Users Manual

CWD 2000
Combustion Calorimeter

For high speed measurement of fuel gases

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Attention:

Please read all safety instructions before you connect the CWD 2000

See section 1.1 page 6

Contents

1. Important Information

Thank you for specifying a Union CWD 2000 Heating Value Analyzer for your online process measurement application.

Please read this manual and follow all directions before installation and use of this gas analyzer.

Unpacking and initial inspection of this unit requires only normal precautions and proceedures applicable to the handling of analytical equipment. All shipping containers should be carefully checked for any included accessories. Check the shipment against the packing slip and any system arrangement drawings to ascertain that the shipment is complete.

The analyzer was carefully inspected and calibrated at the factory. Check the shipment for possible damage incurred during transit. If there is any sign of visible damage to the crate or hidden damage inside the shipment, notify the carrier and the factory immediately as the equipment warranty does not cover damage in shipping.

In the event of trouble during start-up, please contact a factory representative and inform them of the model and serial number of the unit, plus a fully description of the problem. Note: The factory will not be responsible if the customer should attempt repair of the unit during the warranty period without first following any detailed factory instruction.

All possible care has been taken in the publication of this users manual but Union, its agents and distributors, accept no liability for any inaccuracies or omissions that may be found. This manual reflects the state of the product at the issue date below but further refinements may mean that the manual does not fully reflect your particular system.

Union Apparatebau reserves the right to make change without notice both to this publication and the product that it describes.

1.1. Safety Instructions

Before start up and use of the CWD 2000, please take time to carefully review this manual and its contents. Observe all Warnings, Cautions and Notes.

Warning:

Reasons to safe persons allow to do maintenance only after disconnect the main switch.

Before maintenance or repair work on the electrical or on the high voltage equipment the following points have to be considered.

After switching off the main switch the capacities of the equipment store up to 5 min high voltage. It is important to wait this time till the voltage brake down to zero.

At the installation of the protective earth please consider the existing rules for instruments with higher leakage current (> 1,5 mA)

Please pay attention about the safety function of the person current circuit breaker. It is forbidden to manipulate to get a malfunction. (safety switch in the main door).

Before the service at the burner system consider that parts of the burner could be very hot (more than 200 °C). Please wait more than 15 min to cool down all burner parts before doing any service.

At the start up and service or not optimal conditions (not 100 % burnt gases) there is a danger of bad components in the burnt gases of the outlet of the system.

If process gas has toxic components please consider that all actual safety rules has to be abode.

Non toxic gases are without problems. They are very high diluted with cooling air.

All electrical connections to line power must be carried out by a qualified electrician. The analyzers internal electrical components are wired in accordance with NEC, VDE and International standards. Check the power supply voltage, details can be found on the technical data label inside the door.

The gas connections has to be installed only from fort his work qualified persons. All for this job actual laws and rules has to be considered.

The CWD 2000 operates over a specified ambient temperature range. Installing the instrument directly outside is not recommended, since damage to the analyzer may occur from the adverse weather conditions if an outdoor shelter is not used.

Caution:

Caution is necessary during installation because pressurized flammable gases are connected to the instrument and any installation work performed by the customer must conform to all applicable local and national codes. All internal sample gas

components have been leak tested at 1.5 times the normal operating pressure during assembly at the factory. After installation, the entire sample gas system should be pressurized and tested for leaks before use.

When planning the installation, local site conditions must be taken into account. The instrument has a small open flame inside so consult any hazardous area regulations for applicability. The analyzer shelter if supplied may require an air purge system to conform to hazardous area regulations.

Note: A purge system can also be useful for installations in very dusty areas.

A small source of air for combustion is necessary, generally you must ensure that flue gas is not allowed to accumulate the inside of the shelter (CO, H_2 and H_2S may be present) and that any combustion heat is discharged so that the analyzers thermal stability remains unchanged. Any outside vent needs protection from wind to avoid back flow of flue gases into the unit and the possibility of unstable readings.

The analyzer is fitted with numerous safety features and instrument ignition can only occur with the door closed. In the event of failure of gas or cooling air supply, the gas solenoid valve will close and after a short interval the solenoid will reopen and the instrument will enter an ignition cycle. If the ignition cycle or online measurement function is aborted due to flame out or power failure, the gas supply solenoid reverts to its normally closed position and the small amount of sample gas flow is instantly terminated. User intervention is then necessary to resolve the problems source. Calibration is only possible if a calibration gas cylinder is available and contains the correct certified gas. The mixture will normally be similar to the major process gas components with a value around 80% of the analyzers range.

CWD 2000 gas consumption is between 8 and 200 liters per hour and the quantity will depend on the characteristics of the process gas. When designing an outdoor shelter the use of a gas flow restrictor is recommended since it will limit the 'potential to release' in case of any accidental damage to the sample gas tubing inside.

A purge air system will ensure the LEL inside the enclosure remains well within the allowable limits of the standards defined by local or national electrical codes.

2. Introduction

Combustion calorimeters have been an important part of the process industry control scene for a number of years. Some units are valued for their low maintenance requirement, rugged durability and ability to understood and serviced quickly by just about anyone without needing any special tools. Combustion calorimeters burn a small sample of gas and measure the temperature rise of a fluid (usually air) through the system and report this as heat release. The goal of a few manufactures has been to improve response speed of these online units. Over the years, technical progress and the embodiment of smart design strategies have improved response times from around 5 minutes for the old mechanical water bath based units down to just a few seconds for the newly introduced CWD 2000 series.

The CWD 2000 is the successor to the CW95, CW85, CW71 and all previous models (about 10,000 units supplied) during more than 80 years service to the gas industry.

The CWD 2000 is a high-speed combustion calorimeter with a small industrial PC and large digital display, mounted with the combustion chamber, thermopile and other vital components in a custom wall mounted enclosure. A small amount of process gas is measured continuously and the temperature rise from heat of combustion is transferred from the burner to the thermopile, via the cooling air supply and is measured by its thermopile sensor as heat rise.

Measurement is based on the real time Wobbe Index and Specific Gravity values of the gas (a specific gravity sensor is built into the calorimeter). The PC based microprocessor calculates Calorific Value using the following formula:

$$\text{Calorific value} = \text{Wobbe Index} \sqrt{\text{Specific Gravity}}$$

The W 2000 model measures Wobbe Index values of process gas and is supplied without a Specific Gravity sensor.

Most of the CWD 2000 units are supplied to customers that need to measure the Calorific Value of their process gas and simultaneous outputs are available for both upper and lower Calorific Values as well as Wobbe index and Specific Gravity.

The CWD 2000 is a high-speed combustion calorimeter and is usually preferred in control applications as the response time is fast, the measurement is direct and is simple to maintain online by Gas, Industrial, Steel and Petrochemical companies.

Petrochemical industries often need to measure flare gases with many unknown gas components and need to meet the uptime requirements of tough environmental regulations. The CWD 2000 combustion calorimeter responds to all unknown components in the process gas and reports them as heating value or wobbe index.

2.1. Output values

The output values depend on the model (CWD 2000 or W 2000) and these values can be shown on the instruments alphanumeric display. The connection board PCB

provides a series of removable terminal strips where the 0-20 or 4-20 mA DC isolated outputs (proportional to the measuring range) and eight user programmable alarm contacts are available for customer connection. See section 10.2 for details.

The combustion calorimeter is designed to measure very small temperature changes. When selecting a suitable location, avoid dusty areas, locations with strong drafts, rapid temperature changes, direct sunlight or other sources of thermal radiation.

$T_{RE} - 7°C < T_R < T_{RE} + 7°C$ where $\frac{dT_R}{dt} < \frac{2°C}{hour}$

T_R Room temperature
T_{RE} Room temperature during calibration

2.2. Available measurement ranges

Normally 40 - 100 % of the full- scale range can be utilized depending on the gas composition. The measurement range can be wider for gases with a very high flame speeds and the analyzer is designed for a second measuring range, which can be supplied as an option. This dual range option can extend the measurement range from 20 to 100 % and moving from one measuring range to the next provides a step-less transition, and is displayed as one continuous output. Two calibration gases are required for the dual range option. If one calibration gas is in the transition zone from one measuring range to the next, a single calibration gas can be sufficient for both measuring ranges. This must be tested on an application basis by the factory.

Measuring ranges that are too far apart or contain vastly different components can only be combined into a single measuring range under very specific circumstances.

Another more radical triple range option is available for process gas streams with very wide ranges. A carrier gas option can provide a usable range of 0–100% displayed as one continuous output (a continuous supply of Natural Gas or Hydrogen is required for this option).

2.3. Response times

Dead time	3 sec
50% time	7 sec
90% time	20 sec
99% time	45 sec

Response times are measured when the new gas reaches the burner and the values shown above were measured using Methane. Gases with other specific gravities and flame speeds generate different response times some faster and some slower depending on the properties of the gas. In addition to the dead time and response time, the sample lag time for the flow of sample gas through the supply tube and fittings installed upstream of the unit must be added. The gas consumption is based on the total sample volume up to the burner and by using the formula in section 3.3 it is possible to calculate the total installed response time. A fast loop is recommended on long sample lines, see section 4.5.4.

3. Analyzer Overview

All major components are shown below and can be replaced if necessary as a spare part. Items marked with an * are not visible on this drawing – see following drawings.

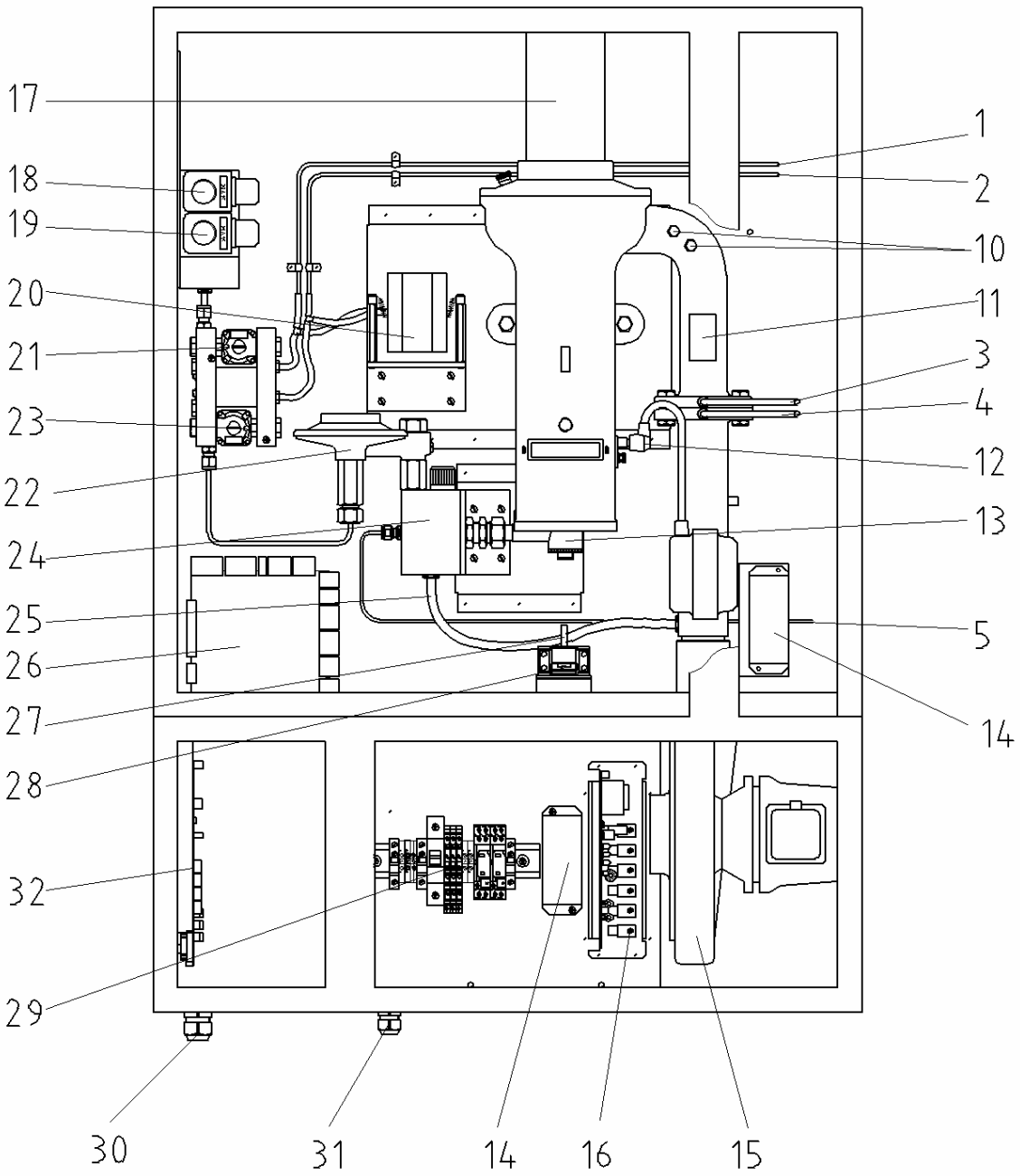


Figure 1: CWD 2000 components shown above but without doors for clarity

1 Differential pressure for density cell + (Tubing connections)
2 Differential pressure for density cell -
3 Differential pressure air - (Tubing connections)
4 Differential pressure air +
5 Gas pressure at range orifice (Wobbe jet)
6 Power supply*
7 PC 104 type processor circuit board*
8 Disk drive*
9 Filter element for air supply*
10 Pt 100 temp correction
11 Pt 100 temp correction
12 Ignition electrode
13 Burner
14 Electrical noise filter
15 Air fan
16 Frequency controller for air fan
17 Discharge pipe
18 Solenoid valve, calibration gas
19 Solenoid valve, process gas
20 Specific Gravity cell
21 Pressure regulator for process gas (RV 12LM)
22 Precision pressure regulator
23 Pressure regulator, specific gravity cell differential pressure (RV 12LM)
24 Range orifice (Wobbe jet) location
25 Primary air supply tube
26 E/A internal (multi functional computational module)
27 Temperature sensor
28 Door switch
29 Terminal block for line power supply
30 Output signal PG cord connector
31 Line power PG cord connector
32 EA/ Extern

The Items marked with " * " are not shown on fig. 1 drawing, see other drawings.

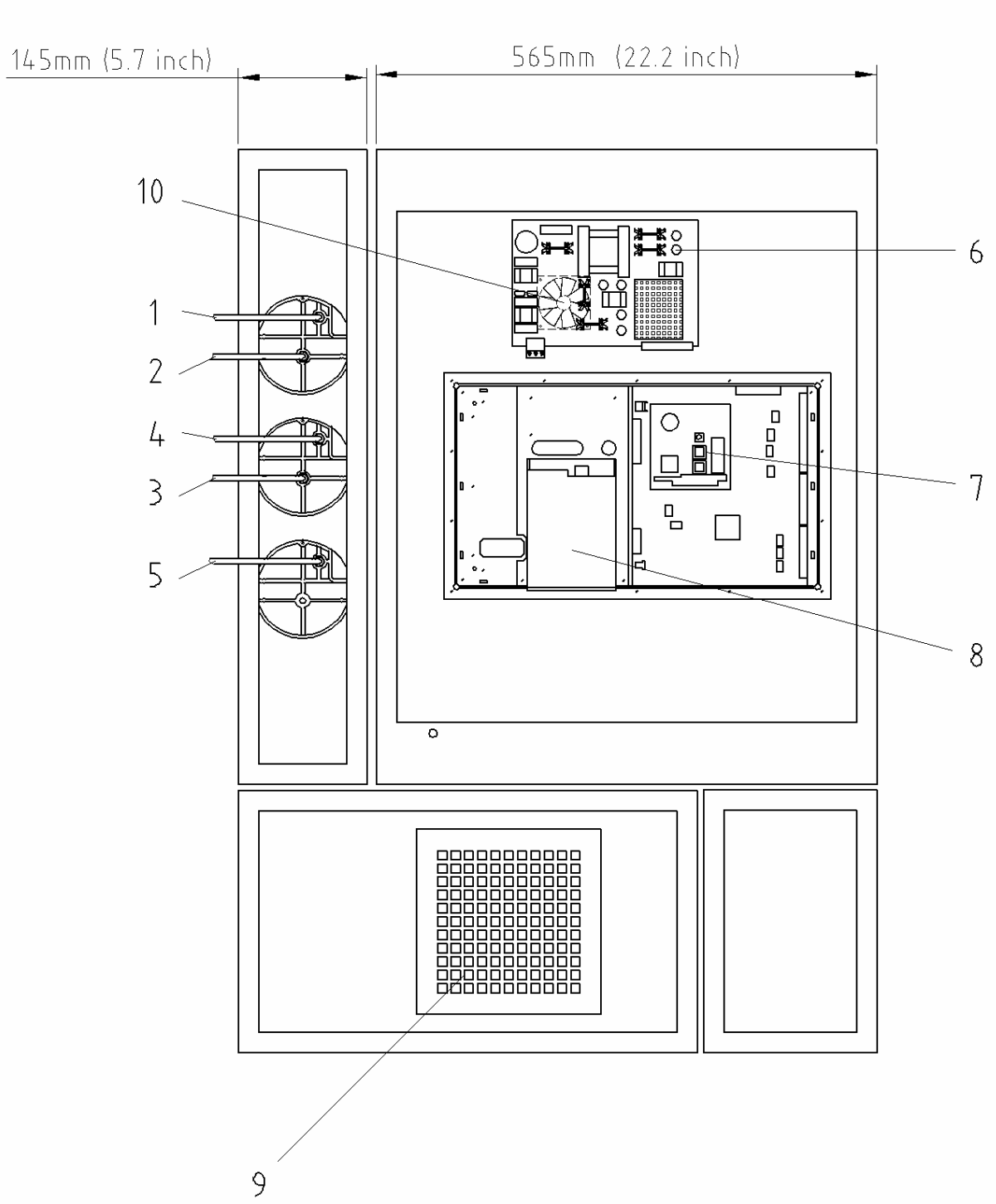


Figure 2: Rear inside view of main door

1	Diff. pressure Sp. Gr. cell +	2	Diff. pressure Sp. Gr. cell -
3	Diff. pressure air -	4	Diff. pressure air +
5	Gas pressure at wobbe jet	6	Switching power supply
7	PC 104 Processor unit	8	Disk drive
9	Air filter element	10	Blower power supply

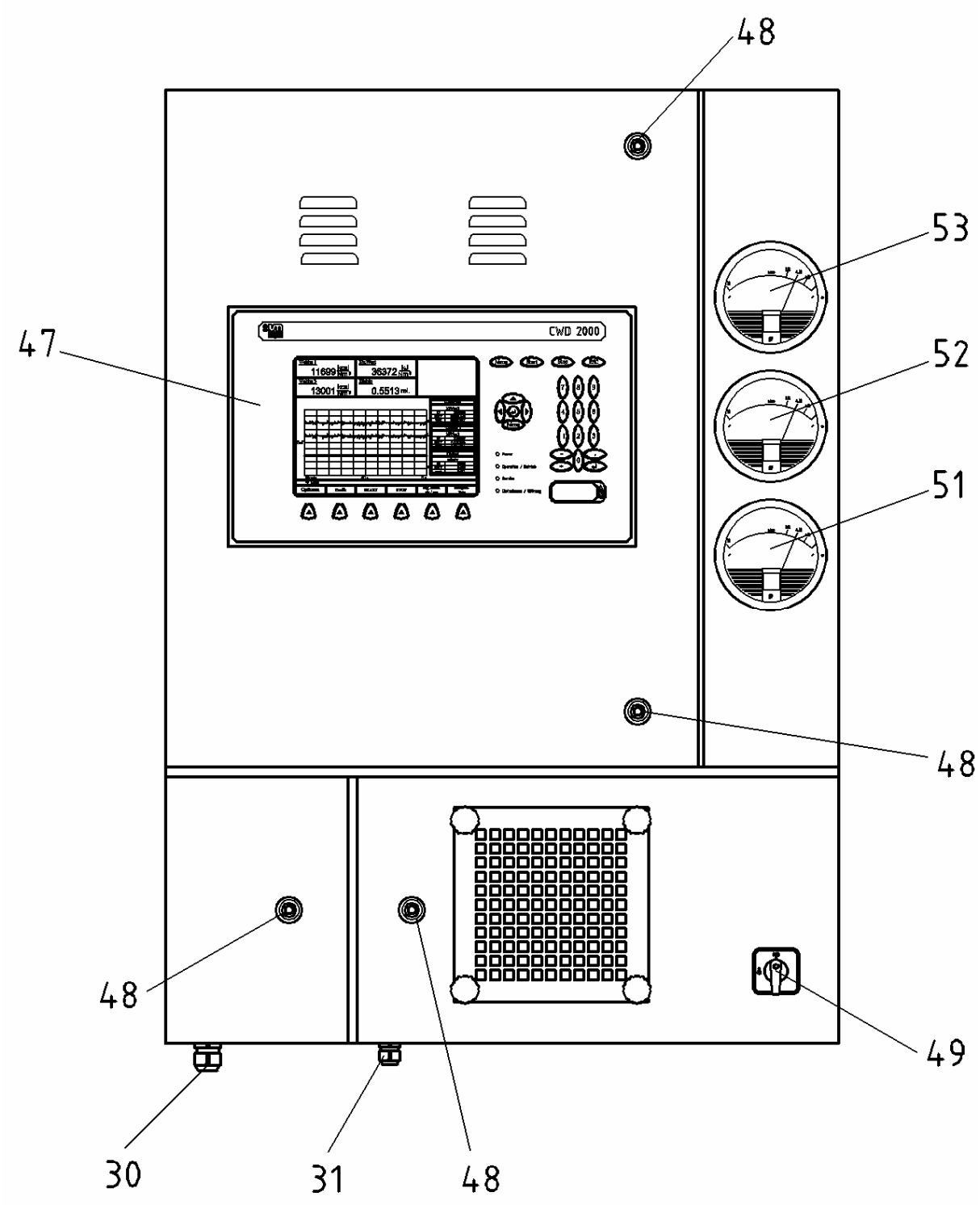


Figure 3: Front view

30	Output signal PG cord connector	31	Line power PG connector
47	Display	48	Lock
49	Power switch	51	Gas pressure gauge
52	Air differential pressure gauge	53	Differential pressure gauge Sp. Gr. cell

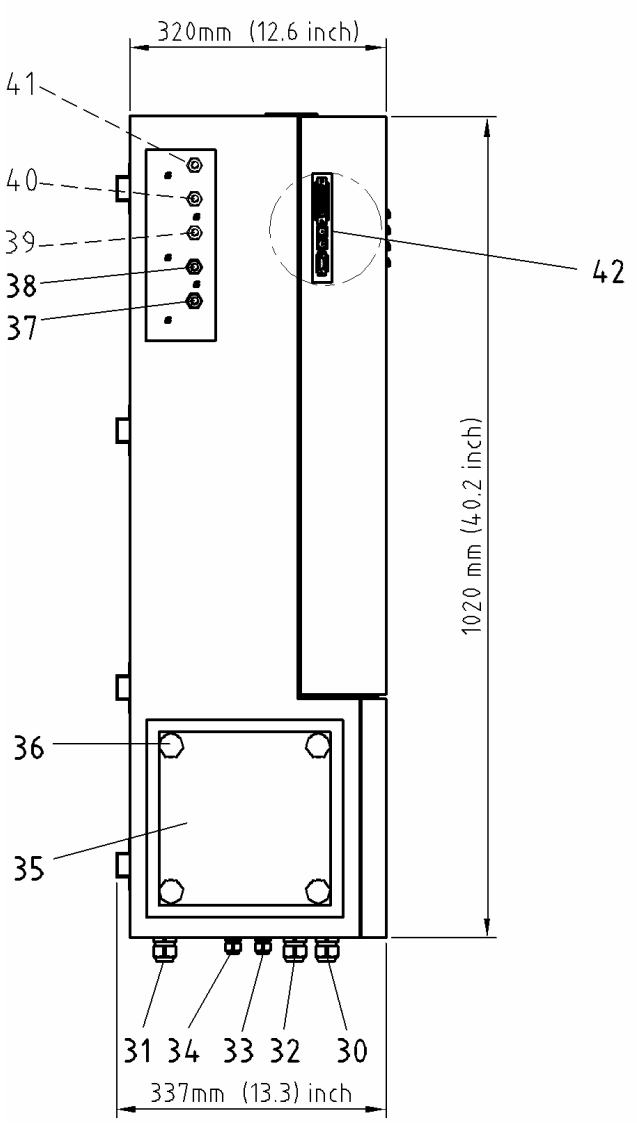


Figure 4: Enclosure shown from left hand side

30	PG connector, signal	31	PG connector power
32	PG connector, signals	33	PG connector, signals
34	PG connector, signals	35	Connection cover (E/A internal)
36	Cover screws	37	Process gas (SV. X11/ 1-2)
38	Calibration gas (SV.X14/1-2)	39	Calibration gas 2 (SV. X14/3-4)*
40	Carrier gas (SV. X11/3-4)*	41	Fast loop*
42	Interface connection		

The above drawing shows a standard instrument or instruments equipped with one or two calibration gases or carrier gas. Instruments with the option of two process gases have a different inlet arrangement and this will be labeled on the instrument.

The items marked with a "*" are available as an option at the time of order and are not supplied as standard.

3.1. Dimensions, weights

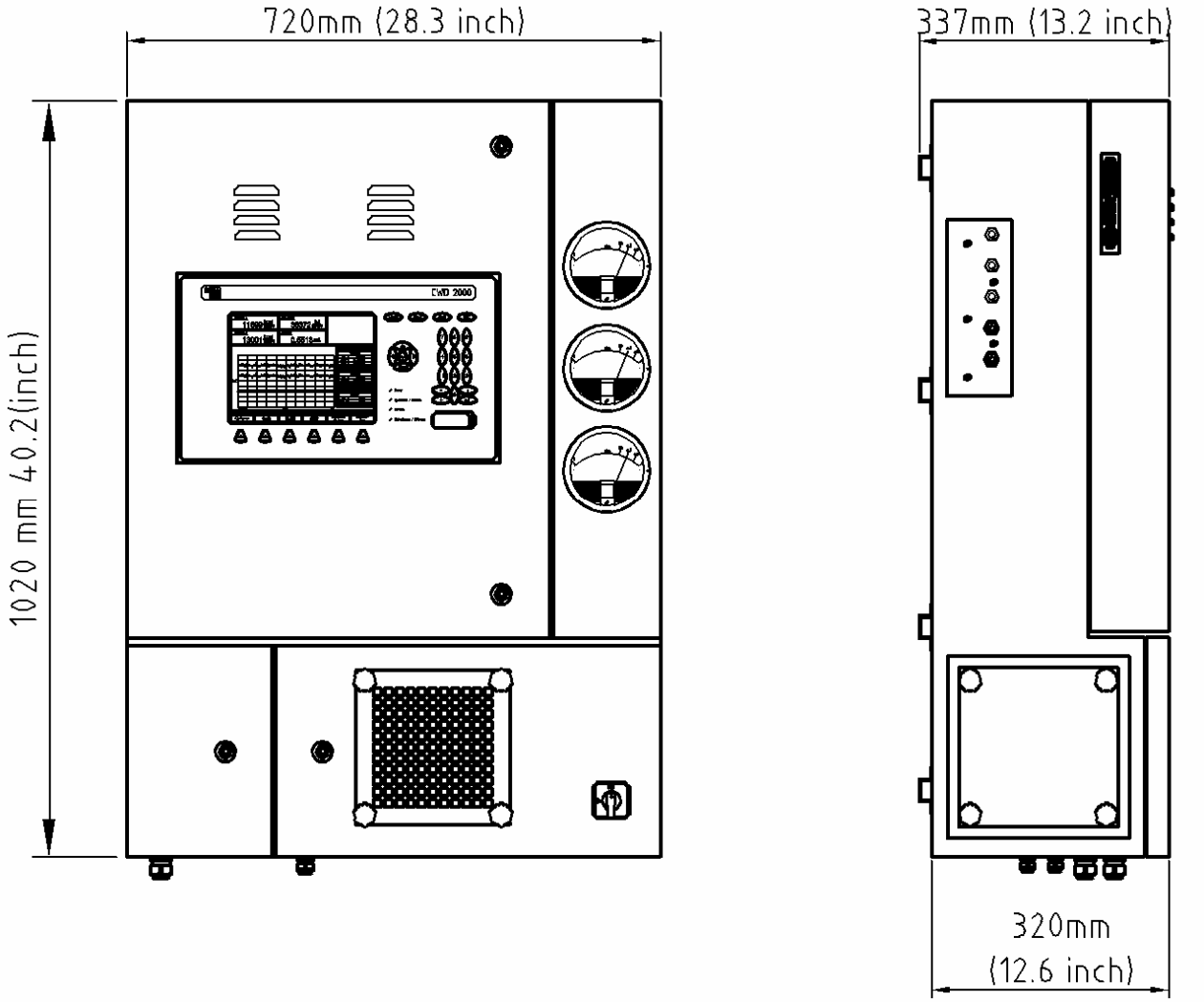


Figure 5: Enclosure dimensions

Height:	1020 mm	40,2 inch
Width:	720 mm	28,3 inches
Depth:	337 mm	13,2 inches
Weight:	50.5 kg	111 lbs
Protection:	IP 54	NEMA 12

The analyzer is supplied for wall mounting and brackets are included. All gas connections are located on the left-hand side of the unit. Allow enough space for the doors to swing open and other accessibility issues, when mounting the unit.

3.2. Gas connections

Gyrolok ¼" tube (6 mm) gas connections are located on the left hand side of the unit. The process and calibration gases should be connected separately. If a very short response time is required, a tube with a smaller diameter 1/8" (4 mm) can also be used, depending on sample gas but check that the pressure drop is not too large.

The input pressure to the instrument must be between 20 and 40 mbar (12" H_2O). Lower calorific gases (1000 kcal) require a pre-pressure of 40 to 60 mbar (24" H_2O).

If the input pressure is too low, the pressure should be boosted with a sample gas pump. A pump is available as an optional extra, and can be mounted on a panel with the necessary pressure gauges and pre-pressure regulator.

The process gas tubing will need a sample gas filter and this can be ordered as an option from the factory or supplied by the customer

A small filter will be sufficient when Natural gas is used because this gas is normally clean. Larger filters are necessary for dirty gases such as Blast Furnace gas and Coke Oven gas. The volume of the filter will effect the response time and the filter element should have a large active face retention area and a small dead volume.

If the process gas is at a much higher temperature than ambient and the humidity of the process gas is high, water can condense in the lower temperature sample tubing runs and this must be avoided. The gas has to be dried or a water separator with a drip leg installed at the lowest point of the process gas line. The gas rapidly warms up above ambient inside the instrument so there is no danger of condensation.

3.3. Gas consumption

Gas consumption will depend on the range orifice (Wobbe jet) in the instrument, and the Specific Gravity of the process gas. Natural gases require 15-20 liters of gas per hour. Blast furnace gases with low calorific values require up to 200 liters per hour.

