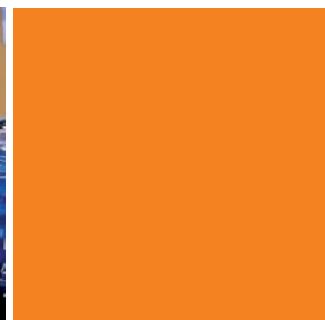
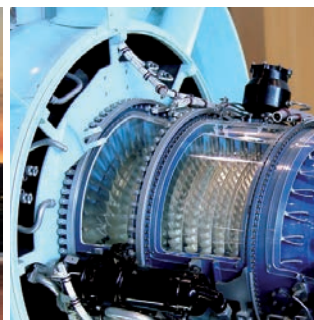


Measurement parameter

- Calorific value / Heating value
- Wobbe-Index
- Specific density
- CARI, air requirement

Applications

- LNG-Terminals
- Offshore Process gas regulation
- Fuel regulation for gas turbines



CWD2005 SPC



Outdoor Calorimeter with type approval for
operation in hazardous area

The combustion calorimeters of the **CWD2005 (Calorimetry, Wobbe-Index, Specific Density)** device series are used to determine the gas quality and the associated measured quantities:

- Calorific value/Heating value
- Wobbe-Index
- Specific density
- CARI, air requirement

The **CWD2005 SPC (System Purge Certified)** is an outdoor variant of the CWD2005 for use in hazardous area (Class I Division 2 Groups B, C, D, T4). SGS North America (SGS: Société Générale de Surveillance) carries out individual device-specific testing and confirms conformity with the following standards:

- NFPA 496, 2013 and
- ANSI/ISA 1212.01

It is typically used for flare gas combustion, control of gas turbines and fuel control in refineries and petrochemical plants.

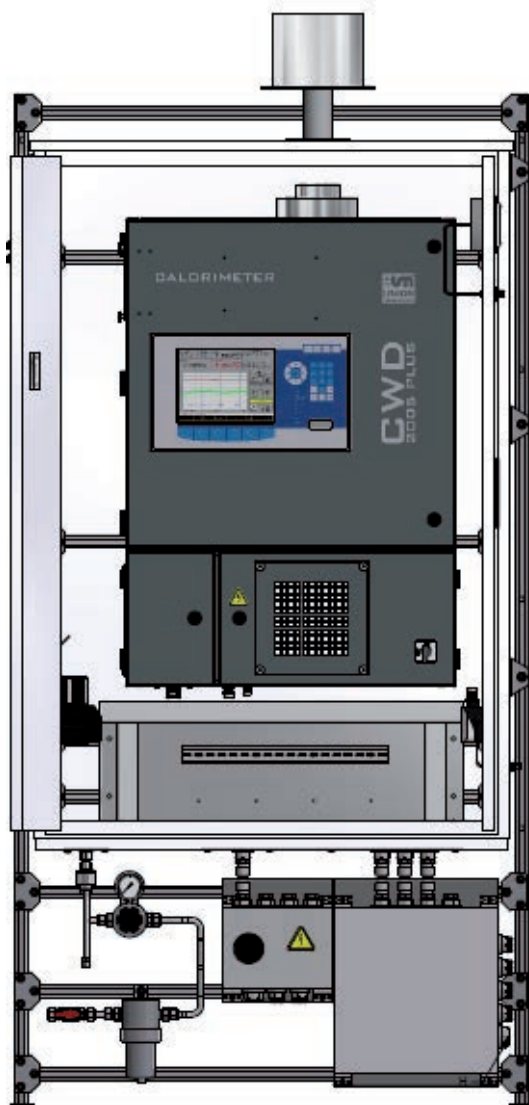


Figure 1: CWD2005 SPC

Typical measuring ranges of CWD2005 SPC

Gas type	Measuring range [MJ/m ³]	Max. Inlet pressure [mbar]	Wobbe-Index accuracy [± % MBE]	Typical gas consumption [l/h]
Flare gas	0 – 15	40	2.0	40
Blast furnace gas	3.5 – 6	40	3.0	170
Converter gas	4.5 – 9	40	1.5	140
Mixed gas	5 – 10	40	2.0	140
Coke oven gas	15 – 30	40	1.5	60
Biogas	25 – 35	40	1.0	70
Natural gas	25 – 48	20	1.0	25
Refinery gas	25 – 50	40	1.5	25
LPG	40 – 90	20	1.5	15

