Instruction manual

VCD2
CO Detector

Vitotherm B.V.
Overgauwseweg 8
2641 NE, Pijnacker

Tel: +31 (0) 15 – 369 47 57
Fax: +31 (0) 15 – 369 77 42
Email: info@vitotherm.nl
Internet: www.vitotherm.nl

Introduction

The following operating and maintenance instructions have been compiled to guarantee a maximum life span for the Vitotherm CO detector.

In accordance with the warranty conditions, the warranty will be invalidated if the operating and maintenance instructions are not adhered to.

All deviating operating situations will be assessed on their permissibility on a per event basis.

Table of contents

All rights reserved. No part of this publication may be reproduced and/or published by means of printing, photocopying, micro film or in any other way, without the prior written permission of Vitotherm BV. This also applies to the accompanying drawings and diagrams.

Vitotherm BV reserves the right to change parts of this manual at any time without prior or direct notice to the customer. The content of this instruction manual can also be changed without prior warning.

This instruction manual applies to the VitoTherm CO detector. Consequently, Vitotherm BV cannot be held liable for any damage resulting from the improper use of the CO detector. Improper use means using the device for purposes other than those stated in this instruction manual. The removal or alteration of parts of the CO detector also falls under the concept of improper use.

Please contact the Vitotherm BV Service Department for information regarding settings, maintenance activities or repairs, as this is not provided in this instruction manual.

Although great care was taken in the compilation of this instruction manual, Vitotherm BV cannot accept any responsibility in respect of possible errors in this instruction manual or any results thereof.

1. General Assembly Instructions.

For the proper functioning of the CO detector, inspection and maintenance play an important role. The operating staff needs to carefully read these instructions which are to be kept in the switch box of the device so they can be consulted in the event of a possible fault.
When the fault cannot be solved on the basis of these instructions, you can contact our Service Department. They can be reached at all times at telephone number +31(0)15-3694757.

1.2 Electrical Connection (referring to NEN 1010)

(also see technical information for an electrical connection).

Connecting the device to the mains requires a power cord with a 230V isolation switch. The power cord must consist of 3 wires, namely phase + neutral + earth. This power cord needs to reach well into the switch box. The CO detector operates on 230V and 100V alternating current and neutral.
When connecting to the mains, the relevant standards (NEN 1010), any relevant local standards and the connection conditions for electric power must be taken into account at all times.

1.3 Mechanical Connections

The CO detector's measuring connection must be fitted above the condenser. This connection must consist of a ø12 mm copper pipe which must be connected as described in the diagram on page 9.

2. VCD2

The VCD uses a priming pump. The flue gasses are measured directly from the boiler to the chimney after which the CO2 sets can be exhausted ensuring a safe operation.

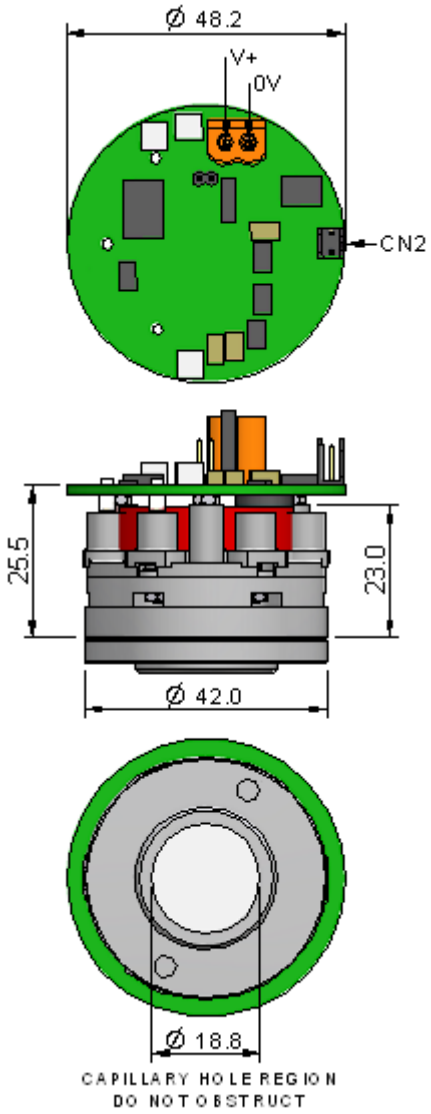
3. Crouzet Millenium 3 PLC

The heart of the CO detector is the Crouzet Millenium which operates via a programme developed by Vitotherm.

3.1 Millennium display

This is a 4 line display in which the status and possible fault lines of the device are indicated. The ESC function, next to the display, offers the option to view the inputs and outputs. In addition, there are a number of buttons next to the display that do not have a function. These are A, B, - and +.

4. Testo Citycell CO Sensor.



This sensor comes with a push button for calibration. The initial calibration is carried out in our factory. A possible re-calibration and the annual inspection can be carried out by our qualified staff on location.

See also the **Calibration Appendix of the VCD2**.

5. The functioning of the CO detector.

In the case of a CO_2 demand, the pump will be activated and will blow clean air over the sensor for 2 minutes. The display will indicate 'flush'. After 2 minutes the device will start measuring the flue gasses which will be released via the connected CO2 fan or chimney valve. The display will indicate the word 'measurement'. There will always be some CO release at the start. The 2 minute waiting time decreases the chance of a fault and immediate shutdown, and leakage of these harmful compounds into the CO2 installation will be prevented.

5.1 The reaction of the CO detector to CO is as follows:

When measuring a CO concentration higher than 30 ppm.

With a CO concentration of more than 30ppm the release will cease after 1 minute and the device will be locked. The pump will flush the sensor with clean air which will ensure that the measured level drops to 0 ppm. Pressing and holding the OK button will display the last recorded fault in the memory showing the last measured CO level.

