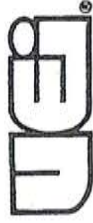


C100A

Compact
Combustion
Analyzer



WHEN QUALITY M



IN USA:

8030 SW Nimbus • Beaverton, OR 97008
(503) 644-8723 • Fax: (503) 643-6322
Effective 7/6/01

IN CANADA 150-13571 Verdun Place • Richmond • British Columbia • V6V 1W5
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Stock No: 17673

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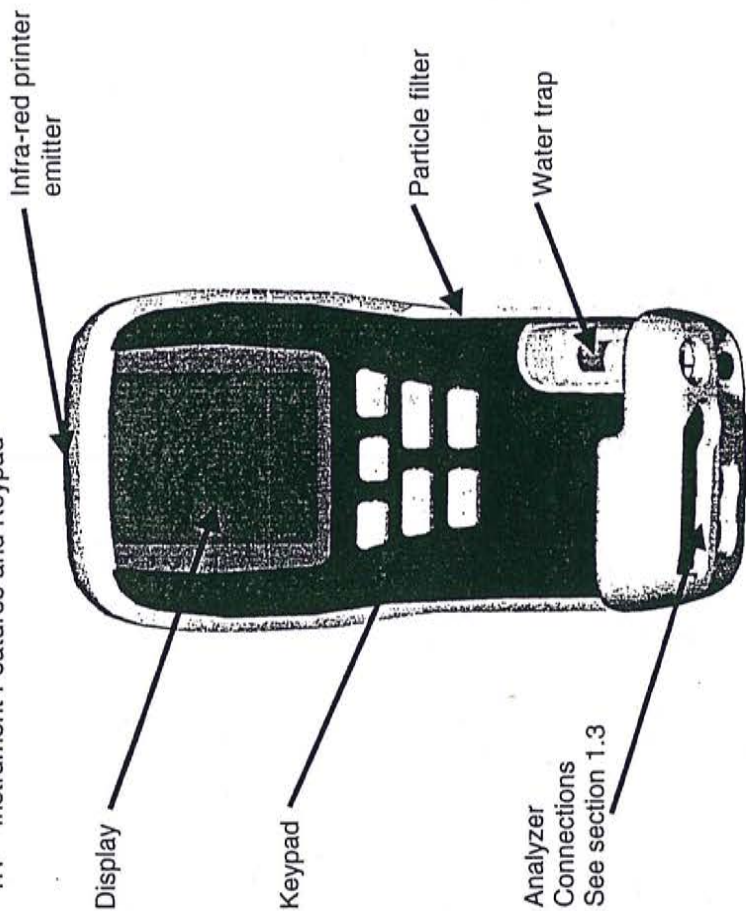
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1 ANALYZER LAYOUT AND FEATURES

