than repeatedly pressing the key to step down to zero (see below). Note however that a pump which has just been turned off will not do so immediately, it will do so when it next get selected in the timing cycle.

A channel with an 'off' pump will still be incorporated into the timing cycle of the valves but the pump will not be energised. This allows the option of blowing air through that channel and opening the flap valves in the 'off'

pump with an external pump. In this scenario, the flow provided by an external pump will be measured and displayed as per normal.

Once a channel has been switched ‘off’ using on/off, the old flow value of an ‘off’ channel reappears if the channel is highlighted and set flow is pressed, or on/off is pressed.
Channel selection is by the down arrow to move the highlighted channel down or the right arrow to move it right.

Pressing set flow will cause the display to change to that shown opposite:

change+ and change- change the flow in 1 µmol m^2 s^1 increments, unless held down for more than 3 seconds, after which they change in 10 µmol m^2 s^1.

When the instrument is in its usual mode of operation, with the zero channel being used for stripped gas, it is generally advantageous to set the flow on the zero channel to a high value, e.g. 300 µmol/sec. This will minimise the time taken for the zero channel to stabilise. Note that setting a channel to a particular flow has an effect on the flow of gas only when that channel is selected as the analytical channel, i.e. there could be a long delay before the setting is actioned. If the user needs the channel to change flow immediately, that channel should be selected for analysis using the auto / manual key.
At the lowest flow, the pumps are turning very slowly. When the instrument is switched on, some of the pumps may not restart until they have been selected for analysis. To ensure correct operation of all the pumps, ensure that the instrument cycles through all the channels that you wish to use at least once after switch-on. If all the pumps have a selected flow of 100 or more this precaution is unnecessary.

copy makes the flow the same as the next highest numbered channel.
page returns to the set flow menu.
on/off has the same function as previously.

17.6 ‘On Time’ Menu

This shows a list (in 5 columns of 5 channels each) of the configured channels. A time in minutes and seconds (e.g. 10:00) indicates the ‘on time’, the time for which the valve for each channel is on.

page returns to the settings menu.
The cursor initially displays at the location that it was on the previous time that this menu was used.
Selecting down to 00:00 ‘on time’ turns a channel off, removing it from the channel sequence.

on/off is a quick way to turn off channels or turn them back on with

the previous timing. The old time value of an off channel reappears if the channel is highlighted and on/off is pressed.
on time works as for set flow, causing the adjacent page to appear:

Pressing change+ and change- change the 'on time' in 1second increments unless held down for more than 3 seconds, after which they change in 10's. The minimum time is 2 seconds, incrementing by 1 second up to 1:59. After 2 mins, increments are in mins up to a maximum of 999 mins.

Setting zero/reference channel 'on time':

The channel times should be long enough for stability to be obtained. This is especially important for the zero channel because it acts as a reference for all the others. E.g., with a set flow of 300 µmol m^2 s^1 on the zero channel, 'on time' should be between 00:60 and 1:30 seconds. If all the channels except the zero channel have similar gas concentrations, it is only necessary to set the channel 1 'on time' to be long enough to reach stability for the concentration change from zero, e.g. 2:00 minutes. All other channels can be set long enough for a much smaller change, for example 00:30 seconds. Higher flows produce quicker stability time, in general. Optimum flow conditions on the EGA61 are between 200 and 300µmol m^2 s^1.

page accepts the new time and returns to the previous page.
cpy.time makes the time the same as the next lowest numbered channel.
on/off has the same function as previously.
Pressing page again returns to the on time menu.

If the 'on time' is reduced below the previously set corresponding 'valid time' (see next, 17.7) the valid time is set equal to the on time and a popup message appears when you have finished making your adjustments. The message says: "Data valid time has been reduced so as not to exceed channel on time".

17.7 Data Valid menu

'Data valid' time counts back from the end of the channel 'on time'.
To give an example: the 'on time' for channel 1 is set to 2:30 (150 seconds), and 'data valid' time is set to 0:10 seconds. In this example, 'data valid' time will begin when 2:20 shows on screen (140 seconds) into channel 1 being selected.

Note: The 'data valid' time must be set to less than the 'on time' by *at least* 1 second.

The EGA60 screen will update every second, during the channel 'on time'. When the data valid time begins (e.g. at 2:20 or 140 seconds in), the 'sw.in' value on main menu 3 (see Section 17.3) is then shown in **bold**: 'sw.in **0:53'**. During the 'data valid' time, the gas readings are **averaged**, and the average value will be saved in the record. [During the 'data valid' time, either or both of the two relays connected to the rear panel connector may be activated, depending on the settings of the

relays menu, see section 17.16. You may wish to deactivate relays, depending on your application.]

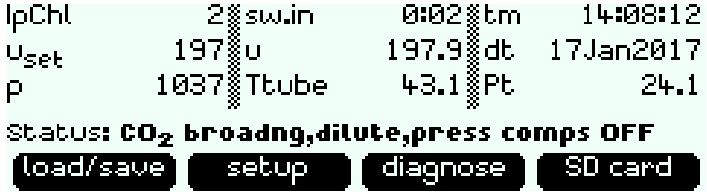
This screen lists up to 24 channels, each having a 'data valid time' in minute and seconds [mmm:ss]. The cursor initially displays at the location that it was on the previous time that this menu was used.

valid will display the adjacent menu where the time in minutes and seconds is the duration of the data valid pulse from Relay 1.

Note: The 'data valid time' must be set to less than the 'on time' by *at least* 1 second.
The factory default 'data valid' is 1 sec.
OK accepts the new time and returns to the valid time menu.
page returns to the settings menu.

17.8 Configure Menu

Press configure in main menu 2 to reach the configure menu page, showing:



IpChl Input channel selected for analysis
Uset Set flow of selected channel. Default = 200µmol m^2 s^1.
U Actual flow of selected channel
sw.in Time until switching to the next channel. Default = 10min.
Ttube is the analysis cell temperature, which is set to stop water condensation at maximum humidity (45°C factory default) or 55°C if 20 or 25 channels are fitted.
Pt is the temperature of the internal pressure transducer (°C).

17.9 load/save

load/save allows you to save all current settings as a named 'setup file' and to load previously saved setup files for use (e.g. when swapping between different experiments).

To save your current settings as a new, named file:

1. Select *new file*
2. Press 'save'
3. Edit the file name using 8 digits or less (e.g. compost1)
4. Press 'page' to confirm
5. You can see here the settings to be saved:
   Save setup YES (default)
   Save preferences NO (default)
   Save calibration data NO (default)
6. Toggle between YES and NO by pressing the 'setup', 'preferences' and 'calibration' buttons. See below for explanation of these options.
7. Press 'page' to confirm and exit. All settings will now be loaded, ready to use.

To load a previously saved setup file:

1. Press ‘configure’
2. Press ‘load/save’
3. Select the desired file (you can scroll down using the arrow buttons) and press ‘Load’.

Screen shot showing SD card fitted, with 3 ‘setup’ files saved on it:

You can also reset the factory default ‘cfg’ settings for each channel (of 200 µmol flow and ‘data valid time’ of 1s). Loading factory default settings will not affect CO_2 range, broadening factor, curves, tubeset temp or any other factory calibration settings.

It is not necessary to save your current setup if you want the instrument to return to it next the time it is powered on. This happens automatically. However, if the instrument is powered down by removing power rather than using the power off key, some if the settings may not be properly restored.

SETUP FILE OPTIONS EXPLAINED

Below are example setup files as viewed from the SD Card of a 5 channel system.