Any CO fault will activate a red light and the device can be reset by pressing the OK button.

5.2 In the case of a cable breakage and sensor malfunction.

The CO detector is safeguarded against a sensor malfunction. This works as follows; if the input signal of the CO sensor is measured and it becomes too low, the CO detector will go into fault mode after 1 minute. Subsequently, the fault light comes on and the display will show 'sensor defective'.

5.3 Resetting the device

You can reset the device by pressing the OK/reset button.
When the fault keeps reoccurring, you will have to contact our Service Department to solve this issue.

5.4 Last fault

The last device fault can be displayed by pressing and holding the OK/reset button.

5.5 Three-way valve

The three-way valve ensures a long sensor life-span and is used to flush the sensor with clean air.

5.6 Timer function

The device contains various timers with set times. Although they are suitable for most applications a customer-specific adaptation is possible.

5.7 Pressure switch

The pressure switch monitors the flow over the sensor. An insufficient flow will result in a fault and immediate shutdown. The device will be locked and the display will read 'pump malfunction'.

5.8 Monitoring the closed position of the chimney valve.
Optionally, it is possible to connect a ES6 limit-switch to the device. The ES6 will monitor the closed position of the chimney valve for 5 minutes after there is no demand for CO2. This is required for the burner to stop drawing in any unwanted flue gasses. There is a contact in the device, part of the safety chain, that needs to be connected to the burner for deactivating/switching off the burner in the case of a fault.

6. Commissioning the VCD2

6.1. Inspecting the VCD2
Inspect the VCD2 for the following:
Whether the steam trap is connected at the right height
Whether the connection diagram relates to the actual situation
(see Chapter 8 for the connection diagram)
Whether the VCD2 is connected to the correct voltage supply
Whether the steam trap holds one centimetre of water

6.2 Testing after leaving the factory
The VCD2 is tested extensively in our factory. When commissioning the device, all that needs to be checked is whether the electrical and mechanical connections are correct.

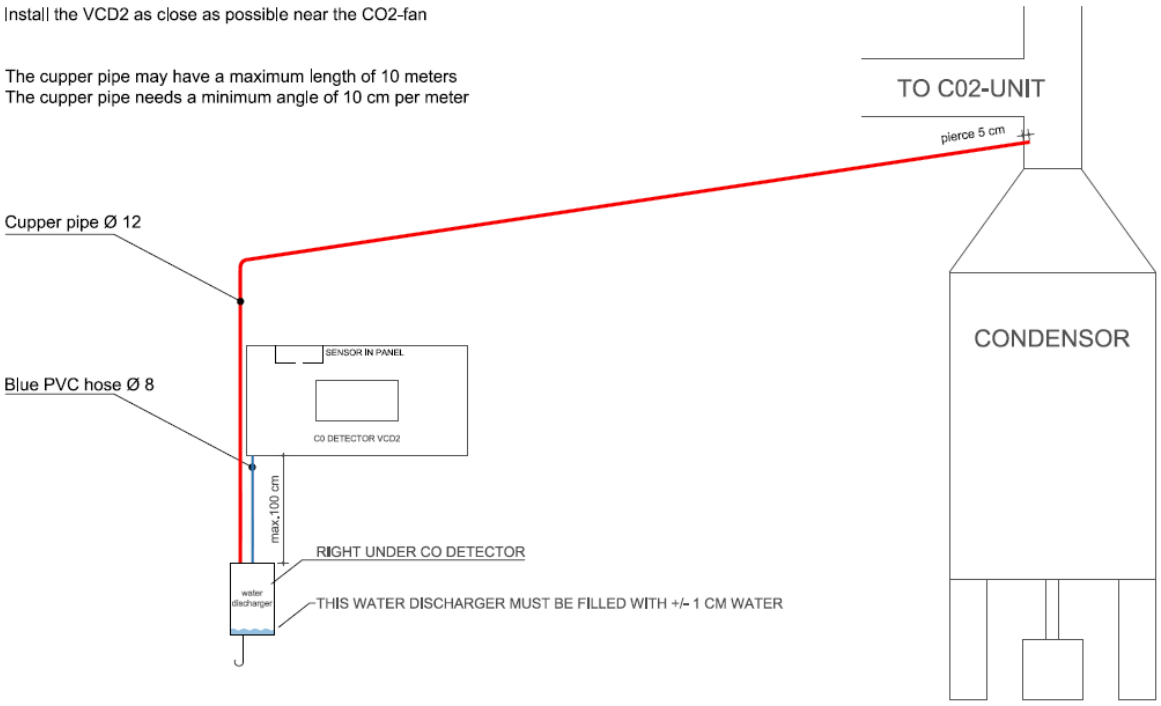
7. Maintenance VCD2
Maintenance of the VCD2 needs to be carried out on an annual basis and by qualified staff.

During this maintenance the CO sensor needs to be checked/calibrated using calibration gas.

The pump needs to be checked for pressure and switch value of the pressure switch.

You can have the maintenance performed by our qualified staff. To discuss the options, please contact our Service Department.
Telephone number: +31 (0)15-3694757.