1.1 Instrument Features and Keypad



ON / OFF

Turns analyzer ON and OFF



PRINT

Print 'live' or stored data



STORE

Access the data memory menu



UP

Changes TOP line of display. See also Section 5.1



MENU

Allows access to all menu function



BACK-LIGHT

Hold to toggle back-light ON or OFF



PUMP

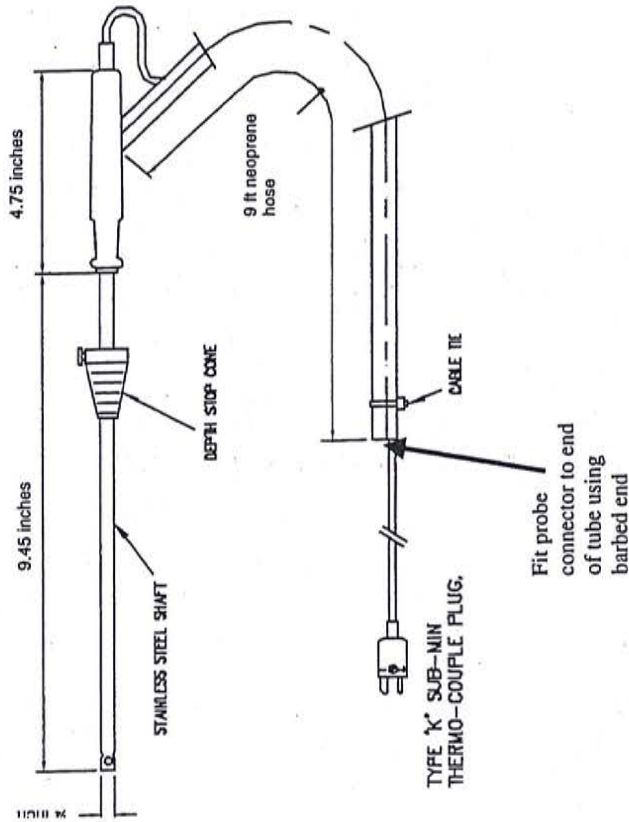
Turns pump ON and OFF



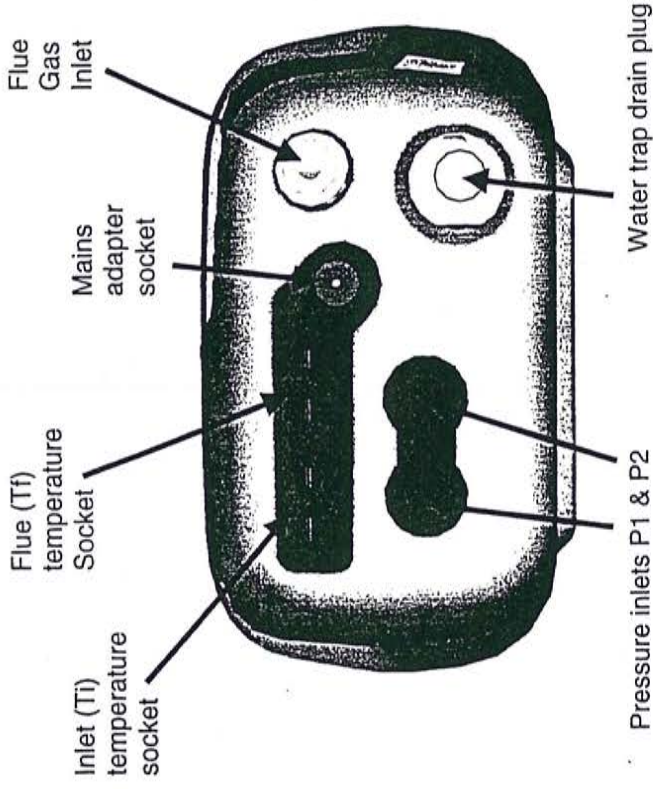
ENTER

Changes BOTTOM two lines of display. See also Section 5.1

2 Standard Probe Configuration

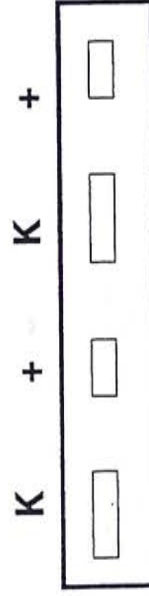


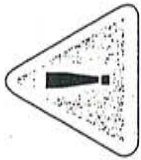
1.3 Analyzer Connections



Note:

Take care when inserting the temperature probes as the pins are polarized. Insert with the smaller pin (+) to the right. A view of the socket is shown below.





SAFETY WARNING

This analyzer extracts combustion gases that may be toxic in relatively low concentrations. These gases are exhausted from the back of the instrument. ***This instrument must only be used in well-ventilated locations. It must only be used by trained and competent persons after due consideration of all the potential hazards.***

FIRST TIME USE

Check that you have all the items you have ordered.

Take time to read this manual fully.

4.1 Installing Batteries

The C100A is supplied with 4 AA size alkaline batteries. These should be installed into the instrument as shown below and indicated on the back of the unit:



See Appendix A - Main Parameters for the Battery Level Indicator.

An optional AC adapter can be supplied to power the analyzer.

Rechargeable batteries can be used in the instrument but will normally give a lower running time than alkaline. Note the AC adapter cannot be used to charge batteries in the instrument and an external charger should be used.

4. NORMAL START UP SEQUENCE

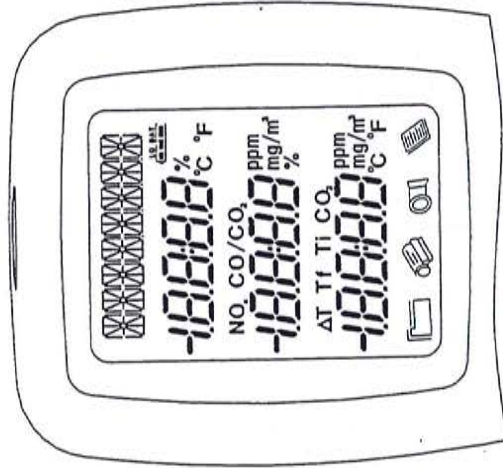
4.1 Every Time You Use The Analyzer

BEFORE SWITCH-ON CHECK THAT:

- The particle filter is not dirty
- The water trap and probe line are empty of water
- All hose and thermocouple connections are properly made
- The flue gas probe is sampling ambient FRESH air
- The water trap is fitted correctly to the instrument
- The flue temperature plug is connected
- The inlet temperature probe is connected if required

Switch ON the instrument by pressing 

After switch-on the analyzer will briefly light all segments on the display as shown below:



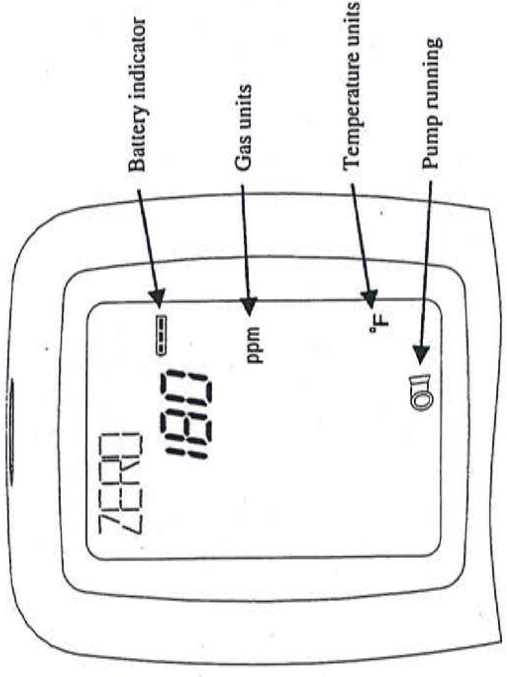
This allows the display to be checked for correct operation, if any segments appear to be missing then the unit should be returned for repair.

Note! The software version number is displayed following the display check.

4.2 Automatic Calibration

During this sequence the analyzer pumps fresh air into the Oxygen and CO (if fitted) sensors to allow them to be set to 20.9 % and zero respectively. See Section 4.4. - **Setting Inlet Temperature** for information on options.

The display will show the zero countdown screen:



The calibration time will count down in seconds to zero and is pre-set to 180 seconds. Ensure the probe is sampling fresh air during the zero sequence. Note the pump key is disabled during this sequence.

At any time during the zero countdown the menu system can be entered to allow the analyzer's settings to be altered. See section 5 – Moving through the menus.