Use the following formula to calculate the gas consumption based on Specific Gravity and range orifice (Wobbe jet) diameter. Quantities expressed in scf/h or l/h.

$$\text{Gas consumption} = \frac{48 * d^2}{\sqrt{\text{Specific Gravity}}} \; Litre / hour$$

Dimensions: Wobbe jet diameter in mm

Specific Gravity: Process gas/calibration gas

$$\text{Gas consumption} = \frac{1{,}695 * d^2}{\sqrt{\text{Specific Gravity}}} \; scf / hour$$

Dimensions: Wobbe jet diameter in mm
Specific Gravity: Process gas/calibration gas

Example 1:

Wobbe jet Size: 0.55

S.G. Natural gas: 0.642

The Natural gas consumption corresponds to a range of Wobbe Index of:

14000 Wobbe (kcal/Nm³) or 60000 Wobbe (kj/Nm³)

18.1 liter/h

In BTU and cubic feet

0 – 1450 Wobbe (Btu/ft.³)

0.64 ft³/ hour

Example 2:

Wobbe jet Size: 0.85

S.G. Coke gas: 0.422

The Coke gas consumption corresponds to a range of Wobbe Index of:

6000 Wobbe (kcal/Nm³) or 25000 Wobbe (to kj/Nm³)

53.22 liter/h

In BTU and cubic feet

0 – 630 Wobbe (Btu/ft.³)

1.89 ft³/ hour

Example 3:

Wobbe jet Size: 1.85

S.G Blast Furnace gas: 1.032

The Blast Furnace gas / Coke gas consumption corresponds to a range of Wobbe Index of:

1400 Wobbe (kcal/Nm³) or 6000 Wobbe (kj/Nm³)

152,5 liter/hour

In BTU and cubic feet

0 – 150 Wobbe (Btu/ft.³)

5.41 ft³/ hour

3.4. Electrical power supply

CWD 2000 power consumption is as follows

220 Volt 50/60 Hz 1.2 Ah

115 (110) Volt 50/60 Hz 2.4 Ah

The instrument is supplied for operation on 220 or 115 Volts. Conversion to another voltage by the user requires the following items to convert from 220 to 115 Volts:

The air fan must be wired for 115 volts and the frequency converter and the ignition transformer must be exchanged for the correct equipment suitable for 115 volts.

3.5. Measurement ranges

The measurement range can be utilized between 20% and 100% of full scale and is dependant on gas composition. A typical measurement range is between 45 – 100 %. The Hydrogen component in the gas increases the available range area and inert gases like N_2, O_2 or CO_2 reduce the flame speed and the available range.

The unit is capable of supporting a second range and this must be specified as an optional extra at the time of order. In the event of gas change, the unit switches to the 2nd measuring range automatically depending on where it is in the first range. The computer calculates the transition between the first and second range, so that one continuous 4-20 mA DC output signal and display is available over the entire range.

3.6. Ambient temperature limits

The CWD 2000 should be installed in a room that does not exceed minimum and maximum temperature requirements. A typical temperature range is 10°C to 38°C (50 °F to 100°F). Higher (100°F or more) or lower temperatures will require cooling or heating. Maximum and minimum ambient temperatures must be specified prior to commissioning, so that the installation location can be modified if required.

Slow temperature fluctuations are fully compensated by the instrument. Very rapid temperature fluctuations should be avoided since the compensation is always reactive, not pro-active. The analyzer is able to compensate for rapid fluctuations after a specific time (2 to 3 minutes) and steady state conditions return.

An outdoor shelter with climate control can also be supplied as an optional extra.

The CWD 2000 can be equipped with an optional onboard temperature controller for better temperature control of the whole system (environmental temperature – shelter temperature). Heating and / or cooling can be provided depending on the ambient conditions. Cooling is always possible with compressed air, A/C unit or even water.

4. Installation

The CWD 2000 is intended for wall mounting and special wall plugs or brackets have been supplied and four attachment points marked (´Z´) are recommended.

Reinforced members with slots have been mounted on the back of the enclosure, from which the unit can be suspended.

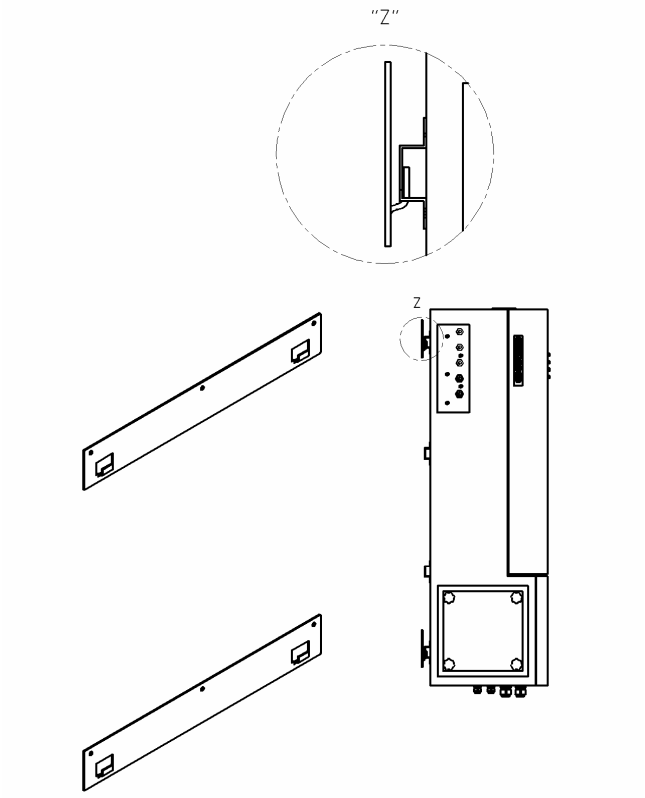


Figure 6: View of enclosure

The unit can also be installed on a freestanding rack and a stainless steel support bracket is available, which must be ordered separately.

4.1. Shelter requirements

The calorimeter shelter is subject to special conditions. How well these conditions are met is of extreme importance for the quality of the measurement. Room temperature changes must be slow. If necessary, only well controlled climate systems should be used.

If an electrical heater is used, the controller should be programmed very carefully.

Direct sunlight from a window should be avoided, since the additional radiant heat will disturb the energy balance in the room.

4.2. Room ventilation

A calorimeter requires approximately 30 m³/h of air. This air must be delivered from outside the enclosure using suitable ventilation. The fresh air should not be connected directly into the unit but should enter the room via a heater or a roundabout route, so that the temperature of the air has time to adjust to the internal enclosure air temperature. With some careful design and attention to a few simple points the possibility for thermal shock can be greatly reduced or eliminated completely.

Note: Sections 4.1, 4.2 and parts of 4.3 are for customer guidance if a shelter has not been purchased from the factory as part of the original order.

4.3. Exhaust gas discharge

The small quantity of flue gas is mixed with 25 m³ of air after combustion and is heavily diluted, with an exhaust temperature around 8-10 °C (15°F) above ambient. Flue gases must be discharged from a flue gas outlet to ensure the thermal balance is not disrupted. This is particularly important with small enclosures or shelters, as air inside may become Oxygen deficient and stale if the supply of combustion air is too small. The very small quantity of sample gas is equal to several pilot lights on a domestic stove and poses no health hazard for most process gases such as Natural gas etc.

With corrosive gases, it is an advantage to generate a slightly higher pressure in the shelter (ventilator or fan), so that all flue gases are discharged from the outlet. Corrosive air in the calorimeter enclosure will result in corrosion in the electronic components. In some cases, it is advantageous for an enclosure or shelter to be purged with clean dry instrument air.

All parts of exhaust system are included with the instrument. All dimensions are in mm. Connect an exhaust tube (not supplied) as shown (1).

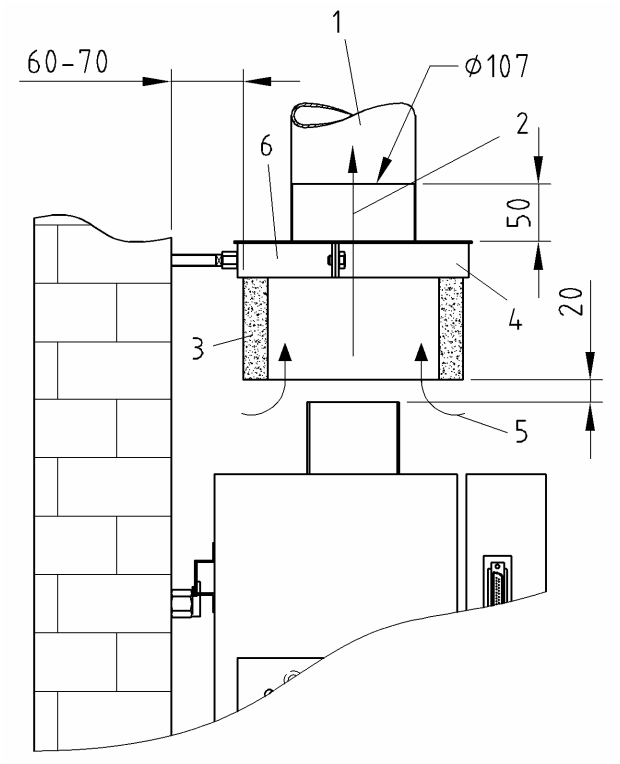


Figure 7: Exhaust gas discharge

1	Exhaust tube	2	Exhaust gas
3	Insulation	4	Mounting bracket
5	Draft break	6	Body SS

4.4. Electrical power connection

The line power supply electrical connections are wired to the terminal block in the bottom section of the enclosure, see drawing figures 1 and 8. Check whether the available voltage supply matches the analyzers rated voltage.

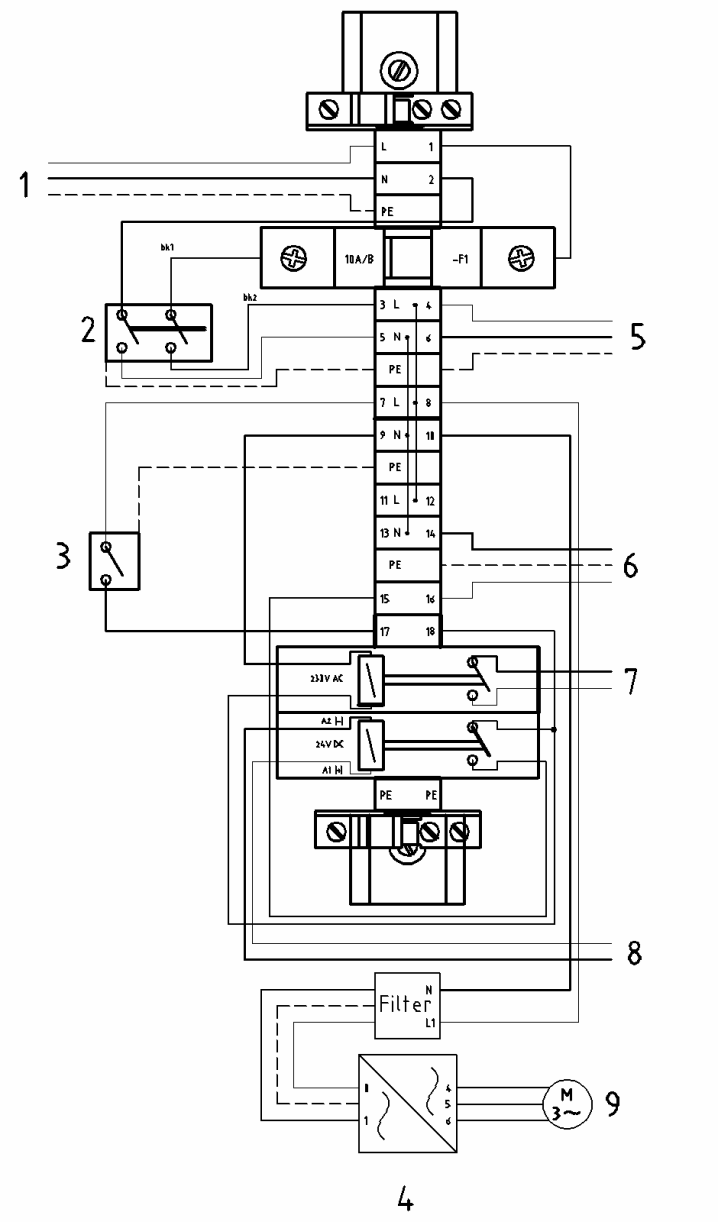


Figure 8: Connector block assembly

1	Main cable	2	Main switch
3	Door switch	4	Frequency converter
5	Power supply	6	Ignition transformer
7	Door switch signal	8	Ignition impulse
9	Fan		

4.5. Gas connections

All gas connections should be leak tested before use. Tube compression fittings are normally supplied and up to 5 gas connections are possible if all options including process gas, 2 calibration gases, carrier gas and fast loop are specified.

4.5.1. Process gas filters

Two types of gas filters are recommended. Natural gas and other clean gases need a filter with small internal volume. Filter elements need to be changed occasionally and a pressure gauge can be used to check filter “back pressure”. The mA hold function can be activated before the filter change to provide a continuous output signal during filter maintenance. Be sure to cancel memory hold after use.

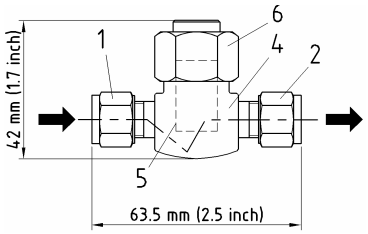


Figure 9: Small filter

1	Input ¼” (6 mm) Gyrolok	2	Output ¼” (6 mm) Gyrolok
3	Removable element cap	4	Filter body 316 SS
5	Filter 20-30 µm		

Dirty gases need a filter with a larger volume and this will increase dead time.

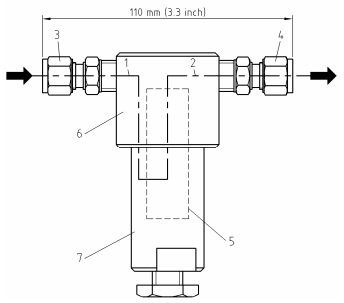


Figure 10: Filter with drain connection

1	Filter inlet	2	Filter way
3	Inlet ¼” (6 mm) Gyrolok	4	Outlet ¼” (6 mm) Gyrolok
5	Filter 99,8% at 0,1µm	6	Filter cap
7	Filter housing 316 SS		

(7) Filter volume: 23 cm³ (0.00081 ft³ or 1.4 cu. inches)

4.5.2. Pressure Regulators

Good pressure regulation is very important for measurement stability. Four different pressure regulators for different applications (and markets) are recommended as options and short description is provided for each regulator in the following section. The outlet pressures range between 20 mbars and 55 mbars. (10”-24” H_2O) depending on type. Gas pressures higher than 6 bars (90 PSI) need a primary regulator to reduce the pressure to the inlet of the pre-pressure regulator.

The standard analyzer consists of one process gas inlet and one calibration gas inlet and both inlet ports require a pre-pressure regulator. All connectors are mm or inch.

Adjust the process gas and calibration gas regulator outlet pressures to read the same pressure when gases are switched, this is important for measurement stability.

The first regulator, Maxitrol 325 < 700 mbar (10 PSI) inlet pressure has an aluminum body and internal parts of steel and elastomers. Two control springs are available:

Violet: 10-30 mbar and Red: 25-55 mbar.

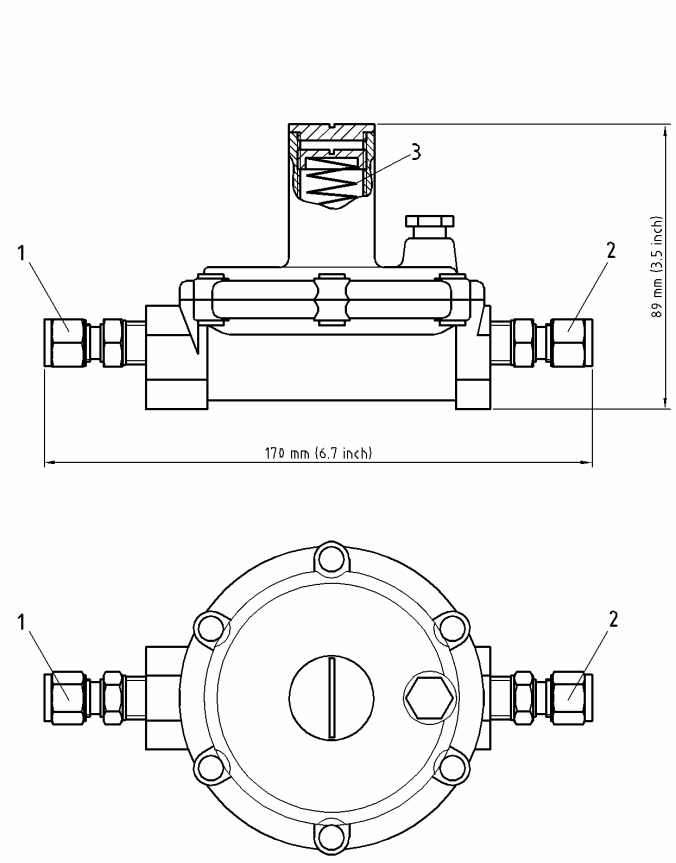


Figure 11: Maxitrol 325 pre-pressure regulator < 700mbar (10 PSI)

1	Inlet ¼”(6 mm) Gyrolok tube	2	Outlet ¼”(6 mm) Gyrolok tube
3	Control spring		

The second pre-pressure regulator < 6 bar (90 PSI) has an zinc die-cast body and internal parts are made of steel and elastomers. Two control springs are available.

12 - 25 mbar. (10" H_2O) orange

30 mbar. (20" H_2O) blue.

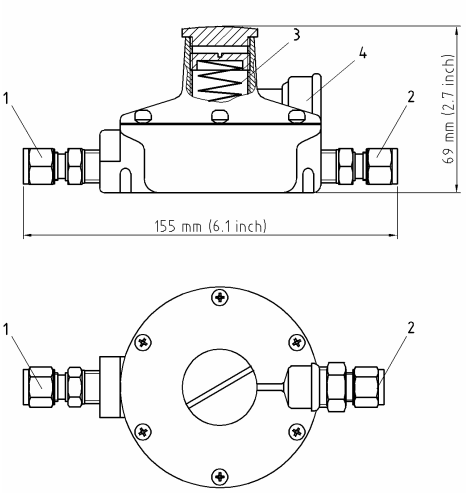


Figure 12: Fisher 912 pre-pressure regulator < 6 bars (90 PSI).

1	Inlet ¼(6 mm) Gyrolok tube	2	Outlet ¼(6 mm) Gyrolok tube
3	Control spring	4	Vent

The next unit is a primary regulator < 250 bars (3600 PSI) type GO PR1 has a 316 SS body and gauges. The outlet (2) pressure is adjustable from 0– 3.4 bar. A pre-pressure regulator is still necessary and acts as a second stage inlet pressure control for the CWD 2000.

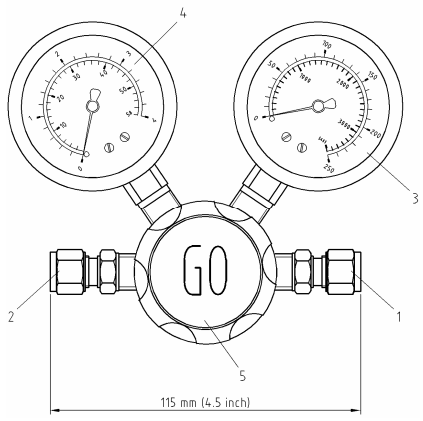


Figure 13: High-pressure regulator GO PR1 < 250 bar (3600 PSI)

1	Inlet ¼" (6 mm) Gyrolok tube	2	Outlet ¼" (6 mm) Gyrolok tube
3	Gauge high pressure	4	Gauge, low pressure
5	Pressure control wheel		

The last is a primary regulator < 250 bar (3600 PSI) with a 316 SS body and gauges adjustable outlet pressure from 0 – 3.4 bar and has a gas cylinder CGA connection.

Hydrocarbons	W 21.8 x ¼“ left.	DIN 477 Nr.1 or CGA sized fittings.
Mixed gas	M19 x 1.5 LH	DIN 477 Nr.14 or CGA sized fittings.

A pre-pressure regulator is still required after the high-pressure calibration gas cylinder regulator, for two-stage inlet pressure control.

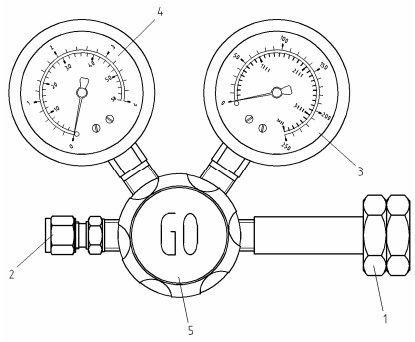


Figure 14: High-pressure regulator GO PR1 < 250 bar (3600 PSI)

1	Inlet connection to suit gas cylinder	2	Outlet ¼”(6 mm) Gyrolok tube
3	Gauge high pressure	4	Gauge low pressure
5	Pressure control wheel		

4.5.3. Sample gas pump

If the process gas inlet pressure is lower than recommended then a sample gas pump should be installed to boost the sample gas pressure. Gas at higher pressure can then be regulated, so that the recommended gas pressure is maintained at the sample gas inlet (see section 3.2). The pump must meet the requirements for flow and installation area classification. See Chapter 11 for more details.

4.5.4. Carrier gas Support

Process gases with a high level of inert gas will not burn with a stable flame and these poor quality gases need a carrier gas support for combustion

Typical carrier gases include Natural gas, Methane, LPG gas or Hydrogen. These gases have a steady calorific value that is calculated as a scaling factor.

Oxygen is a non flammable carrier gas that supports combustion without adding calorific value. Typical flow of carrier gas is 3 – 5 Liter /h. The software is configured at the factory. See Section 6.2.1.3.8. For mechanical installation see section 11.5.3. The carrier gas support option needs to be installed at the factory, as it is difficult to retrofit the system after delivery.

4.5.5. Fast Loop connection

For a more rapid response time, a fast loop connection can be provided. A T-piece with a pressure regulator and a flow meter is inserted before the calorimeter and the excess gas sample is piped to a lower pressure location or a vent header. The dead time can generally be reduced by a factor 1:5 and this normally depends on the gas type and the pressure ratios in the sample tubing. See section 11.5.3 for more details.

4.6. Interfaces

A range of electronic devices can be connected to the CWD 2000. The analyzer can be operated using a plug in mouse and a standard PC keyboard with PS2 connector.

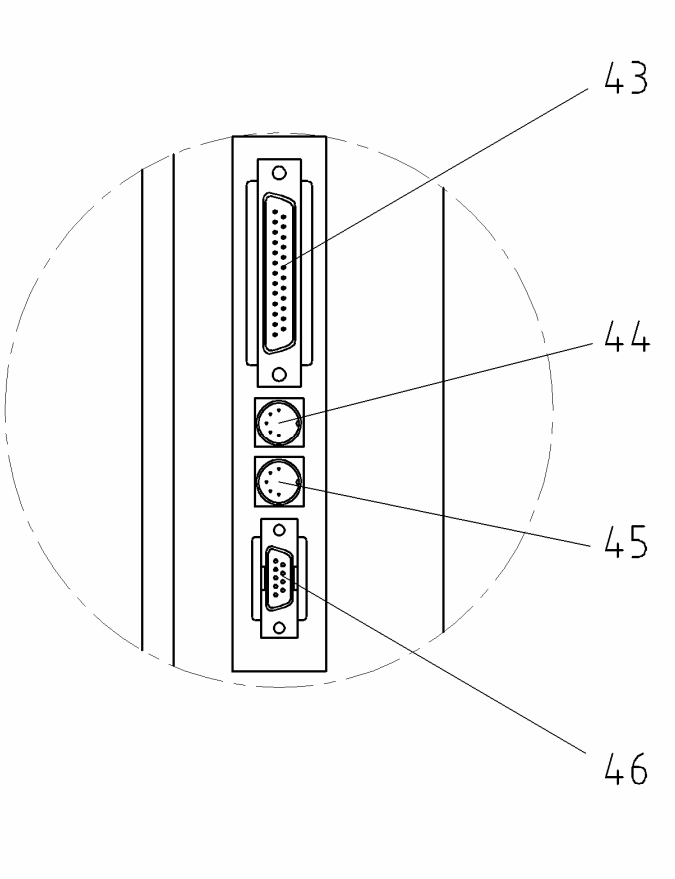


Figure 15: Interface connection on the left-hand side of the main door

43	Parallel printer interface	44	Mouse interface
45	Keyboard interface	46	VGA Display Monitor

5. Commissioning

When all electrical and gas connections have been completed and tested in accordance with all instructions, codes and regulations then the instrument is ready to be powered up.

The following work must be carried out when commissioning the unit:

Remove the transport tie wraps and transport screws from the specific gravity cell. The body of the cell must hang free on the springs and not come into contact with the sides of the bracket. The screw should be removed and stored and the following diagram illustrates the process.

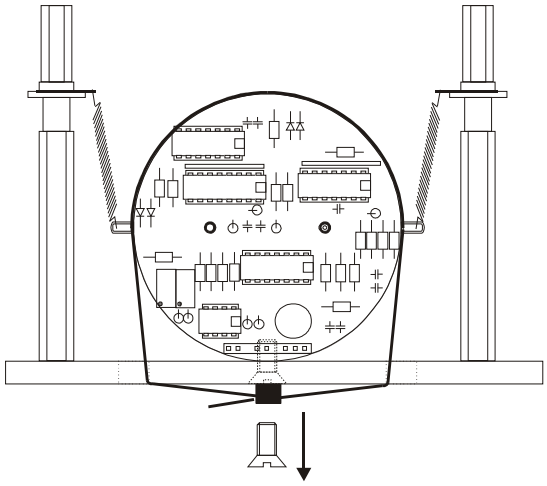


Figure 16: Specific Gravity cell shown locked for transport

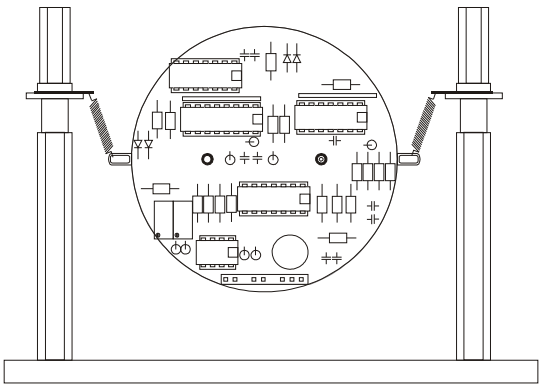


Figure 17: Specific Gravity cell shown in its operating position

Remove the transport packing from the gas pressure regulator. Polystyrene foam is located beneath the removable regulator cover and must be removed before use.

Check the process and calibration gas connections for tightness and correct connection. Check any carrier gas or second calibration gas connection if supplied.

Switch on the power switch. After a short delay while the unit powers up, the main screen will illuminate. An information field in the top right hand corner will show status. After a short purge period the gas valve will open and the ignition will start automatically (Note: This is only possible with the door closed as a safety switch inhibits ignition with the door open). Once the flame is lit, the door can be opened without creating a flame out condition.

The device will start up and after short warm-up period (20-30 minutes during first commissioning from cold) will reach the correct process gas calorific value.

All software, measuring ranges and any other specified options have been pre-set at the factory (see datasheet and floppy disk supplied with the unit).

Following start-up, the gas pressure gauge (red) will read 4 mbar, and the cooling air differential pressure gauge (blue) will also show 4 mbar. If the gas pressure needs adjustment add or subtract weights from the precision weight loaded regulator. The air pressure should need no adjustment by the user, as control is by the variable speed air fan. Check the specific gravity differential pressure gauge (red) reads 4 mbar and adjust if necessary, see section 9.2.4 for more details. All gauge pointers should read zero with no pressure applied and this should be checked before use.

After the warm-up period, the instrument will show the Calorific Value, Wobbe Index Value and Specific Gravity, numerically in the display and a visual trend will be developed onscreen.

The menu system is described in Chapter 6, and this describes how the user enters their application specific values into the various menus. Be sure to read this chapter to gain some familiarity with the equipment before any ad-hoc experimentation or adjustment to the menus.

If the unit should fail to power-up, open the main door and check inside the door that the power supply ribbon cable connections are firmly attached to the power supply as sometimes these have detached during rough shipment and handling.

If questions arise during start-up contact the factory with serial # for further advice.

The unit is supplied factory calibrated and field calibration should only be attempted by users, with a source of calibration gas with known values.

See section 6.2.1.2 for more details.

Check the calibration gas data and enter the values in the correct menu. If only the gas component percentage is known, the correct Wobbe Index value must be calculated from the individual components. The use of cylinders with vendor supplied certified values for BTU and Specific Gravity is recommended as the accuracy of the calibration depends on the accuracy of the gas standards used for calibration.

6. Air Consumption (Option)

It is possible to measure air consumption with a calculation model or with a additional measurement of CO with an integrated IR Card.

6.1. Calculated Air Consumption

The air consumption can be determined with a correlative formula with the variables of specific gravity and heating value. The dimension is Nm^3 air pro Nm^3 process gas The air consumption can be displayed on the screen and an output of 4-20 mA is available.

6.2. Air Consumption with CO measurement

CO contents in the process gas not allow only a calculation of the air consumption. Variable content of CO needs an additional measurement of CO. this is the only way to reach exact values of air consumption.

It is possible to install a CO-module in the CWD 2000. The module is delivered separately and has to be installed before the instrument is started. The CO measuring cuvette is sensitive and could possibly be damaged if it was installed during transportation. The direction of the installation is indicated.

Parallel to the density measurement the CO part in the process gas is detected with an infrared measurement in the CO-module. From the caloric value, the density and the CO part of the process gas the air requirement is correlatively calculated.

The air requirement is presented as a 4-20 mA signal. The CO proportion is displayed in the upper right window of the screen. Both values may also be Bus interrogated by a Bus, if a Bus interface (for .ex. Profibus) is activated.

The CO-Module is tested with a separate calibration gas (combustible 0-Gas with the same Wobbe Index as the second calibration gas but without CO) and adjusted to zero. The second calbration gas contains a CO proportion to calibrate the span of the CO-Module as well as the complete instrument in the described configuration. The calibration procedure is full automatically.

At delivery the two calibration gases are defined by the factory and the customer will be informed. The CO-module needs no more adjustments and is completely maintanance-free. The central processor of the CWD 2000 takes care of the calculation of the value. It also detects if a module is installed or not. The CO indication is only active when a module is installed.

The calibration procedure cycle consists of 3 steps. After the start the calibration 0 – gas is connected to the inlet and the zero cal. point for the CO measurement is defined. After that the calibration gas with known CO part is connected to the inlet and the span of the CO module is adjusted. Following the normal calibration procedure of the CWD 2000 is started.

In menu point 7.1.1.2. at position 7 und 8 the values for IR Zero Cal and IR FS Cal are entered. In case these values are deleted, the CO-module will not be calibrated.

Important : Only the calibration gases subscribed by the factory may be used. Other gas compositions will result in an incorrect calibration of the instrument.

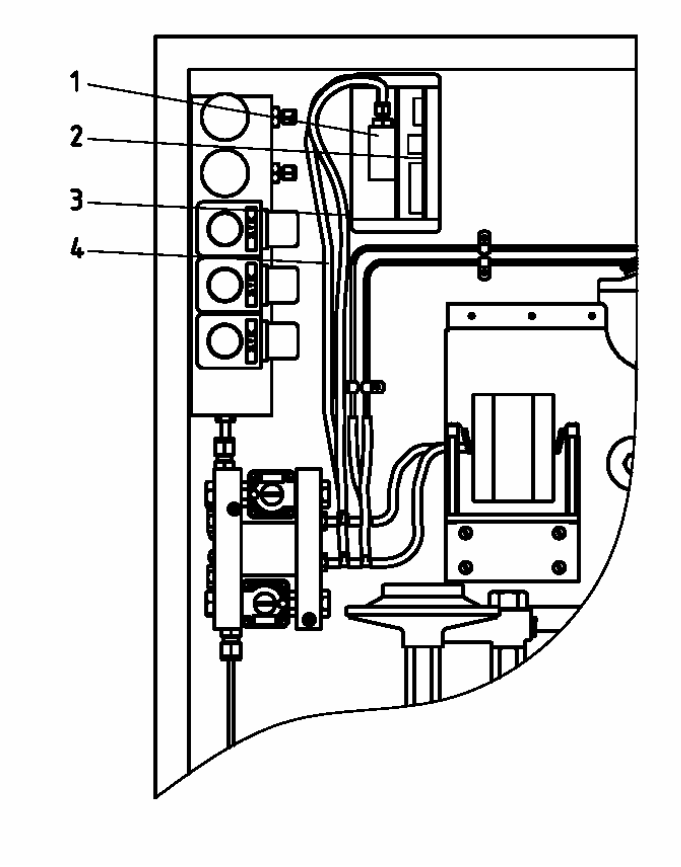


Figure 18 CO-Module installed in the CWD 2000

1	CO Measuring cuvette	3	Gas inlet
2	CO Module	4	Gas outlet

Gas inlet and gas outlet to the module may be inverted. There is no flow direction dictated.