Select Set-up YES to save the following settings:

```
# INSTRUMENT SETTINGS FILE
# ~~~~~~~~~~~~~~~~~~~~~~~~~
# ADC BioScientific  EGA61 System
# EGA61 Software PRD-1070 ver. 1.13
:InstrumentTypeCheck EGA
:EGAtype 61
:AutoZeroMode 0
:LogFile log-001.CSV
:LogDestination 0
:Relay1Function 0
:Relay1Channel 255
:Relay1Level% 0
:Relay2Function 0
:Relay2Channel 0
:Relay2Level% 0
:LogTriggerOnDValid No
:LogTriggerOnCTS No
:LogTriggerOnAnIn4 No
:LogTimerEnable Yes
:LogTriggerOnRL1 No
:LogTimerPeriod 24
:GHUInputSettings 0,600,1,200,255,255
:GHUInputSettings 1,240,1,258,0,255
:GHUInputSettings 2,600,1,200,0,0
:GHUInputSettings 3,600,1,200,0,255
:GHUInputSettings 4,600,1,200,0,255
:GHUInputSettings 5,600,1,200,0,255
```

Channel,	time,	data valid,	flow rate,	timer,	pump
1	240	1	258	0	255
#	(sec)	(sec)	(µmol m^2 s^1)	(On)	(Off)

Select Set-up 'YES' AND Preferences 'YES' to save these additional preferences:

:BeeperEnable Yes
:KeyclickEnable Yes
:BaudRate 8
:EnableRecordButton Yes
:DACOutput 0
:GraphYparam 0
:GraphXmode 0
:GraphTrigMode 0
:GHU_CycleLimit 0
:CO2_Phase 120
:CO2AveMode 1

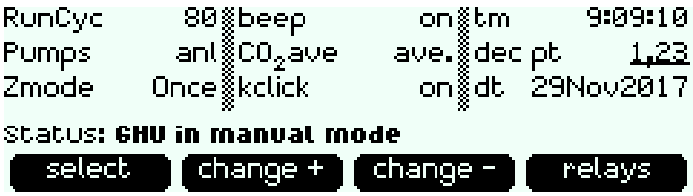
Always select preferences if you wish to save CO_2 Averaging Mode.
Also graphing settings; X and Y parameters.
The cycle limit is also important; this is the number of times the analyser will cycle through all channels before it stops recording measurements.

Select Calibration 'YES' to save calibration settings:

:SkipSectionIfNoConfig
:CO2Poly^0 0
:CO2Poly^1 0.40324512
:CO2Poly^2 0.00197952
:CO2Poly^3 5.89236559E-05
:CO2Poly^4 -3.11088832E-07
:CO2Poly^5 1.20588919E-09
:GHU#Inputs 25
:CO2_FullScale 2000
:CO2_Absorptn 167
:CO2_Absorptn 167
:TubeSetTemp 50
:AnalyserCfgOptions 0
:NominalPhase 120
:FlowCtlLoopGain 1180
:FlowCtlDeadband 7
:--SECTION-END-MARKER--

You will NOT normally need to save calibration data. This is mainly a factory tool.
Each EGA61 is fully calibrated by ADC engineers prior to delivery. Recalibration will not normally be necessary.
We would recommend contacting your ADC representative for advice if you notice your reference gas value to be different from that expected after using the system.

17.10 Setup Menu



RunCyc is the number of times the analyser will sequence through channels 1 to 24 before halting. This allows the user to set the EGA61 to collect a data set unattended. **If RunCyc is set to 0, the EGA61 will run continuously.**
The highest count that can be set is 100 cycles. The time the analyser will take to complete its cycles can be calculated by multiplying the sum of all the 'on' times by the RunCyc value. The result of this calculation is shown as the Tcyc value in the Diagnose menu (see 17.10).

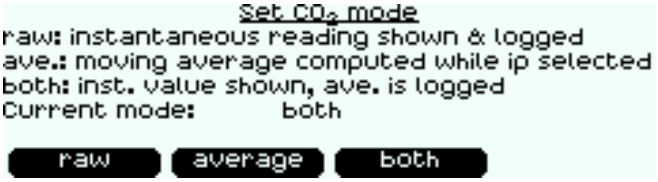
Pumps can be set to 'always' or 'anl'.
'always' is the default setting where all pumps that have been switched on in the Set Flow menu run continuously.
If 'anl' is selected, the pumps all turn off, except for that of the channel being analysed.
This mode allows gases to accumulate in the headspace of experimental chambers when gas production rates are very low.
Zmode Controls the measurement mode for the zero channel (connected to the soda lime column).
The timing can be changed by pressing either [change +] or [change -], the options being:

'every': The zero channel is measured between every channel, every time the EGA61 switches from one channel to the next.
'none': The zero channel is not measured.
'once': Zero channel is measured once per entire cycle through all channels.

page returns to Menu Page 2.

beep is the noise the analyser makes when it performs an action. It may be on or off.

CO_2 Mode
This menu controls what the EGA61 does with CO_2 readings during the 'Data Valid' time, if Data valid has been set to 'on' as a logging condition.



If **'average'** is selected, the average value of all the readings taken one per second during the Data Valid time is sent to the logging destination (SD card / serial port). The current average value is also displayed on screen as soon as the Data Valid time starts. Up to that point, instantaneous readings are shown. The Data valid time is set to a factory default value of 1.

If **'both'** is selected, the average value is sent to the log destination, together with all the 'raw' values that were measured and used to calculate that average during Data Valid. Raw and average readings shown in the '.csv' file are identified by annotation in an additional column with entries of 'raw or 'ave' on the far right of the spreadsheet. For example, if data valid time was 12 seconds the card would have at total of 13 readings at each channel change, the first 12 are raw readings and the last one the average.

If **'raw'** is selected, the instantaneous reading is sent to the log destination at the end of the Data Valid time, and is also shown on the display.

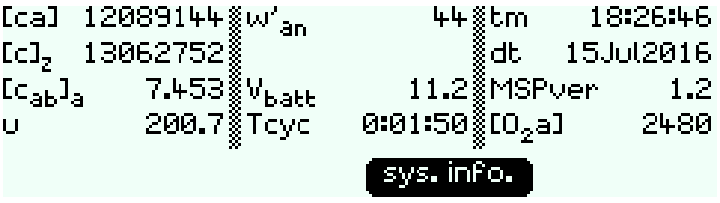
If Data valid has been set to'off' as a log trigger

kclick: To switch the sound 'on' or 'off' when a key is pressed.

dec pt: To choose between displaying a comma as a decimal place indicator (1,23) and a full stop (1.23) when the change+ or change- button is pressed.
If comma is selected, all data shown on the EGA61 display will use a comma, and data that is logged to the SD card or sent through the serial port will use the comma for the decimal point and semi colon as a delimiter instead of a comma, and quotes to enclose all of the values including record number. This behaviour is compliant with RFC4180. If full stop is selected (factory default) all displayed and logged data will use it for the decimal point, the data delimiter will be a comma, and quotes will be absent.
The EGA61 will allow the user to change between the two formats part-way through a log.

17.11 Diagnose Menu

Select 'diagnose' from the 'config' page gives the following menu which has live readings:

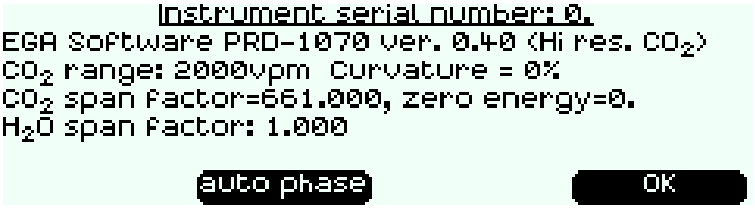


[c]z The A-D counts corresponding to zero gas (through soda lime)
[cab]a The CO_2 absorption factor.
w'an The corrected water analysis.
Tcyc The time the analyser will be running before stopping all pumps and valves (see section 17.15).
MSPver The software version of the slave processor.
[O_2a] The A-D counts relating to the oxygen cell (optionally fitted)

page returns to the 'Config' Menu.

17.12 System Information Menu

The curvature number relates to the CO_2 linearisation curve.
OK and page both return to the previous 'diagnose' page

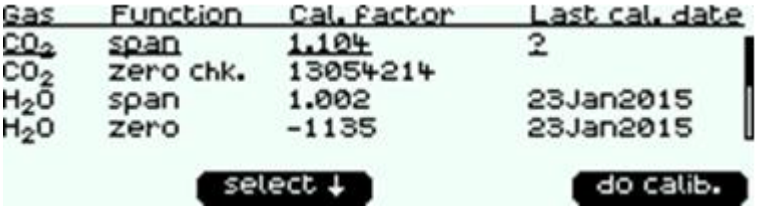


17.13 SD Card Menu

When an SD card* is installed, a red light will show next to the card slot (there may be a delay if the card has a large storage capacity). Information about the card will not be valid until the light has turned OFF.