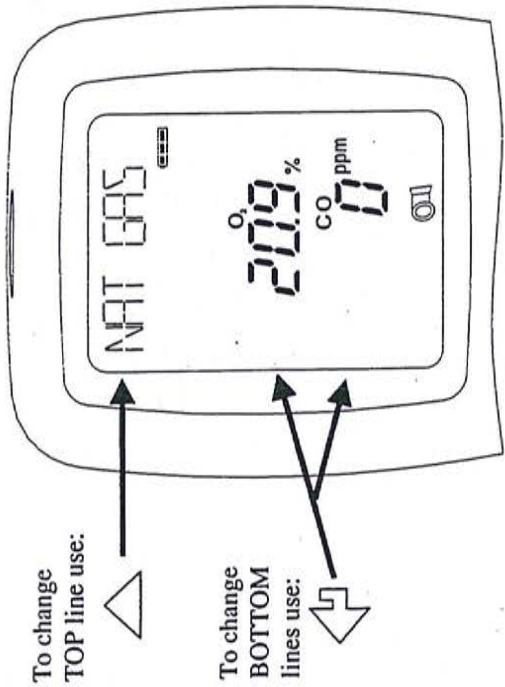
Once the time has reached zero or the sensors are with pre-determined limits the screen shows the selected fuel and analyzer setting:



MAIN DISPLAY

4.3 Changing the Main Display

The Main Display can be configured to read three parameters at the same time. The text display and top numerical display are changed independently of the other two displays. **Appendix A - Main Display Parameters** gives information on each parameter.



The parameters on the text line and top numerical display are selected from the following:

Text display	Numerical display	Description
NAT GAS	No display	Fuel indicator <ul style="list-style-type: none"> NAT GAS Natural Gas PROPANE BUTANE L OIL Light Oil LPG Liquid Petroleum Gas
EFF (G) %	100.00	Efficiency (gross or net)
XAIR %	100.00	Excess air
TIME	12:45	Current time
DATE 00	17.03	Current date (year on text display)
PRS mbar	100.00	Draft or differential pressure reading (option)
CO ppmn	0000	Carbon Monoxide (referenced to O2)

The middle and bottom numerical displays are changed in the following pairs:

Text display	Units	Description
O ₂ and CO	% and ppm or mg/m ³	Oxygen percentage and CO concentration
CO ₂ and ΔT	% and °C or °F	Calculated CO ₂ and Temperature Differential (net)
O ₂ and TF	% and °C or °F	O ₂ and Flue Temperature
CO ₂ and Ti	% and °C or °F	Calculated CO ₂ and Inlet Temperature
CO/CO ₂ and CO	Ratio and ppm or mg/m ³	Ratio of CO to CO ₂ and CO Concentration

4.4 Setting Inlet Temperature

During the Automatic calibration sequence the burner INLET (Ti) temperature used in the NET temperature calculation is stored in the analyzer. There are three methods of storing the INLET temperature.

- Without the flue probe connected temperature inside the analyzer is used
- If the flue probe is connected the temperature of the probe tip is used. This can be useful when the temperature of the air entering the burner is different than the ambient temperature of the room.
- With an inlet probe fitted the ambient temperature is continuously measured. Position the tip of the inlet probe at the air inlet to the burner during combustion tests

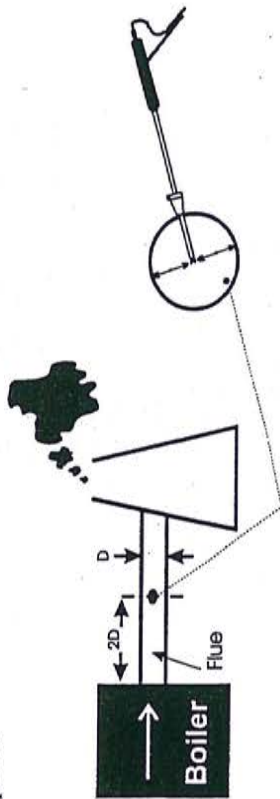
WARNING

If the INLET temperature is set incorrectly then errors will be made in the calculation of the Net temperature and Efficiency.

4.5 Sampling the Flue Gas


Once the automatic calibration procedure has been completed and the specific fuel has been selected (See **MENU** options) the probe can be inserted into the desired sampling point.

It is recommended that the sampling point be located at least two flue diameters downstream of any bend, as close to the source as possible, and that the probe tip is in the center of the flue. With balanced flues and other domestic units the probe should be positioned far enough into the flue so that no air can 'back flush' into the probe.



The probe depth stop cone provided with the instrument allows the probe to be used in holes whose diameters range from $\frac{1}{4}$ to $\frac{4}{5}$ inch (6 mm to 21 mm).

The standard probe is rated at 1112°F (600°C).

TIP To conserve battery power, switch off the pump when you are not taking a measurement. To turn pump ON and OFF press 

TIP By turning the pump off the readings will be held so they can be printed. See section 5.2.1 **Main Menu Options** for information.

4.6 Taking a Pressure Reading

An optional differential pressure sensor is available for the C100A. With this option a flue draft measurement can be made or a differential pressure test made.

To take a flue draft reading, connect the standard probe to the pressure sensor inlet P2 and insert the probe in the flue.

Select PRS on the text line of the screen as indicated:



To take a differential pressure reading, apply positive pressure to P2 and differential side to P1.

4.7 Regular Checks During Sampling


Care must be taken at all times not to exceed the analyzer's operating specifications. In particular ensure the following:

- Do not exceed the maximum temperature of the flue probe.
- The analyzer internal temperature does not exceed normal operating range.
- **DO NOT PLACE THE INSTRUMENT ON A HOT SURFACE.**
- The water trap is correctly attached at all times. Water condenses in the probe line and can quickly fill the water trap when the probe is moved. Take care and watch the water trap closely.
- The particle filter is clean and does not become blocked.

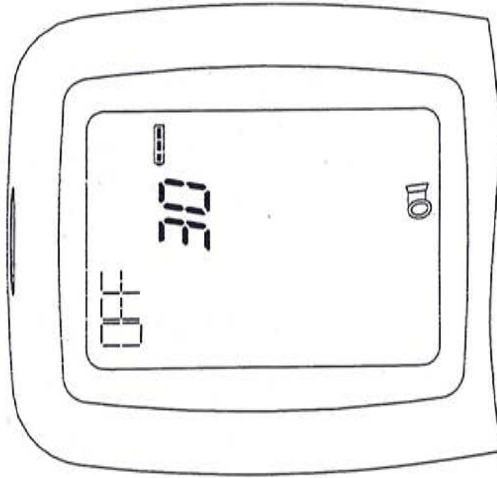
4.8 Normal Shutdown Sequence

DO THIS EVERY TIME YOU USE THE ANALYZER

WARNING! THE PROBE WILL BE HOT FROM FLUE GASES

Remove the probe from the flue and allow it to cool naturally. Do not immerse the probe in water, as this will be drawn into the analyzer and damage the pump and sensors. Once the probe is removed from the flue and the readings have returned to ambient levels hold down  and switch off the analyzer.