Table 1: Typical measuring ranges

Direct and continuous determination of gas quality by combustion calorimeter has been a proven, high-accuracy measurement principle for more than 60 years (see Table 1). During combustion of a defined gas volume, all gas components are thermally converted. The energy released in the process is proportional to the Wobbe-Index. The specific density of the gas is measured simultaneously so that the heating value can be calculated from these two values.

Because it also measures unexpected and unknown gas components, the CWD2005 SPC can be used with a rapidly changing gas composition, such as in the case of residual gases of chemical processes or synthetic gases in the steel industry.

In addition, the system provides a high level of safety in the event of a process shutdown or interruption of the gas supply by extinguishing its flame after a maximum of 10 seconds.

System design



Figure 2: CWD2005 SPC system design

- 1 Protective enclosure vent
- 2 CWD2005 PLUS combustion calorimeter
- 3 Connection boxes for voltage supply and signal cable
- 4 Main switch
- 5 Connection compressed air supply - purge air
- 6 Protective enclosure
- 7 Inlet for process gas and calibration gas

The central component is the CWD2005 PLUS combustion calorimeter that is mounted in a pressurized protective enclosure purged with compressed air.

Additional components of the CWD2005 SPC are:

- Connection boxes (approval: IECEx, ATEX)
- Ventilation system for the protective enclosure
- Manometer and pressure switch on the protective enclosure
- Compressed air supply and ball valve.

The operator control unit comprises the central controller, display and keyboard and is connected to two electronic modules via an internal device bus. The measurement module collects the measurement data and the I/O module undertakes the external communication.

The software is based on a real-time operating system. It is structured in various menu levels that are reached using softkeys.

The device is equipped with one (optionally two) separate calibration gas supply (or supplies) for calibration. Time-controlled calibration is possible.

Technical data for CWD2005 SPC

Weight	Up to approx. 250 kg
Dimensions	
W x H x D [mm]	1150 x 2000 x 600
Degree of protection	IP 64 (Nema4X)
Ex classification	Class I, Div. 2, Group B, C, D, T4
Ambient temperature	-20 – 45 °C
Ambient humidity	0 – 95% relative
External pressure	800 – 1100 hPa (0.8 – 1.1 bar)
Supply pressure of gas	30 – 40 mbar
Process gas supply	max. 2
Calibration gas supply	max. 2
Carrier gas supply	max. 1
Relative gas humidity	≤ 95%, condensate-free
Supply temperature of gas	max. 45 °C
Instrument air consumption	30 m³/h (standard conditions)
Instrument air pressure	min. 5 bar, max. 10 bar
Voltage	240 VAC, 50/60 Hz 110 VAC, 60 Hz
Interfaces	3 x relay; RS232; 4 – 20 mA; Fieldbus; Profibus DP; Profinet IO; Modbus RTU/TCP; Industrial Ethernet
T90 display time	15 s
Certifications/ Conformity	NFPA 496, 2013; ANSI/ISA 1212.01
Approval	IECEx PTB 09.0048
Connection box	PTB ATEX 1108

Table 2: Technical data for CWD2005 SPC



About UNION Instruments

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Our service performance



Support

The **UNION-hotline** helps to solve all inquiries and urgent issues fast and easy. Device specific concerns can be solved worldwide within minutes by direct communication via TEAMVIEWER.



Original spare parts

Original spare parts for the majority of UNION's products are on stock directly at site and ready for dispatch within a few hours.



Software

For read-out of measurement and calibration data a device-specific software is available for our clients. In addition to the graphic display of measurement data its export in several database formats is possible.



Training

UNION offers individual in-house training or on-site seminars for installation, use and maintenance of our devices even at the customer's premises. Training is individually adapted to the client's requirements.



Repair service

A global service for inspection, maintenance and repair of our devices and systems is provided directly by UNION and via its distributors.