*We recommend purchasing any additional SD cards directly from a manufacturer (e.g. SanDisk), to avoid data corruption problems.

17.14 Calibration menu



The units to be calibrated are shown underlined; in this screen snap, CO2 span is underlined and so has been selected.
Use the arrow to scroll down to the options not shown on this screen: (flow span, flow zero, anop. span, and press. trim.)
The calibration date is shown as a '?' if the calibration has been lost, otherwise it shows the last calibration date.

An.OP trim is a +/- 5% scaling factor that is applied to the analogue output of 0-5V or 4-20mA. One of these (either V or mA) must be connected to the analogue output via an internal selector link (see section: "internal links").

Flow zero
Check flow zero before performing flow span (below).

Flow span
Connect the EGA61 up to channel 1 only, by selecting channel 1 ('on') in manual mode. The instrument uses its internal pump to pass air through the external standard flowmeter. Flow zero should be checked and adjusted if necessary before a flow span is performed.

H_2O Zero
Perform an H_2O zero prior to an H_2O span. The procedures are performed similarly (below).

H_2O span
Connect the EGA61 up to channel 1 only, by selecting channel 1 ('on') in manual mode. The instrument assumes that you are pumping the flow externally. If you do not have your own pump, then, before starting the calibration procedure, channel 1 should be set to a fairly high flow, around ¾ of the full scale, and channel 1 should also be permanently selected using the manual option. The instrument automatically uses a flow of 200 µmol/sec.

CO_2 span
To perform a CO_2 span, the EGA61 must have already measured 'zero gas' in 'auto mode' or have just done a CO_2 zero*****. The span gas is then applied to channel 1 (through a 2 stage regulator and throttle, NOT directly from a cylinder[#]) using a 'Tee' connector with three ports. This prevents excess flow from pressurising the instrument.

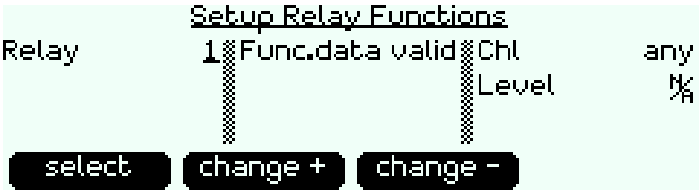
[#]Span gas from a cylinder must NOT be connected directly because the pressure from a compressed gas cylinder will damage the instrument. Span gas must be supplied through a regulator (2 stage type preferred) and a throttle to reduce the flow to somewhere in the range 250 to 500 µmol m^2 s^1. The instrument automatically uses a flow of 200 µmol m^2 s^1, so there will be excess flow escaping from the Tee connection

CO_2 zero
A CO_2 zero adjusts the gain of the detector amplifier so that the detector signal arriving at the analogue to digital converter (A-D) is centred in the A-D dynamic range. During a CO_2 zero procedure, the instrument automatically uses a flow of 200 and also sets the gas zero.

This will not normally be required for several years after purchase. Only performed after analysis cell parts have been replaced, or the instrument has dust deposition inside the cell.

A CO_2 zero is performed by removing the top rear panel and slowly rotating the RV19, until the pointer on the bar graph is centred. Please note: The ribbon cable that connects the top rear panel is not long enough to allow the panel to be lowered to the work bench. To prevent the cable being strained by the weight of the panel, *remove the top two nuts that fix the lower rear panel*, move the panel up and *temporarily fix the panel to the bottom two holes of the top panel.*

17.15 Relays Menu



Relay 1 changes to Relay 2 with change+ and change- and the associated parameters change accordingly.
Having selected the relay, you can then view or modify the settings, Settings are automatically saved when you switch relays or exit the screen.

Relay 1 or Relay 2 can be set to operate on the Functions of: data valid, CO_2 level (for any or all of the gas channels), H_2O level (for any or all of the gas channels), and analogue input level for any of the voltage input channels.

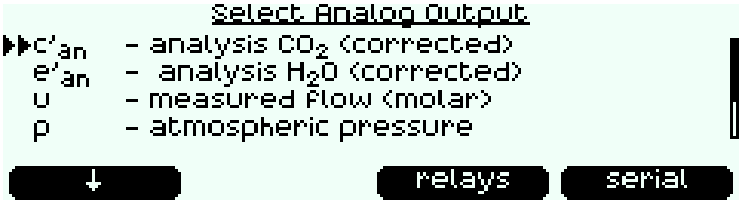
The relay is active at greater than or equal to the Level set in the units relevant for the Function. For example ppm for CO_2.

Chl (channel) selects the channel number (1 to 25 if function is set to CO_2 or H_2O or 0 to 7 if function is set to analogue in).

When the Function is set to CO_2 or H_2O the channel may be selected as 'all'. The instrument checks the CO_2 level and sets the relay accordingly only during data valid. So the relay state will remain on its setting for the previous channel until data valid is true, and then may change state several times if the CO_2 level changes through the threshold level set by you.

The analogue voltage range for channels 1-7 is between 0.05 to 5V in 50mV steps.
The CO_2 range is between 0 and 2000ppm in 20ppm steps.
The H_2O range is in mBar.

17.16 Output menu

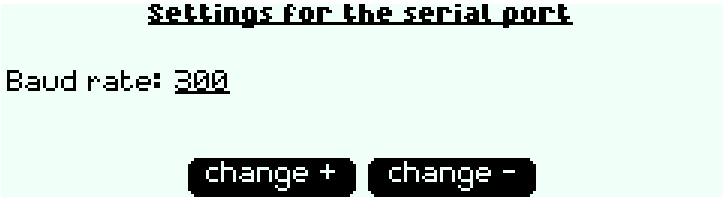


Others in the list obtained with the down arrow are:
Ttube: Gas analysis cell temperature
[C]z: CO_2 analysis zero point, counts
IpChl: Input channel

page returns you to Menu 1 Screen, with the last highlighted choice selected.
serial switches you to the Serial Setup Menu:

17.17 Serial Setup Menu

baud rate cycles between 300, 1200, 2400, 4800, 9600, 19200, 38400, 76800, 115200 and 230400. The factory default setting is 115200.
page returns you to the Output Menu.

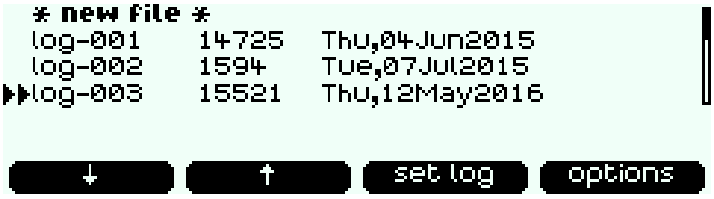


17.18 Logging Menu

Note that logging is disabled when the EGA61 is in its warm-up phase.
The maximum number of files that can be stored on the SD card is 50. A warning message will display when that limit is exceeded.

This screen-shot shows that 67 log records have been sent.
It also shows that logging destination ('log>') has been set to be both to a file on the SD card called log-013 and to the serial port. If logging had been disabled, 'disabled' would be shown as the logging destination.
Logging destination can also be set to a single destination; 'serial' or 'file'.

File menu brings up the adjacent menu:
Here the down arrow will scroll through all the file possibilities.
The solid part of the vertical bar graph, on the right of the screen, shows where the viewed page lies in the total list of files. Use the down arrow to access more log-files.



If "new file" is chosen as set log the adjacent menu appears:
Log file name is automatically set to the next highest number, but retaining the alphabetic prefix "log". All the characters of the file name can be changed using the alphanumeric character set shown. The file name must be unique.

Press 'options' to rename, delete or review a file.

Each file record is displayed over two pages. Here is the first page of the eleventh record of a typical record file. Do not remove the SD card during a record review.

Data storage capacity and limits:

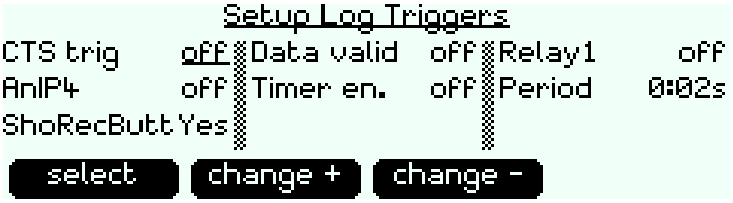
There is a limit on the number of files that the EGA61 is able to access. This number is between 61 and 200 depending on how the card has been formatted. When this limit is reached, a popup message will appear:

Too many files to show!
Some files may not appear on this list – please
delete files to make room
OK

The limit on the number of record is much higher; around 40 million for an 8 GB SD card (10 million for a 2GB SD card).