The instrument will count down from 30 to switch off and display the following screen.



If you press  by mistake  will return you to normal operation.

Note! During the shutdown sequence the analyzer will expect the Flue temperature to be less than 60 degrees centigrade (140 F) and the oxygen level to be greater than 20%.

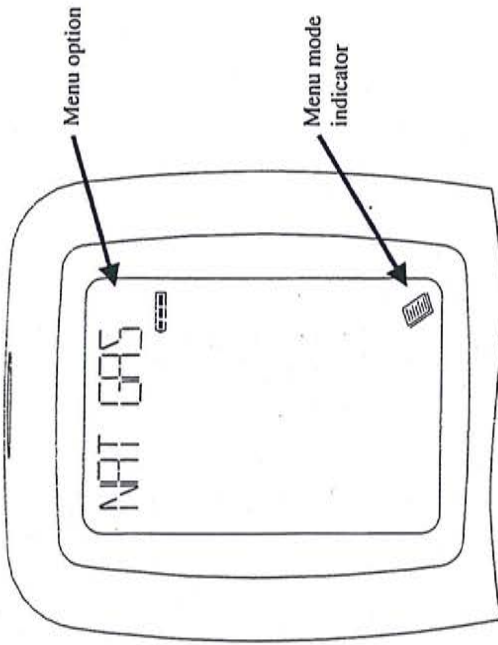
5. MOVING THROUGH THE MENU


The options in the menu system are in the following sequence:

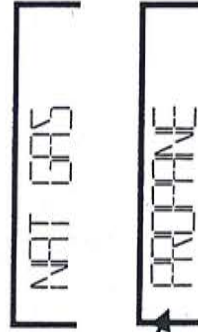
- Fuel selection
- Pump / data hold feature
- Pressure units
- Oxygen reference
- Temperature units
- Gas units
- Efficiency calculation
- Setup
 - Display contrast
 - Fuel table
 - Time setting
 - Date setting (including format)
 - Language


5.1 Basic Operation

From the MAIN DISPLAY press  to access the MENU system.



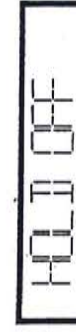
Use  to scroll through the fuel options




Press  to accept the selection And move to next menu option



Use  to scroll through options



Press  to proceed to the next option or

press  to return to the MAIN DISPLAY

5.2 Menu Options and Settings

5.2.1 Main Menu Options

FUEL	DESCRIPTION	DISPLAYED
	Select the fuel being used by the boiler from list of standard fuels:	
	Natural Gas	NAT GAS
	Propane	PROPANE
	Butane	BUTANE
	Light Oil	LIGHT OIL
	Liquid Petroleum Gas	LPG

DESCRIPTION

An option when turning the pump off is to freeze the current readings so that they can be printed and the probe removed from the flue.

PUMP HOLD

DISPLAYED

Freezes display when pump turned off

HOLD ON
HOLD OFF

Display updates with actual readings

Warning!

Turning the pump off while the probe is in the flue will leave toxic gases inside the analyzer. Once data has been printed or copied it is advisable to purge the unit with fresh air as soon as possible. To do this, with the probe removed from the flue, turn ON the pump.

DISPLAYED

DESCRIPTION

Changes the units of the pressure readings from:



- millibar PPS mIBAR
- InWG PPS INWG
- mmWG PPS mmWG
- hPa PPS hPa

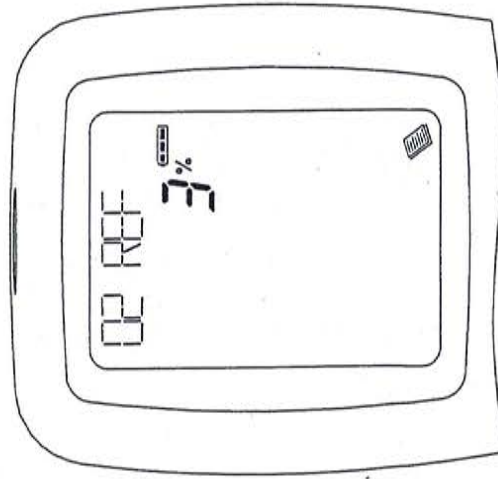
DISPLAYED

DESCRIPTION

Toxic gas measurements can be referenced to defined oxygen levels. Reference values can be set from 0-20% Oxygen Referencing is detailed in Appendix C.

O2 REF 02 REF

The value of the oxygen reference is shown on the top numerical display. The default value is set to 3%. To change the value use  and . See section 5.3 Setting and changing numbers.



DESCRIPTION

Temperature readings displayed in:

TEMPERATURE UNITS

- Centigrade C TEMP C
- Fahrenheit F TEMP F

DISPLAYED

DESCRIPTION

Gas measurement unit can be changed from:

GAS UNITS

- Parts per million (ppm) GAS PPM
- Milligrams per meter cubed (mg/m³) GAS mgm3

DISPLAYED

DESCRIPTION



Efficiency can be selected for Gross or Nett values. Gross efficiency assumes latent heat of vaporization is lost in the boiler and hence will be lower than Nett efficiency. For Natural Gas the difference will be approximately 11%.

EFFICIENCY CALCULATION


- Gross EFF G
- Nett EFF N

DISPLAYED

5.2.2 Set-up menu options

DESCRIPTION	DISPLAYED
Enter a sub menu to change the time, date and language setting.	SET UP
To accept the current set-up press 	
To change the setting press  to enter the set up sub-menu:	

As with the main menu system the set up sub-menu system operates in the same way. The first option in the SET UP menu is:

CONTRAST The contrast is set to a default value or can be adjusted. Note the screen may jump from dark to clear.  To adjust, hold

FUEL TABLE Different countries have different types of fuel and different efficiency calculations. Choose from the following:

- UK
- North America
- Etc.