Certification

Since 20 years we have implemented the ISO9001 system. UNION's products are certified to ATEX and UL/CSA directives accordingly. Industrial safety "**Safety with System**" is part of UNION's company policy.



Engineering

In the last decades UNION compiled a very high level to the state of the art that covers many market segments. So a wide range of possible solution approaches is on hand.



Calibration

As part of maintenance and service UNION provides the validation and re-calibration of measuring devices in conformity with certified custody transfer instruments and / or traceable perpendicular.

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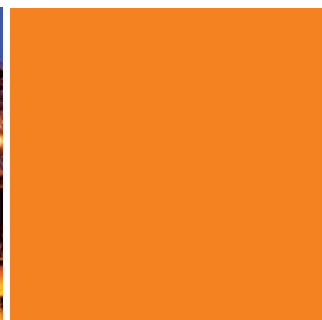


Measurement parameter

- Wobbe-Index
- Calorific value / Heating value
- Specific density
- CARI, air requirement

Applications

- Steel/Iron
- Biogas
- Sewage gas systems
- Landfills
- Glass/Ceramics
- Oil & Gas
- Chemistry
- Energy supply
- Energy production



CWD

Calorimetry Measuring Devices

Gas composition and CWD product series

Gas composition, Wobbe-Index

Natural gas and other combustible gases have gained high importance as fuels for industrial processes. Depending on their origin, they differ significantly in their chemical composition and combustion behaviour. The technical terms are "gas composition" or "gas properties" which describe characteristics such as heating value, calorific value and Wobbe-Index (see textbox below).

In view of the increasing diversification of natural gas sources, consumers are increasingly supplied with varying gas composition of the natural gas and thus different combustion behaviour. If the gas consumer is a thermally sensitive process or burner, the composition of the gas supplied must be monitored and, if necessary, adjusted to the required value by conditioning. Otherwise the function of a burner and of the downstream process and hence also the product quality are jeopardised. Typical examples are processes in the glass industry and in metallurgy. A similar effect is created by the increasing use of bio-gas and bio-methane or process gases (blast furnace gases) as combustion gases.

CWD calorimeter series

A suitable gas measurement technology is required to control the variations in the gas composition while supplying heat to processes – UNION Instruments has been offering this technology with its extensive CWD device series for many decades.

CWD is a mnemonic of the terms **C**alorimetry, **W**obbe-Index and **S**pecific **D**ensity and designates a modular product series for determining calorimetric values in gases according to the DVGW codes of practice G260 and G262 (see page 7).

Table 1 gives an overview of the different CWD variants with their manifold ranges of application, including custody transfer measurements (CT) and the determined parameters. Parameters measured are the Wobbe-Index and Specific Density, from which the heating value and calorific value are calculated.

For details on the device design refer to page 4, for technical data to page 6.

Application segment	CWD2005	CWD2005 CT	CWD2005 PLUS	CWD2005 DPC	CWD2005 SPC	CWD2000 Ex	W2005
Natural gas, Biomethane, Liquid gas	✓	✓	✓	✓	✓	✓	✓
Blast furnace gas, Coke gas, Mixed gas, Low Gas	✓	–	(✓)	–	–	–	✓
Refinery gas, Mixed gas, High gas	✓	–	✓	✓	✓	✓	✓
Certifications / Conformity	NRTL approval by SGS, standards: UL61010-1, CAN/CSA-C22.2 No. 61010-1 (customer reference 710162)	PTB approval 7.631 08.64	NRTL approval by SGS, standards: UL61010-1, CAN/CSA-C22.2 No. 61010-1 (customer reference 710162)	NRTL approval by SGS, standards: UL61010-1, CAN/CSA-C22.2 No. 61010-1 (customer reference 710162)	Standards NFPA 496:2013 ANSI/ISA 12.01 (customer specific "limited production certification report")	BVS 04 ATEX E 018 X	–
Measured values	Wobbe-Index, Specific Density						Wobbe-Index
Calculated values	Heating value, Calorific value						Heating-/ Calorific value (constant Specific Density)
Ex Class	–	–	–	Class I Div 2 Groups B, C, D, T4	Class I Div 2 Groups B, C, D, Methane, T4 (customer specific "limited production certification report")	II 2G Ex d IIA T3 Gb	–

Table1: Device series CWD2005

Net calorific value

Maximum usable heat upon combustion of a gas without condensation of the water vapour in the exhaust gas.