17.19 Trigger conditions

condition brings up the trigger conditions for logging, shown here:



change+ and change- increase and decrease the numerical value or switch between on/off.

'ShoRecButt' 'No': The record is not shown on screen and the 'record' button becomes inactive.
'Yes': The record is shown on screen.
Note: The 'record' button is also turned off when logging destination has not been set (serial, SD card + file name).

Trigger Options:

- **'Data valid'**:
  Data valid logging can only be set when Timed logging is off. A pop-up box will warn the user that this is so. When set to 'on' a data point will be logged (recorded), either at the end of the 'valid' time when the EGA61 is about to change change channels, (factory default of 1 second) or at the user-defined Data Valid time. When Data Valid is reached, it is displayed as **'sw.in'** time in **bold** in main menu 3.

- **'Timer en.'**
  The timed log cannot be set when both Data valid logging and CO_2 'both' is on. A pop-up box will warn the user that this is so. Timed logging of the CO_2 value is are made at the specified period of time continuously. This is mainly a diagnostic tool. The timer will automatically switch to 'on' when Period is changed by the user. The minimum time is 2 seconds, and the maximum time is 99 minutes. The units increment in seconds. As the time changes from 59 to 60 seconds, the units displayed will change to minutes (1, 2, 3 and so on). When 99 minutes are reached, seconds are displayed again, and *vice versa* when using change- . Continuously pressing change+ or change- will cause auto repeat in 10's.

- Operation of **relay 1** (check that relay 1 is 'off' unless required).

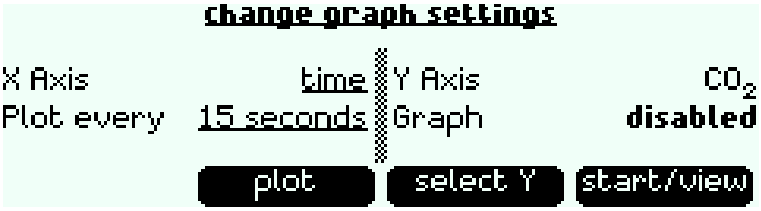
- An **analogue** trigger on analogue channel 4. Trigger occurs when the voltage on A-D channel 4 exceeds the set point of AnLP4. The next trigger occurs after 1 minute has elapsed, and the input voltage rises through the trigger voltage. The level set can be between 0.05V to 5V in steps of 0.05V. This analogue trigger can be switched off by attempting to increment past the 5V or 0V level by one button click, which will set it to 'off'.

More than one trigger can be set. CAUTION: Records may be duplicated in this scenario. Times are is shown in minutes: seconds. The minimum is 2 seconds, the maximum is 99 minutes. Any change in this menu is immediately actioned.

17.20 Graphing

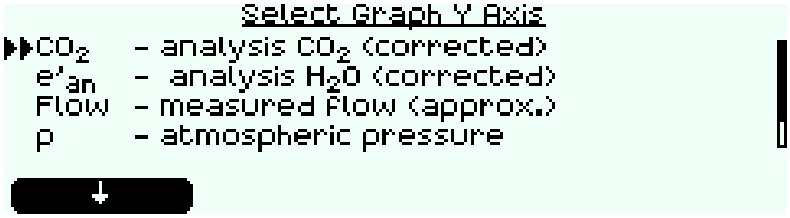
To edit and begin a graph, press 'graph' on Menu 1 Screen

Select the vertical (Y) axis of the graph with 'setup'

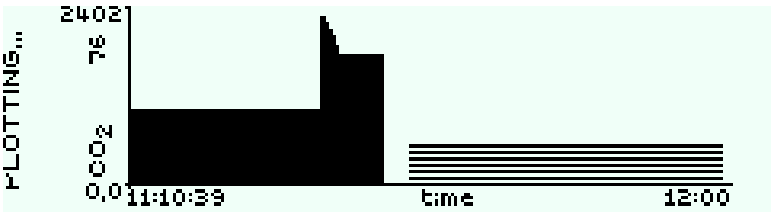


Press plot to change the timing of each data point.
Options: either once per data log, or every 15, 30, 60, or 300 seconds.
Note that if you wish the graph to be synchronised to the channel numbers them it is necessary to set the plot to every log record, and set the logging to record on data valid (see section 17.8). It is not sufficient to set, for example, plot every 15 seconds and 'on times' also to 15 seconds.

SelectY to select from 8 vertical (Y) axis parameters, as shown opposite: including **[C]z** (CO_2 analysis zero point, counts), found by using the arrow button.



start/view initiates the graph, which automatically scales in the Y direction, and scrolls in the X direction when it is full.
The lower and upper limits of the vertical axis are shown, in this example 0.0 and 2402.
The horizontal axis never shows zero on the left.



The most recently plotted value is shown sideways. In this example it is CO_2 with a value of 76ppm. The block of horizontal lines indicate a set of values which were outside of the plot range, in this case, < 0

There is a simple way to avoid your x axis data being compressed if a large transient Y value is about to appear:

Pause automatic X axis scaling:

1. Press any button whilst graph is running
2. A pause and copy button appear
3. Press pause to change 'PLOTTING' to '*PAUSED*'
4. There are now no further additions to the Y axis (X axis continues)
5. Press any button again
6. Press resume button to change back to 'PLOTTING' so the Y axis updates again.

This feature is also useful if you wish to make changes to the pipework or experiment connected to the analyser, but do not wish to record any correspondingly large changes in data to the graph.

The lack of Y axis updates during PAUSE causes a gap to show on the graph for a time corresponding to the pause, so this feature is also useful as a way to add markers to the graph.

The copy button will place a bitmap image of the graph onto the SD card with a filename in the form GRAPH01.BMP. The file number will automatically be incremented: GRAPH01 etc.

17.21 Power off menu

'Yes' causes the instrument to power down
'No' returns you to Menu 2 Screen.

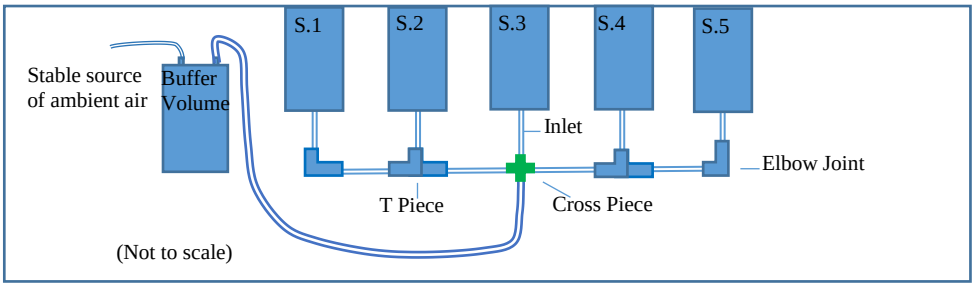
18. CHECKLIST FOR SETTING UP THE EGA61

1. Initial setup:

1. Unpack, check all contents and remove protective coverings. Install the cylinder of soda lime (white chemical) onto the front panel of the EGA61.
2. Position your EGA61 unit and any column racks (ideally with column racks fixed to a wall for stability). Flip down the feet on the EGA61 for easier viewing of the display.
3. Use a 5 to 10cm length of the tubing supplied, to connect the zero channel to the soda lime column "OUT". Once you are using your EGA61, regularly check that the soda lime is a fresh white colour. Thoroughly purple soda lime will need to be replaced.
4. Cut lengths of tubing to the required length, to reach from the channel input connectors to the top of each soil sample column (leaving a little extra length will allow you to re-cut the ends of tubing in the future).
5. We advise connecting the disk shaped hydrophobic filters supplied (630-976) to the inlets on the EGA61 front panel. Filters are recommended to reduce the risk of dirt and moisture entering the EGA61 unit. Use adaptor sleeves of cut tubing (706-100) to fit.
6. If you are using Ambient Air as the Reference Gas, connect channel 1 to an empty column (labelled column 1 or reference). This will monitor the reference and give you a control.
   Alternatively, if you are connecting to Soda Lime as a Zero Air Input, fill the first column with soda lime and connect this to channel 1.
7. Connect your first sample column to channel 2, the second to channel 3 and so on, in sequence.