Other fuel tables included in the analyzer are German (DE), Spain (ESP), France (FR), Italian (IT), Netherlands (NE) and Finland (SU).

The next five options require a number to be set. See section 5.3 Setting and changing numbers.

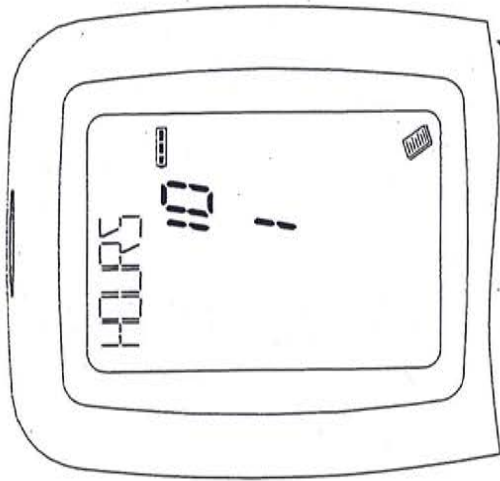
HOURS	Input the time in hours.	HOURS
MINUTES	Input the time in minutes.	MINUTES
YEAR	Input the year.	YEAR
MONTH	Input the month of the year.	MONTH
DAY	Input the day of the month.	DAY
FORMAT	Change the printed format of the date.	DD-MM-YY MM-DD-YY YY-MM-DD



LANGUAGE	Change the language:	English Spanish French
-----------------	----------------------	------------------------------

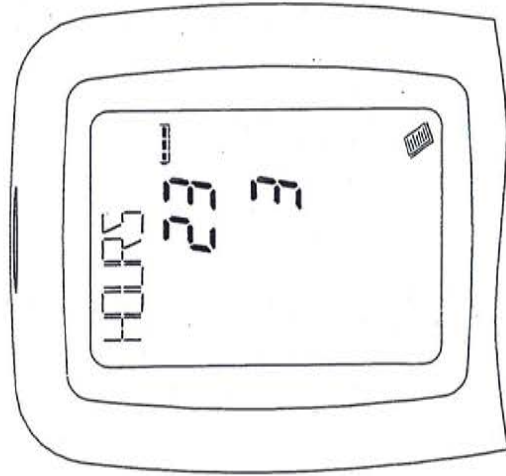
Other languages included are Italian (ITALIANO), Finnish (SUOMI), German (DEUTSCH) and Dutch (NEDERL).

5.3 Setting and Changing Numbers

Once the number changing sequence is initiated from one of the menu options i.e. hours, below the current setting a digit will appear. This digit on the second line of the display indicates that is the number to be changed. The screen below indicates that the one of ten o'clock can be changed.



Use the  key to select the correct number and press  when correct. To change the time to 23 change the one to two and then the zero to three as shown below:



Press  to accept the final value and move to the next menu option.

6. PRINTING INFORMATION

Supplied as an accessory for the C100A is an infra-red thermal printer. Read the manual supplied with the printer prior to operation. Connection to the C100A is detailed below:

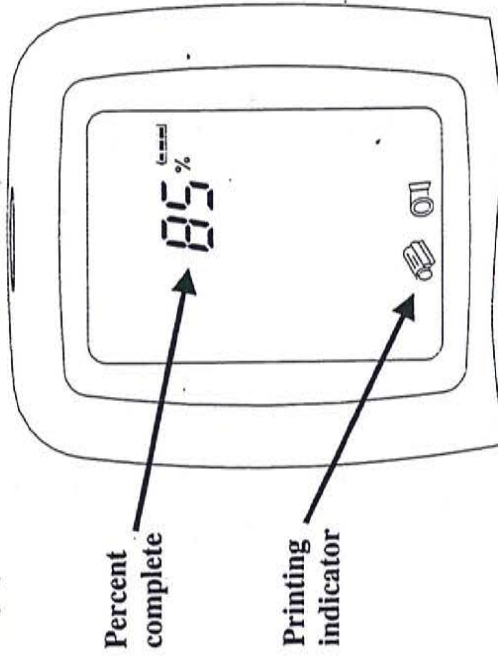
- Infra-red thermal printer - this does not require a cable to transmit the data but uses an infra-red (IR) link similar to a TV remote control. The IR emitter is positioned on the top of the C100A and the bottom of the printer. Ensure they are pointing at each other and within 1 meter, with no obstructions in the way. Data may be lost if transmission is interrupted. Keep the C100A pointing at the printer until the printout has finished.

Data can either be printed from a 'live' test or from stored data. Printing of stored data is detailed in **STORING AND RETREIVING DATA**.

6.1 Printing a 'Live' Test

During a combustion test the C100A will print data on request. With the analyzer showing the **MAIN DISPLAY** press  and current data will be sent to the printer.

The display will show the following until data transmission is complete.



2 Standard Printout

The standard printout is shown below :-

UEI C100A	
06 - 26 - 00	14:27
SMOKE :	
NATURAL GAS	
O2	% 20.9
CO2	% 0.0
CO	PPM 00
EFF% (G)	----
NETT.	F ----
FLUE.	F ----
INLET	F 21
CO/CO2	0.000
XAIR	----
CO PPMN	----
O2 REF...	% 3.0
PRS	INWG 10.00

7. STORING AND RETRIEVING DATA

The C100A can store up to 99 combustion tests. Once stored, the data can be viewed on the display or downloaded to the infra-red printer.