8. Diagram on how to connect the CO detector to the chimney.



9. APPENDIX

9.1 Calibration of the VCD2

EasyCal 4-20 mA Transmitter (Toxic CiTiceLs)

Vitotherm

Instruction manual

Table of contents

Vitotherm B.V.
Overgauwseweg 8
2641 NE, Pijnacker

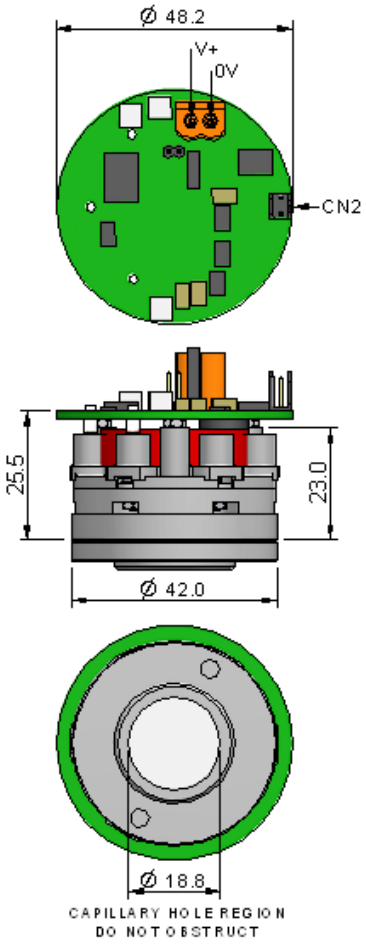
Tel: +31 (0) 15 – 369 47 57
Fax: +31 (0) 15 – 369 77 42
Email: info@vitotherm.nl
Internet: www.vitotherm.nl

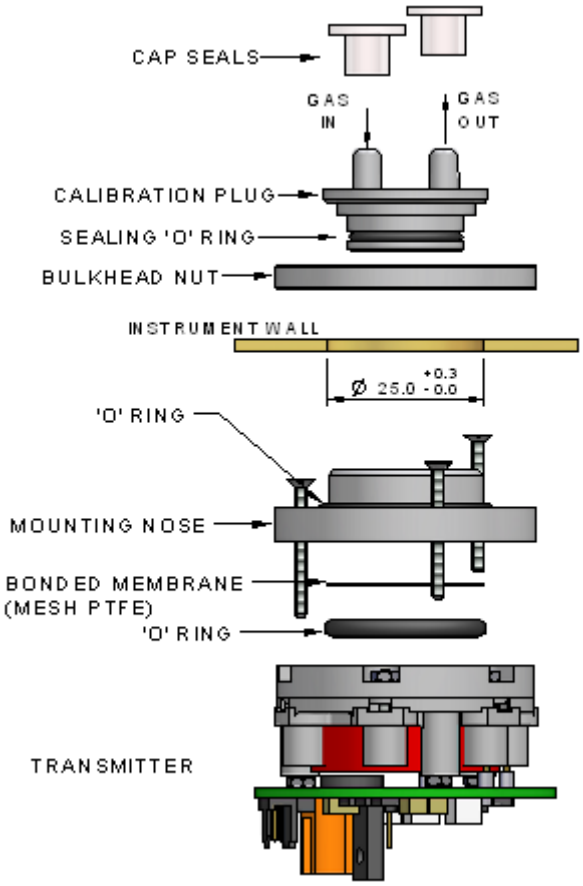
Introduction
In many applications it may be more cost effective to replace a sensing head with one precalibrated at a testing station or laboratory, so reducing disruption of the measuring system. To enable this, some CiTiceLs are available as 4-20 mA Transmitters, comprising a three electrode Toxic Gas CiTiceL and a circular Surface Mount Design (SMD) printed circuit board (PCB). The prime features of these units are ease of use, compactness, and the ability to replace both CiTiceL and electronics very quickly.

The EasyCal PCB has an amplifier circuit to convert the microamp level output signal of the sensor to the industry standard 4-20 mA output for two-wire, remote monitoring systems. The circuit employed imposes no constraints on the sensor, so the performance characteristics of the sensor are unaltered by the addition of the circuit board. The microprocessor board removes the need for potentiometers used on the standard boards, and only requires a single button press when gas is applied for calibration. This makes the calibration process quick and simple to perform.

All transmitters are fitted with a diffusion mounting assembly (the Mounting Nose) for convenient mounting and fast replacement in a wide range of weatherproof housings. It requires a 25 mm diameter hole in the outside wall of the housing to allow installation, and also features a calibration plug for easy zeroing and exposure to calibration gas. A bonded membrane and mesh is included to prevent the ingress of dirt and dust particles into the sensor.

Besides periodic recalibration, transmitters are maintenance-free, and should give faultless service throughout the working life of the sensor. It is a matter of customer choice whether the unit is replaced automatically after this time or when the sensor fails to calibrate.
Toxic Gas CiTiceL 4-20 mA EasyCal Transmitter





Available Options

Every transmitter is supplied precalibrated to a customer specified range. The table in the next section gives an indication of the ranges available for each particular sensor. Any option can be recalibrated to an intermediate range, using the calibration procedure detailed later in this document.

Gas Type	Sensor Type	Minimum Range	Maximum Range
Carbon Monoxide	3E/F 3F/F	0 – 50 ppm 0 – 500 ppm	0 – 500 ppm 0 – 2000 ppm
Hydrogen Sulfide	3H	0 – 20 ppm	0 – 200 ppm
Sulfur Dioxide	3SH 3ST/F 3SF	0 – 5 ppm 0 – 20 ppm 0 – 100 ppm	0 – 50 ppm 0 – 200 ppm 0 – 1000 ppm
Nitrogen Dioxide	3NDH	0 – 5 ppm	0 – 50 ppm
Chlorine	3CLH	0 – 5 ppm	0 – 100 ppm
Hydrogen	3HYT 3HYE	0 – 200 ppm 0 – 20000 ppm	0 – 2000 ppm 0 – 30000 ppm