2. Options for setup:

A. Samples purged with ambient air:
Connect the inlet tubing to a large volume, air tight container to act as an ambient air buffer.
Connect the middle sample column in a rack to a wider piece of tubing (internal diameter greater than 4mm) leading to the buffer volume, to balance gas flow through the samples in sequence.
*The tubing connected to the buffer should be larger in diameter than that connected to the columns, as it carries a higher flow.

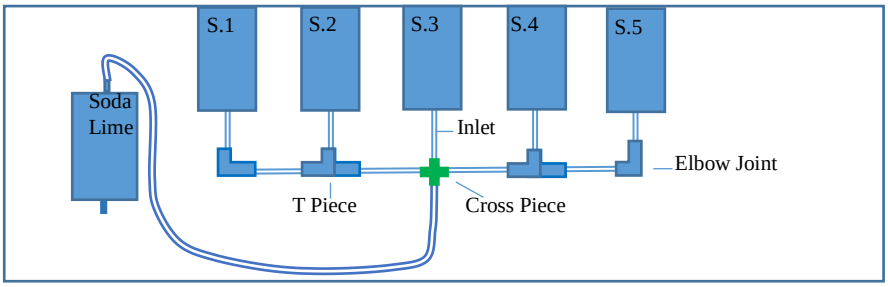


Additional T pieces can be added to the buffer volume tubing, to connect to further sets of sample columns in the same way. Another option is to connect one buffer volume to each rack, if you have the space to do so.

*<u>To fit a wider piece of tubing to the Cross Piece or T Piece:</u>

Cut a short length (3cm) piece of the standard, 4mm tubing. Wipe around the end of the tubing with a cloth or cotton bud dipped in either soap solution or rubber lubricant. Push the short length inside the wider tubing until it makes an airtight seal. As the solution dries, this will further create a seal. This will now fit into the standard Cross and T Pieces easily.

B. Samples purged with air stripped of CO_2 (through soda lime):
Replace the buffer with a soda lime column. If your sample columns are mounted on a wall, the soda lime column will also need to be mounted, below:



This column should be large enough to sustain the stripping of air entering the samples, for a good length of time before requiring the soda lime to be replaced.

3. Set the EGA61 to manual mode at this stage:

Manual mode prevents the EGA61 from switching between channels or logging data.
To do this;

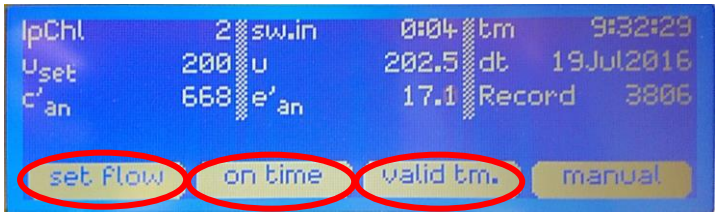
- Press the page button until either ‘manual’ or ‘auto’ is displayed.
- If ‘manual’ is displayed, press “↓” until “Z” is highlighted. Press “page” to enter.
- If “auto” is displayed, then press “auto”. The button will change to “manual”. Now press “manual”, then “↓” until “Z” is highlighted. Press page to enter.
- The system is now set to manual mode with zero gas selected.

4. Configure the EGA61 to your required settings:

Using the menu buttons, enter ‘configure’ and then ‘setup’ on the EGA61.

4a. Set the flow rate to each channel.

- Select Menu 3 screen.



- Select ‘Set Flow’ to view this screen:

‘Z’ is for zero channel (connected to soda lime column).
1,2,3,4 are the sequential channel numbers.
‘on’ tells you which channel is currently being measured.

Default flow rate is **200 µmol/sec**. To change values;

- Select a channel using the arrow keys (down, across).
- Set flow for each with ‘set flow’.
- Change flow value with ‘+’ and ‘-’ keys. Press quickly to increase the value by 1 unit. Hold the key to increase by 10.
- Use ‘Copy flow’ to quickly copy this value into several channels.
- Use ‘on/off’ to switch a channel’s pump on or off (e.g. to connect an external pump or gas source). All channels will still be sequenced, even when ‘off’. This means that the analyser will remain on each channel for the specified ‘on time’.
- Use  to go back one page and select another channel using the arrow keys.

4b. Set the channel ‘on time’

- Go to Menu 2 screen. Select ‘on time’.
- Select each channel using arrow keys (down, across)
- Now press ‘on time’.
- Change time using ‘+’ or ‘-’ keys.
- To copy this time to several channels, use ‘copy time’.

You can switch channels ‘on/off’ here, which removes them from the timed sequence.

4c. Set valid time to record data from a sample, or ‘data valid’

- The EGA61 performs one measurement (of all parameters) every 1 second. This means that the default ‘Data Valid’ time for a channel is 1 second. Therefore, the ‘valid time’ must be set to less than the ‘on time’ by at least 1 second.
- Set ‘valid time’ in exactly the same way as ‘on’ time (above).

4d. Averaging Multiple Measurements in ‘CO2 Mode’

You are provided with the option of averaging all data points automatically after the data valid time. Example: An ‘on’ time set to 150secs, and ‘data valid’ time of 10secs, gives you 10 seconds’ worth of averaged data.

- Go to Menu 1 screen. Select ‘configure’
- Select ‘Setup’
- Select ‘CO2ave’. An additional menu gives the options: ‘Ave.’, ‘Raw’ or ‘Both’.
- Select the option that you require;
  - **‘Raw’** data only (1 record every second for the duration of the data valid time = 30 records)
  - **‘Ave.’** Only an average values are logged (a single record which is the average of the last 30 seconds of data = 1 record)
  - **‘Both’** Raw data with averaged records also (1 record every second for the duration of the data valid time plus the average value = 31 records).

PLEASE NOTE:
The logging period can be adjusted and used when in ‘Ave.’ (average) mode or ‘Raw’ mode. Logging period cannot be adjusted in ‘Both’ mode. This avoids replicating measurements.

5. Set logging conditions: *Also See Quick Start Guide, pg 13.*

For accurate data records, the most stable time at which to log or record data points is the last few (e.g.30) seconds in which the EGA61 analyses one channel, before switching to the next. Set as follows:

- Set destination for logging
- Select ‘File Menu’ and choose a name
- Select ‘Set log’
- Press Page button
- Select ‘Condition’
- Select ‘Data Valid’ then ‘On’*. Remain on this menu page.

*Meaning that a measurement is recorded every 1 second (the default) when the data valid period is reached. Example: Set Data Valid to 30 seconds, to record 30 data points for every selected channel, *during the last 30 seconds* of 'On Time'.
If data valid is 'off', then data will not be logged when the data valid time is reached.

- You *may* wish to record on a timed basis, *throughout the channel On Time* (e.g. every 10 seconds from the moment a channel is sampled). This timed logging will be in addition to any logging that may have been set on the data valid timing. To do this, select 'Period'. Set to your required log time period. Hold down the selected 'Period' button to increment in 10 seconds, or press as normal to increment by 1 second.
- You will not normally require 'Timer' or Period, unless you wish to record data *throughout the channel On Time*. Select 'Timer' to toggle 'on' or 'off'. When you alter the period time, the log timer will automatically switch 'on'. You may turn the log timer off again, without affecting the time that you have set.

6. Save settings as a 'Setup' file

- Enter the **Config**. Menu
- Press **load/save**
- Select **new file**, and create a name (you are given 8 characters).
- Select **Settings 'YES'** and **Preferences 'YES'** to save all your preferred settings.
  You can use 'load' on the Config. Menu to easily and quickly reload this and additional setup files. For example, if you and/or additional users need to change between different measuring protocols or samples.

7. Wait for C'an to stabilise for all channels

This may take longer if using a large buffer volume. Look for the CO_2 readings on screen to stabilise, after a few cycles, so that the difference between channels is greater than the difference between successive readings on the same channel.