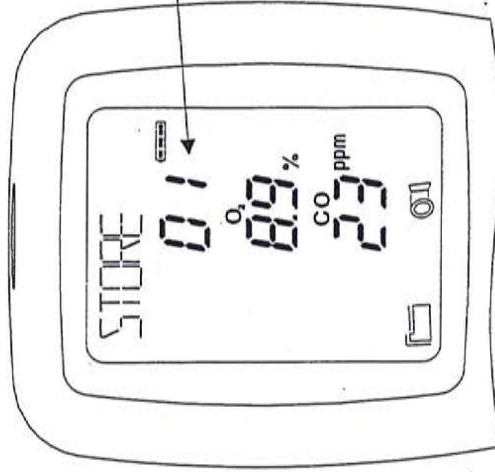
Options in the store menu are:

- **STORE** - Allows data to be stored in memory.
- **VIEW** - Stored data can be viewed or printed.
- **DATA** - Clears all data in memory.

Note! At any time in the store menu press  to exit.

7.1 Storing a 'Live' Test

While performing a test and viewing the data on the MAIN display access the STORE menu by pressing .



To record a test set to **STORE** and press . The current readings will be stored in the analyzers memory. The analyzer will return to the **MAIN DISPLAY**.

Note! The display above shows the location the live test will be stored in the analyzers memory on the top numerical line. The bottom two lines are active flue gas readings.

7.2 Viewing and Printing a 'Stored' Test



To retrieve a stored test from memory access the STORE menu by pressing  to enter the STORE MENU (as above) :-

Select VIEW using 




To indicate the data on the display is stored this symbol will be lit

Use  and  to select the location number to view. See section 5.3 Setting and changing numbers.


As with the main display use  and  to control the top and bottom two rows of data.


To print this location press 

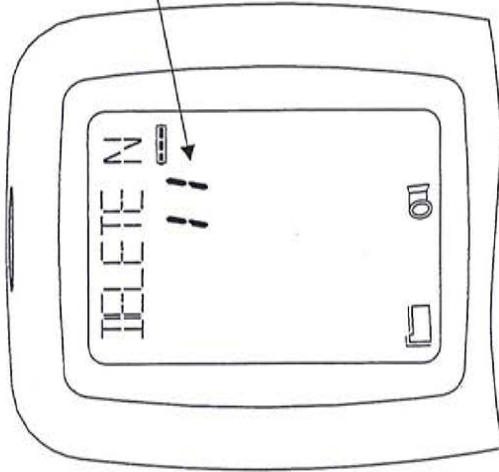
To select another location in memory press  the view screen will be displayed.

Press  to return to the MAIN DISPLAY.

7.3 Clearing Logged Data

To delete the data in stored memory press  to enter the STORE MENU (as above) :-

Use  to select DELETE





Indicates number of logs in memory to be deleted

Use  to select DELETE Y and press .

Note! To exit at this point select DELETE N or press 

If DELETE Y is selected a message will scroll on the screen to ensure you wish to delete all of the data in memory.

PRESS STORE TO DELETE

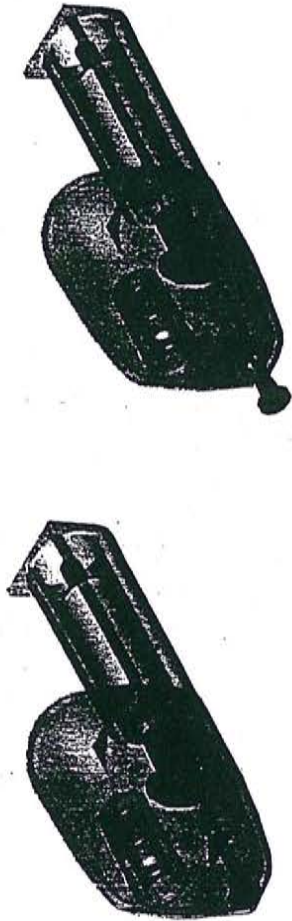
Press  to delete data in memory, press  to exit delete data screen.

8. MAINTENANCE

8.1 Emptying and Cleaning the In-line Water Trap

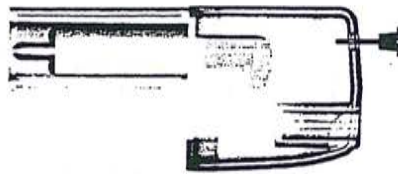
The in-line water trap should be checked and emptied on a regular basis. Water vapor will condense in the probe line, which may cause the water trap to fill suddenly if the probe is moved. Care should be taken at all times.

Emptying of the water trap is detailed below: -



Carefully remove the rubber plug from the bottom of the water-trap housing. Dispose of the condensate in a suitable drain, care must be taken as it could be acidic.

If condensate spills onto the skin or clothing, clean off immediately using fresh water, seek medical advice if problems occur. Ensure plug is replaced before performing further combustion tests.



8.2 Changing the Particle Filter

This is a very important part of the analyzer and should be changed regularly. It prevents dust and dirt particles from entering the pump and sensors that will cause damage. The filter **MUST** be changed when it appears discolored.



Remove water-trap assembly from the analyzer as shown above. Remove the filter and plastic holder from the housing. Discard the filter element but keep the holder to fit to the new filter. Clean the inside of the filter housing with a suitable soft cloth. Fit the holder onto the new filter element and then insert into the housing. Refit the housing onto the analyzer.

9. PROBLEM SOLVING

The following is a list of problems that may occur on the instrument through its operating life. If the cause of the fault is not easy to identify then we advise you contact the UEi Technical Support line at (800) 547-5740.

Fault symptom	Causes
<ul style="list-style-type: none"> Oxygen too high CO₂ too low 	<ul style="list-style-type: none"> Air leaking into probe, tubing, water trap, connectors or internal to instrument. Oxygen cell needs replacing.
<ul style="list-style-type: none"> Oxygen Error (---) CO sensor Error (---) 	<ul style="list-style-type: none"> Instrument has been stored in a cold environment and is not at normal working temperature. Oxygen cell or CO sensor needs replacing.
<ul style="list-style-type: none"> Batteries not holding charge Analyzer not running on mains adapter. 	<ul style="list-style-type: none"> Batteries exhausted. AC charger not giving correct output. Fuse blown in charger plug.
<ul style="list-style-type: none"> Analyzer does not respond to flue gas 	<ul style="list-style-type: none"> Particle filter blocked. Probe or tubing blocked. Pump not working or damaged with contaminants.
<ul style="list-style-type: none"> Net temperature or Efficiency calculation incorrect. 	<ul style="list-style-type: none"> Ambient temperature set wrong during Automatic Calibration.
<ul style="list-style-type: none"> Flue temperature readings erratic 	<ul style="list-style-type: none"> Temperature plug reversed in socket. Faulty connection or break in cable or plug.