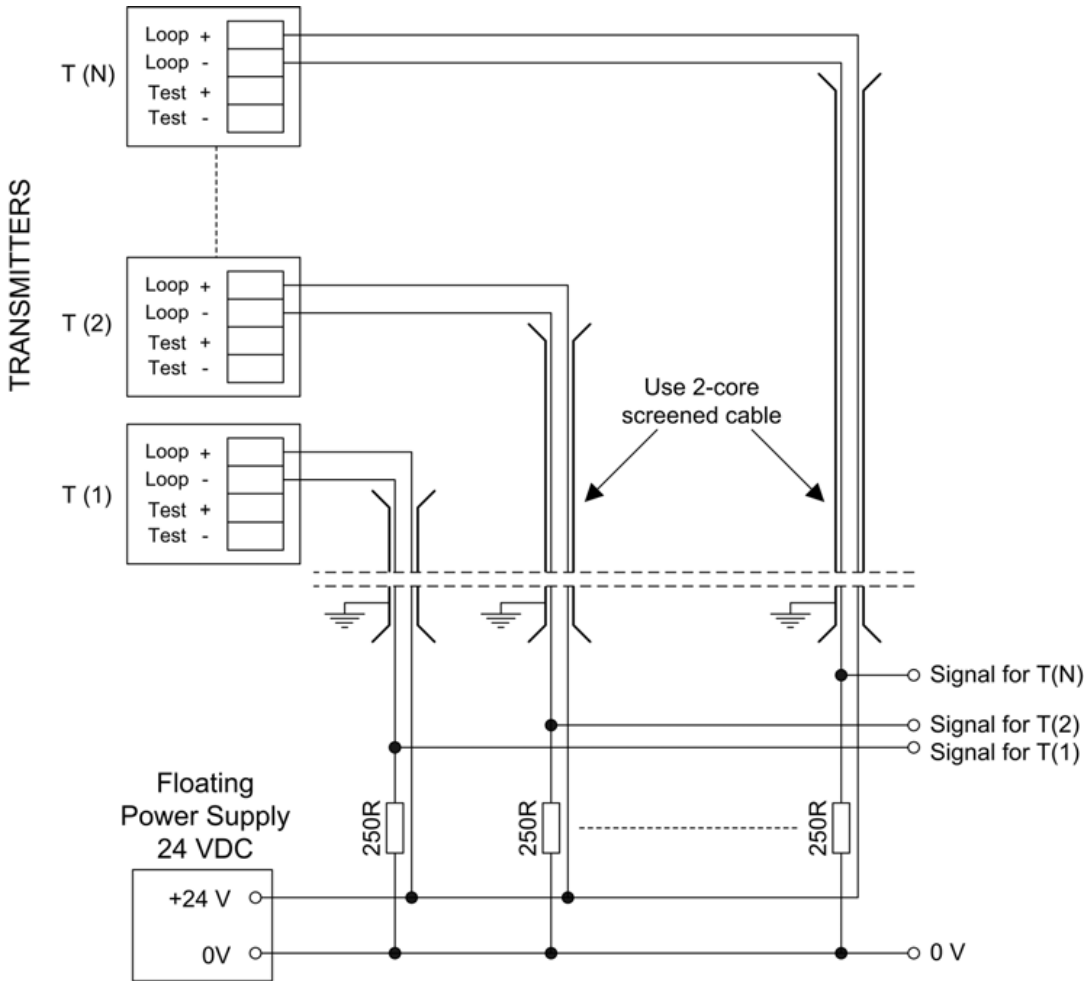
Electrostatic Discharge Guidelines

This component is susceptible to ESD (Electrostatic Discharge) when being installed or adjusted. To prevent ESD related damage during installation, follow the following guidelines.

- Ensure all power supplies are turned off.
- If possible, wear an ESD strap connected to ground. If this is not possible, discharge yourself by touching a metal part of the equipment into which the transmitter is being installed.
- Ensure that any tools are discharged by contacting them against a metal part of the equipment into which the conditioning electronics is being installed.

Connection and Wiring

Transmitters are designed for standard two-wire operation where the output is supplied via the same wire pair as the power supply. The external circuit loop is connected to the transmitter PCB via a screw terminal connector. Schematic Wiring Diagram for 4-20 mA Transmitters



Power Supply and Total Loop Resistance
Transmitters can be operated with any single-sided power supply within the range 10 - 35 VDC. However the power supply used will impose constraints on the total loop resistance in the external circuit, and this must be taken into account when choosing the supply voltage. This includes the measuring resistor at the remote receiver and any meters for calibration etc. The example below illustrates the relationship between the two considerations.

So that the sensor only requires a few seconds to settle after start-up, the transmitter circuit has an FET powered shorting link between the sensing and reference electrodes of the CiTiceL when left unpowered. However, due to the different operating nature of biased sensors (which include nitric oxide and hydrogen chloride sensors), this link is omitted with these transmitters. They therefore require a longer start-up time when first powered, and must remain powered continuously in the actual application.

IMPORTANT : The transmitter is designed for power supplies within the range 10 - 35 VDC only. Connection to mains electricity will result in transmitter failure.

Relationship Between Power Supply Voltage and Total Loop Resistance

Example : Using a transmitter with a standard 24 VDC power supply, the total allowable resistance is as follows:

The minimum voltage required at the transmitter for operation is 10 Volts. Therefore, the maximum drop allowed due to loop resistance is 14 Volts.