In the following the menu system is described to make it possible that the customer can install specific applications.

7. Software

Attention: This Manual is based on software release version 1.22.

The Software consists of a number of menu levels, which can be accessed using the membrane keypad. All operations are similar and are entered via a series of interactive menus with user dialog boxes, system prompts and activity messages.

An on-screen mimic along the bottom edge of the display adapts to the changing requirements of all the corresponding menus and redefines keypad function.

The menu buttons (1) always leads to the next higher menu level. The menu button (5) always returns the user to the start menu regardless of menu level.

When addressing the software interface please allow one second between keypad commands.

7.1. Screen and Keypad layout

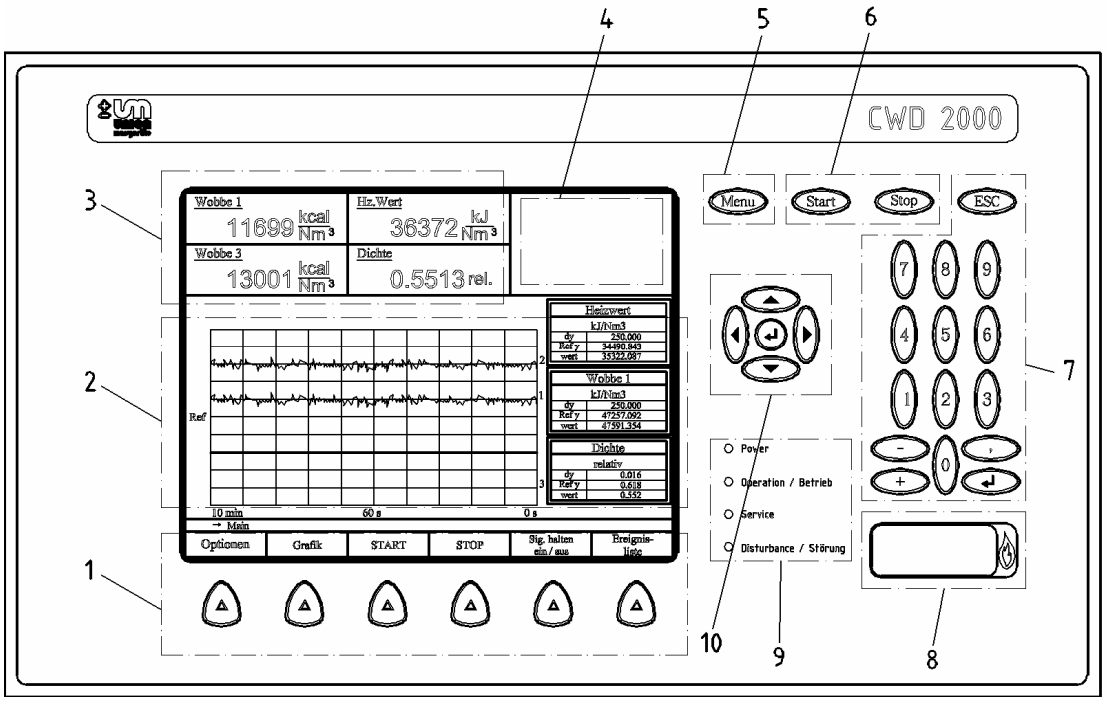


Figure19: Display screen and Keypad

1	Menu keypad	6	Start/Stop
2	Trend display	7	Numeric input keypad
3	Numeric display	8	Flame status window and LED
4	Information field	9	Operating status display LED's
5	Return to main menu	10	Arrow and data entry keypad

7.1.1. Menu keypad

The menu keys are described in the software section and the function depends on the menu currently displayed and the function changes from menu to menu.

7.1.2. Trend display

The trend display shows the both the trend and the interactive screens of the other menus. An area is also dedicated to the display of current operating information

7.1.3. Numeric display

The numeric display is for the display of measured values and units of measurement.

7.1.4. Information field

The info field provides a lot of information: Time, operating mode, solenoid status and also software version and other variables depending on the menu displayed. Additional information is available depending on the specific menu section.

The lower section of the info field is reserved for internal information. The first line is the mV signal from the thermopile. V is the signal in Volts from the specific gravity cell. T1 is the air temperature in °C at the thermopile entrance. The next value is the differential temperature of any change in incoming air temperature. The next value is p for differential air pressure. Fr is the current frequency of the fan speed controller and this value is helpful to monitor the condition of the air filter. Stab. = signal stability value. During calibration the CWD 2000 determines the calibration duration based on current stability verses a pre-set stability value of < 0.15 to complete the calibration cycle and this level ensures that a stable calibration endpoint is reached. Info field is an important source of information when logging troubleshooting data.

7.1.5. Menu

Return to the main menu regardless of menu or level, also updates system memory.

7.1.6. Start/Stop

This key shuts down the system without switching the main power switch off. The fan can be programmed for a delayed shutdown. This option can be activated in menu 6.2.1.3.1. The key also enters the data in the system memory.

Note: A system update is performed by the system every 15 minutes.

7.1.7. Numeric keypad

For data input and escape from a menu (the “comma” key is the decimal point).

7.1.8. Burner window

The burner provides heat to the thermocouples of the thermopile. The flame status uses a red LED, steady = flame ok, flashing = flame out. The system needs a stable symmetric blue flame for a stable measurement.

7.1.9. Status display

Status display comprises of 4 LED´s.

Power: Light for power on.

Operation: In normal operation the LED flashes.

Service: Indicates the need to change the filter element. The upper or the lower limit of the frequency controller has been reached.

Disturbance: Indicates a fault alarm condition.

7.1.10. Arrow and data entry keypad

Move the cursor in the different menu screens and the yellow center key enters data.

7.1.11. Data input

There are “value” fields and “list” fields, which can also appear in each dialog box.

7.1.11.1. Value fields

In the value field the numerical values can be entered with the number keys. Using the arrow keys, you can move on to the next numerical field. The position can be changed in the field menu line by using the arrow keys. Use the escape option to delete any unwanted changes.

7.1.11.2. List fields

In list field, the multiple choice, text based field content can be selected by the user with the menu keys <back><next>. Confirm the entry of a new item using Enter or the Arrow Keys, which lead to the next menu and text field.

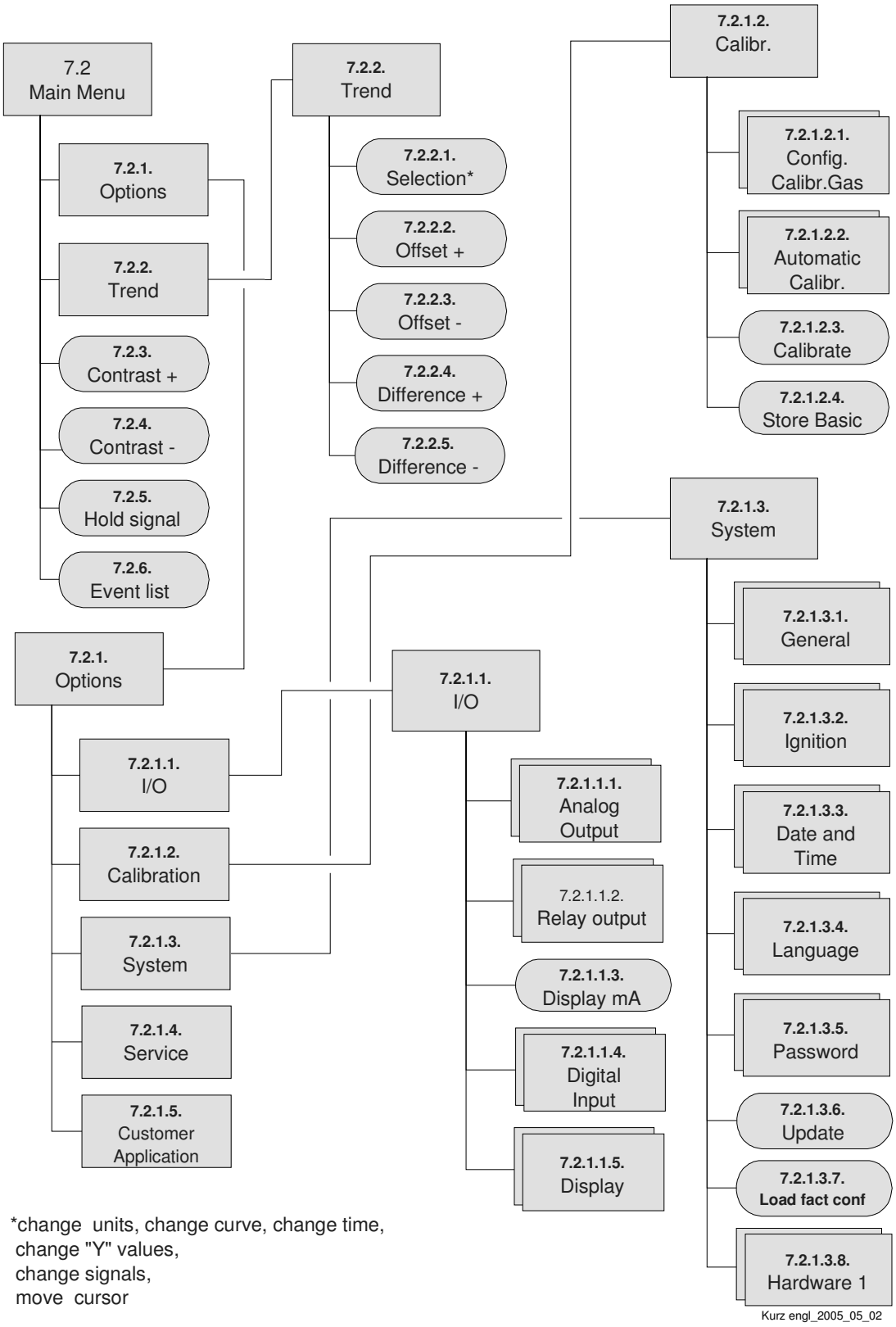
7.1.12. Keypad

The keypad operator matrix is polled by the microprocessor once per second and pressing the button faster than one second will receive no system response.

7.1.13. Menu Navigation

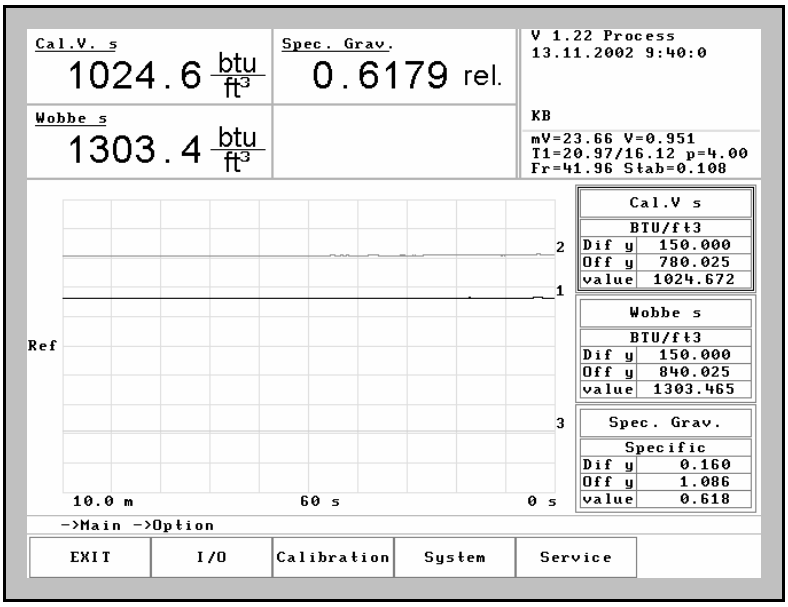
The block diagram shows three different shaped menu areas. The simple square areas indicate that there are more menu levels. The rectangle with the rounded corner indicates that menu is at the lowest menu level. The double square indicates the location of an interactive input screen for value or data fields.

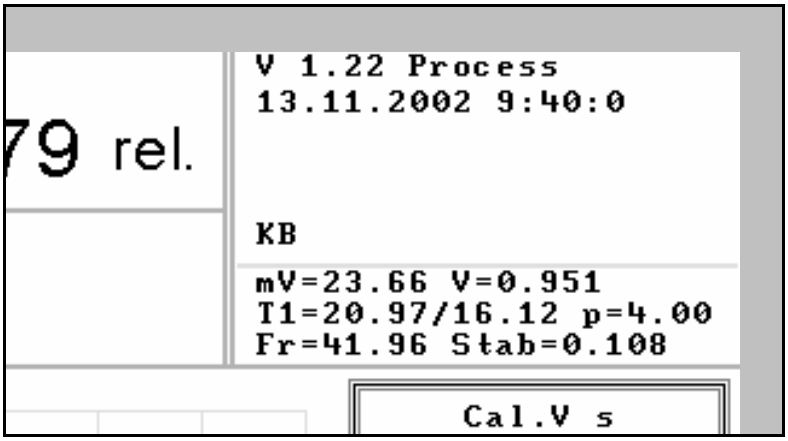
7.2. Menu Overview



7.2.1. Options

The Options menu contains all of the following menus:





The Info field is right ahead on all screens. It shows actual information. Aditionally actual measuring datas are indicated which belong to the actual menu. In every individual screen are different information available. The description is made in the special section in this manual.

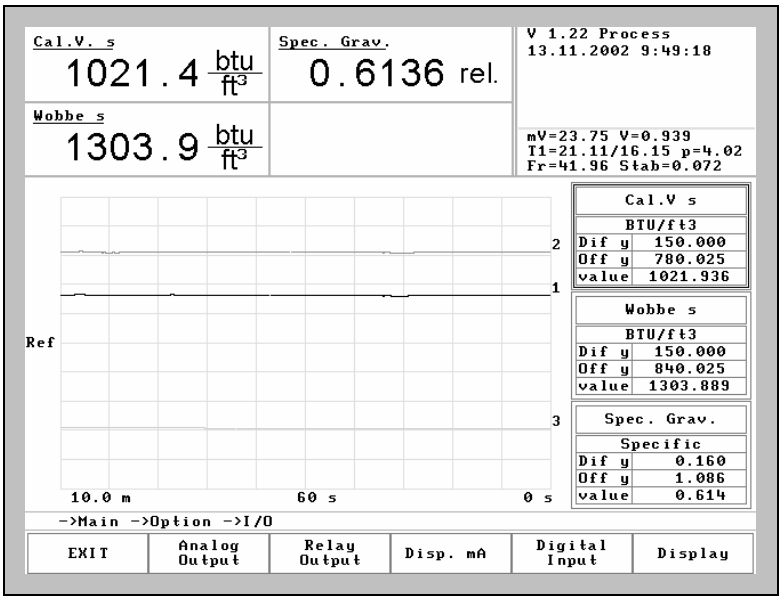
1. V 1.22 version number of soft ware
2. Instrument runs on proces gas. During a calibration indication switches to calibration
3. Actual date and time
4. KB key board activ

5. 23,66 mV signal of the thermopile
6. 0,951 volt signal specific gravity cell
7. T1=20,97/16,12 input Temperature in the thermopile in relation to heated air (differential temperature)16,12 °C.
8. 4,00 (mbar) differential pressure air
9. Fr = 46,91 controlled frequency of the fan
10. Stab = stability, standard deviation of the measured value average over 2 min

This information is important for a successful calibration. A typical value at the end of calibration is less than 0,11. Under this value calibration is finished.

The free area of the info field is filled up with useful information in different menus for example filter changing over temperature etc.

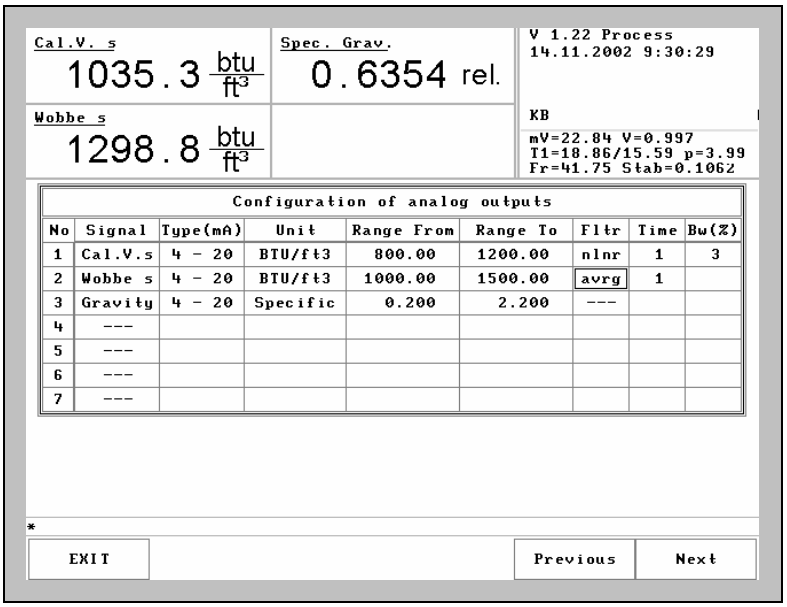
7.2.1.1. Input/Output I/O



Inputs and outputs can be linked together in any order. In the software, multiple identical outputs for a single measured value can also be programmed.

For example: 3 outputs for Wobbe Index or 2 outputs for Specific Gravity etc. 3 remote contact inputs and 4 numeric screen displays are provided.

7.2.1.1.1. Analog outputs



The following items listed below can be selected from a series of multiple-choice lists and the user can define the allocation order of the analog outputs and other data. Example: Wobbe = Number 1 or 2 or 3 etc. Cal. V. = Number 3 or 2 or 1 etc.

Signal is a multiple choice scrolling list field with the following text entries:

Calorific Value; Wobbe, < Wobbe >, Specific Gravity, CV net <or gross>.

Type is a list field with the following entries: 0 – 20 mA or 4 – 20 mA

”Unit” is a list field with the following contents:

Calorific: BTU /ft^3, kJ/Nm^3, MJ/Nm^3, kWh/Nm^3, kcal/Nm^3, kJ/Sm^3, MJ/Sm^3, kWh/Sm^3

kcal/Sm^3,

Specific Gravity: specific to air (1.0), absolute kg/Nm^3

“Range from” – “Range to” are value fields for numerical inputs.

Note: Items shown below are reserved for special output filtering applications and have no effect on display speed or trending and are not normally used.

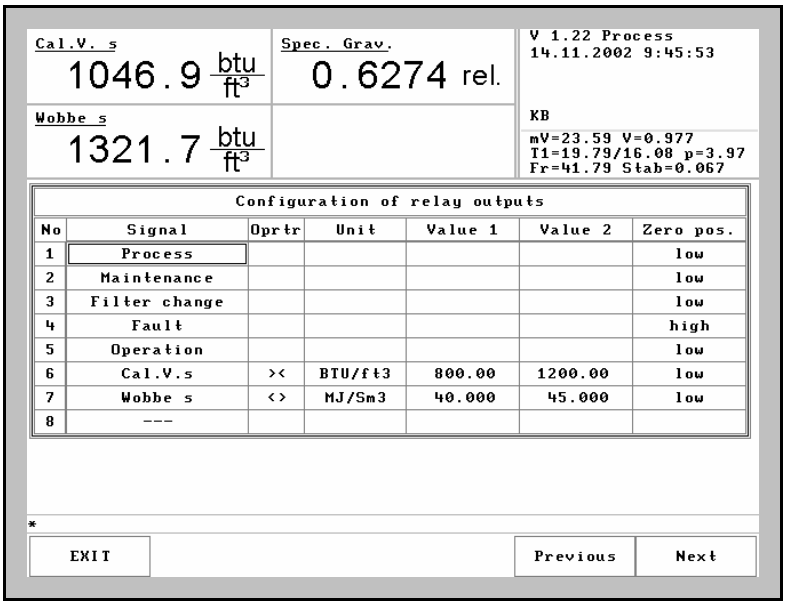
Filters: “ avrg”: mean value filter or “nlnr”: non-linear filter.

Time: Filter time constant - adjustable over a selectable time period.

Bw %: Rejection band of a non-linear filter in %

Within its bandwidth, the filter acts as a delay with a R/C time constant and changes greater than the rejection band are allowed to pass through the non-linear filter.

7.2.1.1.2. Relay output



The relay output configuration menu consists of signals in combination with threshold values or operating status messages. If an alarm is triggered a message will appear in the information field and the fault LED on the door will light.

Signal is a list field. Wobbe, Calorific Value and alarm messages can be selected.

Operation will show < > if an alarm value is programmed.

Unit and Value 1 and Value 2 fields contain configurable operating data.

Example No.6: The Wobbe i signal in MJ/Nm^3 has an alarm value at 47.000 and 50.000 units. The zero position is high.

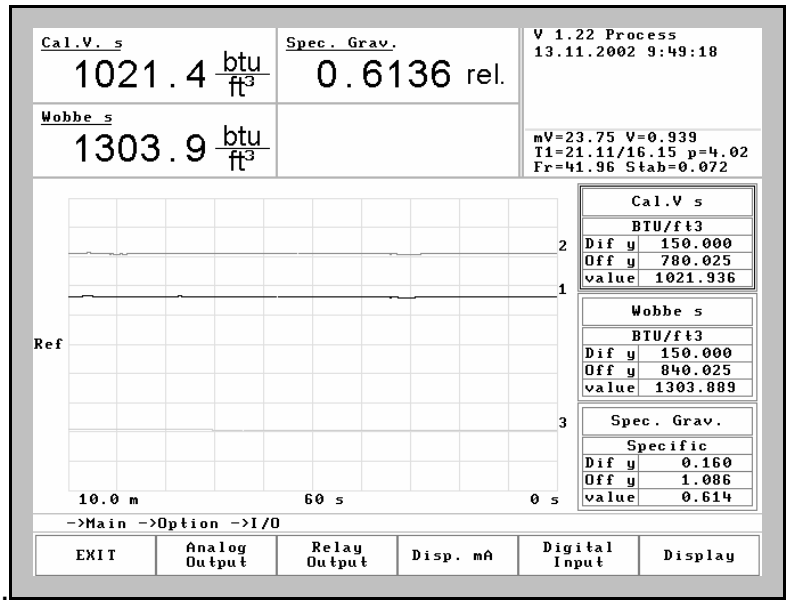
Note: Zero position low = no power applied to relay coil in normal operation.

Zero position high = power applied to relay coil normal operation.

Eight normally open or normally closed contacts are available. (See section 10.2.1).

7.2.1.1.3. Display mA

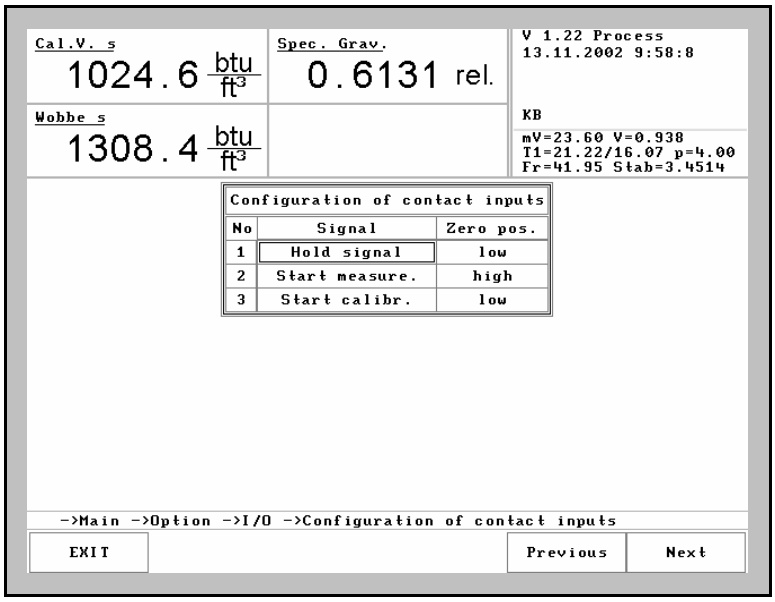
This menu displays the mA output of each of the installed output modules in the information display. In the screen example, the first output is selected (using the “Display mA” key) and indicates 20 mA. Up to seven outputs can be installed. This feature can be helpful for output signal loop tests to remote equipment.



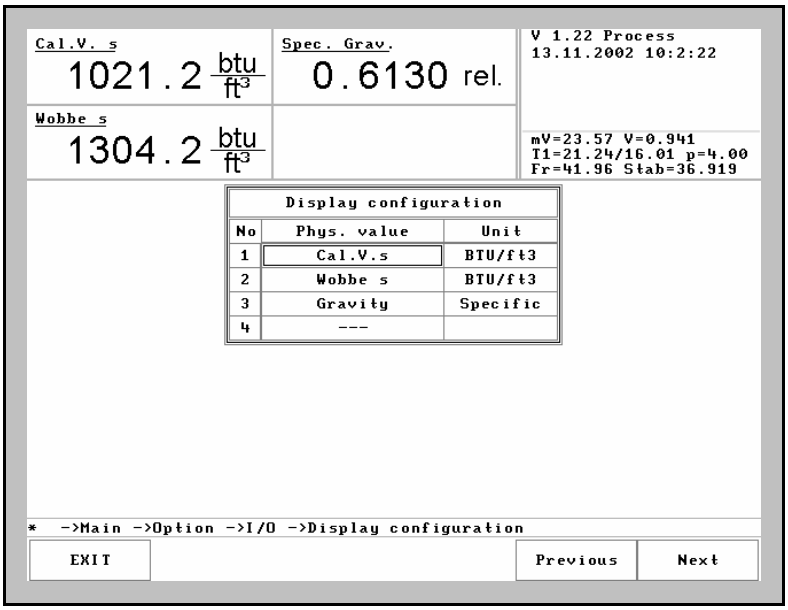
7.2.1.1.4. Digital inputs

Signal and zero position are multiple choice list fields. These inputs can start a calibration cycle, or switch on and off an output hold module. The inputs are polled once a second and any change of status must apply for at least one second to be recognized by the system.

Configuration example: On the connection board E/A external, the 3 remote digital contact inputs; Start measurement, Start calibration and Start hold are connected to terminal block number X3, on terminals 1 to 6. (See Chapter 10 for wiring details).



7.2.1.1.5. Display



Physical value and Unit are list fields. They determine the numerical display on the user configurable display screen. In the example, Specific Gravity, Wobbe Index and Calorific Value are displayed on screen and the fourth screen value remains blank and no values are displayed.

7.2.1.1.6. Pressure sensors (Smart Calorimeter)

On this model a series of pressure sensors replace the Dwyer gauges to monitor gas pressure for the wobbe jet and the specific gravity cell differential pressure.

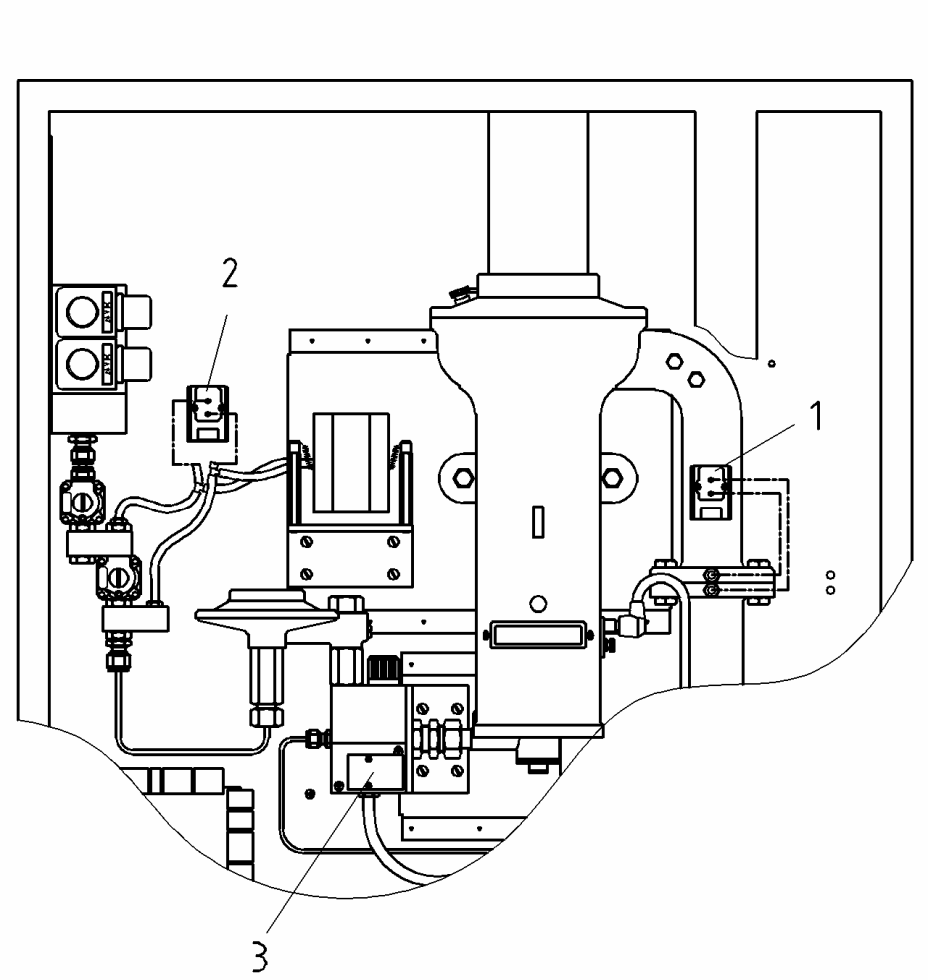


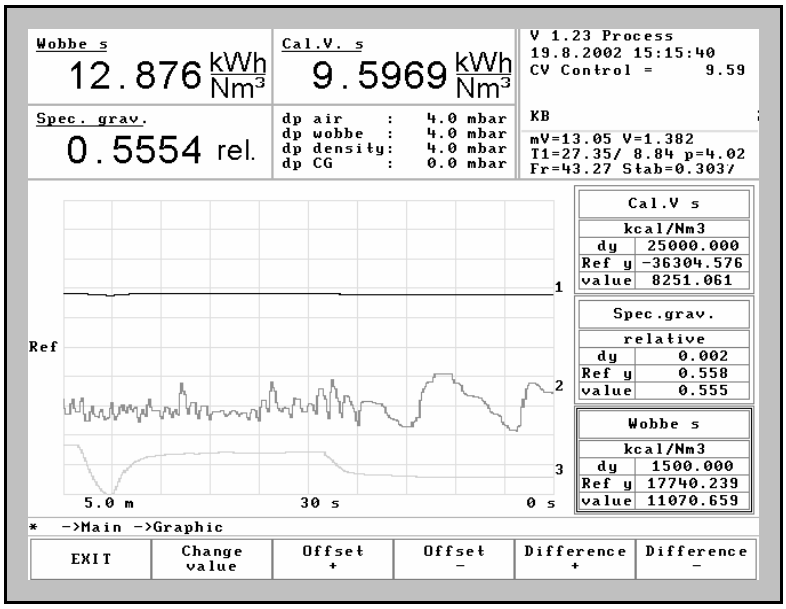
Figure 20:SMART p-sensors

1	p sensor diff air	2	p-sensor gas
3	p sensor diff S.G.	4	p-sensor carrier gas *

Item 4 marked with "*" is an option and not shown in this drawing .

When the pressure sensor option is installed, the fourth display area can be configured to show the pressure sensor readings. The standard version displays cooling air differential pressure in the information field as shown below p = 4.02.

The fourth value (dp CG) is for carrier gas differential pressure when this option is supplied. All 4 values for pressure are all displayed in mbar and they are configurable to be displayed in any of the 4 display areas.



7.2.1.2. Calibration

Calibration for CWD 2000: Calibration data is entered as Wobbe Index and Specific Gravity values. The standard analyzer will have one measuring range and will require one calibration gas.