Gross calorific value

Maximum usable heat upon combustion of a gas with condensation of the water vapour in the exhaust gas.

Wobbe-Index (Wobbe number, kWh/m³)

Indicator of the interchangeability of combustion gases with respect to the thermal load on the burners. Important when using combustion gases of changing composition in one burner. If combustion gases of different composition have the same Wobbe-Index and the same flow pressure at the burner, they have approximately the same heat capacity.

Wobbe-Index - Direct or indirect determination

Wobbe-Index

The Wobbe-Index of a gas is a corrected heating value (see equation 1) and serves as an index for the interchangeability of combustion gases at burners. Gases of different chemical composition but with the same Wobbe-Index are equivalent in terms of burner load and can be interchanged without jeopardising the burners. For safe and efficient operation of a combustion system, the Wobbe-Index must therefore be continuously determined before the combustion gas enters the burner. For this purpose, direct and indirect determination methods are in use.

Direct determination (Principle of the CWD)

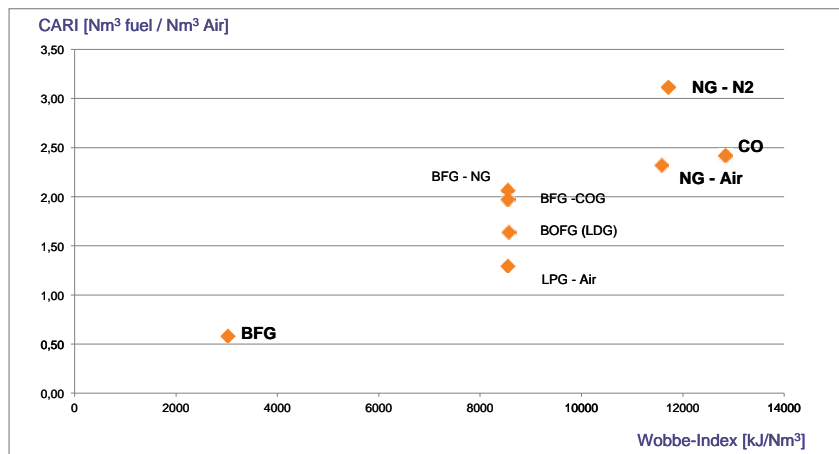
All devices of the CWD series use the direct measurement method to determine the Wobbe-Index: Continuous measurement of the energy released by the combustion of a defined gas flow determines the Wobbe-Index directly. In addition, the specific gravity is measured which can serve to calculate the heating value. A correlation function is not required at any point.

Even unknown and unexpected components in the gas are determined during combustion and taken into consideration in the measurement. That is of great importance with rapidly changing gas compositions of e.g. residual gases from chemical processes or substitute gases in the steel industry.

Indirect determination

Many Wobbe devices do not determine the Wobbe-Index directly; they determine the residual oxygen remaining in the gas after a leaner-than-stoichiometric, catalytic combustion of the gas. Once this indirect value is determined by means of gas analysis, the air requirement is calculated and then, after its correction, the characteristic CARI (**Combustion Air Requirement Index**) for combustion. Finally, the Wobbe-Index is determined from CARI (see equation 2) via a correlation function.

The precision that can be achieved with this method depends on how the catalyst influences the completeness of the combustion and on the precision with which the used correlation function represents the respective application (i.e. the current gas mix). Studies in the steel industry have shown that when using "substitute gases", faults cannot be ruled out as frequently used gas mixtures are positioned outside the typical correlation curves. Figure 1 shows this situation: There is a by no means clear correlation between the Wobbe-Index and CARI for gases typically used in the steel industry.