8. Activate logging

Activate logging once CO_2 readings are stable and you are happy to begin collecting data

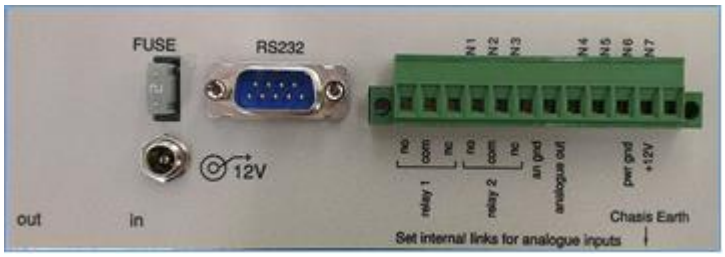
- Press 'Logging',
- Press 'File Menu' (or 'Serial', to save data to RS232),
- Select the Log File Name and press the yellow page button to finalise name, select and return to main menu.
- The status will now be 'Auto' mode, a message along the bottom of the screen will tell you this. (You can change to manual mode by selecting the Auto/Manual toggle button).

Connecting EGA61 to a computer device for direct data retrieval

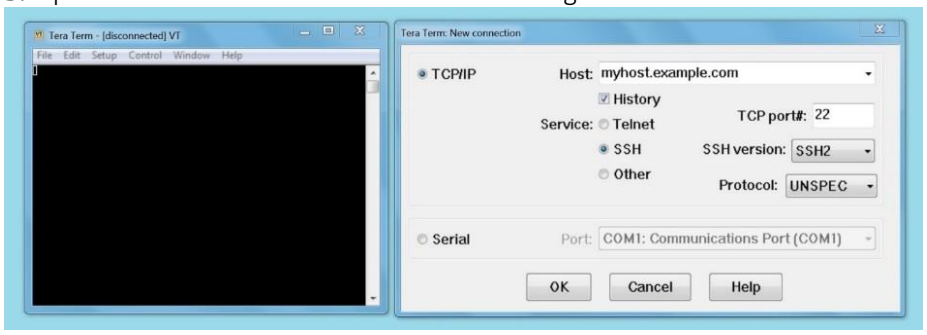
You may choose to connect an RS232 cable, or a RS232 to mini USB cable between the EGA61 and PC or laptop. The RS232 plug must be “female” at the EGA61 end. If using an RS232 to RS232 cable, the PC end also needs to be “female”.

1. Install a free, terminal emulating software for example “Tera Term”. Please ensure compatibility with your computer operating system and scan any new software for viruses prior to installation.

2. Connect an RS232 cable or RS232 to mini USB cable to the RS232 port on the back panel of the EGA61. If a RS232 to USB cable is used, it may need a driver software to be installed. Try this procedure first, without a driver.

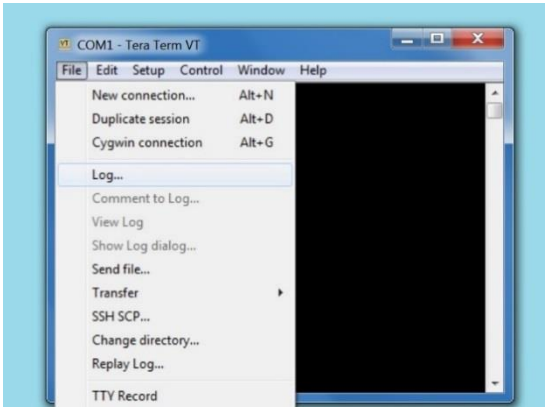


3. Open Tera Term. You should see the following:

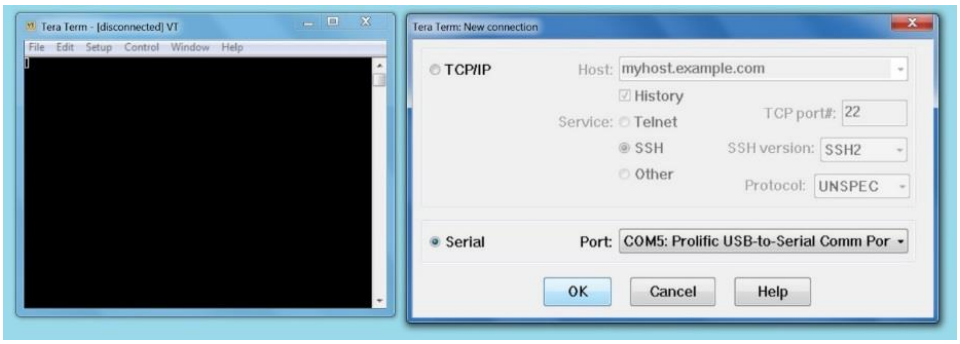


4. Select the serial option and select correct port*.
The correct port can be identified by noting the list of available ports on Tera Term, then closing Tera Term. Disconnect the RS232 cable then reopen Tera Term.
Again look at the list of ports and see which option is missing. That missing port is the correct one to select. Close Tera Term, reconnect the cable, reopen Tera Term and select the correct port.

5. In Tera Term, click ‘FILE’ then select ‘LOG’ from the drop down list.



6. The log options box will now pop up. Select a destination for the log file and enter a file name ending with “.csv”. Select the options as shown:



7. Click ‘SAVE’. The log file may now be sent to the PC/laptop.
8. On your EGA61, enter the ‘LOGGING’ menu and press ‘FILE MENU’
9. In the next menu, use the up and down arrows to select the file you wish to transmit. Next, press the ‘OPTIONS’ button.
10. In the next screen, press ‘SEND’.
11. In the next screen, press ‘ASCII’ at the top left:
12. The file will now transmit to the PC/laptop. When this is completed, the message “Transfer complete O.K.” will appear.
13. Close the Tera Term terminal on the PC/laptop and select ‘SAVE’ if a save option appears on the screen.
14. Finally, open the CSV file from the location chosen earlier on. It should open with Microsoft Excel™ or a similar program.

19 PARAMETER INFORMATION

Symbol	Description	Log #	An. o/p?	Menu	Units	Type	Range
Record	Current record number	1		2 and logging			
Dt	Date (text)	2		3			
Tm	Time (text)	3		1			
IpChl	Input channel	4		1 and 3			0 - 24
C'an	CO_2 analysis (corrected for dilution)	5	y	1	ppm	M,Co	0-2000
e'an	H2Oanalysis, dilution corrected	6	y	1	mBar	Ca,Co	0-100
p	atmospheric pressure	7	y	configure	mBar	M	600-1100
u	Achieved flow	8	y	3	µmol s^{-1}	M	68-341
Ttube	Analysis cell temperature	9	y		°C	M	-5 to +50
Relays	Relay in operation	10	y	2			1, 2
Power	Voltage	11			V	M	10.5-14.3
A1-7	Analogue input 1-7	12-18			V	M	0-5.0
CO2rdg	Analysis CO2 format: Raw or Average	19					
Power	Bargraph showing supply voltage			1		M	10.5-14.3
Log:	Name of log file			3 and configure		G	
[C]z	Raw A-D counts for CO_2		y	diagnose		M	0-166777216
Mem.	Free space on memory card			card	M bytes	C	

The "Type" column indicates the method of derivation, according to the following code:

- Ca = Calculated (generally by a formula given in the appendices)
- Co = Corrected (by terms defined in the appendices)
- F = Factors (established by experiment or other means)
- G = Given (i.e. entered by the user)
- K = Constants (physical or scientific)
- M = Measured raw values by transducers

20 ROUTINE MAINTENANCE

20.1 CO_2 Stripper

The performance of the EGA is dependent on the satisfactory condition of the soda lime stripper, which is in the column on the front panel. The life expectancy of the soda lime depends on; ambient conditions, the 'zero' flowrate and 'on time'. To minimise the usage of soda lime, the instrument switches off the zero pump when the zero channel is not being used as reference gas.

The EGA61 is supplied with an indicating type of soda lime, which will work until 90% has changed colour. After this point, the soda lime becomes 'exhausted' and will not function. To maintain the performance of the EGA61, always replenish the Soda Lime when the colour first changes from white to violet.
NOTE: The soda lime colour change is temporarily reversible until it is fully depleted.

Re-conversion back to soda lime is not practicable. Some water content is necessary to assist the chemical reaction, which is to convert CO_2 to calcium carbonate + H_2O. This increases the moisture content of dry air.
NOTE: If the analysis CO_2 reading '**Can**' falls below 100 ppm, a warning message appears and prompts the user to check the soda lime, which may be exhausted.