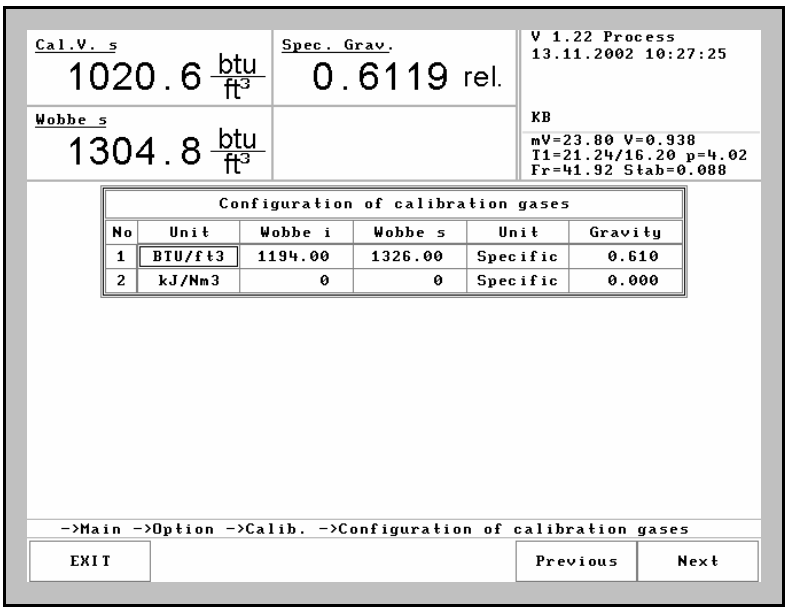
For a dual or three measuring ranges configuration, 1 or 2 calibration gases are required. This depends on how far the two measuring ranges overlap. If the overlap is large, a single calibration gas is usually sufficient. This is determined on an application basis during final calibration. All analyzers with the carrier gas option calibrate during operation on carrier gas and again using both carrier gas and process gas to establish correct calibration in all modes against calibration gases.

Dual sample stream analyzers usually use a single calibration gas.

Calibration for W 2000: The W 2000 is supplied without a density cell and does not require a specific gravity input. Enter “0” in the density field display because if there is a number entered, the software will try to calculate to calculate the specific gravity and calorific value using this number.

Note: This feature can also be useful when measuring process gases with very steady specific gravity using the W 2000. Instead of entering the specific gravity as “0”, enter the expected specific gravity of the process gas. The W 2000 will then display the current “correct” wobbe index measurement and the customer entered “fixed ” value of specific gravity and use this to calculate a calorific value based on the real wobbe index value and customer entered estimated specific gravity data.

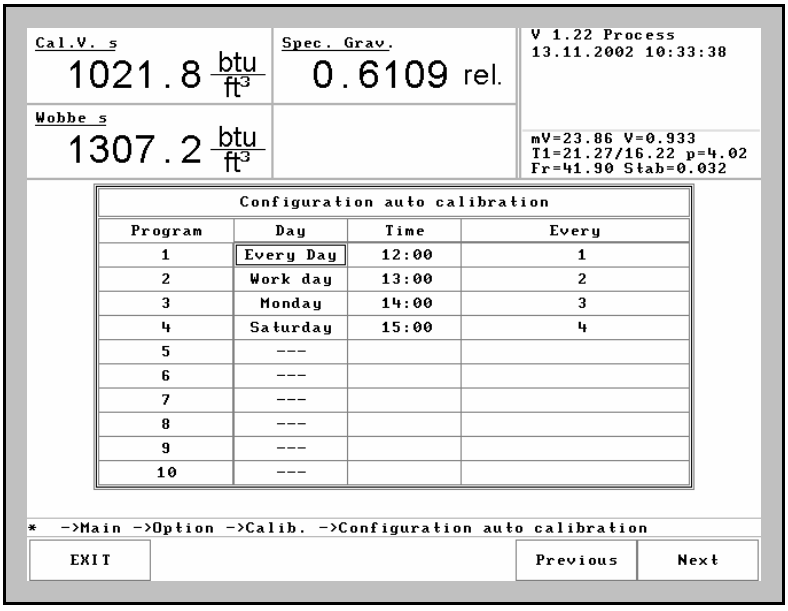
7.2.1.2.1. Configure Calibration gas



Calibration gas data is entered as a Wobbe Index and Specific Gravity number. If the gas vendor has only supplied the component % then the user must calculate and enter these three calibration gas values from the components of the calibration gas.

A small software program can be obtained from the factory, which can also be downloaded from the Internet homepage listed in front of the users manual. This includes most of the gases found in many common process gas streams and this utility will help speed and any necessary calculations.

7.2.1.2.2. Automatic calibration



Day is a list field (Sun, Mon, Tue, etc.). Time and Cycle are value fields.

Program 1: Calibration every day at 12.00 hours.

Program 2: Calibration every workday at 13.00 hours.

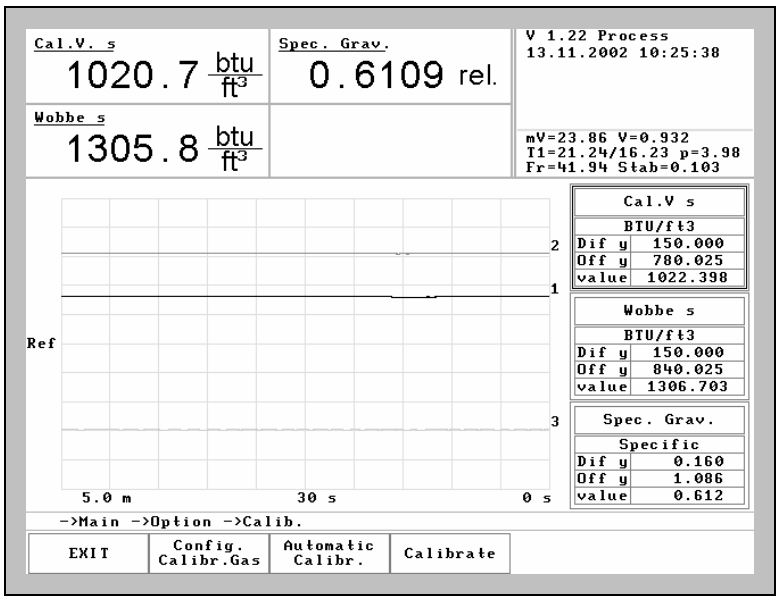
The calibration gas purge time duration is adaptive and automatically selected by the software. The instrument looks for end-point stability and this is normally achieved in 6 to 10 minutes, depending on the gas type. After a short period of operation (about 5 minutes) at a value below the programmed stability number, the instrument then calibrates and automatically switches back to the process gas. If the required stability is not achieved, the calibration cycle will be aborted after a selected period (usually 10 minutes). A failed calibration will be recorded in the event list and may indicate a maintenance condition has occurred.

Warning: Air can become trapped in the gas supply tubing during installation. Purge the lines before first calibration or after changing the calibration gas cylinder. The “Start calibration” command may need to be executed several times.

7.2.1.2.3. Calibrate

This menu item starts the manual calibration cycle and will override any programmed auto calibration for this one time only. The next auto calibration cycle will then start normally as programmed by the user.

Manual calibration uses the same routine to verify readings as auto calibration but automatically adds a memory hold function that allows manual calibration to be performed by the user at any time, without a spike in the output signal. If an output signal hold is required during auto calibration, the user can select the hold function with the keypad from the main menu, a “hold signal on” message will then appear in the information field to alert the user that this feature is now active.



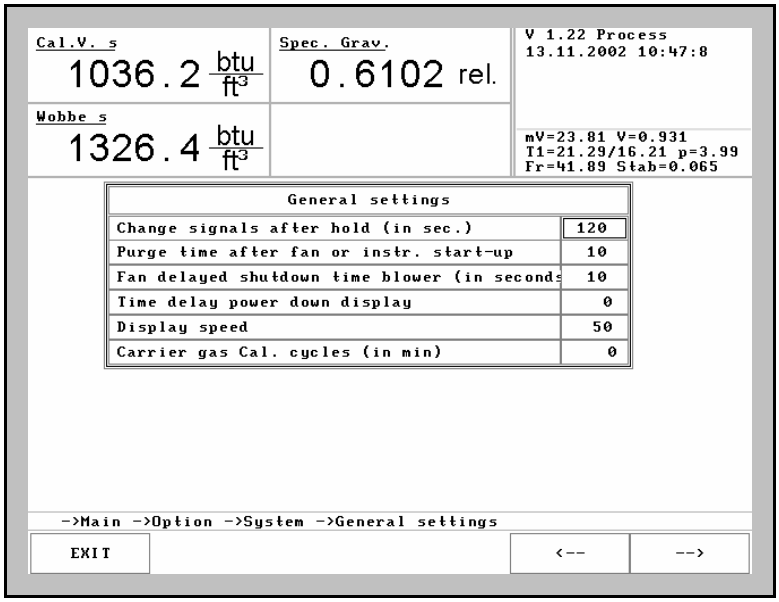
7.2.1.3. System

This menu item contains the following basic analyzer configuration parameters.

7.2.1.3.1. General

Change signal after hold provides in a soft transition to and from the calibration cycle or when switching off the output signal hold module. This prevents a sudden rise or fall in the measured value occurring in output signal. The transition between values is shown in seconds and this allows the signals to blend together for a smooth transfer.

“Purge time” purges the unit with air from the fan prior to ignition. The delayed shutdown of the air fan following a shut down removes any residual heat from the system and the shutdown of the fan saves energy and filter life. A value of “0” will run the cooling air fan continuously and the unit is ready for immediate use after a restart.



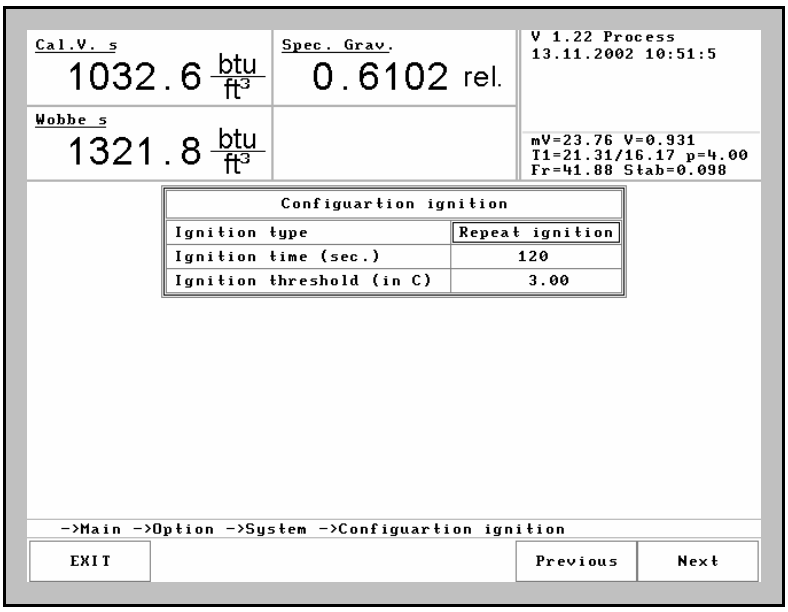
When selecting “Delayed shutdown” the air fan can be switched off after the time shown in seconds. In the example, the air fan will run for a further 30 seconds after process gas shutdown before the fan shuts down automatically. (With a delayed shutdown value of 0 the air fan to run continuously).

“Time until power down display” determines the time before entering the screen saver mode after a period of keypad inactivity.

“Display speed” is the response speed time constant. This value is preset at the factory and differs from gas family to gas family and measuring ranges.

“Carrier gas Cal cycles” determines the carrier gas calibration cycle in minutes.

7.2.1.3.2. Ignition

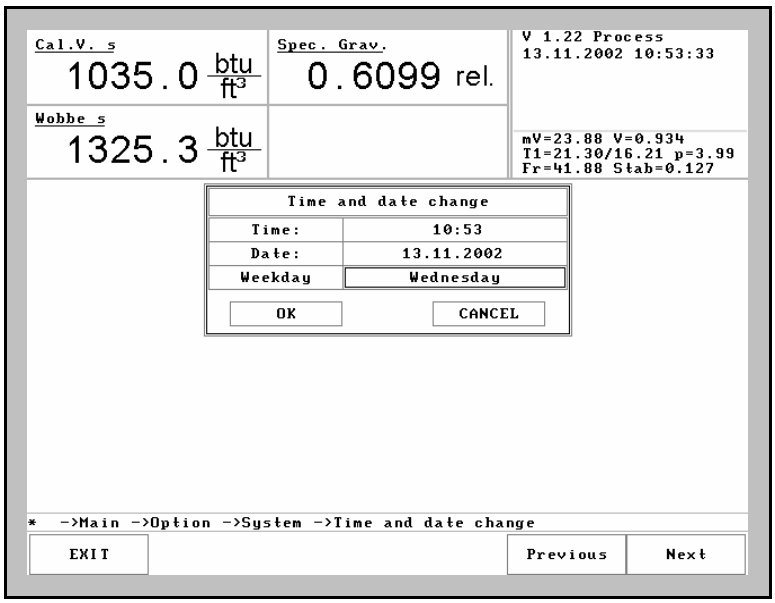


"Ignition type" can be single ignition or repeat ignition. The ignition cycle is always the same as the ignition duration. The longest ignition duration is 100 seconds. Normally speaking, an ignition cycle should last between 15 and 20 seconds.

When the ignition threshold is reached, ignition ceases. The "Ignition threshold" is the degree count that the thermopile recognizes the flame is burning.

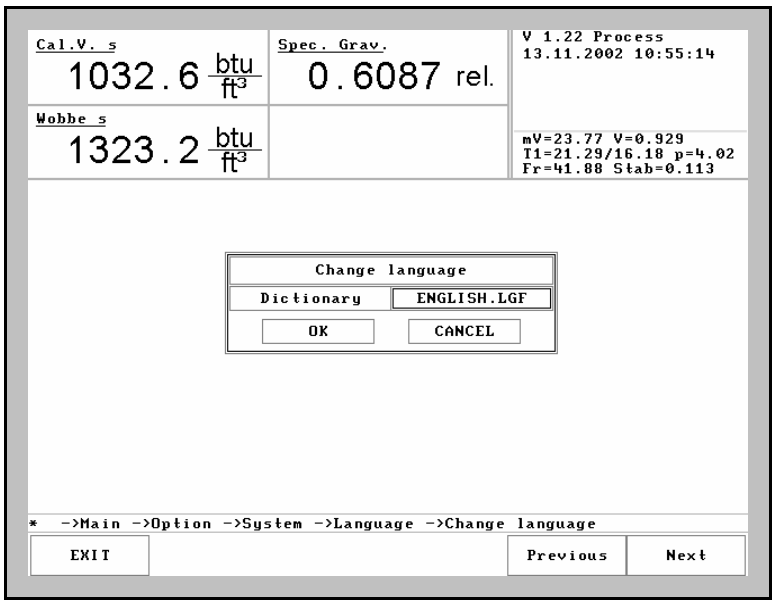
Flame temperatures are gas composition dependant so the factory will preset the optimum temperature for the specified measuring range. In the example, 3°C is the differential temperature of the incoming cooling air/flue gas mix at the thermopile.

7.2.1.3.3. Date/time



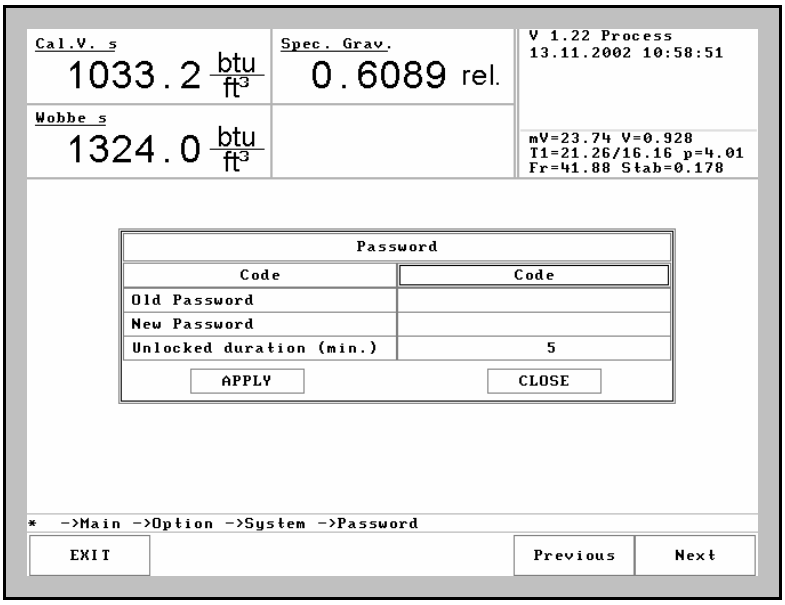
Set the system time and date, the clock stops when the menu is open. Use CANCEL to exit the menu without making any changes.

7.2.1.3.4. Language



The analyzer has German and English display capability. Other languages can be included relatively easily. A TXT file is available for translation by a customer from one language (English) into another and requires ~ 1100 words.

7.2.1.3.5. Password



A password can be selected if required by the user. If selected, no system changes can be made without entering the pass-code. When unlocked, system access is denied after 30 minutes and will ask for the password. Entering 0 switches the password system off. A default is available if the password is lost.

7.2.1.3.6. Update

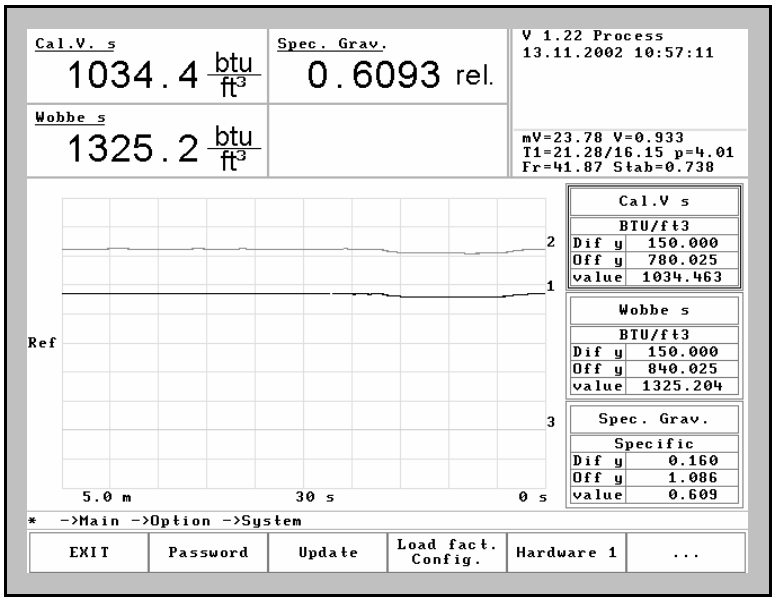
If a new update is required, a CWD 2000 software disk is inserted in the floppy disk drive located inside of the door. Start by pressing the “Update” menu key and the update starts automatically.

After the copy procedure to the “disk on chip” is finished, remove the floppy disk (copy time is about 1 minute).

The CWD 2000 boots automatically and starts the measurement operation.

Note: An error message appears “Unable to open file” appears if the key is activated without a disk in the drive.

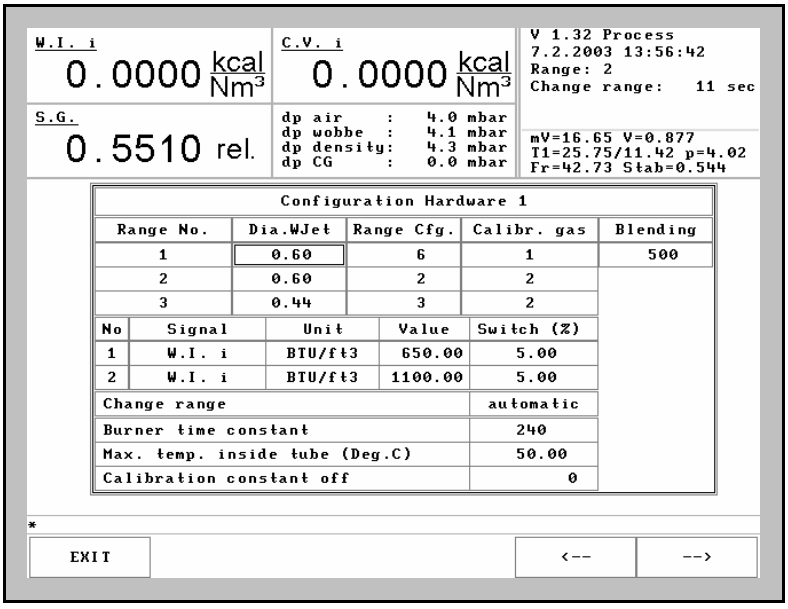
7.2.1.3.7. Load factory configuration



Load factory configuration loads the standard data input as supplied by the factory or installed at the last service. If the customer has changed several menu items and problems arise because of malfunction with the instrument, this key allows a return to factory default by a running the standard configuration as supplied by the factory

Note: An error message appears “Unable to open file” without a disk in the drive.

7.2.1.3.8. Hardware 1



This menu contains data parameters for dual range and carrier gas options. The amount of dual range overlap can be selected. Burner time constant, wobbe jet and

range conf. are specific to the burner type, range and configuration. These parameters are application specific and it is strongly recommended that changes in this table should not be made without consultation with the factory. The data values have been tested at the factory to match the process gas, if the customer decides to change ranges or carrier gas type, contact the factory for new data.

The previous screen shot shows all inputs for different ranges and carrier gases.

Range No. the number of ranges installed . Maximum number is three.

Diam Wjet. The Wobbe Jet diameter in mm.

Range Cfg. Code (binary) for measuring status during a range change.

-1 Range not selected or displayed.

1 Wobbe jet set 2 or jet set 1.

2 Combustion air jet on or off.

4 Carrier gas (combustible gas)on or off.

8 Carrier gas (non combustible gas) on or off.

16 Carrier gas (combustible or non combustible gas) on or off.

Number 6: Range with jet combination 1 , combustible carrier gas with an air jet.

Number 2: Jet combination 1 with an air jet.

Calibr.gas: Number of calibration gases for the total range. The first jet set=1 and the lower set shows number 2.

Blending: After a range change, the change is blended to the new value.

No.: Range switch point 1 or 2

Signal: Wobbe, Calorific Value or Specific Granity

Unit: Engineering units selected.

Value: *E*xample 1 shows a switch to the second range at 650 + 5% kcal/Nm^3.

Switch (%:) Range overlap between ranges in %. Example: 5% hysteresis above.

Change range: Range switching can be done manually or automatically. If manual is chosen an additional menu appears, see section 6.2.1.3.9. for more details.

A 2 point calibration is a additional function for 2 point calibration with 2 calibration gases. In the screen page 58 in the line change range are 4 different indications possible

1. non
1. automatic
2. manuell
3. calculate

„Calculate“ calculates 2 calibration gases in one line. Under „Rage No“ third line “range cfg” enter -1 for supressing the third range. Now the instrument is prepared for calibrating with 2 calibration gases. The input line 3 calibr gas is without any influence.

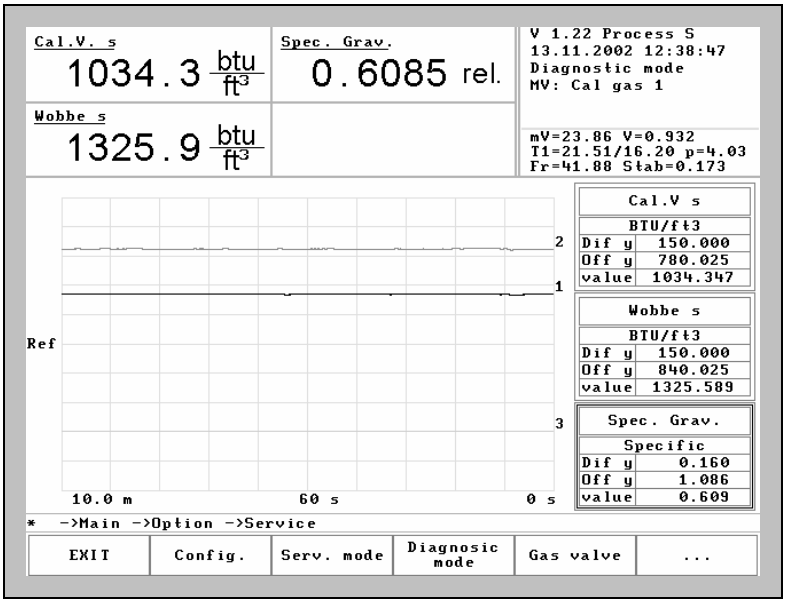
Now every calibration takes 2 calibration gases automatically. It is necessary to up date the screen in menu 7.2.1.3.8. with the values of the two calibration gases. After finishing the new screen inputs, the instrument calibrates always at everey time with the two calibration gases one after another. 2 calibration gases has to be connected.

Burner time constant: This is a burner specific factor. Different burner types for Natural gas, BF gas, LPG gas etc. have there own specific factor.

Max temp insite tube: Shut down immediately if the thermopile temperature is too high (50 °C limit).

Calibration constant off: System offset in running time, application specific only.

7.2.1.4. Service



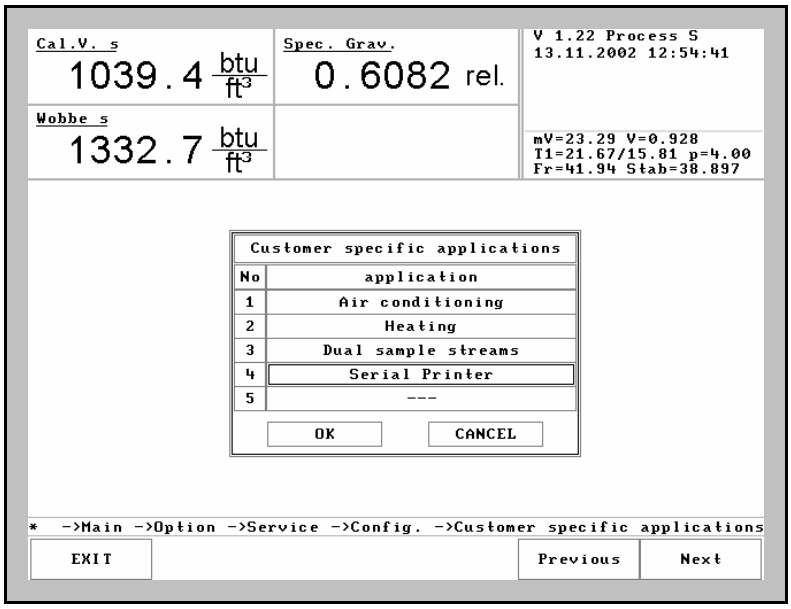
User access to the service menu is not required for normal operation as all the user menus and controls are located outside of this area. The screen shot above shows a sample of the menu beyond the password-protected area.

Note: Service menus are only accessible to the technical staff of the manufacturer, and contain specialized areas for data calculation, compensation for various temperatures, operating functions and internal system calibrations. Access to this area by the may **void the equipment warranty** if data in this area is corrupted by the user. A special service manual is required for work in any of the special service areas.

To enter the service menu press the “Service” key, enter the special service password code number and press OK to confirm. Exit the input routine by **pressing the escape or exit keys.**

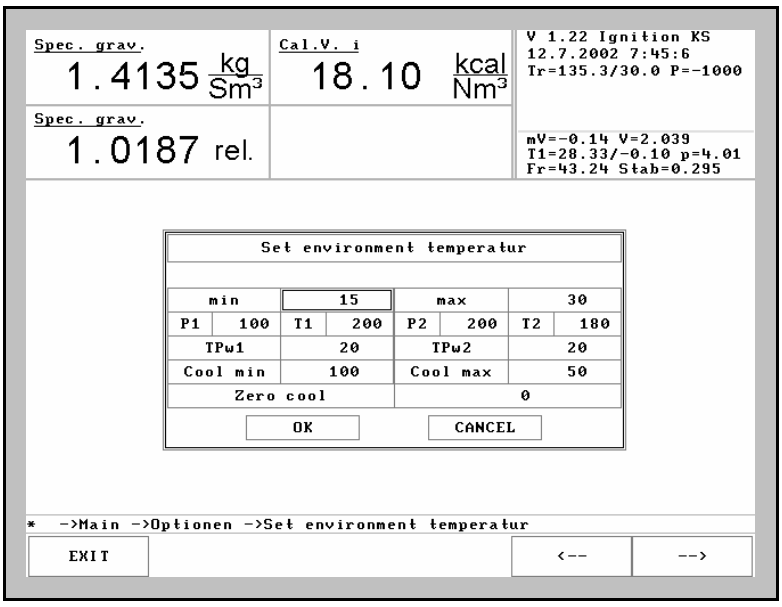
7.2.1.5. Customer specific application

Several different menus described below. These options are pre-programmed by the factory as required. Restart power to the unit after an option is selected to enable it.



7.2.1.5.1. Air conditioning room temperature

A PID controller is available as an option for use with variable room temperatures and can control high and low room temperatures. The parameters are programmed at the factory only change parameters after consultation with the manufacturer.

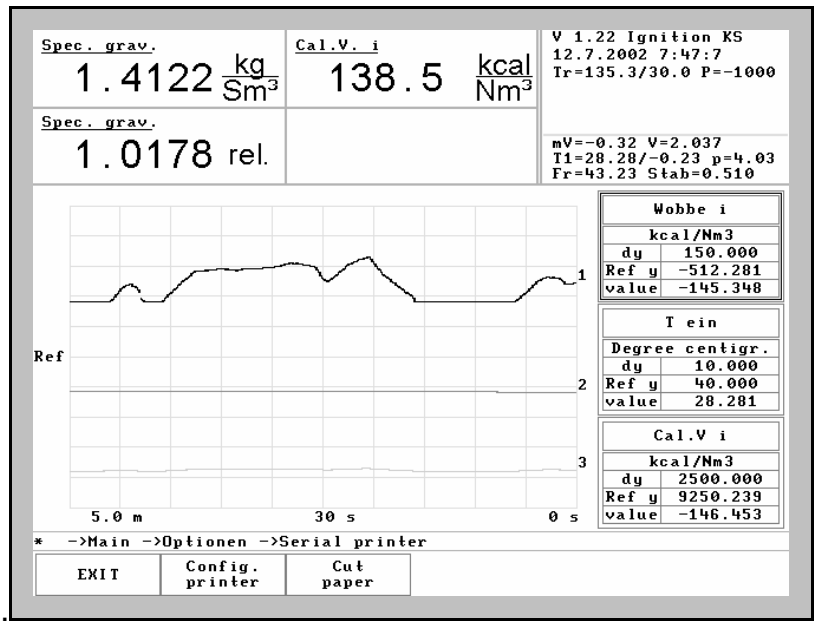


7.2.1.5.2. Serial Printer

The RS 232 interface can be connected to a printer and the Star Micronics model TSP 600 is recommended by the factory.

The analyzers software supports this model of printer. The paper empty or interrupt during paper reload function are programmed in the software and the necessary feed back signals come from the printer.

Other printers can be installed but will need extensive software changes. The printer drivers can only be changed by the factory and may be unavailable for use in this operating system from the printer vendor.

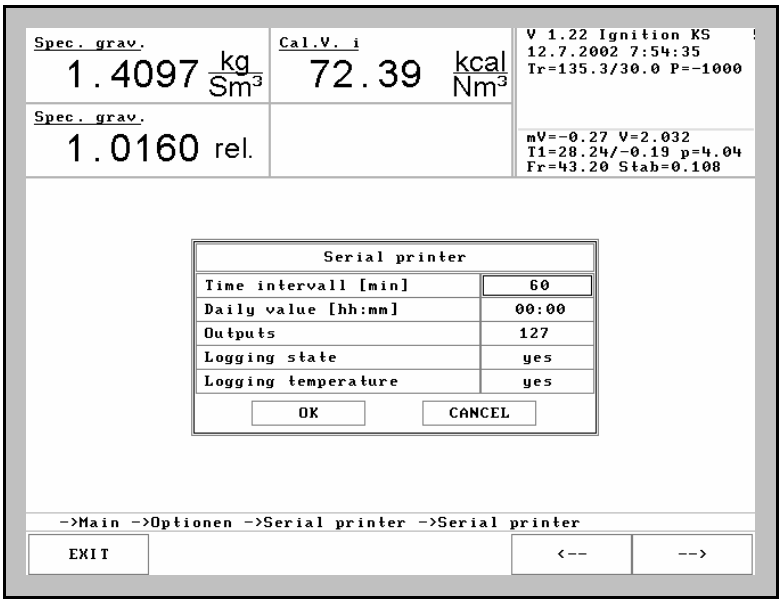


The “Cut paper“ command cuts the printer paper. During the procedure any data is stored and printed afterwards.