10. ANNUAL RE-CALIBRATION

While the sensor has an expected life of more than two years in normal use it is recommended that the analyzer is re-calibrated at least annually. This is so that long-term drift on the sensor and electronics can be eliminated. Local regulations may require more frequent re-calibration and users should check with appropriate authorities to ensure they comply with relevant guidelines.

11. PRODUCT SPECIFICATION

Parameter	Resolution	Accuracy	Range
Temp Measurement Flue Temperature	1.0°F/C	±5.0°F (2°C) ±0.3% reading	32-1112°F 0-600°C
Inlet Temperature	1°F/C	±1°F/C ±0.3% reading	32-212°F 0-100°C
Temp (Nett) ^{*2}	1.0°F/C	±5°F (2°C) ±0.3% reading	32-1112°F 0-600°C
Gas Measurement Oxygen	0.1%	±0.2% ^{*1}	0-21%
Carbon Monoxide	1ppm	±10ppm <100ppm ^{*1} ±5% of reading	0-2000ppm nom. 4000 ppm max for 15 minutes
Carbon Dioxide ^{*2} Efficiency ^{*2} Excess Air ^{*2} Poison Index ^{*2} CO/CO ₂ ratio ^{*2}	0.1% 0.1% 0.1% 0.1% 0.001	±0.3% reading ±1.0% reading ±0.2% ±5% reading ±5% reading	0-30% 0-99.9% 0-250% 0-99.9% 0-999
Pressure (differential)	0.004 inWG 0.01 >20 inWG (0.01 mbar)	±1% of full scale	0-19,999 inWG 20-40 inWG (0-100 mbar)
Pre-programmed Fuels	Natural gas, Light Oil, Propane, Butane, LPG.		
Dimensions	1kg (2.2lb) 7.9"(200mm) x 1.8"(45mm) x 3.5"(90mm) L 11.8"(300mm) x Dia 0.25"(6mm) with 7.8"(200mm) long stainless steel shaft, type K thermocouple and 6'(3m) long neoprene hose		
Ambient Operating Range	+32°F to +104°F (0-40°C) 10% to 90% RH non-condensing		
Battery Life	4 AA cells >8 hours using Alkaline AA cells		
AC adapter (optional)	Input: 110Vac/220 Vac nominal Output: 10 Vac off load		

^{*1} Using dry gases at STP

^{*2} Calculated

^{*3} Nominal range of the sensor. Higher concentrations can be measured for short periods (15 minutes maximum).

APPENDICES

A. MAIN PARAMETERS

The following section gives details of the main display parameters.

- O2 :** Oxygen reading in percentage (%)
- Tf :** Temperature is measured by the flue gas probe in Centigrade or Fahrenheit. Will show ambient temperature after fresh air calibration and '----' if the flue probe is disconnected.
- CO:** Carbon Monoxide reading displayed in ppm (parts per million). '----' is displayed if there is a fault with the CO sensor or the instrument has not set to zero correctly, switch off instrument and try again.
- CO PPMN :** Carbon Monoxide reading referenced to a particular oxygen level. Do not confuse this reading with the actual CO reading as detailed above. See appendix C for more details.
- CO₂ :** Carbon Dioxide calculation determined by the type of fuel. This only shows a reading when a combustion test is being carried out. '----' is displayed while in fresh air.
- ΔT :** Net temperature calculated by deducting the **INLET** temperature from the measured **FLUE** temperature. Displays in either Centigrade (°C) or Fahrenheit (°F) and will display '----' if the flue probe is not connected.
- EFF (G) :** Combustion efficiency calculation displayed in percentage. Gross (G) or Net (N) can be set (see **MENU**). The calculation is determined by the fuel type and uses the calculation in British Standard BS845. The efficiency is displayed during a combustion test, '----' is displayed while in fresh air.
- XAIR % :** Excess air calculated from the measured oxygen and type of fuel used. Displays reading during a combustion test. '----' is displayed while in fresh air.
- Ti :** Boiler air **INLET** temperature used to calculate the **NET** temperature.

CO/CO₂ : The CO/CO₂ ratio is the ratio of measured CO divided by calculated CO₂.

It gives an indication of:





- How good a gas sample the instrument is reading.
- How clean the boiler is running.

For example: A new or clean domestic boiler will display a ratio of less than 0.004, a unit in need of cleaning 0.004-0.008 and a unit in need of major overhaul will show greater than 0.008.

This only shows a reading when a combustion test is being carried out.

'----' is displayed while in fresh air.

Displays the approximate battery level as follows:

- Full battery level 
- Battery at 75% 
- Battery at 50% 
- Battery at 25% 

When the LO BAT symbol appears this indicates the batteries are at less than 10% of charge and should be replaced, readings may be affected if the analyzer is used with low power batteries.

DATE : Date shown as day, month and year. The order can be changed using the menu function. Date is stored with a combustion test.

TIME : The time is shown in hours and minutes, these details are stored with each combustion test.

Note! When changing the batteries on the instrument the memory will store the date and time for up to one minute, if outside this time it may be necessary to re-enter the details.

PRS : Pressure measured by the instrument. Can be displayed in mBar, mmWG, inWG or hPa.

B. COMBUSTION EFFICIENCY CALCULATION

The efficiency calculation is based upon British Standard BS845.