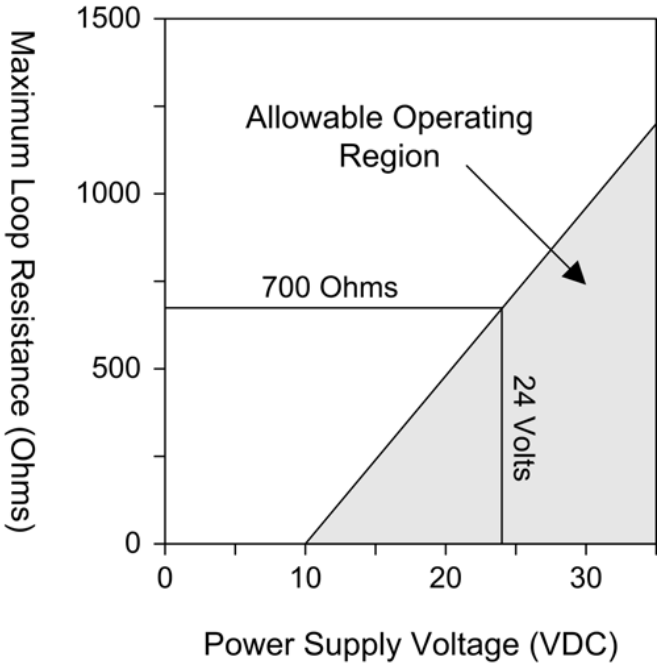
Full scale deflection current requirement : 20 mA

Therefore, the maximum loop resistance allowable (using Ohm's law):

R = V / I

R = (14 x 1000) / 20

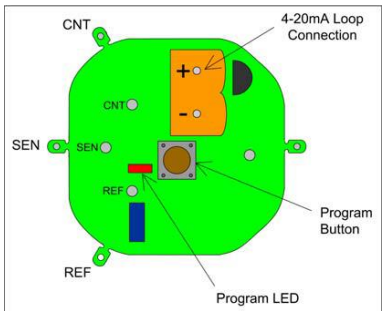
R = 700 Ohms



In this case, a measuring resistor of 250 Ohms is appropriate, giving a scale of 1 V to 5 V.

Calibration Guidelines

CiTiceL transmitters are supplied precalibrated, and the sensitivity of the device should not drift by more than 2% of full signal per month. The circuit board has a single push button which can be used to calibrate the transmitter should this be required.



The standard mounting system allows easy aspiration using the calibration plug provided. With the plug in place and sealing caps fitted, the CiTiceL is completely isolated from the atmosphere. With sealing caps removed, calibration gas can be supplied through one inlet and exhausted through the other.

Calibrating to Cross Sensitive Gases

Electrochemical CiTiceLs are cross sensitive to certain non-target gases. Information regarding cross sensitivities for particular sensors can be found on the product datasheets. It is important to remember however, that cross sensitivity data is only very approximate and cross sensitivities will vary between sensors and sensor batches. Therefore, it is not advisable to calibrate sensors or transmitters to non-target gas as this will result in a degree of measurement error.

Recommended Gas Flow Rates

A minimum flow rate is required to ensure accurate calibration - it also means that the response from a CiTiceL is equivalent in configurations where gas is flowing over the sensor and those where the sample is allowed to diffuse into the sensor. The minimum flow rate which is required will be different depending on the CiTiceL type – these are shown in the table below.

Gas Type	Option	Minimum Flow Rate
Carbon Monoxide, CO	All options	150 ml/min
Hydrogen Sulfide, H_2S	All options	400 ml/min
Sulfur Dioxide, SO_2	3ST/F 3SH	400 ml/min 1000 ml/min
Nitrogen Dioxide, NO_2	All options	1000 ml/min
Chlorine, Cl_2	All options	1000 ml/min
Hydrogen, H_2	All options	150 ml/min
Hydrogen Chloride, HCl	All options	1000 ml/min

These flow rates are based on gas delivery apparatus used at City Technology Ltd. Other designs of gas delivery may have an influence on the flow rates required. EasyCal Circuit Board Layout

Standard User Calibration Method (Span Gas = 20 mA Signal)

1. Connect loop power to the transmitter.
2. Apply clean air or an inert gas to the transmitter for 2 minutes.
3. Hold down the program button until the LED flashes at approximately 1 Hz. The 4 mA level is now set.
4. Apply the required span gas to the transmitter for 2 to 5 minutes.
5. Press and release the program button. The 20 mA level is now set to represent the concentration of the calibration gas used.
6. The LED will flash at approximately 8 Hz for 8 Seconds. This is the timeout period.
7. Calibration is complete. The LED will clear and the transmitter will return to normal mode.

Non-Standard Span Gas Calibration Methods

Span Gas Within ±5% of Full Range

1. Calculate the mA signal expected for span gas. The output range available is 19.2 mA to 20.8 mA.

   Example
   Required 4-20 mA range is 0-500 ppm
   Available span gas is 480 ppm
   Dynamic Range is 16 mA
   Therefore, 1 mA = 31.25 ppm
   Expected signal at 480 ppm = (15.36 mA + 4 mA) = 19.36 mA

2. Connect loop power to the transmitter.
3. Apply clean air or an inert gas to the transmitter for 2 minutes.
4. Hold down the program button until the LED flashes at approximately 1 Hz. The 4 mA level is now set.
5. Apply the required span gas to the transmitter for 2 to 5 minutes.
6. Press and hold the program button to set the 20 mA level.
7. The LED will flash at approximately 8 Hz for 8 Seconds. Continued momentary pressing of the program button during this timeout period will increase the output by 40 µA per press. When the output reaches 20.8 mA, the next button press will take the output to 19.2 mA. Further button presses will again increase the output by 40 µA When the required output is reached, allow the transmitter to time out.
8. Calibration is complete. The LED will clear and the transmitter will return to normal mode.

Span Gas not within ±5% of Full Range
Note : A current source is required for this procedure.

1. Apply a gas of known concentration to the sensor for 2 to 5 minutes.
2. Measure the current from the sensor. This can then be used to calculate the sensitivity (in µA/ppm) for the specific sensor being calibrated (see step 3).
3. Calculate the expected current when the sensor is exposed to the full scale of target gas.