The service LED on the screen flashes as a warning to change the printer roll. During this procedure any data is stored and printed afterwards.

During the instrument start-up the printer will be unavailable during the warm up period and the printer will start at the selected time cycle.

Configure the printer options from the table below and 5 different parameters are available.



“Time interval“ selects the print time in minutes. This is an average of the time interval and the minimum and maximum value of this interval is also displayed.

The daily value gives an average over one day. The example prints out at midnight. .

Outputs are prepared in a bit code of the outputs 1 – 7.

Output 1 = 1

Output 2 = 2

Output 3 = 4

Output 4 = 8

Output 5 = 16

Output 6 = 32

Output 7 = 64

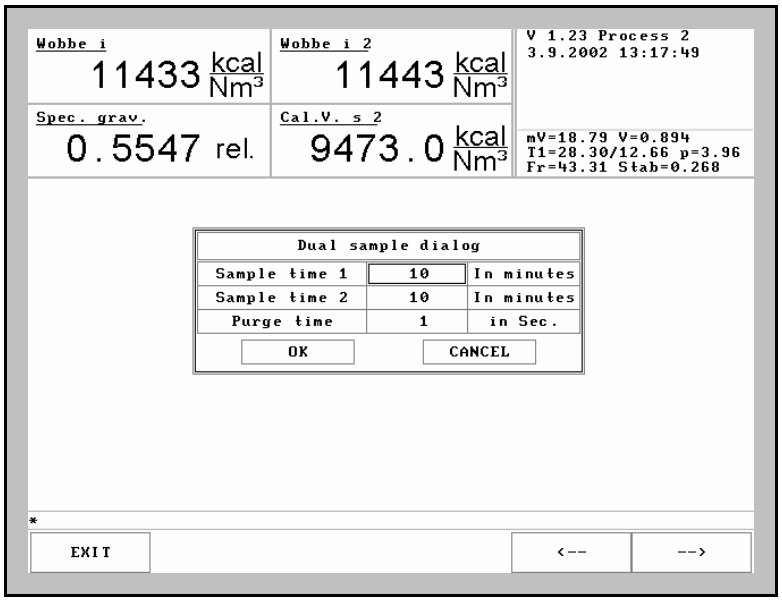
For all outputs enter code 127 (1+2+4+8+16+32+64). (Example: Sum of outputs 1 to 7). Output 1 and 2 is the code 3 (1+2). Output 1,2 and 3 (1+2+4) is code 7.

“Logging state” is the output of all state changes. These states are also available in the event list and stored. Yes or no switches this function on or off.

“Logging temperature” logs the room temperature if the sensor is connected to the system. This is very helpful for locating problems if the measurement of the CWD 2000 is unstable.

7.2.1.5.3. Dual Sample Streams

As an option the instrument can be configured to measure two different process gas streams in sequence. Each process gas can be measured on line for a specified time period. Each gas stream has a dedicated 4-20 mA output signal.

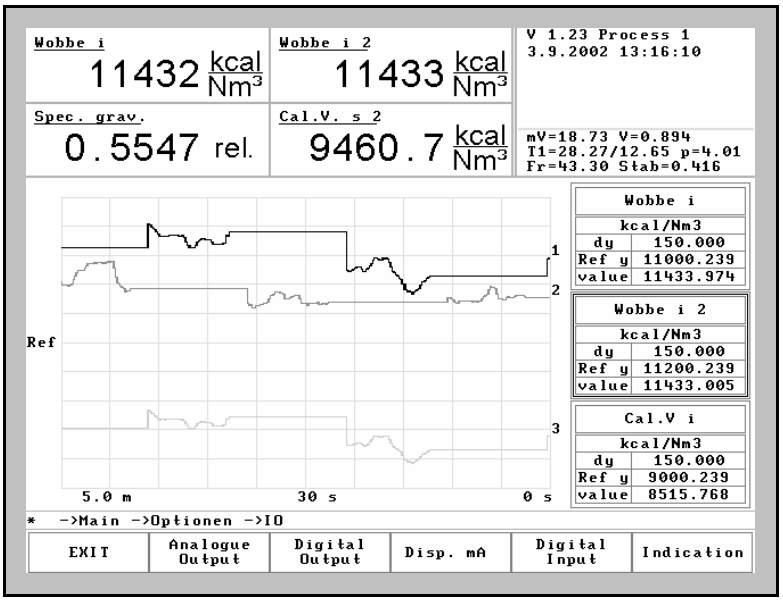


In the screen shot above, process gas 1 and process gas 2, measure for 10 minutes and the purge time for process gas 1 and 2 is 1 second to smooth the transition time to the new stream. After a purge time of 1 minute the process gas shows the new stream value and this is a standard configuration.

In the example above, the values for the two gases are shown, the last measured gas stream is displayed as a fixed value in the left hand display screen and the right hand display is the online value. The information window at the top right indicates process gas 2 is online.

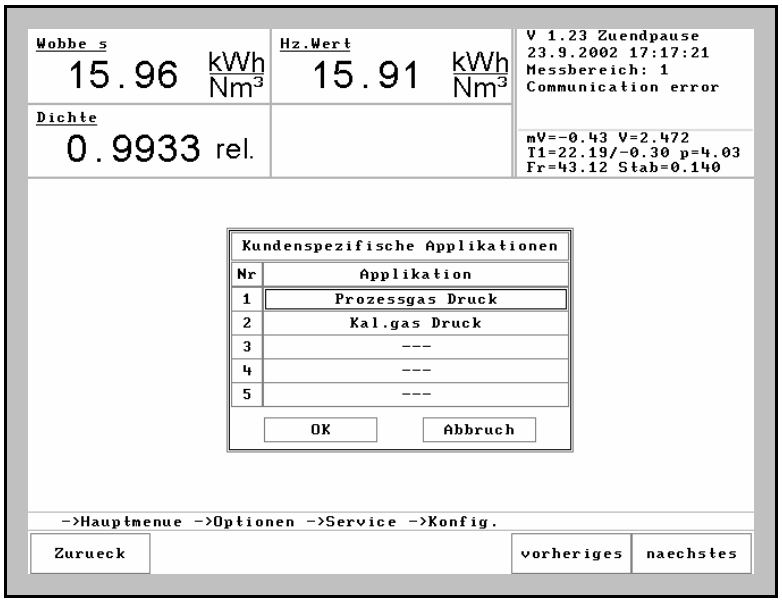
Note: A small dual stream sample module with gauges, regulators and filters, including a calibration gas connection is available as an option. This module can be wall mounted near the CWD 2000 gas inlet connections.

The following screen shows a typical dual sample stream trend with 10 minutes on each sample stream with process gas 1 currently online.



7.2.1.5.4. Process or calibration gas monitoring (Pressure switch option)

This menu contains the process gas and/or calibration gas pressure switch set points and an alarm can be generated if their levels fall below the set points.



The factory default set points are: 20 mbars for Natural gas and 30 mbars for B.F. gas. Adjust the rotary dial to adjust the switch set point if necessary. Any alarm condition is displayed on screen as “cal gas error” or “sample gas error” and the “Service” alarm contact will be activated. An alarm condition will not effect the measurement. Alarm connections to remote devices are detailed in Section 10.2.3.

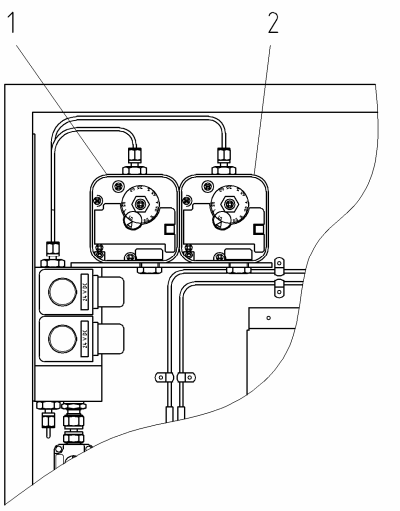


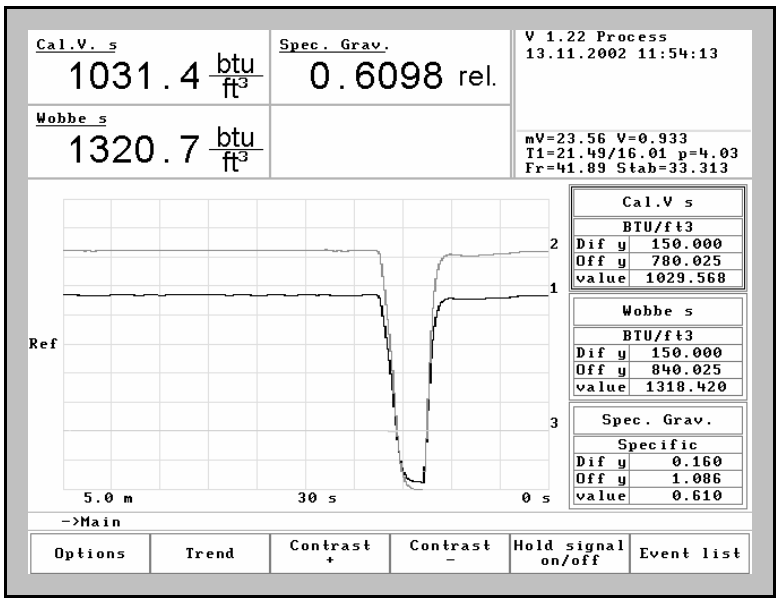
Figure 21: Optional pressure switches

1. Pressure switch, Cal gas.
2. Pressure switch, process gas.

7.2.2. Trend Display

The CWD 2000 has a very powerful trend capability that can be plotted on the screen in user configurable time scales and in different units of measurement including Calorific Value, Wobbe Index, and Specific Gravity and others.

Different contrast levels identify the three different trends and numbers state the relationship to the data boxes at the right of the screen.



7.2.2.1. Trend

This menu allows the selection of 5 different trend parameters. Each menu is described in the following sections.

1. Change times
2. Change “y” values
3. Change signals
4. Change units
5. Move cursor

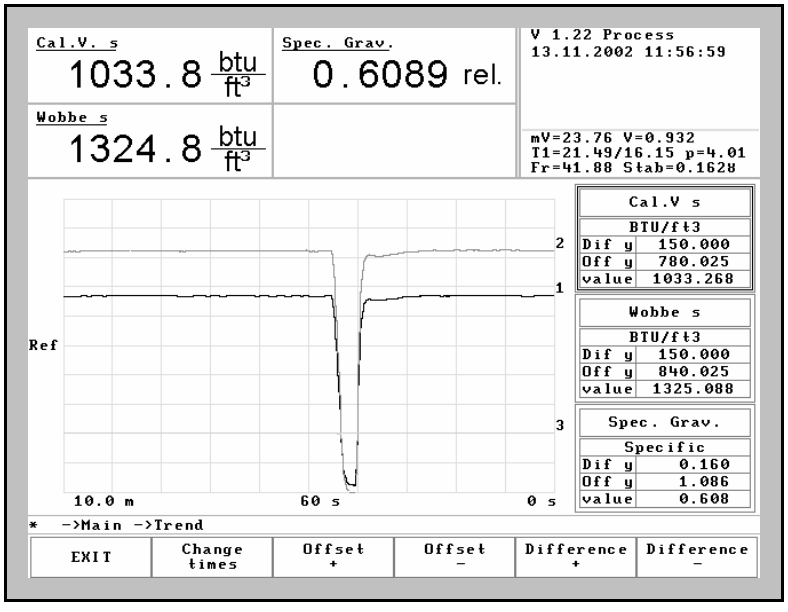
Note: The trend data is the only data that will be erased if power is lost to the instrument.

7.2.2.1.1. Change Times

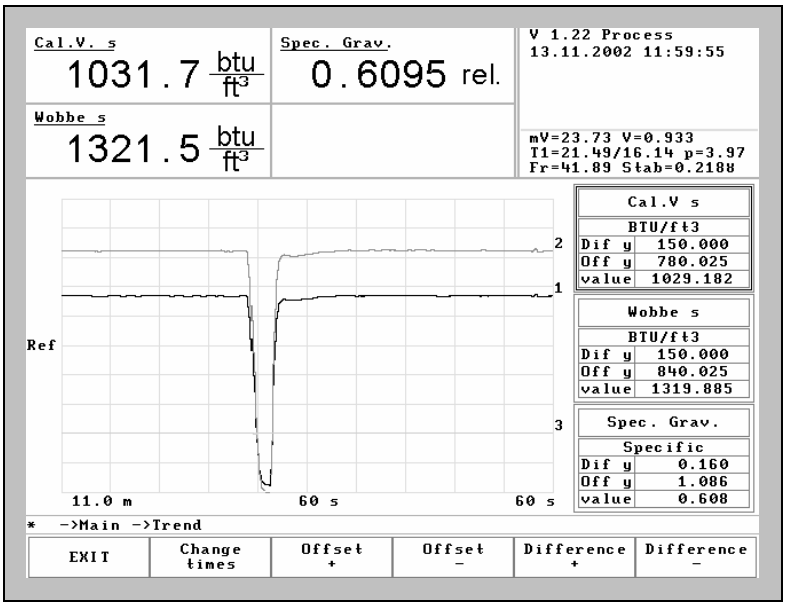
Press the “Trend” button and “Change times” appears.

Buttons “Difference +” and “Difference -” select the time scale and time interval on the “X” (time) axis and the starting point can be time shifted or offset along the “X” axis in a series of pre-programmed steps by using “Offset +” and “Offset -”.

Example: The time axis shows the start time at 0 sec. and the time interval between lines at 30 sec. the trend graphic time scale is 5 minutes.



Example: Time axis shows the same trend with the start time offset by 60 sec.

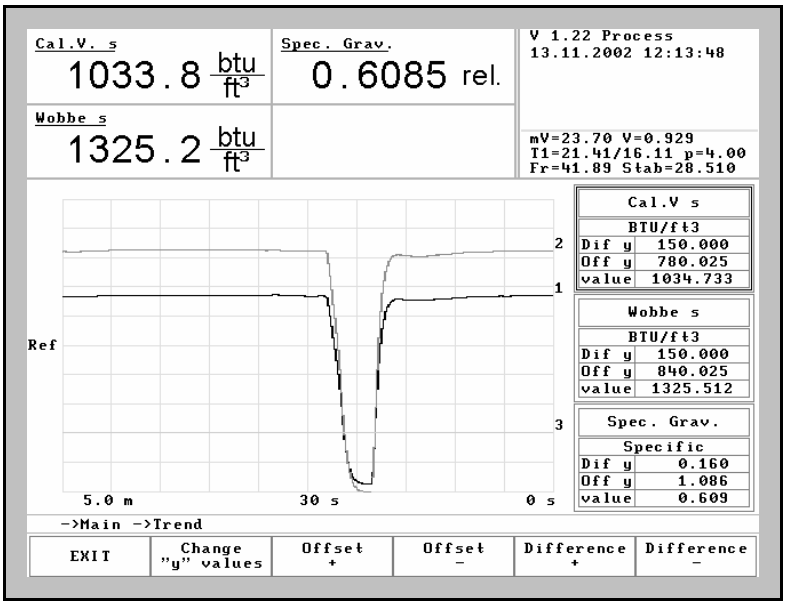


7.2.2.1.2. Change “y” values

Use Change “y” values and buttons Offset “+” and Offset “-“ for moving the reference point on the “Y” (value) axis. The offset is set on the line “Off Y” in the three boxes shown at the right of the screen below.

Example: Cal. V. i line shows Off y (Ref y) = 1011.476.

Entering a larger Off y number will lower trend line towards the “Y” axis.



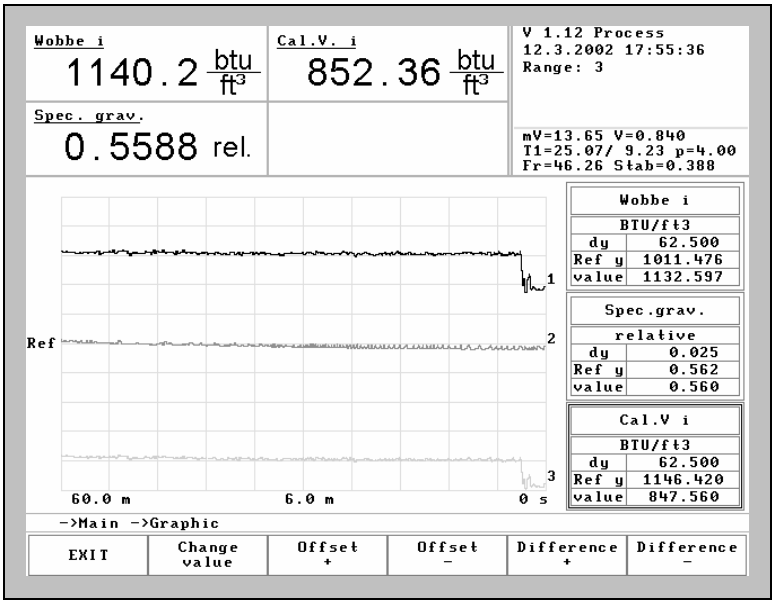
The buttons marked “Difference +”and “Difference -” determine the value steps in small pre-programmed increments and are displayed on line “Dif y” in the three boxes.

Example: Cal. V. i line shows Dif (dy) = 62.500 BTU/ft^3.

Entering a larger number for Dif y will result in smaller trend scaling.

Note: Changes can only be made if the box is highlighted with a double frame.All trend menus also allow the use of the keypad arrows keys left and right for signal selection and up down arrows for box selection (see section 6.1 fig 18, number 10).

7.2.2.1.3. Change Signals



Re-title the box headers by selecting from a list of up to 26 different signals with “+” and “-” buttons. The first 5 options are the most common:

1. Cal .V i. Calorific Value (inferior) – also called net or lower calorific value
2. Wobbe i Wobbe Index (inferior) - net or lower calorific value
3. Wobbe s Wobbe Index (superior) – gross or higher calorific value
4. Spec. grav. Specific Gravity
5. Cal .V s. Calorific (superior) - gross or higher calorific value

(The following trend parameters are only used for service or troubleshooting use)

6. T sec. – 7. T one – 8. dT – 9. T amb – 10. T Res 2 – 11. T Res 3 – 12. p Air

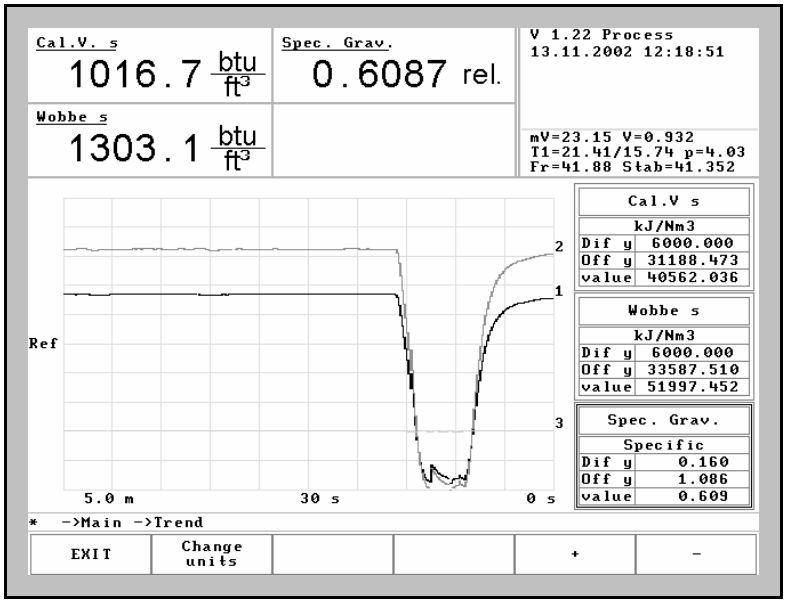
13. p res 1 – 14. p res 2 – 15. p res 3 – 16. mV – 17. V density – 18. mA sol 19. Frequency – 20. Res 1 – 21. Res - 22. W mV – 23. W Ts – 24. W Ti – 25. W Tk

26. Res 3.

Trending the above parameters provides a valuable trouble shooting resource and may be printed by connecting PS2 keyboard and a HP 500 or PCL3 printer to the interface connections on the door (see section 4.6) and press ‘Shift + $’ to print the screen. Press ‘Shift + %’ to save screen as a PCX file on to a disk inserted into the disk drive

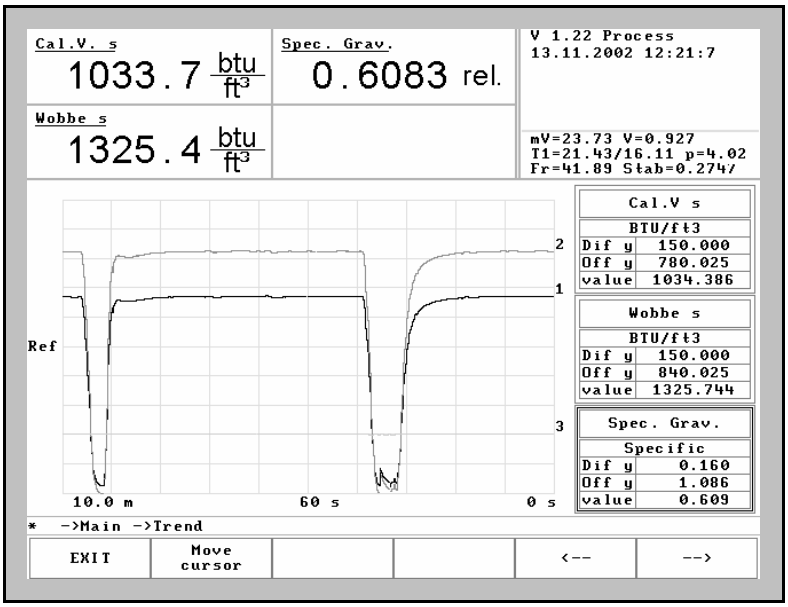
7.2.2.1.4. Change Units

To change the type of engineering units shown in the highlighted box, press “+” or “-”.In this menu, the up and down keypad arrows also select the boxes and the left and right arrows select the type of engineering units shown in the headers.



7.2.2.1.5. Move cursor

Highlight the next data box using the left and right screen arrows. See Change Units. In this menu, the keypad up and down arrows also select the boxes and the left and right arrows select the type of trend shown in the box titles.



7.2.2.2. Offset “+” or “-”

Offset + or - optimises the time base or trend in the screen.

7.2.2.3. Difference “+” or “-”

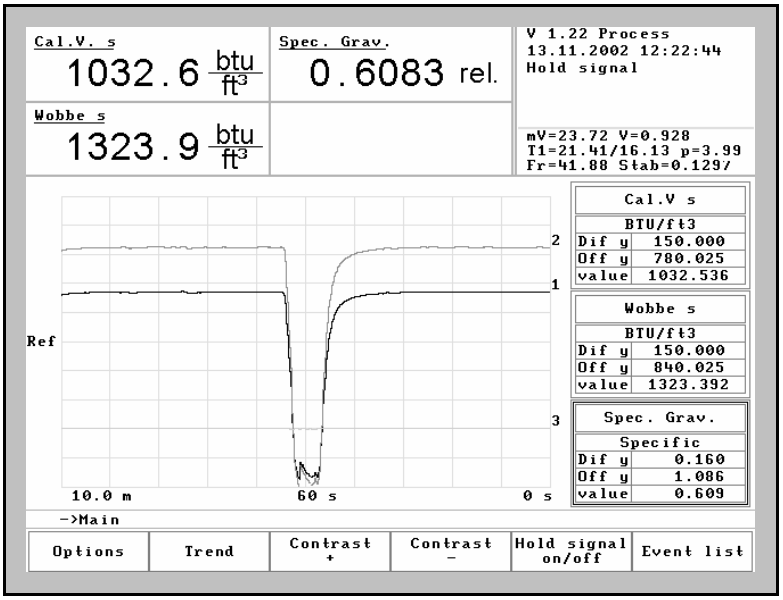
Difference + or - optimises the time base or trend in the screen.

7.2.3. Contrast “+” or “-”

Screen contrast adjustment. A screen saver activates after 5 min. without any input.

7.2.4. Hold Signal

The hold signal retains the 4-20 mA output signal at its last value for example, during calibration or the activation of the hold signal on an unsteady process stream. A filter blends the original held value with new value over a selectable time period so that a step-less transfer between the two values occurs without process upset.



7.2.5. Event list

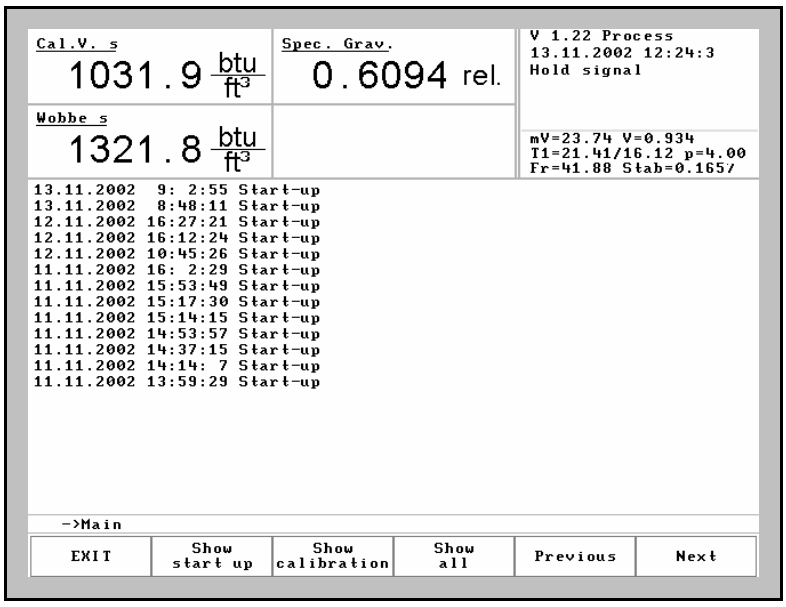
The event list stores all events that are important and helpful for operating and servicing the CWD 2000.

Up to 1000 events can be stored before the system overwrites events and stores the new information by time and data of occurrence.

The buttons “Show start up” and “Show calibration” select these specific events. The button “Show all” displays all events. The buttons “Previous” and “Next” scroll the screen up and down.

“Status calibration” gives deviation from the last calibration in % with date and time.

During an update of the CWD 2000 sometimes a message can appear „ADU error“. This message is also shown in the event list. This message is not a real error. It is only an indication that the AD converter is recalibrated. The new version of software shows the message “AD calibration” and not “ADU error”.



8. Maintenance

8.1. Safety instructions for maintenance or repair

Use the main power switch to remove power for maintenance and other work.
Caution: The burner, ignition electrode and the heat exchanger can be very hot.
Do not jump out any switches or safety devices.
Please use only factory original spare parts for any service or repairs.

8.2. Periodic maintenance

Inspect the following parts after 6 months operation.
The maintenance intervals for the instrument are dependant on the ambient air and the process gas conditions found at the job site.
After 6 months of operation inspect the following parts.

All hose connections to the gauges, pressure sensors, specific gravity cell and the primary air connection to the burner should be checked and changed if necessary during annual maintenance.

The gas pressure regulator diaphragm should be checked if this has become hardened or brittle it has to be replaced, as this is essential for stable measurement.

Check the rubber connection on the wobbe jet and air jet for any leakage.

Both the thermopile and heat exchanger should be removed and cleaned. Combustion by-products can form crystals and these can be washed away with warm water and when these parts have been thoroughly dried, they can be re-installed. **Note:** The heat exchanger is mounted on a gasket that remains in place and the gasket should always be inspected visually and replaced if necessary whenever the heat exchanger is removed.

Calibration, which usually lasts 5 to 10 minutes, uses 5 to 10 liters of calibration gas (see formula in section 3.3). It is possible to estimate how long the remaining calibration gas will last if the calibration cycle is programmed at set intervals.

8.3. Consumables

Consumables include paper filters, fuses, connection hoses and calibration gas. All the consumables considered essential by the factory are contained in the optional spare parts package for normal annual operation.

Wherever possible, calibration gas should be purchased by the customer in cylinders from a local supplier. The gas can also be purchased from the manufacturer, with all necessary fittings.

Note: International and Federal regulations prohibit air transport of compressed gases.

8.4. Replacement I/O Boards

If a replacement board E/A intern or E/A external becomes necessary, special updated software is required (delivered with the new board). Boards of old style and new style are similar and exchangeable (for more details, see section 10.2.).

Exchange: Switch off line power and change out the board. The new style board has additional 4 open collector drivers. See section 10.2.2.4.for more details.

8.5. Spare parts packs

A number of different spare parts packs are available depending on the operational period. Consideration should also be given to the country of use and conditions at the site where the analyzer will be used. Following careful evaluation, the spare parts package can be adapted as necessary. The packs shown below contain a sufficient range of parts, based on normal operating experience.

The one-year pack contains consumables and spare parts for 1 year of normal operation. Process criticality, installation location and country of use should be taken into consideration to determinate what spare parts should always be available locally.

Spare parts list: One Year operation

1	(1) Blower power supply	2	(2) Fuse to power supply
3	(10) Quartz burners jets	4	(2 m) EMV door gasket
5	(2) Paper filters	6	(2 m) Rubber tube NBR 4x2 mm
7	(1) Diaphragm gas pressure regulator	8	(1) Ignition electrode

The 2-3 years operation pack contains the same parts as a 1 years operation pack but with an extended supply of consumables, as well as electrical and electronic components which based on experience, can fail first in corrosive environments or under other severe operating conditions.

Spare parts list for 2-3 years operation

1	(1) Blower power supply	2	(2) Fuse to power supply
3	(10) Quartz burners jets	4	(2 m) EMV door gasket
5	(2) Paper filters	6	(2 m) Rubber tube NBR 4x2 mm
7	(1) Diaphragm gas pressure regulator	8	(1) Heat exchanger
9	(1) Gasket for heat exchanger	10	(1) Solenoid valve
11	(1) Thermopile 1x24 TE	12	(1) Diff. pressure gauge – air
13	(1) Pressure gauge - Gas	14	(1) Diff pressure gauge - Sp.Gr.
15	(1) (1) Ignition electrode	16	(1) Ignition transformer

This spare parts pack serves as a source of local stock. If components in the unit fail, that are not contained in the spare parts pack, they can be ordered from the factory by stating the 5-figure serial number list on the data plate. Without this number, the spare part type or version cannot be accurately determined. All the serial numbers are registered in a database together with all calibration data and settings that where established before delivery from the factory.

9. Troubleshooting

Troubleshooting section is broken down into various topics such as unstable readings, drift in readings and incomplete ignition. The following list describes typical faults and corrective actions. This list will be updated in the future as the need arises.

9.1. Event list

The software maintains an event list that records up to 1000 events in order of occurrence, with date and time. If more than 1000 events have occurred, the log will start to overwrite and the oldest event will be erased.

Events include: Start, Stop, Ignition, Calibration, Low cooling airflow, Flame out etc.

Using the list it is possible to identify which operations have occurred and when. This offers an initial clue when problem solving. The list can be downloaded and sent to the factory for analysis in the event of a problem.

9.2. Unstable readings

1. The pre-pressure regulator is unable to maintain constant pressure. Process pressure is insufficient. This can be the case with Blast Furnace gas. A sample gas pump must be installed.