This identifies three sources of loss associated with fuel burning:

Losses due to flue gasses: Dry Flue gas loss, Moisture and hydrogen, Sensible heat of water vapor, Unburned gas

Losses due to refuse: Combustible in ash, riddlings and dust

Other losses: radiation, convection, conduction other unmeasured losses

Net efficiency calculations assume that the energy contained in the water vapor (formed as a product of combustion and from wet fuel) is recovered and the wet loss term is zero. Gross efficiency calculations assume that the energy contained in the water vapor is not recovered.

Since the fuel air mixture is never consistent there is the possibility of unburned/partially unburned fuel passing through the flue. This is represented by the unburned carbon loss.

Losses due to combustible matter in ashes, riddlings, dust and grit, radiation, convection and conduction are not included.

Efficiency Calculation:

Known Data - Fuel:

Qgr = Gross Calorific Value (kJ/kg)

Qnet = Net Calorific Value (kJ/kg)

K1 = Constant based on Gross or Net Calorific Value:

K1g = (255 x %Carbon in fuel)/Qgr

K1n = (255 x %Carbon in fuel)/Qnet

K2 = % max theoretical CO₂ (dry basis)

K3 = % Wet Loss

H₂ = % Hydrogen

H₂O = % Water

Measured Data:

Tf = Flue Temperature

Ti = Inlet Temperature

O_{2m} = % Oxygen in flue gas

O_{2r} = Oxygen reference %

Calculated data:

Tnet = Net Temperature

% CO₂ content in flue gas

% Dry Flue Gas losses

% Wet losses

% Unburned carbon loss

% Efficiency

Tnet = Flue Temperature - Inlet Temperature

Dry flue gas loss % = 20.9 x K1 x (Tnet) / K2 x (20.9 - O_{2m})

Wet loss % = 9 x H₂ + H₂O / Qgr x [2488 + 2.1Tf - 4.2 Ti]

Simplified = [(9 x H₂ + H₂O) / Qgr] x 2425 x [1 + 0.001 Tnet]

Wet loss % = K3(1+0.001xTnet)

Where K3 = [(9 x H₂ + H₂O) / Qgr] x 2425

Net Efficiency % = 100 - dry flue gas losses

= 100 - 20.9 x K1n x (Tnet) / K2 x (20.9 - O_{2m})

Gross Efficiency % = 100 - {dry flue gas losses + wet losses}

= 100 - {[20.9 x K1g x (Tnet) / K2 x (20.9 - O_{2m})] + [K3 x (1 + 0.001 x Tnet)]}

Excess Air = [20.9 / (20.9 - O_{2m}) - 1] x 100

CO₂ % = [(20.9 - O_{2m}) x K2 / 20.9]

Unburned fuel Loss % = K4 x CO / (CO + CO₂) Note: CO scaled in %

Where K4 = 70 for coke

= 65 for anthracite

= 63 for Bituminous coal

= 62 for coal tar fuel

= 48 for liquid petroleum fuel

= 32 for natural gas

The formula for K4 is based on the gross calorific value Qgr. To obtain the loss based on net calorific value multiply by Qgr/Qnet. Since this loss is usually small this conversion has been ignored. This loss is subtracted from the efficiency.

C. OXYGEN REFERENCE AND CONVERTING TO mg/m³

Oxygen referencing is required by some regulations such as TA-LUFT. If a reference value is selected then the CO gas measurement will be displayed with the symbol (n) attached to the reading. i.e. PPMn

What does Oxygen reference mean?

If 3 % O₂ reference (O_{2r}) is selected and 5 % O₂ is measured (O_{2m}) in the flue then the CO gas value will be recalculated as if 3 % were measured. The equation for referencing is as follows :-

$$\text{CO PPMn} = \text{CO PPM} \times (20.9 - \text{O}_{2r}) / (20.9 - \text{O}_{2m})$$

In our example if a reading of 95 PPM were measured then the referenced value would be calculated as follows: -

$$\text{CO PPMn} = 95 \text{ PPM} \times (20.9 - 3) / (20.9 - 5)$$

$$\text{CO PPMn} = 95 \text{ PPM} \times (17.9) / (15.9)$$

$$\text{CO PPMn} = 107$$

We may be given a limit on our boiler by the local authority which stated that we must not emit more than 100 PPM Carbon Monoxide referenced to 3 % Oxygen. In the example we would be breaking the limit and corrective action should be taken to reduce the level of CO.

Oxygen referencing prevents false readings being submitted, e.g. allowing more air into the boiler will increase the oxygen level in the flue and dilute any toxic gas reading. Oxygen referencing gives readings as if they were undiluted.

Oxygen referencing is also referred to as :-

- o Normalizing
- o Diluted and Undiluted readings
- o 'Air Free' measurements when referenced to zero % oxygen.

Converting ppm to mg/m³.

To convert Carbon Monoxide to mg/m³ = CO ppm x 1.25

D. ELECTROMAGNETIC COMPATIBILITY (EMC) STATEMENT

This product has been tested for compliance with the following generic standards:

EN 50081-1
EN 50082-1

and is certified to be compliant

Specification EC/EMC/KI/C100A details the specific test configuration, performance and conditions of use.



Electromagnetic Compatibility

The European Council Directive 89/336/EEC requires that electronic equipment do not generate electromagnetic disturbances that exceed defined levels and has an adequate level of immunity to enable it to be operated as intended. The specific standards applicable to this product are detailed in the appendices.

Since there are many electrical products in use that pre-date this Directive and may emit electromagnetic radiation in excess of the standards defined in the Directive there may be occasions where it would be appropriate to check the analyzer prior to use. The following procedure should be adopted:

- o Go through the normal start up sequence in the location where the equipment is to be used.
- o Switch on all localized electrical equipment that might be capable of causing interference.
- o Check that all readings are as expected. (A level of disturbance in the readings is acceptable).
- o If not, adjust the position of the instrument to minimize interference or switch off, if possible, the offending equipment for the duration of the test

At the time of writing this manual (July 2000) Kane International Ltd is not aware of any field based situation where such interference has ever occurred and this advice only given to satisfy the requirements of the Directive.