   Example
   Required 4-20 mA range is 0-500 ppm
   Available span gas is 300 ppm
   Current from sensor when exposed to span gas = 33 µA (from step 2)

Therefore, sensitivity = (33 µA/ 300 ppm) = 0.11 µA/ppm
Expected signal at 500 ppm = (0.11 µA/ppm x 500 ppm) = 55 µA

4. Connect the current loop power to the transmitter
5. Connect the current source to the transmitter.

   or Oxidising Sensors (CO, H_2S, SO_2, NO ...) Connect the negative to 'SEN' and the positive to 'CNT'. Connect 'CNT' and 'REF' together. For Reducing Sensors (CL_2, NO_2 ...). Connect the negative to 'CNT' and the positive to 'SEN'. Connect 'CNT' and 'REF' together.

6. Set the current source to zero.
7. Hold down the program button until the LED flashes at approx. 1 Hz (4 mA level now set in RAM).
8. Set the current source to the value calculated for the full scale of target gas (from step 3).
9. Press and release the program button (20 mA level now set in RAM).
10. The LED will flash at approximately 8 Hz for 8 Seconds. This is the timeout period.
11. Calibration is complete. The LED will clear and the transmitter will return to normal mode.

Important Notes
Recalibration is only possible if the output of the sensor at full scale is greater than 50% of the original factory calibration. Failure can occur if:

1. Attempt is made to recalibrate to a range less than 50% of the original calibrated range.
2. The output of the sensor has fallen by more than 50%. In this case, the sensor must be replaced.
3. Incorrect span gas is used.
4. Insufficient time is allowed for the output to settle after exposing the sensor to span gas. Span gas should be applied for 2-5 minutes before setting the 40 mA level.

Transmitter Error Condition
Any time the error condition is set, the output will be forced to 21 mA and the LED will be held on. Carry out the Reset function to reset the sensor.

Reset to Factory Calibration

1. Remove loop power from transmitter.
2. Hold down the program button and connect loop power to transmitter.
3. The LED will blink as soon as power is applied (approx. 2 Hz). The transmitter output is now set to 21 mA.
4. Releasing the program button will start an 8 second timeout period.
5. After 8 seconds, the factory calibration will overwrite the user calibration.
6. The LED will clear and the transmitter will return to normal mode.

Handling and Storage

Electrochemical sensors are relatively insensitive to mishandling. Following the simple guidelines given below should ensure correct operation.

Sensors may be stored for up to six months. They should be kept sealed in the containers in which they were supplied in clean dry air at 0 - 20°C.

Sensors should not be stored in areas containing solvent vapours. All electrochemical sensors are unsuitable for use in applications where organic solvent vapours are present as exposure may inhibit performance.

Sensors must not be subjected to any pressure when handling or clamping.

MSDS's can be provided for all City Technology products, detailing their hazardous content. The hazardous waste disposal regulations depend on geographic location, and local regulations should be checked before discarding the sensors.

WARNING: By the nature of the technology used, any electrochemical or catalytic bead sensor can potentially fail to meet specification without warning. Although City Technology makes every effort to ensure the reliability of our products of this type, where life safety is a performance requirement of the product, and where practical we recommend that all sensors and instruments using these sensors are checked for response to gas before use

Every effort has been made to ensure the accuracy of this document at the time of printing. In accordance with the company's policy of continued product improvement City Technology Limited reserves the right to make product changes without notice. No liability is accepted for any consequential losses, injury or damage resulting from the use of this document or from any omissions or errors herein. The data is given for guidance only. It does not constitute a specification or an offer for sale. The products are always subject to a programme of improvement and testing which may result in some changes in the characteristics quoted. As the products may be used by the client in circumstances beyond the knowledge and control of City Technology Limited, we cannot give any warranty as to the relevance of these particulars to an application. It is the clients' responsibility to carry out the necessary tests to determine the usefulness of the products and to ensure their safety of operation in a particular application.
Performance characteristics on this data sheet outline the performance of newly supplied sensors. Output signal can drift below the lower limit over time.

9.2 Technical instruction manual service technicians

Clip numbers Crouzet M3:

Input:	output:
+ 24 VDC	01 three-way valve measurement flue gas
- 24 VDC	02 output alarm red light
I1 enable controls	03 safety circuit burner ok
I2 start CO2 demand	04 pump activated
I3 pump pressure present	05 chimney valve open (make contact in centre)
I4 selection text CO2 vent activated instead of RGK activated	06 chimney valve closed (when desired with CO2 vent activated)
I5 ES6 chimney valve not closed	07 alarm potential-free (make contact in centre)
I6 *not in use*	08 no alarm potential-free
IB 0-10V input CO sensor	
IC *not in use*	
ID reset	
IE *not in use*	

Description VCD2 Programme:
After enabling the controls and start of CO2 demand at input I1 and I2, the pump will be activated. The pressure switch will get a 10 second window to build up pressure. After a delay-time the three-way valve will activate and flue gasses will be measured. When U5 increases, the fan or chimney valve will be activated. After losing the demand for CO2, I1 and I2, U5 (chimney valve) and U1 (3-way valve) will switch over and after the flush time U4 (pump) will switch off. After the delay of the chimney valve, approx. 5 minutes, I5 should be present. When I5 is not present, I4 will switch off (safety circuit burner ok) and so will the MY2 relay. The contacts of the MY2 relay are connected to 3 terminals as a potential free contact which can, subsequently, be connected to the safety circuit of the burner.