2. Direct sunlight results in rapid temperature fluctuations.

In unprotected installations direct sunlight on the analyzer should always be avoided.

3. Rapid temperature fluctuations

Air conditioning systems or heating units with large cooling capacity and large control hysteresis can cause instability.

9.3. Drift in readings

Readings drift upwards in one direction and calibration no longer restores the calibration value. Air fan frequency control is at its maximum value.

Heavy air filter contamination that can no longer be corrected for by the speed of the air fan. The filter element must be replaced.

Reading drift downwards. The heat exchanger is worn out. With Propane and Butane, this can occur if the flame burns with insufficient primary air (Yellow flame) and the heat exchanger can become clogged with soot and carbon deposits.

Remove and wash the heat exchanger with warm water, the use of a brush to remove any stubborn deposits is recommended. The heat exchanger should then be dried with compressed air before reinstallation.

9.4. Incomplete ignition

Warning: Ignition only operates with the door closed.

1. **Incorrect temperature setting:** The temperature threshold should be reduced. The unit tries to ignite while the flame is burning and the device does not switch to normal operating mode.

2. **Incorrect temperature setting:** The temperature threshold should be increased. The device switches to operating mode, although the flame is not burning, and then switches back to ignition mode.

3. **Ignition electrode corroded:** Normal wear following heavy use. The ignition electrode should be replaced if necessary.

4. **Gas problems:** With poor, barely flammable gases, a special burner needs to be installed that will provide a stable flame pattern.

5. **No ignition spark:** Door is open during ignition cycle. The electrode is corroded or bent, or is short-circuiting because of fouling or carbon tracking down the body of the insulator. Check the cooling airflow on the air pressure gauge, as a lack of flow will trip the safety pressure switch. Check the ignition transformer primary and secondary for continuity.

9.5. Software troubleshooting

The CWD 2000 has an onboard PC 104 processor and several printed circuit boards, which can only be operated with its own unique software configuration data file. A configuration file is provided with each instrument and it is stored on a floppy disk for safety. If the floppy disk is misplaced or the configuration is corrupted due an incident, the device cannot be reconfigured without this disk. The service disk contains several programs that will restore the original configuration, reboot the system, execute and backup data and also configure the EA-external board and the EA-internal board. This is also important if one of these boards is ever replaced.

The disk contains six different program routines, which can be executed in the CWD 2000 drive and are explained in the following text. The disk must be removed after the completion of the selected program and the unit has to be rebooted.

Only programs 1 and 6 are of user interest if the unit works correctly. Programs 2 to 5 contain board specific calibration data for the normal operation and after delivery are of no interest. If the boards are replaced or software updates are required, a disk with configuration data for the new board is supplied with the boards.

After inserting the disk in the drive and rebooting the CWD2000 the following information will appear on the screen. The arrows on the lower part of the screen refer to the keys below the screen.

Note: After a several minutes of loading files the screen will return to the start menu with the six vertical arrows, power down the unit, remove disk and restore power. The unit will now run through the normal short start-up routine.

This is a recovery disk.

With this disk you can reboot or repair the system after a crash

You can reformat the "Disk on Chip" for regenerating the system.

You can install different updates and you can save any instrument specific data.

Each command name points withan arrow to a push button.

Caution:

The program starts automatically and after finishing the routine (ignore any other screen prompts!) will return to the screen shown below, remove disk and turn the

Power switch off then on again. The software starts normally, with a basic configuration or with individual configurations if the disk contains this data.

1	2	3	4	5	6
Full	Instrument	EAintern	EAextern	Configuration	Instrument
update	backup	update	update	update	Backup
					.int
	+				.ext
to		To	To	To	.cfg
	full				. par
system	update	system	system	system	to disk

▼	▼	▼	▼	▼	▼

Full update

This program should only be initiated after consulting the factory. This program updates the complete software with standard factory data or the last stored data.

Attention: Before executing this program run the program “instrument backup” so that individual calibration data is loaded from the computer to the disk, so that the customer specific configuration is retained after the “Full update”. The menu item 6 should always be executed, when the customer changes configuration parameters.

Instrument backup + full update

This program provides the possibility of a program update, without loss of the data and parameters stored in the system. Here first all system-relevant and customized parameters on the inserted disk become secured. Afterwards all secured data with the new software in the system are installed.

EA-intern update

This program generates the calibration data of the EA-intern board when the board is replaced in a CWD2000 system with a new one. The data is provided and delivered with the board by the manufacturer. An operation error is impossible because the floppy disk supplied in this case only executes program 3.

EA-extern update

This program generates the calibration data of the EA-extern board when that is replaced in a CWD2000 system with a new one. The new data file is provided and delivered with the board by the manufacturer. An operation error is impossible because the floppy disk supplied in this case only executes program 4.

Config. update

This program generates the configuration data in the CWD 2000 that can be saved to disk as a backup from program 6.

Instrument backup

This program copies the customer specific data to a floppy disk.

1 .int for the EA-intern board.

2 .ext for the EA-extern board.

3 .cft for the central unit and the pressure sensors.

4 .par for the measurement range switching.

After the CWD 2000 operates on the process and all parameters such as measurement range, units, calibration cycle, filtering etc. are finalized, initiate program 6. The floppy disk contains the current data and it can be used to reboot by running program 1 after an incident (which eventually might damage the data in the device). It is recommended to always make a copy of the disk supplied with the unit so that an unmodified original is always available.

10. Measurement principle

The measurement of process gases by the CWD 2000 is based on a thermopile principle that has been proven over many years in every type of industry. The thermopile used is of unique construction and the use of a high-speed thermopile sets the CWD 2000 apart from all other indirect BTU measuring methods since high speed response is usually preferred in control applications

10.1. Heating Value measurement, an overview

Analyzers that measure the components of the process gas (G.C.) are well known and are sometimes used if only some of the gas components are required to be measured. Often in the process industry the inability of the G.C. columns to detect all of the components (leading to errors), slow response speed with the long cycle times render it unsuitable for dynamic process control applications due to long blind periods with no measurement response between cycles.

Some manufacturers use an expanding temperature element to measure temperature rise but the removal of this type of element for cleaning during service is usually an issue and the use of very small pneumatic nozzles in a position sensing control system (to maintain element temperature) are subject to blockage.

Other less well known manufacturers measure other parameters than the above to report calorific value by measuring residual oxygen in exhaust gas and pass-off the measurement of Combustion Air Requirement Index or CARI as being the ”same as“ heat release value.

Note: Indirect measuring methods using Zirconia oxide sensors (ZrO_2) where only developed for applications where the gases are stable and remain in the same family, (usually Natural gas) and may require many calibration gases to curve fit the results of waste, flare or other unknown gases into a useable linear output. Errors from CO, H_2 or O_2 in process gas can be up to 100% per % of component. For example: 5% fuel based O_2 produces a potential 5% error that would only be noticed if the user happened to use a series of calibration gases that reflected this effect as the unit will always repeat if the same calibration gas is used. This and the fact they are really measuring fuel/air ratio and not BTU has kept these units out of mainstream use on process fuel gas applications.

Conductivity, catalytic or optical sensors have surfaced over the years, but for various reasons, they have been withdraw or not been accepted by the market.

The water bath combustion calorimeter was for many years the gas industry standard with its many moving parts submerged in water. Slow response, weekly calibration with an open hydrogen flame, lack of product development and its orphan status by a large corporate owner ensured its demise as the industry looked for new features. The CWD 2000 combustion calorimeter responds to all components contained in the process gas and reports them online as heating value and the measurement is fast, direct and simple to maintain online.

The measuring principle is described below. Two independent physical measurements are carried out. These are Wobbe Index value and Specific Gravity and the computer calculates the Calorific Value using following formula:

$$\text{Calorific value} = \text{Wobbe Index} \sqrt{\text{Specific Gravity}}$$

10.2. Thermopile measuring system

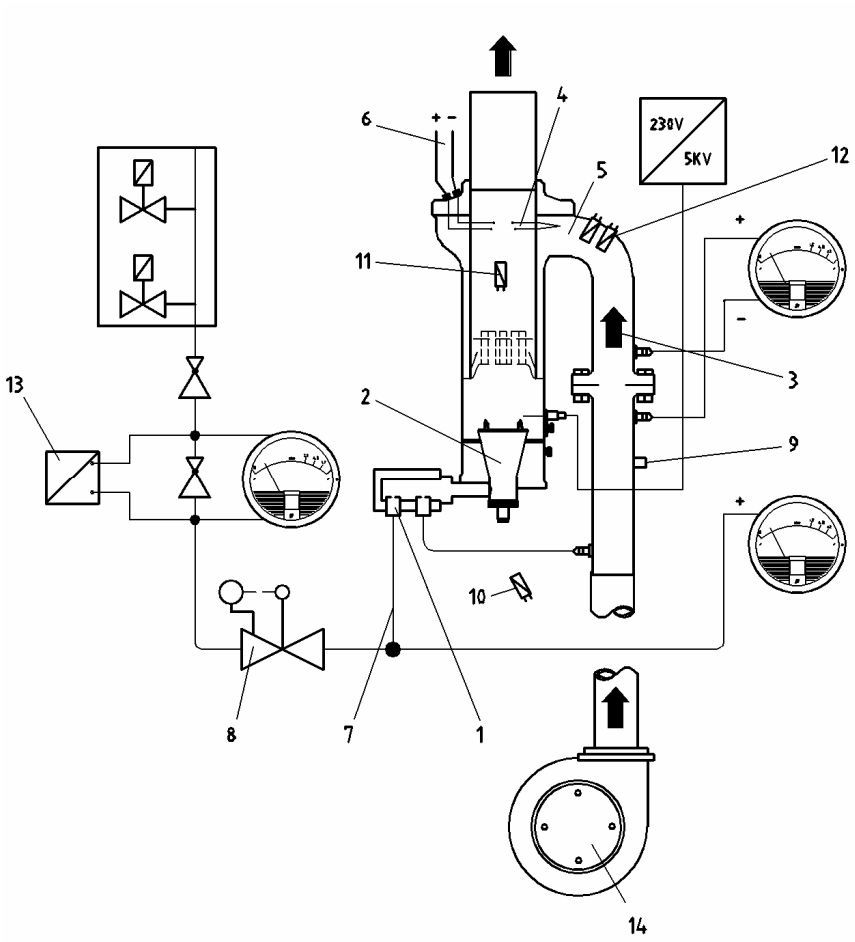


Figure 22: The main components of the calorimeter

1	Range orifice	2	Burner
3	Cooling air flow	4	Thermopile (hot junctions)
5	Thermopile (cold junctions)	6	Output signal
7	Gas flow	8	Pressure regulator
9	Pressure sensor	10	Temperature sensor
11	Temperature sensor	12	Temperature sensor
13	Specific Gravity cell	14	Cooling air fan

Sample gas is passed to the burner (2) via a wobbe range orifice (1) at very precisely regulated pressure, and burned at atmospheric pressure. The gas flow is therefore dependent on the specific gravity of the gas.

The flue gases are mixed with the cooling airflow (3) the temperature of the overall mix is measured by the thermopile hot junctions (4). At the cold junctions (5), the thermopile measures the temperature of the incoming flow of cooling air. The result is a differential voltage (6) at the thermopile that is independent of the cooling air temperature. Broadly speaking this is proportional to the Wobbe Index of the gas.

Airflow (3) and gas flow (7) must be very accurately regulated. The gas flow is regulated to a constant level by an extremely precise, weighted gas pressure regulator (8). The flow of cooling air is kept constant by using a pressure sensor (9) to control the speed of the cooling air fan.

During heat transport from the burner to the active elements of the thermopile (4), all parts of the system absorb heat. Heat for the thermocouples is also lost. The heat management of this process is monitored by a number of thermal elements (10, 11, 12), and the result is included in a calculation, which ensures the Wobbe Index value is linear. In addition, the response time of the system can be considerably reduced by the use of a proximity equation and end point forecasting.

The output signal is not yet the Calorific Value but is proportional to Wobbe Index, because the specific gravity of the gas is taken into account in this measurement.

For this reason, the Specific Gravity (13) of the sample gas is measured and calculated with the Wobbe Index, in the process calculator to get calorific values in BTU or other units.

Three output signals are generated

1. Wobbe Index as a real time measurement
2. Specific Gravity as a real time measurement
3. Calorific value as a real time product of the above measurements.

10.3. Specific Gravity measuring cell

The CWD 2000 (The W 2000 is supplied without the Specific Gravity cell) is fitted with a specific gravity measurement cell, which is mounted in the enclosure. The specific gravity cell determines the specific gravity of the process gas in a specially designed sample chamber in the presence of a modulated acoustical field.

10.3.1. Operational overview of the measuring cell

The process gas flows through the measuring chamber of the measuring cell. The oscillations of a transmitter membrane with a constant amplitude and frequency are transferred to a pressure transducer by the gas.

The amplitude of the signals on the pressure transducer is directly proportional to the density of the process gas.

This inherent, oscillating signal is amplified and further processed, in such a way that a continuous output signal in volts is generated.

The expansion of the sound waves in the measurement chamber is not only dependent on gas density but also other parameters such as viscosity and heat conductivity. The selectivity of the measuring cell to gas density is a question of geometric shape, dimensioning and a few other proprietary factors.

The key to stability is a reference chamber that compares the measurement with atmospheric air at ambient conditions. The signal received from the chamber with the reference measurement controls the amplitude of the oscillating transmitter membrane and the density measurement is insensitive to small particles on the oscillating membrane. A small heater is used to maintain thermal stability.

Warning: The gas pressure in the measuring cell may not deviate considerably from the ambient pressure in the reference air cell. Any spikes in sample pressure may result in apparent density deviations that have nothing to do with a change in sample gas density.

The sensitivity of the measuring cell to external influences, such as mechanical vibration, impact or pressures are greatly reduced due to its mounting system, relatively high mass, and electronic filters.

10.3.2. Functional diagram

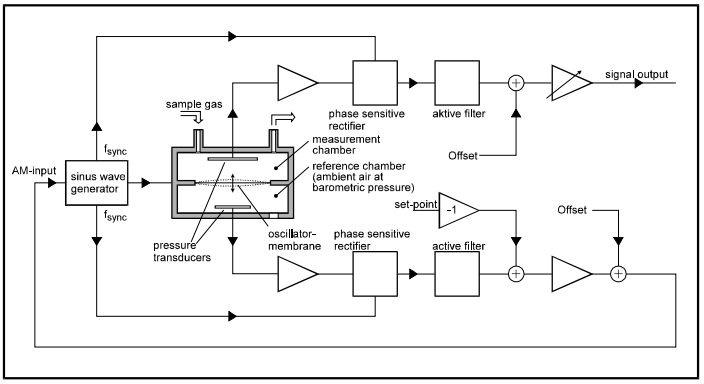


Figure 23: Functional diagram of the Specific Gravity measuring cell

10.3.3. Output signals

The standard measuring range is 0.2 – 2,2 Specific Gravity (Air = 1.0) The output signal for the measuring cell is expressed as: U **Specific.Gravity** 0 - 5 Volt

U Spec. Gravity / V = 2.5 x Specific Gravity – 0.5

In certain cases, the measuring range is 0.0 – 2.0 Specific Gravity (Air = 1.0) The output signal for the measuring cell is expressed as: **U Specific.Gravity** 0 – 5 Volt

U Spec. Gravity / V = 2.5 x Specific Gravity

10.3.4. Commissioning

The specific gravity cell is supplied with a transport lock, after installation remove the tie wraps. The cell is fitted with tension springs that mechanically de-couple the system. Vibrations in the unit (air fan etc.) cannot be transferred to the specific gravity cell if the cell can move freely.

The differential pressure across the specific gravity cell is shown on display [53]. It should be approximately 4 mbar (+/- 0.5 mbar) controlled by regulator [23] adjust the regulator if necessary as a low differential pressure will slow response speed. (If the regulator [23] is out of range, see section 11.5.1 for more details). The measuring cell is already connected and is provided with DC power from the ST2 plug. Part of the process gas (approx. 4-5 l) flows through the measuring cell, this small sample is returned to the main gas stream and no gas is vented to the atmosphere.

10.3.5. Testing and calibration

Specific gravity cell function can be tested using 2 gases. The specific gravity of the two gases should differ by more than 0.5 so that the zero and span can be checked. If non-flammable gases are used, such as N_2 or air, the ignition cycle will time out so set the purge time to a high value so the solenoid valve remains open and the gas will flow. Restore any program data after testing and crosscheck the results.

10.3.6. Maintenance

The specific gravity cell requires no regular maintenance. From time to time, the pressure drop across the density cell should be checked. After installation the sensor housing must be able to move freely on the springs.

A defective specific gravity cell can be sent in for repair. The output for calorific value can be turned off in the software and the unit will now measure Wobbe Index only.

10.3.7. Technical specifications

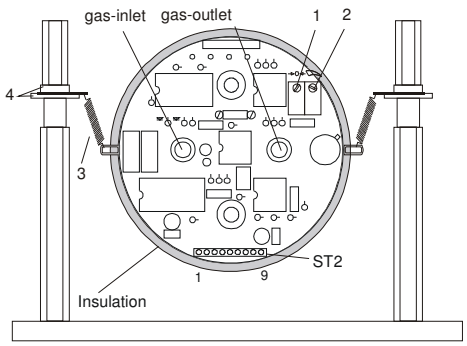


Figure 24: Specific gravity measuring cell, heated and insulated

1. Potentiometer 1 Zero
2. Potentiometer 2 Span
3. Suspension Springs
4. Insulating discs

ST2 PIN terminals

1	+ 15 V	Power Supply 7 VA
2	- 15 V	Power Supply 7 VA
3	Location pin	
4	Ground	
5	Not Connected	
6	Location pin	
7	+ 5 V	Measurement signal
8	Not Connected	
9	Ground	Specific Gravity 0-5 Volt

11. Circuit diagrams

The following circuit diagrams show only the major components. Component level drawings are only supplied under special confidentiality terms and conditions.

11.1. Input-Output card: E/A internal

There are 2 different electornic input-output EA intern, the type _06, and type _07.
The card type _06 is built-in up to the serial no. 84 324.
The card type _07 is built-in from the serial no 84 513.
The pin-configuration and function at the versions 06 and 07 is identic

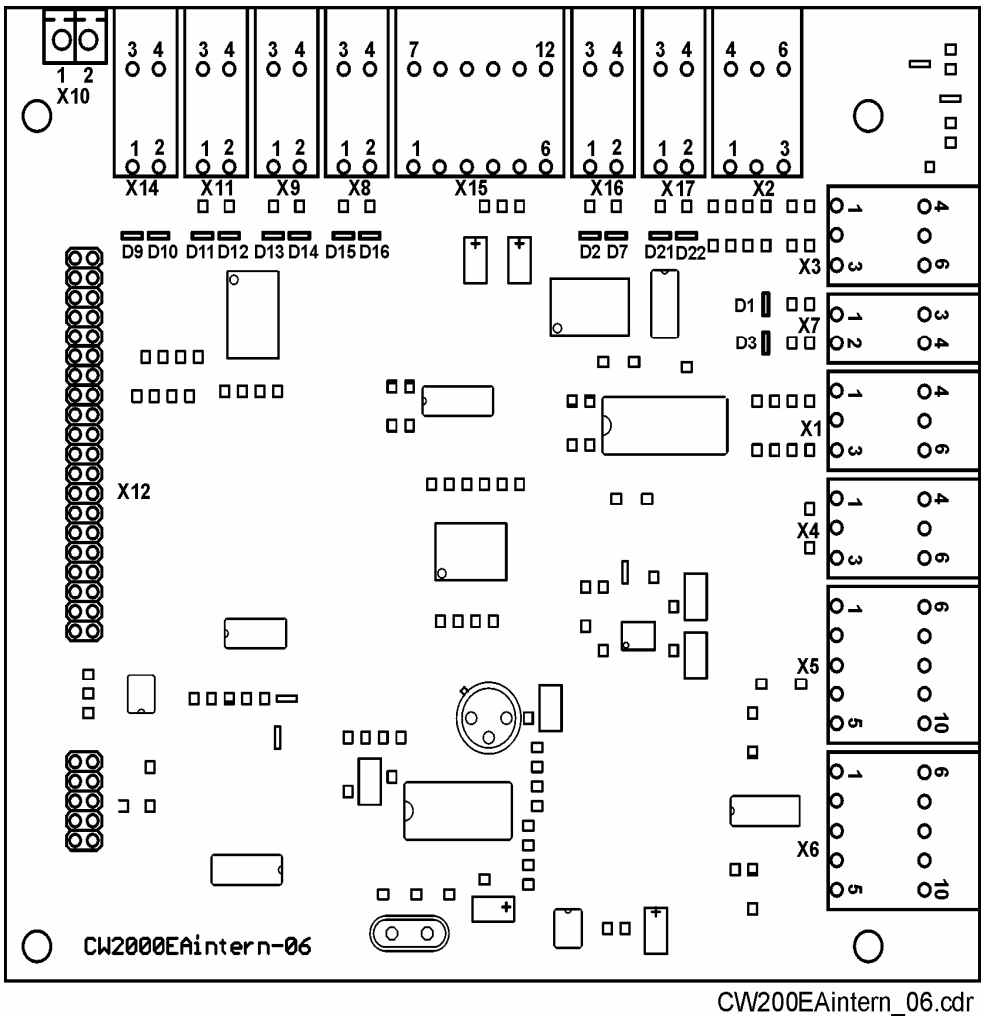


Figure 25: Input/output card E/A internal showing module/plug positions.

Note: This card requires no customer connection. D1 to D16 are status LED's.

Plug X10

Pin 1	+24V VI	Thermal switch
Pin 2	-24 V VIS	Thermal switch

Plug x14

Pin 1	GND	Solenoid valve calibration gas I
Pin 2	+24V	Solenoid valve calibration gas I
Pin 3	GND	Solenoid valve calibration gas II
Pin 4	+24V	Solenoid valve calibration gas II

Plug x11

Pin 1	GND	Solenoid valve process gas
Pin 2	+24V	Solenoid valve process gas
Pin 3	GND	Solenoid valve carrier gas
Pin 4	+24V	Solenoid valve carrier gas

Plug x 9

Pin 1		N.C.
Pin 2		N.C.
Pin 3		N.C.
Pin 4		N.C.

Plug x 8

Pin 1		N.C.
Pin 2		N.C.
Pin 3		N.C.
Pin 4		N.C.

Plug x15

Pin 1	PE	Screen
Pin 2	GND	S.G. cell supply
Pin 3	-15 V	S.G. cell supply
Pin 4	DI -	S.G. cell signal
Pin 5	DI +	S.G. cell signal
Pin 6	+15V	S.G. cell supply
Pin 7	N.C.	
Pin 8	N.C.	
Pin 9	N.C.	
Pin10	PE	Screen
Pin11	Wobbe -	Signal 30 mV
Pin12	Wobbe +	Signal

Plug x 16

Pin 1	N.C.	Solenoid valve gas (upper side, front side)
Pin 2	N.C.	Solenoid valve gas (upper side, front side)
Pin 3	N.C.	Solenoid valve air (upper side, back side)
Pin 4	N.C.	Solenoid valve air (upper side, back side)

Plug x 17

Pin 1	N.C.	Solenoid valve gas (lower side, front side)
Pin 2	N.C.	Solenoid valve gas (lower side, front side)
Pin 3	N.C.	Solenoid valve air (lower side, back side)
Pin 4	N.C.	Solenoid valve air (lower side, back side)

Plug x 2

Pin 1	PT1+	TOB Temperature upper enclosure
Pin 2	PT1-	TOB Temperature upper enclosure
Pin 3	PE	Screen
Pin 4	PT2+	TL1 Temperature air 1
Pin 5	PT2-	TL1 Temperature air 1
Pin 6	PE	Screen

Plug x 3

Pin 1	PT6+	No Connection	
Pin 2	PT6-	No connection	
Pin 3	PE	Screen	
Pin 4		N.C..	
Pin 5	N.C.		
Pin 6	N.C.		

Plug x 7

Pin 1	No Connection	
Pin 2	No Connection	
Pin 3	No Connection	
Pin 4	No Connection	

Plug x 1

Pin 1	PT3+	No Connection	
Pin 2	PT3-	No Connection	
Pin 3	PE	Screen	
Pin 4	PT4+	No Connection	
Pin 5	PT4-	No Connection	
Pin 6	PE	Screen	

Plug x 4

Pin 1	P1T5+	T Thermal temperature surface component	
Pin 2	IPT5-	T Thermal temperature surface component	
Pin 3	PE	Screen	
Pin 4	P2T5+	TL2	Temperature air 2
Pin 5	IPT5-	TL2	Temperature air 2
Pin 6	PE	Screen	

Plug x 5

Pin 1	PE	No Connection	
Pin 2	DP2-	Input adapter	Option (Signal differential pressure S.G.Sensor)
Pin 3	DP2+	Input adapter	Option (Signal differential pressure S.G.Sensor)
Pin 4	AGND	Input adapter	Option (Supply differential pressure S.G.Sensor)
Pin 5	+15V	Input adapter	Option (Supply differential pressure S.G.Sensor)
Pin 6	PE	No Connection	
Pin 7	DP1+	Signal differential pressure air	
Pin 8	DP1	Signal differential pressure air	
Pin 9	AGND	Supply differential pressure	
Pin10	+15V	Supply differential pressure	
Pin10	PE	No Connection	

Plug x 6

Pin 1	PE	No Connection	
Pin 2	DP4-	Input adapter	Option (Signal differential pressure Wobbe jet)
Pin 3	DP4+	Input adapter	Option (Signal differential pressure Wobbe jet)
Pin 4	AGND	Input adapter	Option (Supply differential pressure Wobbe jet)
Pin 5	+15V	Input adapter	Option (Supply differential pressure Wobbe jet)
Pin 6	PE	No Connection	
Pin 7	DP3+	Input adapter	
Pin 8	DP3	Input adapter	
Pin 9	AGND	Input adapter	
Pin10	+15V	Input adapter	

11.2. Input-Output Card E/A external

Three types of electronic boards are available, type_04, type_05 and type_06.
The type_04 is used up to serial No 82 345.
The type_05 is used from serial No 82 346 to serial No 8445
The type_06 is used from serial No 84 460 to present.
The boards are compatible but a software update is necessary when exchanged and a new disk will be included. See Chapter 8.5.

11.2.1. Input-Output Card E/A external Type _06

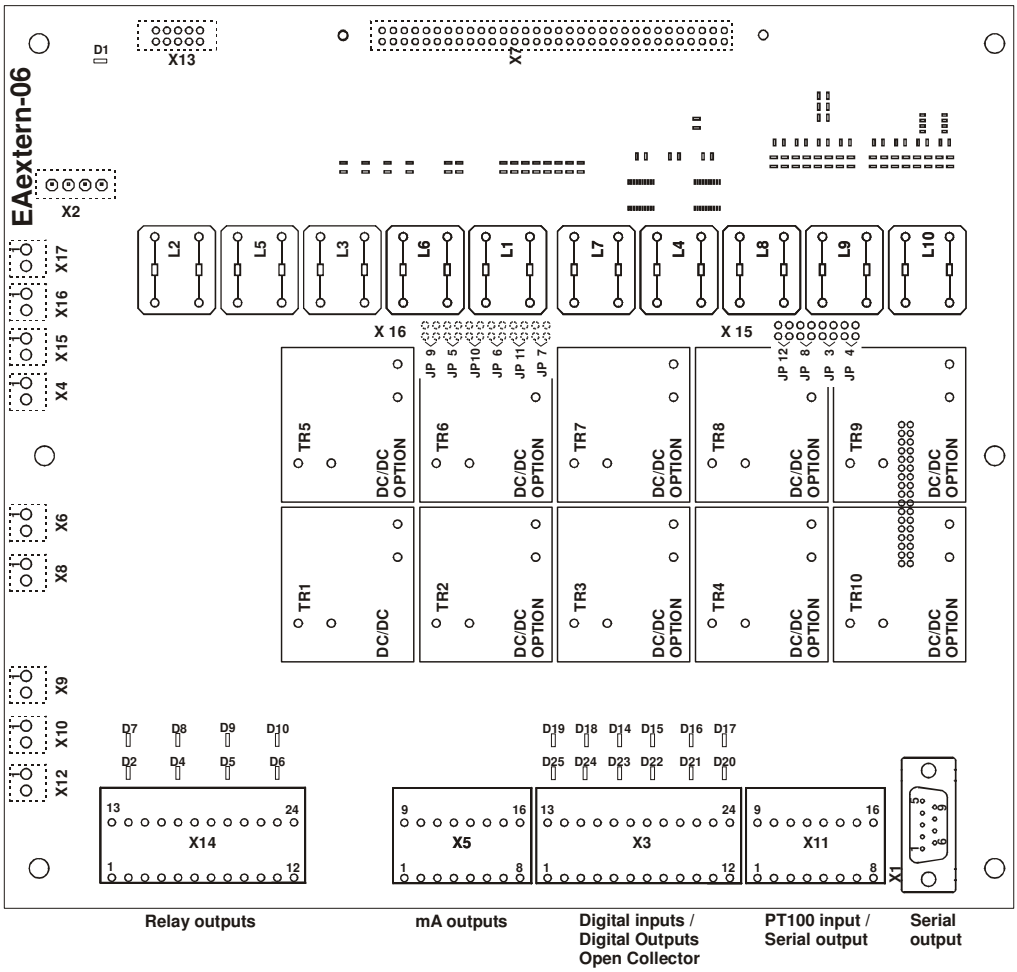


Figure 26: Input-Output -E/Aextern_06

Type external with removable terminal blocks.

Terminal blocks X3, X5, X11 and X14 are customer connections for contact inputs, relay outputs, analog outputs and RS 232 and have removable plugs for wiring. D1 to D25 are status LED`s.

11.2.1.1. Relay outputs

The relay outputs are connected to terminal block X14.

The relay contacts have the following specifications

Maximum current: 1amp max. 100 Volt, 100V DC/30Watt, 100V AC/60VA

If the relay is operational, a red alarm LED is illuminated.

The functional position for the relay outputs can be user configured from the menu and the standard factory configuration is shown below.

Block X14 on I/O Card EA External type_06

Position	Terminals			Function	Alarm LED
1	1	COM	Common	Process	D 2
	2	NO	norm.open		
	3	NC	norm.closed		
2	4	COM	Maintenance		D 4
	5	NO			
	6	NC			
3	7	COM		Filter change	D 5
	8	NO			
	9	NC			
4	10	COM		Fault	D 6
	11	NO			
	12	NC			
5	13	COM		Wobbe I <XXXX	D 7
	14	NO			
	15	NC			
6	16	COM		Wobbe I <XXXX	D 8
	17	NO			
	18	NC			
7	19	COM		Customer-specific pos.	D 9
	20	NO			
	21	NC			
8	22	COM		Customer-specific pos.	D 10
	23	NO			
	24	NC			

11.2.1.2. Analog outputs

The mA outputs are connected to terminal block X 5

The maximum loop resistance for the mA outputs is 500 Ohms with signal isolation.

If more than three current outputs are required, additional DC/DC isolation modules will be required for each output.

A maximum of seven analog outputs are available, up to three are supplied as standard. The functional position of the current outputs can be user selected using the Analog output menu and the standard delivery configuration is shown below.

Block X5

Analog	**Terminals**		**Function**	**Isolator module**
Output	Pin #			Jumper No. open
1	1	+ mA	Wobbe Index Value	TR 1 / JP 5
	2	- mA		
2	3	+ mA	Specific Gravity	TR 2 / JP 6
	4	- mA		
3	5	+ mA	Calorific Value	TR 3 / JP 7
	6	- mA		
4	7	+ mA	User selectable	TR 4 / JP 8
	8	- mA		
5	9	+ mA	User selectable	TR 5 / JP 9
	10	- mA		
6	11	+ mA	User selectable	TR 6 / JP 10
	12	- mA		
7	13	+ mA	User selectable	TR 7 / JP 11
	14	- mA		
	15	N.C.		
	16	N.C.		