NG	Natural Gas
BFG	Blast Furnace Gas
BOFG	Basic Oxygen Furnace Gas
LPG	Liquified Petroleum Gas
LDG	Linz Donawitz Gas
COG	Coke Oven Gas

Figure 1: Non-linear correlation between CARI and Wobbe-Index (steel industry)

Wobbe-Index

$$\frac{\text{Heating value}}{\sqrt{\text{Specific gravity}}} \quad (1)$$

CARI

$$\frac{\text{Air demand}}{\sqrt{\text{Specific gravity}}} \quad (2)$$

Specific gravity

$$\frac{\text{Density fuel gas}^*}{\sqrt{\text{Density air}^*}} \quad (3)$$

*At the same conditions

Device structure and device function

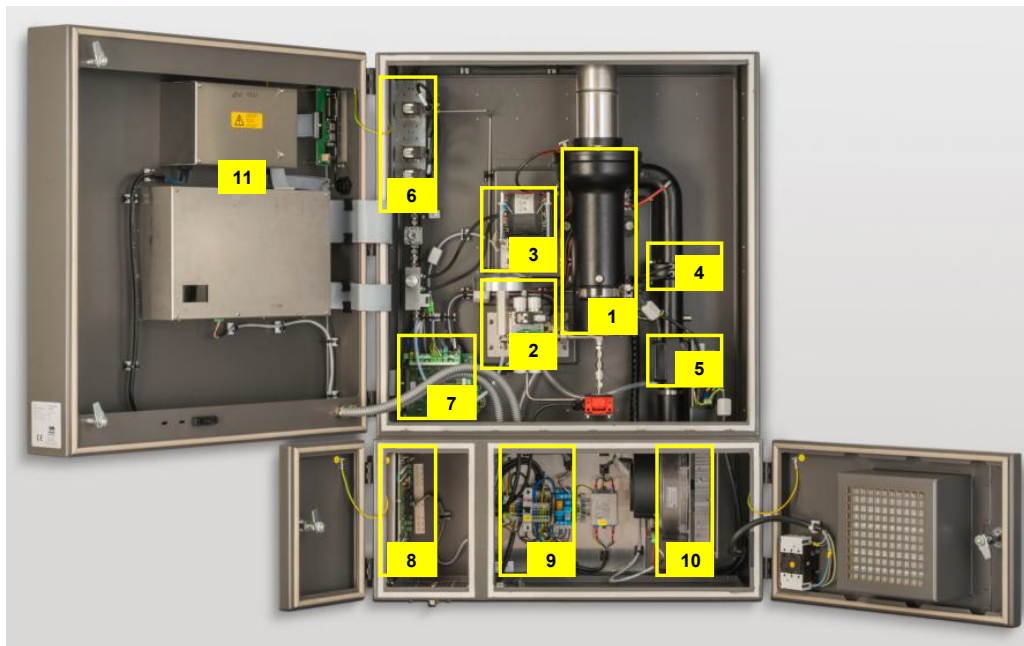


Figure 2: Device layout CWD

The sample gas is combusted in the **measuring cell with burner (1)**. The flame is detected via the energy release on successful ignition. To determine the energy quantity, the temperature increase is determined directly in the exhaust gas flow using very rugged thermocouples. This allows for particularly fast measurement of heating value variations of the sample gas.

The **low-pressure gas supply (2)** offers the user a number of advantages:

- The inlet pressure of only 20 – 40 mbar allows the use of a pressure booster pump to be eliminated in many cases. This also eliminates a possible source of errors because the compression of vapour-saturated gases (e.g. boiler gases) generates condensation which impairs the subsequent measurement. This influence is deliberately minimised in the CWD by the low inlet pressure.
- The metering technology of the CWD enables measurements with small gas flows from 10 l/h. This allows the entire sample gas to be combusted. This eliminates the problems otherwise encountered by the user of the gas disposal.

- For precise measurement of the Wobbe-Index, the gas must be metered with high precision. In the CWD, this is ensured by a system of pressure controller and nozzle: The precision pressure reducer from UNION Instruments is temperature independent and can control pressure differentials of 4 mbar in constant operation. The measuring range is determined by a gas nozzle with a diameter of 0.4 – 1.5 mm.

The acoustic **density measurement (3)** is performed in the bypass to the main sample gas flow. It offers a wide measuring range from 0.2 to 2.2 relative density.

The **air measurement (4)** is performed via a measuring orifice and a precision differential pressure sensor.