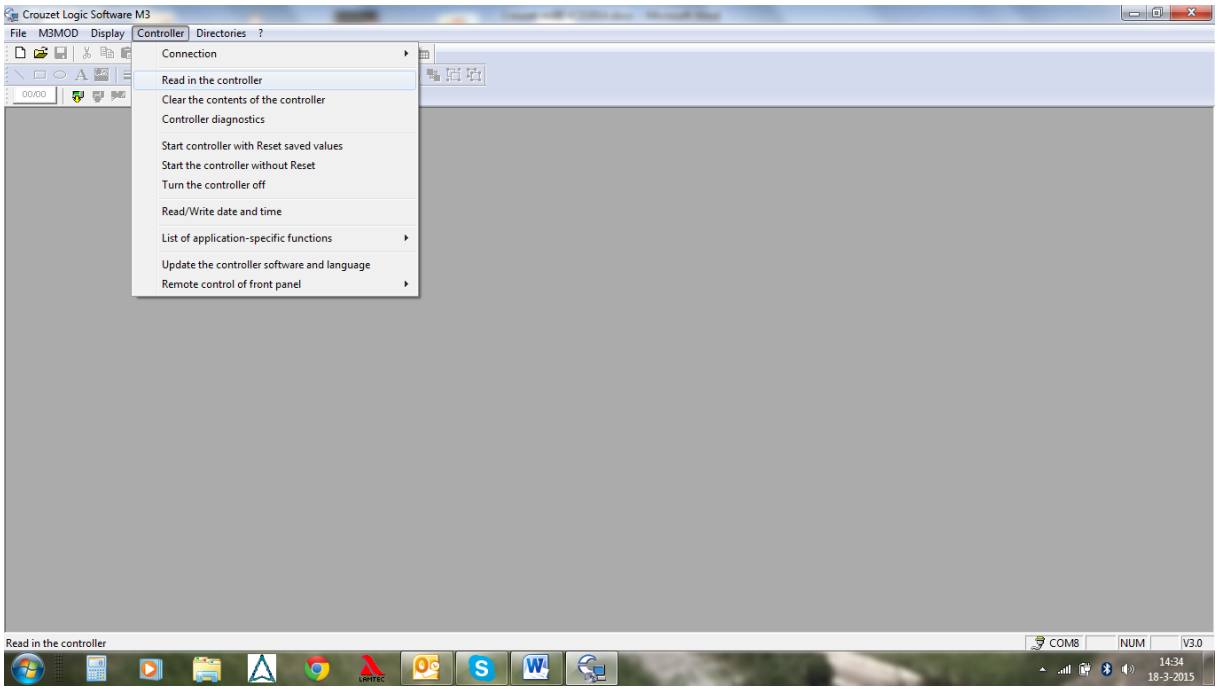
In the following situations a fault and immediate shutdown will take place:
1. Pump pressure not present; U5/6 and U7/8 and U2 will switch over. The three-way valve is activated for 2 min. (flushing).
2. CO too high after a delay-time of 1 minute, the display will show 'CO too high'. U5/6 and U7/8 and U2 will switch over. The three-way valve is activated for 2 min. (flushing).
3. Sensor signal not present (4 mA not present)

4. Chimney valve not closed. U5 safety circuit burner Ok will shut down which will cause the MY2 relay to switch off.

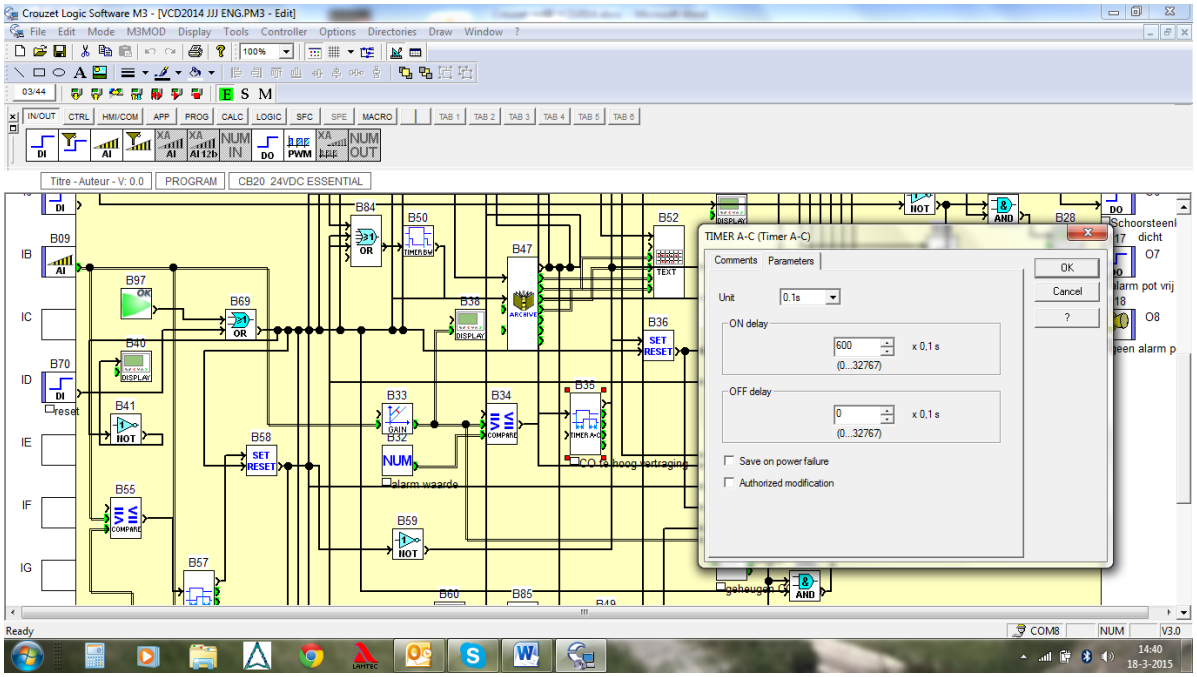
The standard set timer times and CO alarm level in the Crouzet programme can be adapted for specific situations by using M3 software and the Crouzet PLC plug.