20.2 Gas Filters

The gas connections on the front may become blocked with dirt if the instrument is placed with this surface downwards. If the bottom outlets on the left are blocked, it may be possible to carefully poke at the blockage with the instrument running, so that the debris is expelled. We recommend to fit loops of pipe to the entries when they are not connected.

When the instrument is not in use, e.g. being transported, we recommend keeping and using the PVC caps supplied with the EGA61, to place over all gas entries.

If dust or pollen is drawn in from the air supply, this eventually may cause a malfunction of the mass flow sensors and/or the optical bench. The EGA61 filters are designed to prevent this, but will gradually restrict the airflow in the process. If difficulty is experienced in obtaining the maximum flow of 230 μmol m^{-2} $sec^{-1.}$ (i.e. the indicated flow 'u' is very much less than 230 μmol sec^{-1} and pump is "racing"), this is a sign that filters should be changed.

Note: In dusty atmospheres, with continuous operation, and no other external filtering, filters can become blocked in less than a week. If in doubt, compare filter colour with one in the spares kit.

20.3 Suggested Maintenance Schedule

O-rings: check for wear or damage each time a column is changed or removed. Take care not to damage the large o-rings on the columns when re assembling the columns. Keep these O-rings free from chemical granules and lightly greased with silicone grease (supplied in the spares kit).

Soda lime: Replace when the colour changing indication shows that approximately 80% of the chemical has been used.

External filters: Regularly inspect external filters to ensure they are not clogged. These should be used on the front panel gas connections. The filters should always be connected in the same direction of air flow, to avoid dust and water droplets entering the console (which may clog the internal filter and damage the analyser). A badly clogged filter may damage its associated pump (as the pump works harder to overcome impedence).

Recommended Recalibration Schedule:
CO_2: at least once every year
H_2O: every two years
Whole instrument: 4 years, to be carried out by ADC BioScientific Ltd.
The last calibration dates are to be found on the calibration screen.

20.4 Tools

For dismantling the EGA61 and replacing parts: No specialist tools needed

To replace electronic components:
Small, thermostatically controlled soldering iron+
Anti-static wrist strap (especially when working on the digital board).

For testing leaks:
A sphygmomanometer without the cuff
OR a water manometer connected with pipe and a tee to a 100ml disposable syringe
A small paintbrush – to apply soapy water where a leak might be suspected

For cleaning:
Cotton wool buds or alcohol are good for cleaning the cell (do NOT use methylated spirits)
Small paintbrush for gentle, general cleaning

Replacing screws:
All screws are metric except the hexagonal pillars on the 'D' type connectors.

Fitting/removing pipes:
All pipes are push-on although some have been fitted using 'Hellerman'™ oil, which allows pipes to push on easily, but sticks them in place when dry. If a pipe will not pull off easily, do not continue to tug as the pipe tends to become thinner and grip even tighter. Instead, use **a pair of thin nosed pliers** with one jaw either side of the connector to push on the end of the pipe. Do NOT use a sharp blade or knife, especially for removing any barbed plastic fitting around pipes. These may be damaged by a sharp blade, causing leaks.

20.5 Accessing the Inside of the Main Instrument

With the EGA switched off, unscrew the M3 screws securing the front panel. The panel can then be lifted off and to one side.
If you are planning to dismantle or remove parts, take photographs of each step for reference.
Care should be taken to protect the display membrane as it can be easily damaged.
The digital board (PCA-307) is attached to the display panel and, unless you are taking static precautions, you should avoid touching the electronics. Do NOT pull on the electrical cables.

20.6 Air Flow (Mass Flowmeter)

The mass flow meter is in a feedback loop with the pumps, and the microprocessor will drive them faster or slower until the set flow is achieved. If a pump has stopped or is going as fast as possible, the mass flow meter may be faulty. If there is a leak inside the console, in the piping between a flow meter and its pump, the pump will run faster than normal, but insufficient flow will emerge from the flow meter. See leak testing, below:

The air mass flow meter is very stable. If its calibration changes, the cause is almost certainly contamination inside it. If this happens, a replacement of the flow meter is recommended. It might be possible to blow out the contamination if it is dust, but if it has been carried into the flowmeter by liquid, the flowmeter will almost certainly need replacement. The flowmeter (part number FS4001-1000-CV-A), is on the PCA309 board plugged in to a socket and mechanically attached with two screws. Support the flow meter with one hand when removing or refitting the pipes with the other. After replacement, it is recommended that a flow zero calibration is done, and this is simple. If you have access to a good standard mass flowmeter, the flow span may also be done.

20.7 Leak Testing

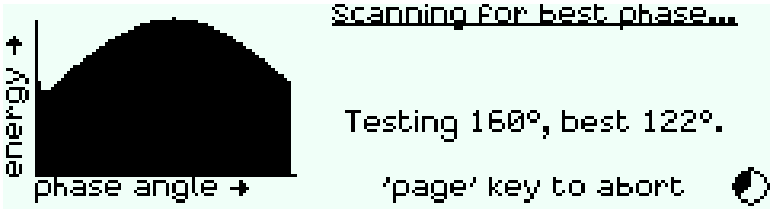
Leaks may be easily tested for using a water filled manometer and an inflation bulb connected with a ‘Tee’. Connect the manometer to the gas circuit to be tested, and apply about 10cm water gauge of pressure to the manometer and inlet. Wait a few seconds for the manometer reading to settle then note the reading. Wait a further 10 seconds then, if you cannot detect a fall in the reading the system is sufficiently leak tight.

20.8 Chemical and Soil Column filters

Maintenance on the chemical or soil columns is limited to checking the general condition of the ‘O’ rings and the filters in the column caps each time their contents are changed. In particular check for, and wipe away, any chemical dust has not become embedded in the surface of the ‘O’ rings. Damaged or flattened O-rings should be replaced using the spare O-rings provided in the spares kit. Additional O-rings may be ordered from ADC or an approved agent.
Occasionally the columns should be cleaned in soapy water and left to dry before replacement.
Air seals should be maintained around all of the ‘O’ rings. The use of silicon grease provided will greatly assist this and help to keep them in good condition.
The white filters in the end bungs of the soil columns are made from sintered polythene which is resistant to acidic effects and is mildly hydrophobic**.** The filters screwed in; if they become

clogged they should be removed, washed in soapy water and thoroughly rinsed. They should be refitted finger tight without glue or excessive torque.

20.9 Cleaning Dust from the Analysis Cell



During the CO_2 measurement cycle;

1. The analysis cell is supplied with air which has been stripped of CO_2 by the soda lime.
2. The detector signal is then measured and stored.
3. The analysis cell is then filled with air for CO_2 analysis
4. Again, the detector signal is measured and stored.
5. The CO_2 concentration in the air that has been supplied to the analysis cell is calculated from the ratio of the two detector signals.

The analysis cell may collect dust after prolonged operation. Small amounts of dust will not affect the CO_2 reading.

It is usually only after several years of continuous use that dust will reduce the detector signal and cause an error message to be displayed when the software can no longer correct for the reduced signal. When this happens, it is necessary to remove and clean the analysis cell.

Removing and cleaning the analysis cell:

1. Unclip the flat white plastic ties around the cell insulation but leave them in place, held under the lower insulation block.
2. Lift off the top insulation, remove the 2 screws holding the heater resistors.
3. Disconnect the 3 way connector for the detector and the 2 way connector for the source, and the 2 way connector for the cell temperature sensor
4. Remove the 4 nuts and washers holding the cell in place
5. Lift out the cell, noting that 4 metal spacers remain in the lower insulation block.
6. Disconnect the two pipes by the method described in the tools section.
7. The screws each end of the cell can now be removed.
8. The cell is best cleaned with a good quality, nonabrasive cotton wool moistened with iso-propyl alcohol or ethyl alcohol. The cotton wool can be wrapped around the end of a thin wooden stick or pulled through the cell with strong cotton.
9. Wipe the widows* with cotton wool moistened with alcohol if they look dirty.

*__Take care with the windows__ which are made from calcium fluoride, as they are brittle and can be easily scratched.