The **gas is supplied (6)** via a valve block which controls the supply of sample gas and calibration gas to the analyser. In device variants approved for custody transfer, a "block and bleed" circuit with increased security is used.

The other modules in Figure 2 are:

- (5) Automatic ignition device
- (7) Data logger
- (8) I/O section
- (9) Power supply
- (10) Fan
- (11) Electronics/power supply unit

Acoustic density measurement of gases

The piezoelectric effect converts mechanical deformations into electric signals and vice versa.

One of the many applications is the acoustic density measurement of gases with particularly high linear measuring range (0.0 – 2.0 relative density). **The piezoceramics used for this in the CWD** are gold-plated and therefore extremely corrosion-resistant. The measurement is performed in the bypass with a very small gas throughput (1 – 4 l/h) and hence very low risk of soiling. The high measurement precision allows the Wobbe-Index to be converted into calorific value even for custody transfer measurements for natural gas.

Control system (hardware and software)

Control and operation

The operating unit HMI (Human Machine Interface) comprises the components central control unit, display and keyboard and is linked to two modules via the device bus (Figure 3): The measurement technology module collects the measurement data, the I/O module controls the external communication. The details of the user interface are shown in Figure 4.

The software

is based on a real-time operating system. It is structured in various menu levels which are reached via softkeys.

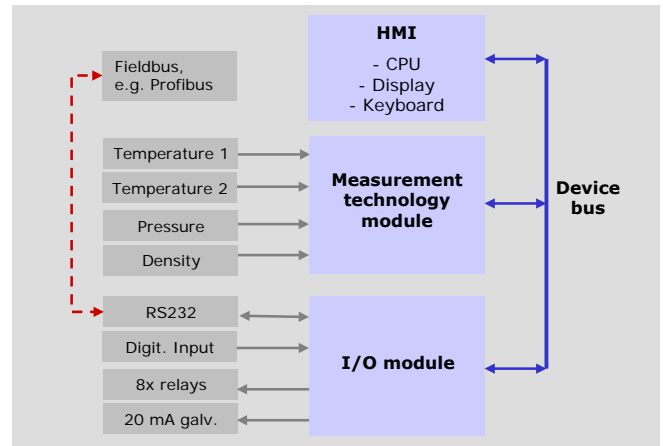


Figure 3: CWD function flowchart

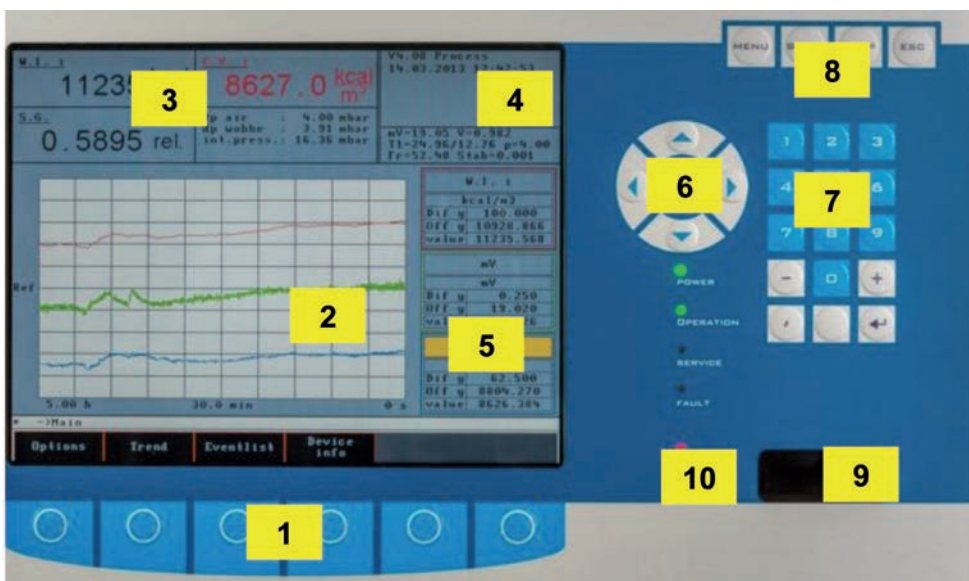


Figure 4: Operation and display panel CWD (Human Machine Interface)