11.2.1.3. Digital/ Relay contact inputs

The digital control inputs are connected to terminal block X 3

All digital control inputs are protected by internal opto-isolators.

If the control input in question is connected, an LED will display its status.

Control inputs can be user configured from the operating menu and the example shown below is the standard configuration as delivered from the factory.

Block X 3

Digital	Terminals	Function	Alarm LED
	Pin #		
1	1	Start measurement	D25
	2	Start measurement	
2	3	Start calibration	D24
	4	Start calibration	
3	5	Hold output signal	D23
	6	Hold output signal	
4	7	Pres. Sw. process gas (option)	D22
	8	Pres. Sw. process gas (option)	
5	9	Pres. Sw. cal. gas (option)	D21
	10	Pres. Sw. cal. gas (option)	
6	11	Not connected	D20
	12	Not connected	
7	13	Not connected	D19
	14	Not connected	
8	15	Not connected	D18
	16	Not connected	
9	17	Not connected	D14
	18	Not connected	
10	19	Not connected	D15
	20	Not connected	
11	21	Not connected	D16
	22	Not connected	
12	23	Not connected	D17
	24	Not connected	

11.2.1.4. Open collector drives or mA outputs

Warning: To avoid possible damage to the output circuit, please ensure that the open collector output is connected correctly.

OC = Open Collector output
Rel. = Relay output
mA = mA output

Output.	Plug Pin		Function
OC X17	1 +24V	500mA	Heating (solid state relay)
	2 GND	500mA	Heating (solid state relay)
OC X16	1 +24V	500mA	Compressor air conditioner (solid state relay)
	2 GND	500mA	Compressor air conditioner (solid state relay)
OC X15	1 +24V	500mA	Valve hot gas (solid state relay)
	2 GND	500mA	Valve hot gas (solid state relay)
OC X 4	1 +24V	500mA	
	2 GND	500mA	
mA X 6	1 +20mA		PIN 12 Frequecy converter FU04G (internal signal)
	2 GND		PIN 11 Frequency converter FU04G (internal signal)
OC X 8	1 +24V	500mA	+24 Volt Relay ignition impulse (internal signal)
	2 GND	500mA	GND Relay ignition impulse (internal signal)
OC X 10	1 +24V	500mA	(Heating solid state relay for Z-purge enclosure)
	2 GND	500mA	(Heating solid state relay for Z-purge enclosure)
OC X 12	1 +24V	500mA	
	2 GND	500mA	
Rel X 9	1 Common		PIN 23 Frequency converter FU04G (internal signal)
	2 Closed		PIN 15 Frequency converter FU04G (internal signal)

11.2.1.5. Serial interface RS 232 (Option)

The RS 232 interface can be used to transmit measured values to a remote location.
Parameter selection is made in the menu “I/O Analog outputs”.
The RS 232 interface is connected to block X 11 and to block X 1.

Interface parameters: Transmission rate: 9600 Baud
Parity-bit no
Stop-bit: 1
Data-bit: 8

Data output format:

111111.111 222222.222 333333.333 444444.444 555555.555 666666.666 777777.777
111111.111 = value analog output 1
222222.222 = value analog output 2
....
....
777777.777 = value analog output 7

Block X 11

Pin	Signal
1	Not connected
2	Not connected
3	Not connected
4	Not connected
5	PT100 air conditioner / heating enclosure
6	PT100 air conditioner / heating enclosure
7	Not connected
8	RI
9	RTS
10	CTS
11	DSR
12	DTR
13	TXD
14	RXD
15	DCD
16	RS232 GND+

Block X 1

Pin	Signal
1	DCD
2	RXD
3	TXD
4	DTR
5	RS232 GND
6	DSR
7	RTS
8	CT
9	RI

11.2.1.6. Profi Bus Interface

The CWD 2000 can be supplied with several Bus-interfaces. The system provides float Data in Intel Type and Byte Data. They can be connected to the Field Bus at the serial interface. T

he binary data in Intel Format must be interpreted by the customer.

The by the manufacturer allready programmed Anybus Comunicator can be connected with the provided serial Interface Cable (see Page 92 Figure 25). The Communicator is powered by common 24 Volt .

The blocs are interpreted according to following memory pattern

1.	Float 4 Byte	Cal.val upper	Intel
2.	Float 4 Byte	Cal. val lower	Intel
3.	Float 4 Byte	Wobbe i	Intel
4.	Float 4 Byte	Wobbe s	Intel
5.	Float 4 Byte	dv	Intel
6.	Float 4 Byte	Reserve	Intel
7.	Float 4 Byte	Reserve	Intel
8.	Float 4 Byte	T in	Intel
9.	Float 4 Byte	CO	Intel
10.	Float 4 Byte	air min	Intel
11.	Float 4 Byte	Reserve	Intel
…	……	……	……
20.	Byte 1 Byte	12345.6789	Intel
21.	Byte 1 Byte	Operation	Intel
22.	Byte 1 Byte	Change filter	Intel
23.	Byte 1 Byte	Reserve	Intel
…	……	……	……
38.	Byte 1 Byte	Reserve	Intel

Position 20 is a test-number to check the complete Protocol. For the Anybus Communicator there is a separate manual available.

11.2.2. Input-Output Card E/A external Type _05

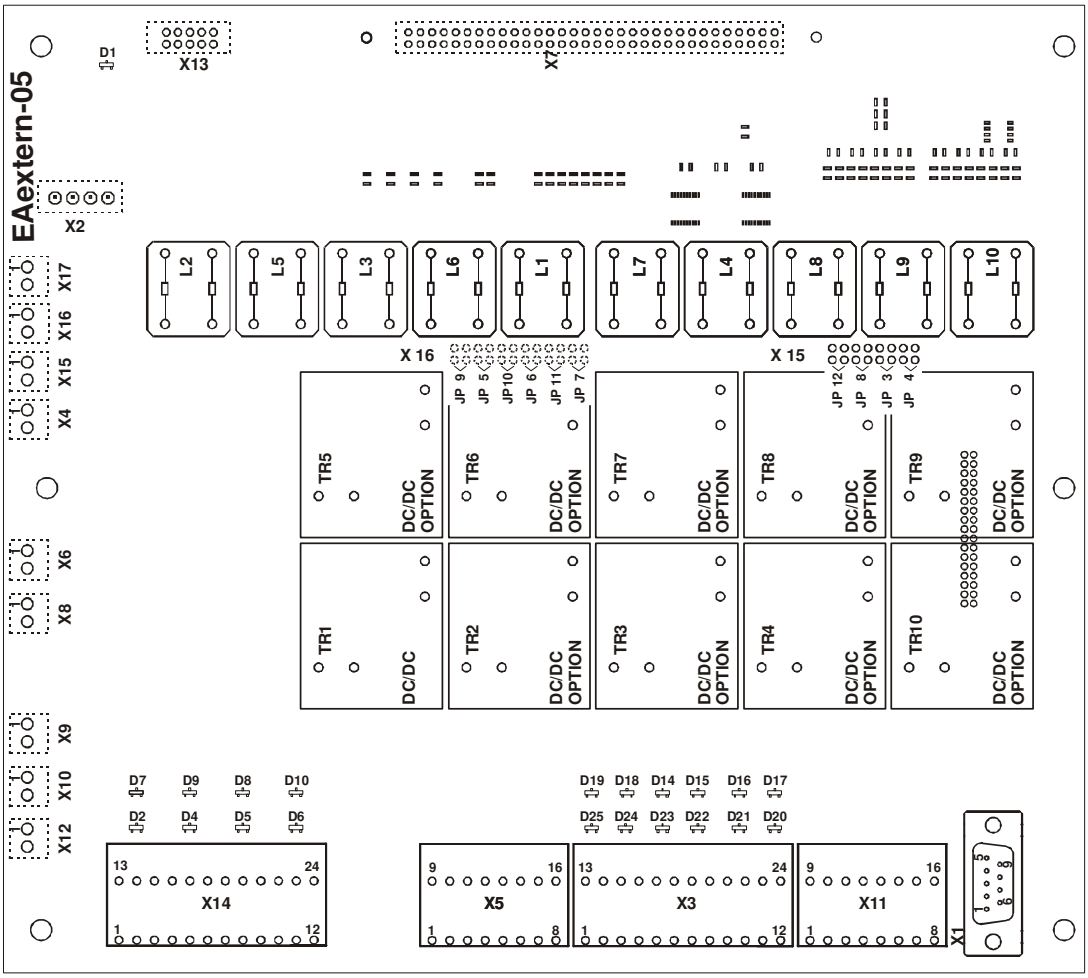


Figure 27: Input-Output -E/A

Type external with removable terminal blocks.

Terminal blocks X3, X5, X11 and X14 are customer connections for contact inputs, relay outputs, analog outputs and RS 232 and have removable plugs for wiring.

D1 to D25 are status LED`s.

11.2.3. Input-Output Card E/A external Type _04

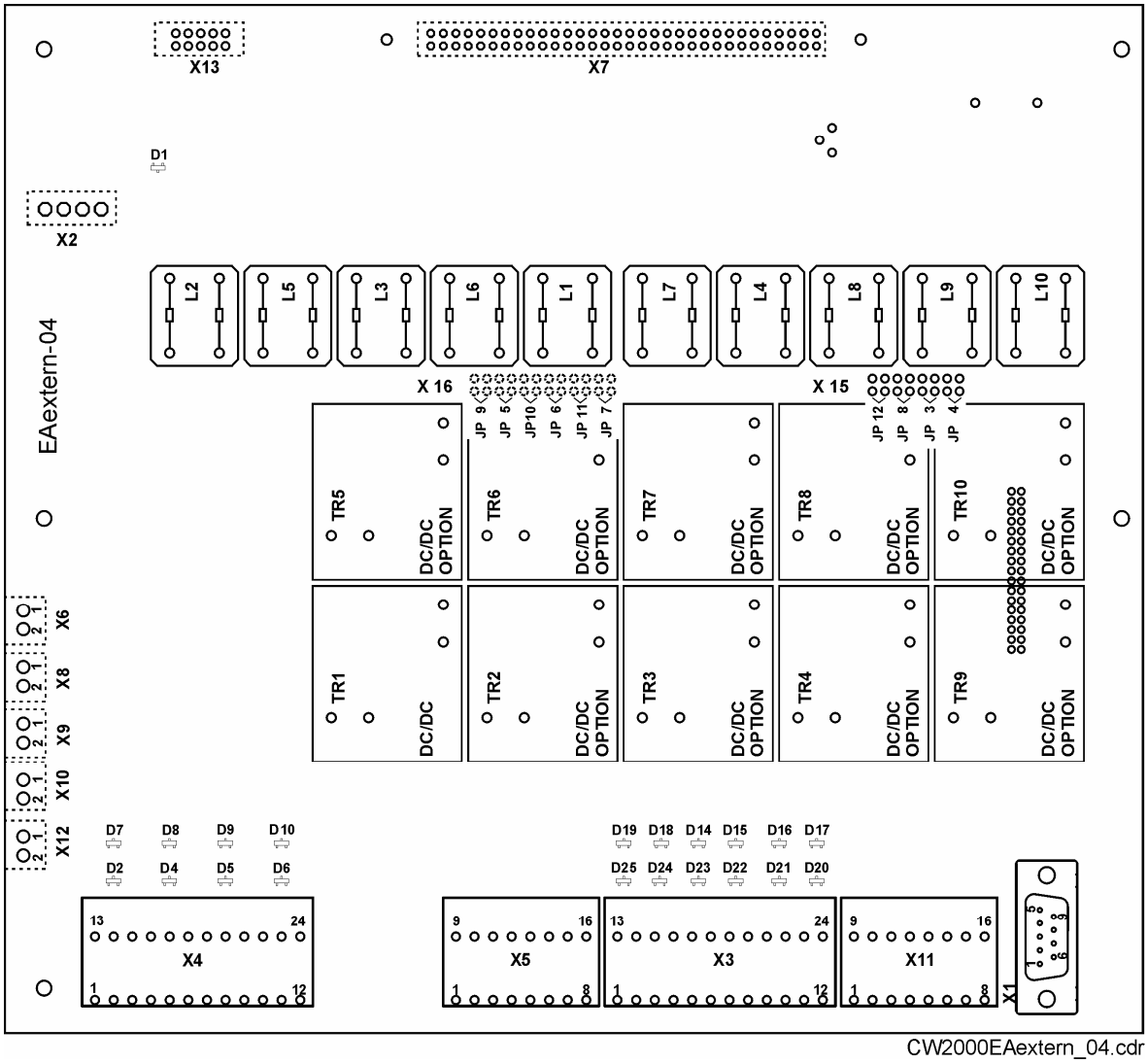


Figure 28: Input-Output -E/A Type external with removable terminal blocks.

Terminal blocks X3, X4, X5 and X11 are customer connections for contact inputs, relay outputs, analog outputs and RS 232 and have removable plugs for wiring.

D1 to D25 are status LED`s.

11.2.3.1. Relay outputs

The relay outputs are connected to terminal block X14.

The relay contacts have the following specifications

Maximum current: 1amp max. 100 Volt, 100V DC/30Watt, 100V AC/60VA

If the relay is operational, a red alarm LED is illuminated.

The functional position for the relay outputs can be user configured from the menu and the standard factory configuration is shown below.

Block X14 on I/O Card EA External type_05 or block X4 on type_04

Position	Terminals		Function	Alarm LED Typ 4	Alarm LED Typ 5
1	1	COM	CommonProcess	D 2	D 2
	2	NO	norm. open		
	3	NC	norm. closed		
2	4	COM	Maintenance	D 4	D 4
	5	NO			
	6	NC			
3	7	COM	Filter change	D 5	D 5
	8	NO			
	9	NO			
4	10	COM	Fault D 6	D 6	D 6
	11	NO			
	12	NC			
5	13	COM	Wobbe I <XXXX	D 7	D 7
	14	NO			
	15	NC			
6	16	COM	Wobbe I <XXXX	D 8	D 9
	17	NO			
	18	NC			
7	19	COM	Customer-specific pos.	D 9	D 8
	20	NO			
	21	NC			
8	22	COM	Customer-specific pos.	D 10	D 10
	23	NO			
	24	NC			

11.2.3.2.Analog outputs

The mA outputs are connected to terminal block X 5

The maximum loop resistance for the mA outputs is 500 Ohms with signal isolation.

If more than three current outputs are required, additional DC/DC isolation modules will be required for each output.

A maximum of seven analog outputs are available, up to three are supplied as standard. The functional position of the current outputs can be user selected using the Analog output menu and the standard delivery configuration is shown below.

Block X5

Analog	**Terminals**		**Function**	**Isolator module**
Output	Pin #			Jumper No. open
1	1	+ mA	Wobbe Index Value	TR 1 / JP 5
	2	- mA		
2	3	+ mA	Specific Gravity	TR 2 / JP 6
	4	- mA		
3	5	+ mA	Calorific Value	TR 3 / JP 7
	6	- mA		
4	7	+ mA	User selectable	TR 4 / JP 8
	8	- mA		
5	9	+ mA	User selectable	TR 5 / JP 9
	10	- mA		
6	11	+ mA	User selectable	TR 6 / JP 10
	12	- mA		
7	13	+ mA	User selectable	TR 7 / JP 11
	14	- mA		
	15	N.C.		
	16	N.C.		

11.2.3.3. Digital/ Relay contact inputs

The digital control inputs are connected to terminal block X 3

All digital control inputs are protected by internal opto-isolators.

If the control input in question is connected, an LED will display its status.

Control inputs can be user configured from the operating menu and the example shown below is the standard configuration as delivered from the factory.

Block X 3

Digital	Terminals Pin #	FunctionAlarm	LED
1	1	Start measurement	D25
	2	Start measurement	
2	3	Start calibration	D24
	4	Start calibration	
3	5	Hold output signal	D23
	6	Hold output signal	
4	7	Pres. Sw. process gas (option)	D22
	8	Pres. Sw. process gas (option)	
5	9	Pres. Sw. cal. gas (option)	D21
	10	Pres. Sw. cal. gas (option)	
6	11	Not connected	D20
	12	Not connected	
7	13	Not connected	D19
	14	Not connected	
8	15	Not connected	D18
	16	Not connected	
9	17	Not connected	D14
	18	Not connected	
10	19	Not connected	D15
	20	Not connected	
11	21	Not connected	D16
	22	Not connected	
12	23	Not connected	D17
	24	Not connected	

11.2.3.4.Open collector drives or mA outputs

Available on I/O Board EA external type_05 only

Warning: To avoid possible damage to the output circuit, please ensure that the open collector output is connected correctly.

OC = Open Collector output

Rel. = Relay output

mA = mA output

Output.	Plug Pin		Function
OC X 17	1 +24V	500mA	Heating (solid state relay)
	2 GND	500mA	Heating (solid state relay)
OC X 16	1 +24V	500mA	Compressor air conditioner (solid state relay)
	2 GND	500mA	Compressor air conditioner (solid state relay)
OC X 15	1 +24V	500mA	Valve hot gas (solid state relay)
	2 GND	500mA	Valve hot gas (solid state relay)
OC X 4	1 +24V	500mA	
	2 GND	500mA	
mA X 6	1 +20mA		PIN 12 Frequecy converter FU04G (internal signal)
	2 GND		PIN 11 Frequency converter FU04G (internal signal)
OC X 8	1 +24V	500mA	+24 Volt Relay ignition impulse (internal signal)
	2 GND	500mA	GND Relay ignition impulse (internal signal)
OC X 10	1 +24V	500mA	(Heating solid state relay for Z-purge enclosure)
	2 GND	500mA	(Heating solid state relay for Z-purge enclosure)
OC X 12	1 +24V	500mA	
	2 GND	500mA	
Rel X 9	1 Common		PIN 23 Frequency converter FU04G (internal signal)
	2 Closed		PIN 15 Frequency converter FU04G (internal signal)

11.2.3.5. Serial interface RS 232 (Option)

The RS 232 interface can be used to transmit measured values to a remote location.
Parameter selection is made in the menu “I/O Analog outputs”.
The RS 232 interface is connected to block X 11 and to block X 1.

Interface parameters: Transmission rate: 9600 Baud
Parity-bit no
Stop-bit: 1
Data-bit: 8

Data output format:

111111.111 222222.222 333333.333 444444.444 555555.555 666666.666 777777.777
111111.111 = value analog output 1
222222.222 = value analog output 2
....
....
777777.777 = value analog output 7

Block X 11

Pin	Signal
1	Not connected
2	Not connected
3	Not connected
4	Not connected
5	PT100 air conditioner / heating enclosure
6	PT100 air conditioner / heating enclosure
7	Not connected
8	RI
9	RTS
10	CTS
11	DSR
12	DTR
13	TXD
14	RXD
15	DCD
16	RS232 GND+

Block X 1

Pin	Signal
1	DCD
2	RXD
3	TXD
4	DTR
5	RS232 GND
6	DSR
7	RTS
8	CT
9	RI

12. Appendices

12.1. Spare parts list

A list of recommended spare for 1 year and 2-3 years operation can be found in chapter 7 under the heading Consumables.

If any unusual conditions are inspected at the job site, the factory can offer advice, so that specially selected spare parts packs can be provided.

Note: In certain countries, hardware parts and screws that are commonly available in Europe can be difficult to obtain so a small stock of these parts is available.

12.2. Pressure regulators

Stable measurement requires very stable pressure regulation and several pressure regulators for process and calibration gases are approved for use by the factory.

When operating pressures exceeding 6 bar. (90 PSIG) a 2-stage pressure regulator must always be used.

12.3. Low sample pressure

If the process pressure cannot always be expected to reach 30 mbar (12”H2O), 60 mbar (24” H_2O) with low calorific gases, then a sample gas pump is required. The boosted pressure is then reduced to required inlet pressure.

The pump should be suitable for the volume, gas type and area code requirements and gas consumption (see Chapter 3 or details). A flow of gas between 8 l/h and 220 l/h is required depending on measurement range and speed loop gas consumption.

12.4. Gas conditioning

Coke Oven gas and Blast Furnace gas contain moisture, sulfur, tar and dust. Dust and moisture in the sample gas must be removed and a sample system is available as an option that cleans and simultaneously removes moisture from these gases (Ask for Pury 100 W sample gas conditioner details).

The system consists of a process mounted SS sample probe with filter element and cooling unit that cools the sample gas down to around 4-5°C.

An optional sample conditioning system with standard filters can be used for less dirty gases as shown in the following drawing. All components are mounted on SS mounting plate with a filter bypass that allows you to change the filter element online.

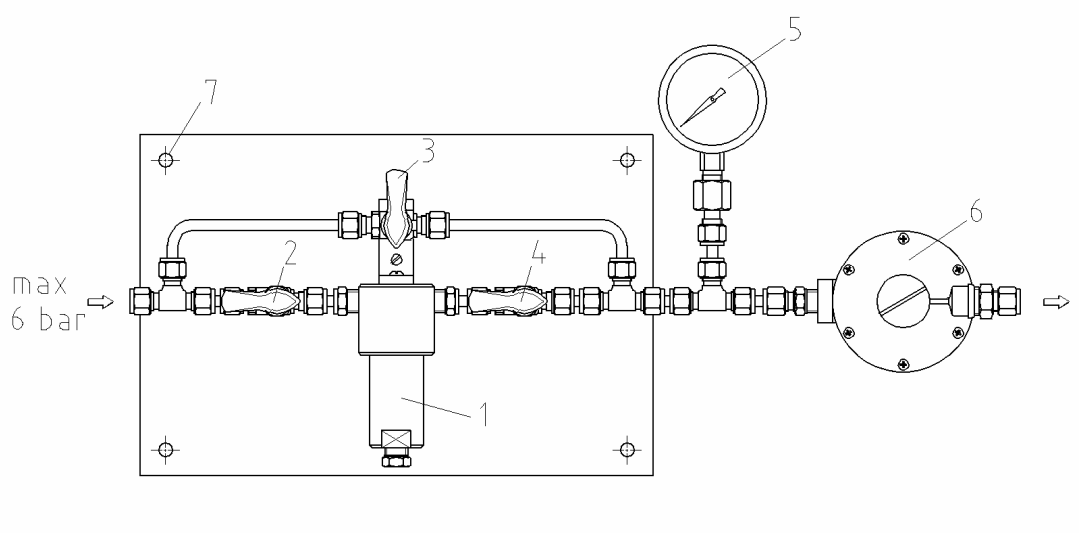


Figure 29: Filter unit with bypass valve

1. Filter
2. Ball valve
3. Ball valve
4. Ball valve
5. Indicator
6. Pre-pressure regulator (6 bar-18 mbar max.)
7. Holes for wall mounting

12.5. Gas connections

The CWD 2000 requires a very stable inlet pressure for correct operation and the factory recommends the following pressure regulators.

A primary regulator is recommended together with a second regulator in front of the CWD 2000 for pressures exceeding 6 bars. The second regulator has to be adjusted at 18 – 30 mbar in accordance with the factory specification.

12.5.1. Adjust pressure regulator

The pressure regulator (6) is adjustable by the user and a small adjustment may be necessary on the regulator(s) to allow the small specific gravity differential pressure regulator (23) to operate within its correct input range. This facilitates any adjustment to differential pressure as this controls the specific gravity sensor response speed.

12.5.2. Calibration gas connection

Connect the calibration gas using a high pressure dual stage gas regulator with high pressure flexible metal hose and quick connections, a regulator for low pressure output 18 mbar and an pressure gauge range 0 - 25” H_2O (0-60 mbar).

The gauge in front of the CWD 2000 is necessary to show inlet pressure level.

Calibration gas is clean and a filter is not necessary.

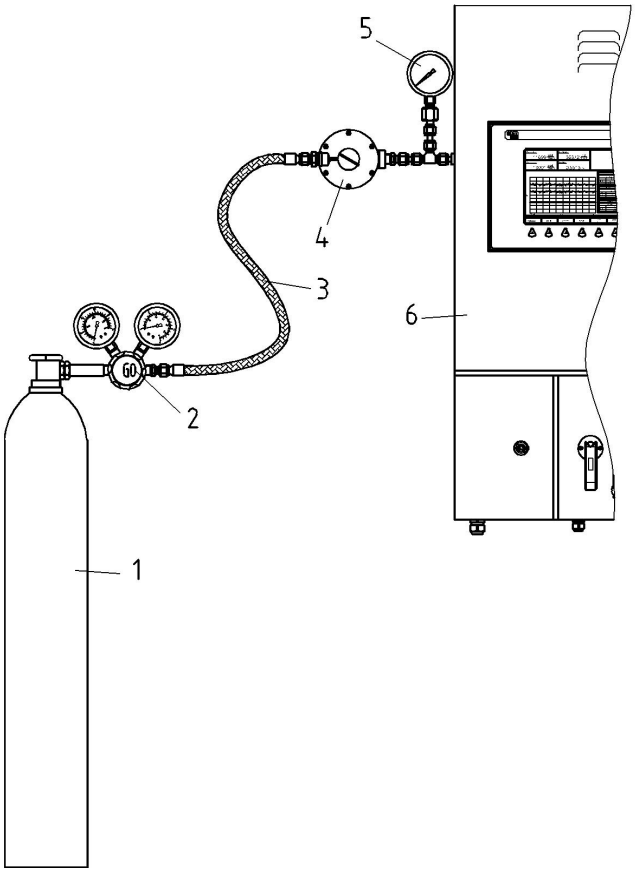


Figure 30: Calibration gas connection

1. Calibration gas cylinder
2. Regulator, two stage
3. Flexible metal braided gas hose
4, Pre regulator 6 bars to 18 mbar
5. Pressure gauge 0-60 mbar
6. CWD 2000

12.5.3. Process gas connection

An inline filter is required at the process gas connection. LPG gas or Natural gas is clean and a small filter can be used as protection against particles (see section 4.5.1 fig. 9). The use of a pressure gauge 0-25 "H_2O (0–60 mbar) is recommended between the pre regulator and the input of the CWD 2000.

Steel industry gases such as BF gas or Coke gas need a larger filter (see section 4.5.1 fig.10) and a mounting plate complete with a filter and bypass valves is an available option.

Very dirty, contaminated gases need a special sample gas conditioning system (available as an option) to remove Naphtha, H**2**S Tar, and NH**3** plus coal dust from the sample gas.

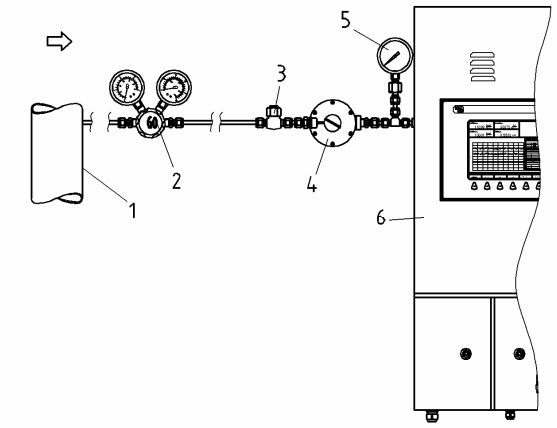


Figure 31: Process Gas line (maximum pressure 60 bar)

1.	Process gas supply line	2.	High-pressure regulator
3.	Sample gas filter	4.	Pre regulator (Zn) 6/18mbar.
5.	Pressure gauge 0-60 mbar	6.	CWD 2000

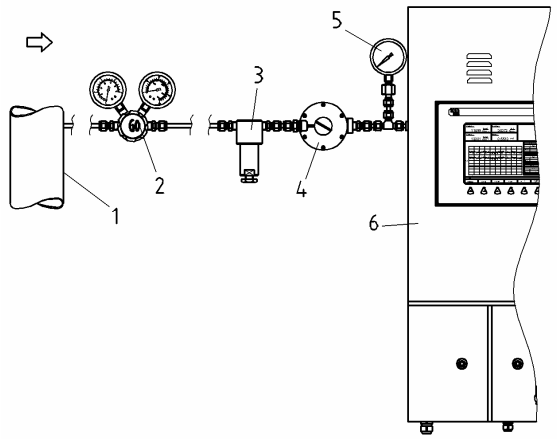


Figure 32: Process Gas line (maximum pressure 60 bar)

1.	Process gas supply line	2.	High-pressure regulator 60 bars – 3.4 bar
3.	Sample filter	4.	Pre regulator (ZN) 6/18mbar
5.	Pressure gauge 0-60 mbar	6.	CWD 2000

The high-pressure regulator (# 2 in figure 27) is not necessary if the process pressure is below 6 bars.

12.5.4. Double Range

If an extended range is necessary (for example 20-100 %) it can´t be done with one jet combination of Wobbe jet and air jet.For this purpose the CWD2000 will be equipped with a double orifice for 2 wobbe-jets and 2 air-jets. .The jet-change will be made with 4 solenoid valves automatically. The instrument changes in a predetermined point to the next range. The electronic calculates a continuous switch from one range to the other range.

With similar ranges the air consumption may be very different from one gas to an other gas. In this case it is switched, the wobbe-jet can be kept and the air-jet can be changed.

In connection with carrier gas it is possible to measure –if needed- with and without carrier gas. The change considers the calibration with or without carrier gas. The system checks, if carrier gas will be considered or not.

The decision, if carrier gas is necessary or not, can be made manually or automatically. With manual change there is in the system-menue an additional point “change range”. Next range change, for example carrier gas, switch on or off carrier gas.

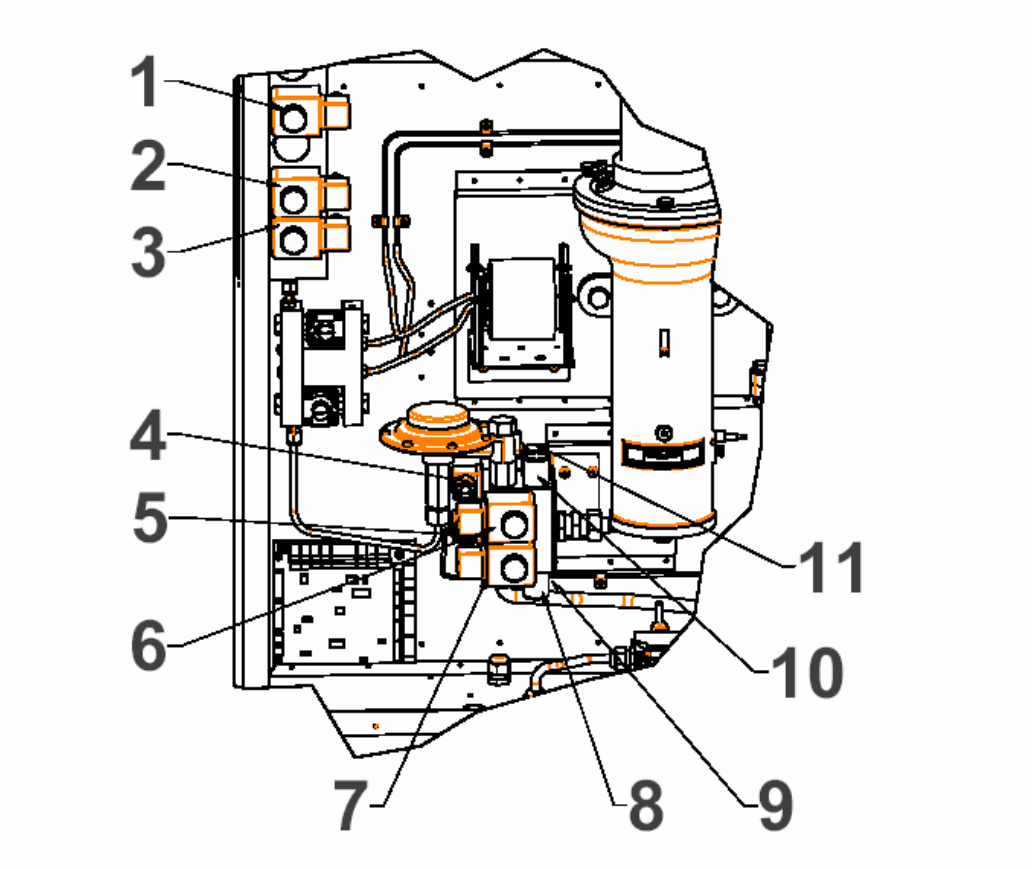


Figure 33: Double Range

1. Carrier gas (Range change)
2. Calibrating gas
3. Process gas
4. Solenoid valve Wobbe-jet 1
5. Solenoid valve Air-jet 1
6. Wobbe-jet 2
7. Air-jet 2
8. Wobbe-jet 1
9. Solenoid valve Air-jet 2
10. Air-jet 1
11. Solenoid valve Wobbe-jet 2

12.5.5. Carrier Gas

When a carrier gas is necessary both combustible and non combustible gases can be suitable for carrier gas, depending on process gas used in the application.