Immediately remove any water which may enter the cell:

Water not removed will cause corrosion leading to permanent discoloured patches inside the analysis cell. If these are large in area, they will remove so much infra-red energy from the beam that it may be impossible to set zero. In that case the cell will need to be replaced or returned to ADC for re-plating. Even small areas of damage may affect the linearity of the cell response and hence the accuracy of measurement.

20.10 Source and Phase

If the source looks blackened, it should be replaced for best signal and lifetime. The new source may respond at a different speed to the old one, so the phase difference between the source drive waveform and the detector waveform may change. To optimise the detected signal, the phase relationship should be checked using the auto phase menu, when you will be presented with a graph similar to that shown here. For this, the instrument automatically chooses a flow of 200µmol/sec.

20.11 Display Contrast Setting

The normal contrast setting for the display changes little with variations in ambient temperature. Manual re-adjustment to suit your preference is via the 'contrast' potentiometer RV127 in the upper right corner of circuit board PCA-307. This can be accessed by removing the front panel of the EGA as previously described, and looking at the panel from above.

20.12 Software and Serial Number

The software part number and version and the instrument serial number for the EGA61 are shown on the display when it is first switched on. The serial number is also shown on a label which is attached to the rear panel. These details should be quoted in any correspondence. The ADC part number for the software is PRD1070. If the instrument is in a dismantled state for servicing, the software part number and version can also be found on a label attached to the digital board (PCA-307).

20.13 Software Upgrades

The software on the EGA61 can be upgraded from a file which ADC has sent you. A typical filename might be EG612-00.IMG for software version 2.00.
To install new software:
1. Ensure that there is no printer connected to the serial port.
2. Copy the file to an SD card if it is not already on one.
3. Turn on the EGA.
4. Plug in the SD card.
5. A message will appear saying 'New firmware is available on this SD card. Do you want to update the firmware?' Accept this option.
6. A confirmatory message 'Firmware update cannot be undone! Are you SURE you wish to continue?' will appear. Again accept this.

The software will then be updated and the instrument will restart.
The operation is quick but must not be interrupted. Please ensure that the power is reliably connected and that the card is fully inserted, to avoid damage to the software.

21 TECHNICAL SPECIFICATION

Pump flow maximum at least 340 µmol/sec

Flowmeter: scale 680 µmol/sec

Flow measurement accuracy +/- (1.5% of reading + 0.5% of scale)

Heated analysis cell at factory default of 50 deg C (for 25 channel version)

DC Voltage in: Minimum 11.5V Maximum 17.5

DC Current in: 1A maximum. Protected with replaceable fuse

Analogue input channel resolution: 12 bit, accuracy +/- 1.5%

Overall case size including feet, handle & entries cm: 17 depth x 25.5 width x 28.5 height

CO_2: Span 2000 ppm as standard
Resolution: 1ppm

H_2O: Resolution: 0.1mBar

Atmospheric Pressure range: 600-1100 mbar. Accuracy -4/+2 mbar

IP rating 42

Weight with 25 channels and stripper column 8.55kg

Width 260mm x Depth 191mm x Height 284mm (including stripper column but without packaging or accessories)

Specifications subject to change without notice

22 SPARE PARTS

Standard **Spare Parts Kit for an EGA61 system ordered *without* sample columns:**		
Part Number	**Description**	**Use**
M.LCM-068	SODA LIME indicating 2.5-5mm 500g jar (with health and safety leaflet)	Stripping air of CO2 for automatic zero calibration of the EGA61
M.867-056	TRIMMER TOOL 543-43, mod-8T000	Adjusting the CO2 zero (only if analysis cell has been replaced, not normally required).
M.802-151	CALCIUM SULPHATE 1 Lb 10-20 ME	Dehumidifying the air passing through samples
M.706-145	TUBE PVC IND 6mm OD x4mm ID	Cutting to size to connect sample inlets and outlets in series and with the EGA61.

M.651-551	O RING 28.30ID X 1.78mm	Replacing an O Ring (seal) within the lids of the chemical column to fit onto front panel of EGA61.
M.650-652	O RING 6.07ID X 1.78mm	Replacing an O Ring (seal) on the connecting, smaller ends of the chemical column
M.630-976	FILTER HYDROPHOBIC 1µ 50mm diameter	Hydrophobic filter for connecting to channel inlets to prevent dust and water droplet ingress.
M.706-100	TUBING 8mm OD, 5mm ID	50cm length supplied to cut and fit to filter M.630-976, allowing connection to standard tubing on channel entries.
M.614-660	FEMALE LUER thread style 5/32" 200 ser. Barbed.	Larger adaptor for connecting tubing to luer fittings
M.197-715	SECURE DIGITAL CARD 4GB SanDisk	Data storage, transfer and download
M.022-804	FUSE car mini blade 2A	Safety fuse
M.994-283	USB cable	Connecting the USB port to PC or laptop USB port for data download
M.809-151	Silicone Grease 100g tube	For maintaining all O rings

Standard Spares Kit for an EGA61 system ordered *with* any number of sample columns (kit quantities vary according to number of columns):

Part Number	Description	Use
M.415-200	CLIP TUBE 50mm diameter	Replacing the clip on a rack.
M.614-750	5/32"ID tee connector	Connecting more than one column in series, with tubing.
M.615-051	ELBOW Algarde Bend air line fitting	Connecting the final/end of rack column in series.
M.615-162	Air line cross piece 5mm OD, 3mm ID	Connecting 4 pieces of tubing at right angles.
M.653-822	O RING 34.3 ID x 5.33mm	Replacement column end seals
M.706-145	TUBE PVC 6mm OD x 4mm ID (5m supplied per rack of columns)	Cutting l ect column inlets and outlets in series and with the EGA61.
M.708-101	TUBE PVC 9mm OD X 6mm ID (3m supplied per rack of columns)	Cutting lengths to connect each rack of columns to a buffer or wetter volume.

M.614-660

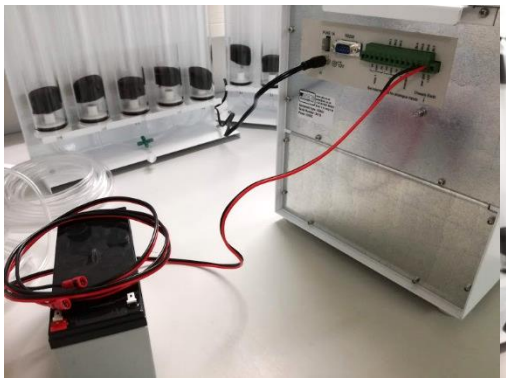
M.614-665

M.615-710	Adaptor	Connecting 6mm tubing to 9mm tubing.
M.SRS-101	SOIL Respiration COLUMN acrylic	Replacement soil sample columns.
M.SRS-116	Vyon Filter, M20	Replace any old/damaged filters (screw into column caps).
M.SRS-114	Stopper Removal Tool	(Included in the main instrument case) a tool for easily removing column lids
M.630-976	FILTER HYDROPHOBIC 1µ 50mm diameter	Hydrophobic filter for connecting to channel inlets to prevent dust and water droplet ingress.
M.706-100	TUBING 8mm OD, 5mm ID	50cm length supplied to cut and fit to filter M.630-976, allowing connection to standard tubing on channel entries.

All parts listed are available to order from ADC BioScientific Ltd. direct or through your local ADC product support centre.

EGA61 Accessories and Additional Spares Available to order

M.EGA-033 External battery kit. 7Ah Lead Acid Battery and 2m cable.
Emergency power supply in case of laboratory power cut or accidental removal of power cable during data logging. EGA61 has no internal battery.



M.614-657 Adapter, Luer 187" Female

M.708-101 9mm inner diameter tubing to connect columns to volumes

M.614-697 Coupling, Luer 3.0mm Male MTLL230-6005

M.653-822 O Ring, 34.3 ID x 5.33mm NBR70

M.LCM-167 Volume Filter, Vyon 3/16" ID

M.197-715 Secure Digital Card 4GB (R)

M.SRS-015 5 Columns and rack (purchased separately from analyser)

M.SRS-114 Additional column lid removal tool

M.SRS-117 Foam cylinder filters for 30cm columns. Use 2 per column.

Optional accessories for 15cm columns M.SRS-016:

Foam cylinder filters. Use 2 per column.

Septum fitted to a 15cm column.