- 1: Menu keys (softkeys)
- 2: Current measurement data (graphic display)
- 3: Current measurement data (numerical, with dimension)
- 4: Info field (date, time, internal operating data, ...)
- 5: Trend displays
- 6: Position keys
- 7: Input keys
- 8: Start/Stop
- 9: Burner window (for observing the flame)
- 10: LED status displays

Fieldbus

Term for serial communication bus systems in production and process automation in which field devices such as sensors, measurement devices and actuators (slaves) are connected to control systems (masters). The bus enables bidirectional communication among the bus participants for digital data exchange. The most successful field bus worldwide is Profibus. Fieldbuses are increasingly replacing the conventional 4 – 20 mA technology.

CWD - Technical data

Device CWD series	CWD2005	CWD2005 CT	CWD2005 PLUS	CWD2005 DPC	CWD2005 SPC	CWD2000 Ex	W2005
Weight	ca. 54 kg	ca. 54 kg	ca. 54 kg	ca. 85 kg	ca. 250 kg	ca. 450 kg	ca. 54 kg
Dimensions W x H x D [mm]	720 x 1020 x 337	720 x 1020 x 337	720 x 1020 x 337	821 x 1853 x 414	1150 x 2000 x 600	1540 x 2380 x 600	720 x 1020 x 337
Protection class	IP 50	IP 50	IP 50	IP 50	IP 64 (Nema 4X)	--	IP 50
Ambient temperature	5 – 45 °C	5 – 35 °C	5 – 45 °C	5 – 45 °C	-20 – 45 °C	-20 – 45 °C	5 – 45 °C
Ambient humidity	0 – 95 % relative	0 – 95 % relative	0 – 95 % relative	0 – 95 % relative	0 – 95 % relative	0 – 95 % relative	0 – 95 % relative
External pressure [hPa]	800 – 1100	800 – 1100	800 – 1100	800 – 1100	800 – 1100	800 – 1100	800 – 1100
Supply pressure of gas	20 – 40 mbar	20 – 40 mbar	20 – 40 mbar	30 – 40 mbar	30 – 40 mbar	40 - 50 mbar	20 – 40 mbar
Process gas supply	max. 2	1	1	max. 2	max. 2	1	max. 2
Calibration gas supply	max. 2	max. 2	1	max. 2	max. 2	max. 2	max. 2
Carrier gas supply	optional	--	optional	optional	optional	optional	optional
Relative gas humidity	≤ 95 %, condensate-free	≤ 95 %, condensate-free	≤ 95 %, condensate-free	≤ 95 %, condensate-free	≤ 95 %, condensate-free	≤ 95 %, condensate-free	≤ 95 %, condensate-free
Supply temperature of gas	max. 45 °C	max. 45 °C	max. 45 °C	max. 45 °C	max. 45 °C	max. 45 °C	max. 45 °C
Instrument air consumption	--	--	--	ca. 25 m³/h	ca. 25 m³/h	30 m³/h	--
T90 display time	≤ 20 sec	≤ 15 sec	≤ 15 sec	≤ 15 sec	≤ 15 sec	≤ 15 sec	≤ 20 sec
Interfaces	240 VAC, 50/60 Hz, 110 VAC, 60 Hz						
Schnittstellen	3 x Relais; RS232; 4 – 20 mA; Feldbus; Profibus-DP; Profinet IO; Modbus RTU/TCP; Industr. Ethernet						

Table 2: Technical data device series CWD

Ethernet

Term for a communication technology for data exchange among devices in a network with especially high transfer rates. In its variant "Industrial Ethernet", Ethernet is the accepted industry standard on the level of interlacing control systems and implementing control technology to higher levels. Particularly in combination with other protocols, Ethernet is widely used in the form of Ethernet-based solutions such as PROFINET or Modbus TCP. PROFINET in particular is both Industrial Ethernet and 100% Ethernet and is therefore suitable for all industrial applications and also for the use of all web-based services and tools.

CWD – Applications

There are many applications for CWD devices, both with regard to the gases to be measured and to the process-engineering aspects (industries) and applications in the production lines. Table 3 provides an overview. Special CWD device variants allow use in custody transfer traffic and operation in potentially explosive atmospheres.