Normally blast furnace gas with a low content of CO and H_2 needs a carrier gas option. The amount of CO and H_2 in the process gas determines if Oxygen or CH_4 is suitable as a carrier gas. A wide ranged flare gas will usually use Methane as a carrier gas. See section 6.2.3.8. for a list of carrier gas configuration details.

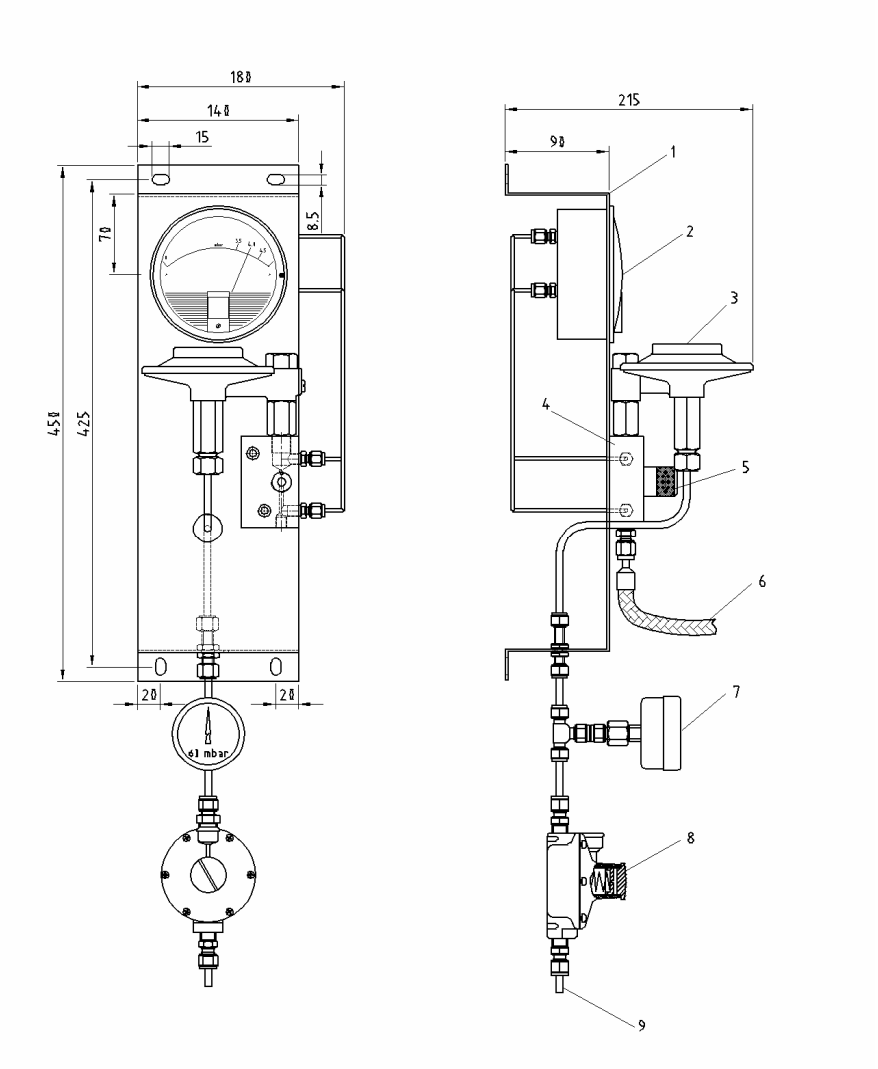


Figure 34: Carrier gas module

1. Mounting bracket S/S
2. Dwyer pressure gauge
3. Pressure governor
4. Jet block
5. Flow control jet with cap
6. Flexible outlet connection
7. Inlet pressure gauge S/S
8. Pre pressure regulator
9. Inlet connection for carrier gas

12.5.6. Fast loop

The CWD 2000 itself has a high-speed response time but the installed response speed depends on the volume of the process connections with regulators and filters.

To calculate the volume of the tube with the volume of filters and regulators, see Chap. 3.3.

A fast loop 'speeds-up' sample gas delivery to the instrument. The tee-piece outlet allows 80 % of the gas to flow past the instrument to a lower pressure area and 20% of the total gas volume is sampled by the instrument with a 1:4 improvement in response time. The flow meter control valve (customer supplied) allows the customer to adjust the by-pass ratio.

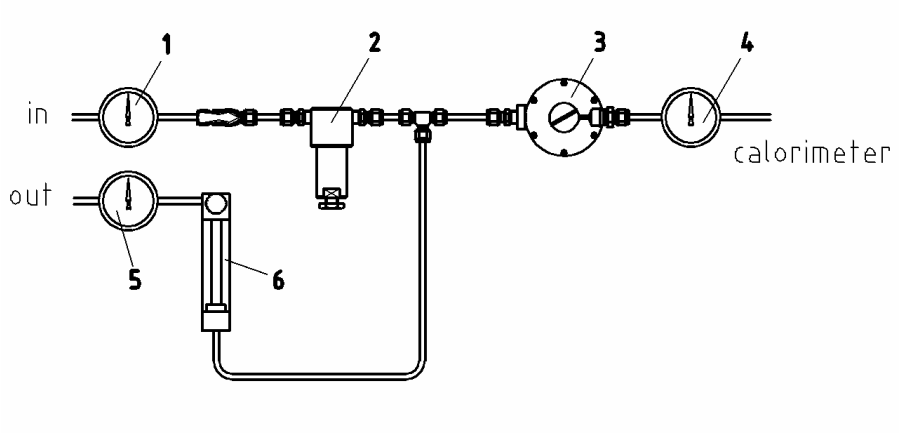


Figure 35: Fast loop schematic

1. Gauge inlet pressure
2. Filter
3. Pressure regulator
4. Gauge instrument inlet
5. Fast loop outlet pressure
6. Flow controller

12.6. Enclosures for outdoor installation

The CWD 2000 has a (IP 54) NEMA 12 case and is not suitable for direct outdoor installation. If an analyzer shelter is not available, or if the unit has to be placed as close as possible to the process gas pipeline or sample take-off, a suitable outdoor enclosure will be required.

The design of an outdoor shelter will require that a stable temperature must be maintained within the enclosure, since ambient temperatures can fluctuate over a very wide range depending on the installation location. The enclosure is either heated or heated and cooled using a programmable climate control system depending on the users specific requirements.

Special enclosures can be supplied to suit the users application as part of a turnkey calorimeter system to suit general purpose areas or areas classified as hazardous by local electrical codes and ordinances.

12.6.1. "Z" Purge System

Important: Purge the enclosure before power is applied using the customer supplied externally mounted line power disconnect switch, unless the area is known to be Non Hazardous per local codes or ordinances. Bypassing the low purge pressure switch allows power to be applied during maintenance with the door open. See 11.8.2. See enclosure maintenance procedures and the circuit diagram drawing number (XXX-300) for more details.

Start-up procedure:

1. Close door and lock all three fasteners.
2. Open instrument air valve (XXX-26).
3. Adjust the pressure regulator (XXX-091) to 3bar. Check the enclosure pressure (XXX-094) and adjust the pressure to 2.0 $\pm$0.5 inches of water with regulator (XXX-091). If the enclosure pressure is low, the pressure switch inhibits power.
4. Wait 30 minutes.
5. Switch on power.

Caution: The enclosure has to cool down for 30 minutes before the purged enclosure is opened unless the area is known to be safe. Before start-up, the gas supply must be installed and leak checked. The power supply must be connected in accordance with all local codes and ordinances.

12.6.2. Gas Supply

Connect the sample gas to the enclosure inlet connections.

The maximum gas pressure is: 6 bars (90 psig).

The process gas and the calibration gas require a pressure set point of 22 mbar (9" H2O). Pressure regulators need to be installed at the gas inlet if not supplied with the equipment. If supplied by the factory, the pressure regulators will be mounted on a plate with the pressure gauges and must regulate the gas pressure to within $\pm$ 2mbar (1" H2O) of set point. If the inlet pressure is above 6 bars (90 psig) install a primary pressure regulator in the sample gas line.

12.6.3. Power Supply

Connect the enclosure (XXX-001) line power supply to the Main power switch terminals in box XXX-022 (terminals L1, N, PE). Use an external disconnect switch

(customer supplied) and follow all applicable local electrical codes and ordinances relating to electrical wiring and grounding practices. For technical data see also Chapter 12.

12.6.4. Enclosure Heating

An enclosure heater with a small electric fan is used for heating the enclosure in conjunction with an onboard temperature controller in the CWD 2000 software. This combination ensures that the incoming purge air is circulated around the enclosure and is rapidly equilibrated with the inside environment of the enclosure. This approach eliminates the potential for thermal shock due to severe outside environmental conditions. Inside temperature and ambient temperatures have to be similar (winter/summer).

If the ambient temperature is higher than the enclosure temperature, raise the enclosure temperature via the controller menu to a value above the expected ambient temperature. If ambient temperature cannot be reached, the set point of the controller may need to be lowered.

A solid-state relay is used to switch the heater power and this is located with the terminal strips in a polycarbonate enclosure with a clear removable cover that restricts casual access to line power components.

12.6.5. Vortex Cooler

A vortex cooler is also used to provide temperature control inside of the enclosure and this supplies cool air to the enclosure and this reduces the chance of local overheating due to adverse ambient conditions. The vortex cooler requires air at 100 $\pm$ 20 psig for best performance since the amount of cooling drops rapidly at low pressures.

12.6.6. Air Conditioner

For applications involving installation in very hot areas, two types of air conditioners are available as an option, depending on the installation area electrical classification: General purpose or Hazardous area. The air conditioners are designed to be maintenance free, with the exception of the air filter and condenser unit. To ensure reliable, continuous operation, the air filter (indoor unit, bottom) and the condenser (outdoor unit) should be cleaned periodically.

12.6.7. Enclosure maintenance procedures

“Z” Purge system
Enclosure pressure does not reach 1 inch of water.
-Enclosure door is not locked ->lock door with all three fasteners.
-Air filter (XXX-090) is loaded with dust-> change air filter.
-Door gasket is damaged or misplaced->adjust or replace gasket

Calorimeter does not start:

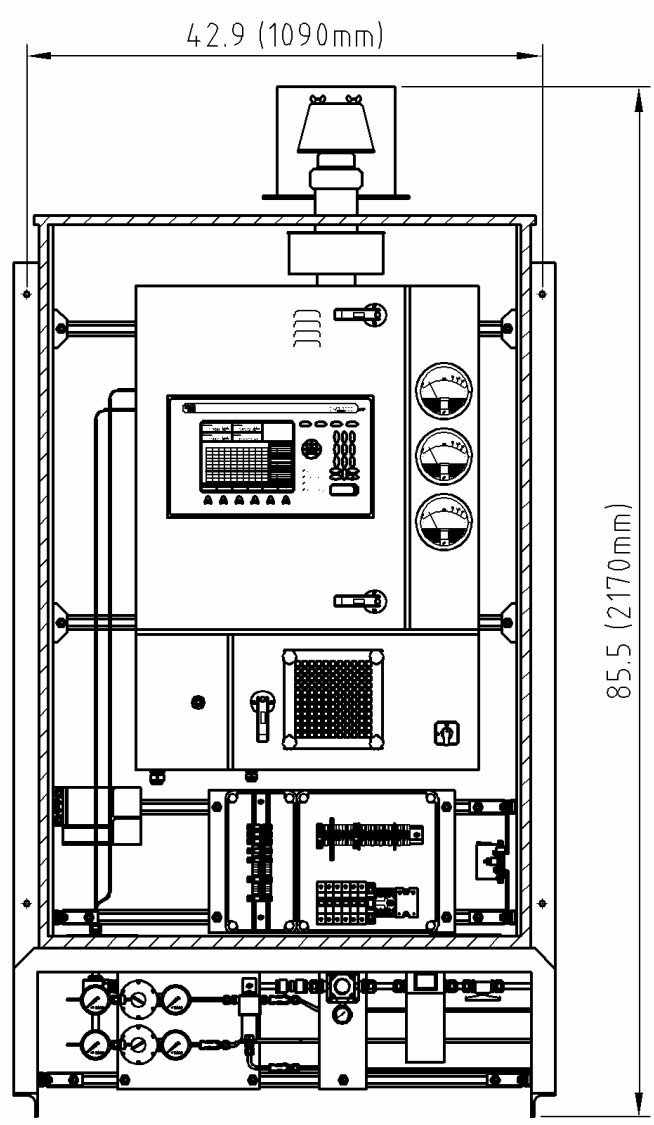
-Enclosure pressure (XXX-94) is too low -> check the enclosure pressure (XXX-094) and adjust the pressure to 2.0 ±0.5 inches of water with regulator /XXX-091). Check enclosure pressure switch for functionality. Switch N/O (normally open).

Circuit Breakers

The enclosure has several circuit breakers located with the terminal strips in the polycarbonate enclosure. The circuit breaker power ratings are clearly marked on the body of the breakers.

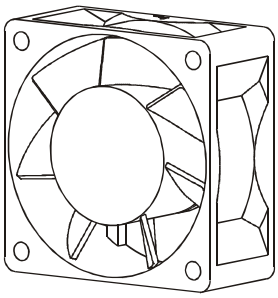
Enclosure

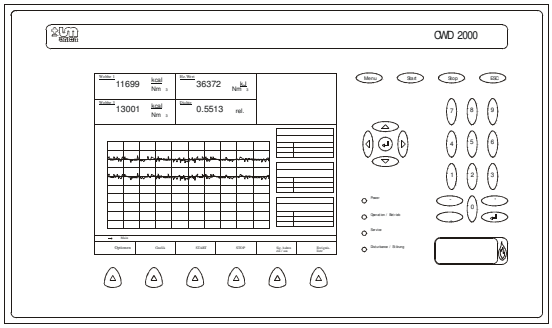
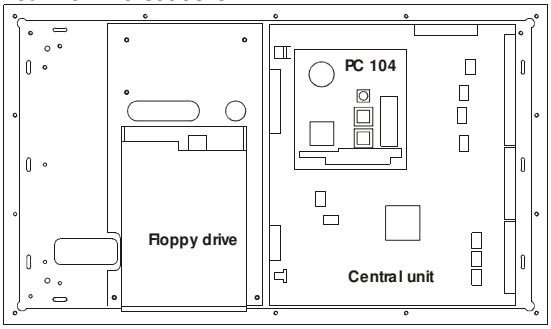
Check periodically that the flue gas exhaust connection is clean and rain tight.

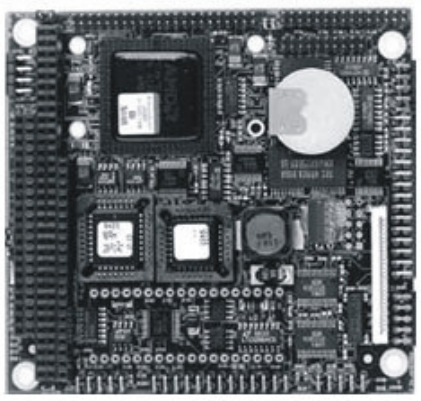


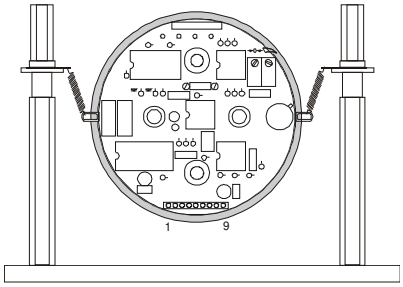
13. Spare parts

13.1. Spares electronics

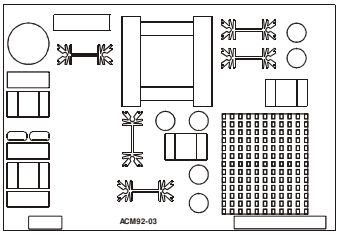
	Blower Power supply CWD 2000, Type 614 /24V DC, 2.5 VA Dim. 60 x 60 x 25 mm Weight: 90 gram
Order description:	Blower Powersupply cwd 2000, Typ 614 /24V DC, 2.5 VA
Order number:	cwxx-s-e-blow

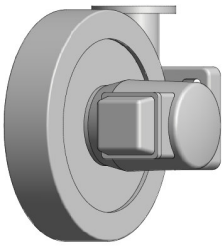
 **Rear view without cover** 	PC104 CWD2000 complete - Typ cw2000c central-unit - PC104, - Floppy drive - Frontpanel + keypad + display
Order description:	PC104 CWD 2000 complete
Order number:	cw00-s-e-pc04

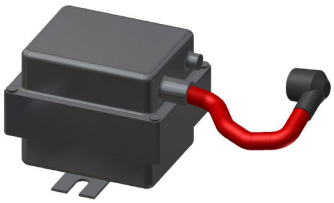
	PC 104 CWD 2000 -TypeMSM486SV4 - Disc on chip MD2800-D08 8MB
Order description: PC104 CWD 2000 Order number: cw00-s-e-pc104	

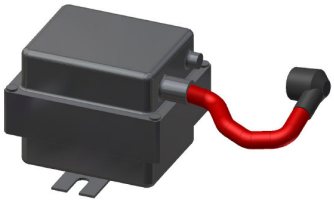
	Specific Gravity Sensor - heated - +/-15V / 7VA - **Range 0,2 – 2,2 dv** Specific Gravity Sensor - heated - +/-15V / 7VA - **Range 0,0 – 2,0 dv** Weight: 90 gram
Order description: Specific Gravity Sensor heated Order number: cw00-s-e-sg7w / range _____dv	

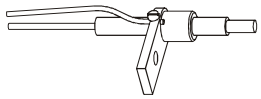
13.2. Spares Electric

	Powersupply ACM92-03 V1 = 5V / 3,0A V2 = 15V / 0,5A V1 = 15V / 0,5A V1 = 24V / 0,5A V1 = 24V / 2,0A V1 = 24V / 0,1A
Order description:	Powersupply CWD 2000, Typ ACM92A03, 110-240VAC
Order number:	cw00-s-e-ps03

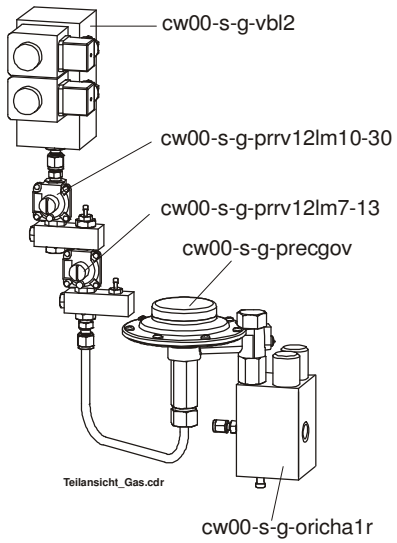
	Fan cwd 2000, Typ RDO 110 resp. 190 VAC Weight: 6000 gram
Order description:	Fan cwd 2000, Typ RDO 110 resp. 190 VAC
Order number:	cw00-s-e-fan

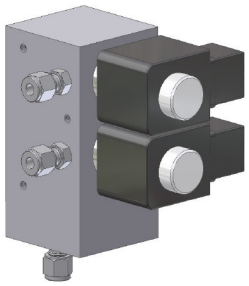
	Igniontransformer TZI5/100W, 230V/50Hz with ignitionkabel and plug Weight: 1600 gram
Order description:	Igniontransformer TZI5/100W, 230V/50Hz
Order number:	cw00-s-e-igtran230

	Igniontransformer TZI5/100N, 115V/50(60)Hz with ignitionkabel and plug Weight: 1600 gram
Order description:	Igniontransformer TZI5/100N, 115V/50(60)Hz
Order number:	cw00-s-e-igtran115

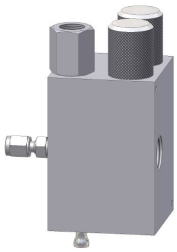
	Ignition electrode, Type ZE 6-44-30 Compatible to Union instruments CW85/CW95/CWD2000 Weight: 20 gram
Order description:	Ignition electrode CW85/CW95/CWD2000
Order number:	cwxx-s-e-igel

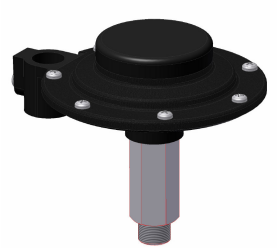
13.3. Spare gas



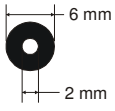
	Solenoid valve block with 2 valves - Material Aluminium, anodized - Input / output tube fitting 6mm Gyrolok SS316 - Solenoid valves 24V DC/9 VA Weight: 2100 gram
Order description:	Solenoid valve block with 2 valves
Order number:	cw00-s-g-vbl2

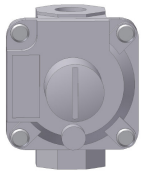
	Solenoid valve CWD 2000, type 24V DC / M25 X 1 -Solenoid, valve, valve seat
Order description:	Solenoid valve CWD 2000
Order number:	CW00-S-E-SOL

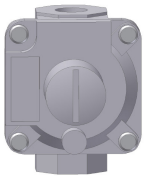
	Orifice chamber type CWD2000 - with jet caps and connectors for gas and air - without Wobbe orifice Weight: 490 gram
Order description: Orifice chamber type CWD2000 with 1 range Order number: cw00-s-g-oricha1r	

	Mounting screw for precision gas regulator with 2 gasket 24x17x2 mm Weight: 110 gram
Order description: Mounting screw for precision gas regulator Order number: cwxx-s-g-prgovscr	
	Precision gas regulator Compatible to Union instruments CW85/CW95/CWD2000 Pin max. 50 mbar, Pout 4 mbar Weight: 490 gram
Order description: Precision gas regulator to type CW85/CW95/CWD2000 Order number: cwxx-s-g-precgov	

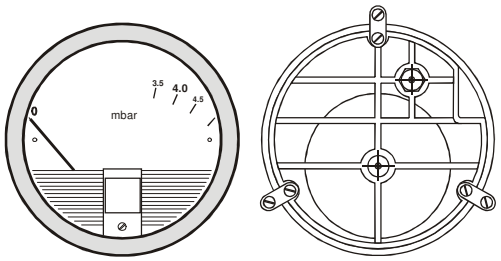
	Diaphragm for precision gas regulator - D = 96 mm - Material NBR - Compatible to Union instruments CW85/CW95/CWD2000 Weight: 10 gram
Order description: Diaphragm to precision gas regulator CW85/95/CWD2000 Order number: cwxx-s-g-precdia	

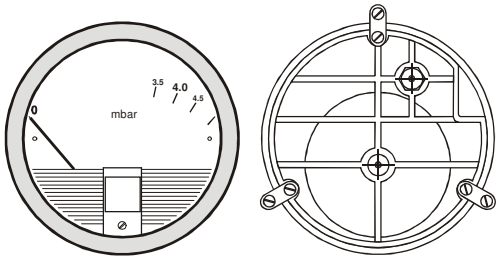
	Neoprene tube 6 x 2 mm, black, lenght1 m Compatible to Union instruments CW85/CW95/CWD2000 Weight: 30 gram
Order description: Neoprene tube 6x2,1m, to instrum. CW85/95/CWD2000,1m Order number: cwxx-s-g-rutu6x2	

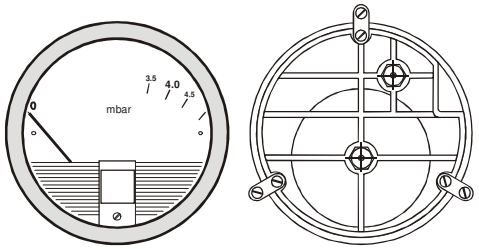
	Pressure regulator gas Typ RV12LM: - Pin max 100 mbar, output 10-30 mbar - Material zinc - Inlet + outlet G1/8 Weight: 45 gram
Order description: Pressure regulator RV12LM 10-30mbar Order number: cw00-s-g-prrv12lm10-3	

	Pressure regulator gas Typ RV12LM: - Pin max 100 mbar, output 7-13 mbar - Material zinc - Inlet + outlet G1/8 Weight: 90 gram
Order description: Pressure regulator RV12LM 7-13mbar Order number: cw00-s-g-prrv12lm7-13	

13.4. Spares pressure gauges / switches

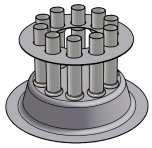
		Pressure gauge for gas 4 mbar type Dwyer with gland for rubber tube compatible to instruments Typ C/W/85/95/2000 Weight: 550 gram
Order description: Order number:	Pressure gauge for gas 4 mbar type Dwyer cwxx-s-i-4gas	

		Differntial pressure gauge for gas 4 mbar type Dwyer with gland for rubber tube compatible to instruments Typ C/W/2000 Weight: 550 gram
Order description: Order number:	Differntial pressure gauge for gas 4 mbar type Dwyer cw00-s-i-4diffgas	

		Differntial pressure gauge for air 4 mbar type Dwyer with gland for runbber tube compatible to instruments Typ C/W/85 /95/2000 Weight: 550 gram
Order description: Order number:	Differntial pressure gauge for air 4 mbar type Dwyer cwxx-s-i-4diffair	

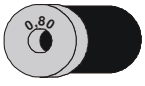
13.5. Spares measurement system

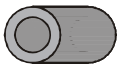
	Thermopile with 24 thermoelemnts, diameter=1,0mm Compatible to Union instruments CW85/CW95/CWD2000 Weight: 700 gram
Order description: Thermopile with 24 thermoelemnts, diameter=1,0mm Order number: cwxx-s-m-tp1	

	Heat exchanger 0,2mm with clamp collar Compatible to Union instruments CW85/CW95/CWD2000 Weight: 60 gram
Order description: Heat exchanger 0,2mm with clamp collar Order number: cwxx-s-m-heat	

	Gasket to heat exchanger Compatible to Union instruments CW85/CW95/CWD2000 Material: ISOPLAN-750, 94x84x2mm Weight: 3 gram
Order description: Gasket to heat exchanger to instruments CW85/95/2000 Order number: cwxx-s-m-heatgas	

	Orifice gas (Wobbe orifice) - Material Alu/ Perbunan NBR - Diameter mm Weight: 3,5 gram
Order description: Orifice Gas (Wobbe orifice) Order number: cw00-s-m-origas **x.xx mm**	

	Orifice air - Material Alu/ Perbunan NBR - Diameter mm) Weight: 3,5 gram
Order description: Orifice air Order number: cw00-s-m-oriair **x.xx mm**	

	Rubber tube to orifice gas or air Material Perbunan, NBR 7 mm x 11 mm x 23 mm (D1xD2xL) Weight: 3 gram
Order description:	Rubber tube to orifice gas or air instrum. CW85/95/CWD2000
Order number:	cw00-s-m-orirutu

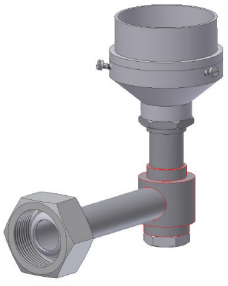
13.6. Spares burner

	Burner Type H with 9 quartz-jets to CWD2000 - Material Aluminium-Stainless Steel Weight: 125 gram
Order description: Burner Type H complete (Mat. Alu./SS) to CWD2000 Order number: cw00-s-b-hcalss	

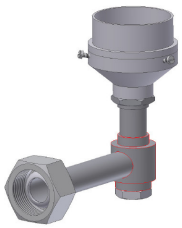
	Single quartz-jet with threaded sleeve Weight: 2 gram
Order description: Single quarz-jet with threaded sleeve Order number: cwxx-s-b-sq	

	Landfill gas burner to CWD2000 - Material Aluminium-Stainless-Steel Weight: 110 gram
Order description: Landfill Gas Burner comple.(Mat.Alu./SS316) to CWD2000 Order number: cw00-s-b-mcalss	

	Wire-sieve for Landfill gas burner to CWD2000 Material Brass, Stainless steel Weight: 8 gram
Order description: Wire-sieve for landfill gas burner (Mat. Brass./SS316) Order number: cwxx-s-b-mws	

	Burner type LM for low BTU gas with Aluminium head for CWD 2000 - Material Aluminium-SS316 - Burner head 36 holes diameter 1,9 mm Weight: 115 gram
Order description: Burner LM for low BTU gas with ALU-head for CWD2000 Order number: cw00-s-b-lmcalss	

	Burner head type LM for CW85/95/CWD2000 - Material Aluminium -- 36 holes diameter 1,9 mm Weight: 17 gram
Order description: Order number:	Burner head LM for low BTU, ALU-head for CW85/95/2000 cwxx-s-b-lmbh

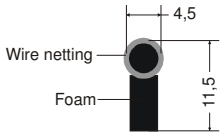
	Burner type L for low BTU gase with Aluminium head for CWD2000 - Material Aluminium-SS316 - Burner head 36 holes diameter 2,5 mm, 1 hole diameter 4,2 mm. Weight: 115 gram
Order description: Order number:	Burner type L for low BTU gas with ALU-head for CWD2000 cw00-s-b-lcalss

	Burner head type L for CW85/95/CWD2000 - Material Aluminium - 36 holes diameter 2,5 mm, 1 hole diameter 4,2 mm. Weight: 17 gram
Order description: Order number:	Burner head L for low BTU, ALU-head for CW85/95/2000 cwxx-s-b-lbh

13.7. Spares air

	Air filter for CWD2000 - 200 x 200 x 95 mm Weight: 510 gram
Order description:	Air filter for CWD2000, 200 x 200 x 95 mm
Order number:	cw00-s-a-pafi

13.8. Spares enclosure

	EMV-sealing to CWD2000 case (length 2 Meter) Typ Laird BE-4011-1107-1 Weight: 42 gram
Order description:	EMV-sealing to CWD2000 case (length 2 Meter)
Order number:	cw00-s-c-emvseal

14. Technical Data

Technical Data

System CWD 2000:

Process computer:	PC104, 486, 66MHz, 8MB disk on chip flash memory. Real time processing system with multi-tasking ability
Measuring Range:	40 to 100% F.S.
Dual Range:	20 to 100% F.S.
Low Range:	75 to 150 BTU/scf (700 to 1400 kcal/Nm3.
High Range:	1600 to 3200 BTU/scf (15000 to 30000 kcal/scf).
Accuracy:	± 1.0% F.S. CV or Wobbe Index.
Specific Gravity:	± 0.8% F.S. Specific Gravity.
Linearity:	± 0.2%
Repeatability:	± 0.5%
Response Time:	50% 7 seconds: 90% 30 seconds: 99% 45 seconds.
Outputs:	4-20 mA DC isolated (600 ohms max load). Up to 7 mA outputs, 1 or 3 normally supplied. RS 232.
Alarm Relay:	8 Alarm relays.
Contact rating:	1.0 amp at 100 volt.
Digital output:	4 - Open collector.
Digital Input:	3 Contact closures.
Communication:	RS 232.

System Details;

Gas Pressure:	6 to 15” H2O (15 to 37mbars).
Gas Consumption:	0.5 to 7 scfh (15 to 200 l/ph) application dependant.
Gas Connection:	Tube fitting (Compression ¼” or 6mm).
Ambient Temperature:	5 to 40C (Rate of change ± 5C per Hr).
Power:	115 volt 50/60Hz (330 VA) or 220 volt 50/60 Hz (165VA).
Dimensions:	30”W x 40”H x 13”D.
Weight:	111lb (50.5 kg).