Use in custody transfer

Calibration laws require that measuring devices used in commercial business (purchase and sale of measurable goods) must be calibrated. This is referred to as custody transfer.

This is of special importance in the oil and gas industry because of the immense volume and energy flow moved in that field and delivered between different suppliers or to consumers. This obligatory calibration also applies to calorimeters for the calorific value of gases.

The calorimeter CWD2005 CT from UNION Instruments was approved in 2009 as a calorific value measuring device for custody transfer. It can be used for all gases according to Code of Practice G260/262 of the DVGW (Deutscher Verband der Gas- und Wasserwirtschaft, German Association of Gas and Water Management) for officially verified determination of the calorific value in the range 8.4 – 13.1 kWh/Nm³. Applicable for calibration is the measurement of processed biogas, including gases which are conditioned by using air and liquified gas.

Use in potentially explosive areas

When calorimeters are used in the oil and gas industry, they are frequently installed in potentially explosive areas. This requires special protective measures in the device technology and corresponding approval by the authorities.

The version CWD2005 DPC (**D**irect **P**urge **C**ertified) is designed accordingly and approved as Class1, Div. 2 according to NEC500 (USA). The housing has compressed air purging (Type Z) and a safety shutdown. An additional variant for use in explosive areas (Ex II 2G Ex d IIA T3 Gb) is the CWD2000 Ex with an EC type examination certificate (BVS 04 ATEX E 018 X) (see Figure 5)



Figure 5: CWD2000 Ex for potentially explosive areas

Typical measuring ranges [MJ/m³] / Accuracy Wobbe-Index [± %FS]														
CWD device series	CWD2005		CWD2005 CT		CWD2005 PLUS		CWD2005 DPC		CWD2005 SPC		CWD2000 Ex		W2005	
Flare gas	0 – 15	2.0	—	—	—	—	0 – 15	2.0	0 – 15	2.0	—	—	0 – 15	2.0
Blast furnace gas	3.5 – 6	3.0	—	—	3.5 – 6	3.0	3.5 – 6	3.0	3.5 – 6	3.0	—	—	3.5 – 6	3.0
Converter gas	4.5 – 9	1.5	—	—	—	—	4.5 – 9	1.5	4.5 – 9	1.5	—	—	4.5 – 9	1.5
Mixed gas	5 – 10	2.0	—	—	5 – 10	2.0	5 – 10	2.0	5 – 10	2.0	—	—	5 – 10	2.0
Coke oven gass	15 – 30	1.5	—	—	15 – 30	1.5	15 – 30	1.5	15 – 30	1.5	—	—	15 – 30	1.5
Biogas	25 – 35	1.5	—	—	25 – 35	1.0	25 – 35	1.0	25 – 35	1.0	—	—	25 – 35	1.5
Natural gas	25 – 48	1.5	30 – 47	1.0	25 – 48	1.0	25 – 48	1.0	25 – 48	1.0	30 – 47	1.0	25 – 48	1.5
Refinery gas	25 – 50	1.5	—	—	25 – 50	1.5	25 – 50	1.5	25 – 50	1.5	—	—	25 – 50	1.5
LPG	40 – 90	1.5	—	—	40 – 90	1.5	40 – 90	1.5	40 – 90	1.5	40 – 90	1.5	40 – 90	1.5

Table 3: Typical measuring ranges device series CWD

CWD in use in the production of float glass

The production of float glass is a continuous process. At 1100 °C, the glass melt is guided into a bath of liquid tin on which the lighter glass floats. Optimal combustion conditions and a constant temperature of this bath are crucial for a consistently high glass quality. The energy content of the combustion gas, preferably natural gas, varies however over time. By having the CWD permanently determine the energy content and by corresponding compensation with suitable additions, constant flame temperature and stable combustion conditions can be achieved.



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Certification

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Engineering

In the last decades UNION compiled a very high level to the state of the art that covers many market segments. So a wide range of possible solution approaches is on hand.



Calibration

As part of maintenance and service UNION provides the validation and re-calibration of measuring devices in conformity with certified custody transfer instruments and / or traceable perpendicular.

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