B72 Delay chimney valve:	3000	(5 min.)
B02 Delay CO2 activated:	1200	(2 min.)
B21 Sensor flushing time:	1200	(1 min.)
B12 Delay pump alarm:	300	(0.5 min.)
B35 Delay alarm 'CO too high':	600	(1 min.)
B89 Input delay ES6:	10	(1 sec.)
B57 Delay sensor defective (min 4 mA)	600	(1 min.)
Set CO level:		
B32 alarm level	30 ppm	

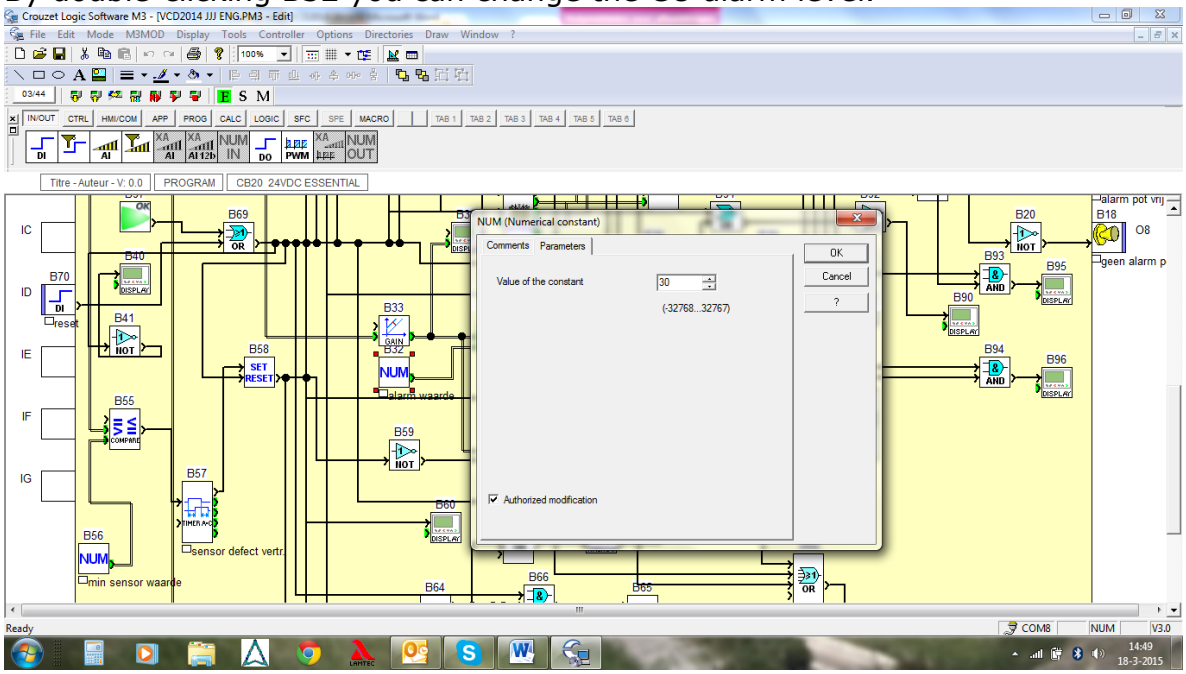
By selecting 'Read' in the controller, the programme is loaded using the M3 software. For this the access code 4321 is required.



By, for example, double-clicking on B35, the delay for 'CO too high' can be changed. The standard setting is for 60 seconds.


Crouzet Logic Software M3 - [VCD2014 JJJ ENG.PM3 - Edit]
TIMER A-C (Timer A-C)
Comments
Parameters
Unit
0.1s
ON delay
600
x 0,1 s
(0...32767)
OFF delay
0
x 0,1 s
(0...32767)
Save on power failure
Authorized modification
OK
Cancel
CB20 24VDC ESSENTIAL
PROGRAM
Ready

By double-clicking B32 you can change the CO alarm level.



ES6 must be connected when the flue gas valve is not being used.
Outputs 8/9/10 are the releases for the chimney valve or the CO2 fan. This is a potential-free contact which can be used as follows:
1. 230V or 24 VDC will be connected to the common power supply for the purpose of a servo motor for the chimney valve. The terminal strips include a separate phase/neutral or 24 VDC for this purpose.
2. The potential-free contact is included in the safety circuit of the CO2 set to shut down in the event of an excess of CO.

The most common operating situations of the device are as follows:

1 device not operational

I1 CO2 demand		NO CO2 DEMAND	U1 3-way valve	
I2 release			U2 red light	
I3 pump pressure		CHIMNEY VALVE CLOSED	U3 Burn. saf. circ. Ok	X
I4 text valve/fan	X	0000 PPM	U4 pump activated	
I5 ES6	X		U5 chimney v. open	
IB sensor	X		U6 chimney v. closed	X
ID reset			U7 alarm	X
			U8 no alarm	

2 start device

I1 CO2 demand	X	CO2 DEMAND/RELEASE	U1 3-way valve	
I2 release	X		U2 red light	
I3 pump pressure	X	CHIMNEY VALVE CLOSED	U3 Burn. saf. circ. Ok	X
I4 text valve/fan	X	0000 PPM FLUSH	U4 pump activated	X
I5 ES6	X		U5 chimney v. open	
IB sensor	X		U6 chimney v. closed	X
ID reset			U7 alarm	X
			U8 no alarm	

3 device has started (chimney valve)

I1 CO2 demand	X	CO2 DEMAND/RELEASE	U1 3-way valve	X
I2 release	X	MEASURING	U2 red light	
I3 pump pressure	X	CHIMNEY VALVE OPEN	U3 Burn. saf. circ. Ok	X
I4 text valve/fan	X	0000 PPM	U4 pump activated	X
I5 ES6			U5 chimney v. open	X
IB sensor	X		U6 chimney v. closed	
ID reset			U7 alarm	X
			U8 no alarm	

4 device has started (CO2 fan)

I1 CO2 demand	X	CO2 DEMAND/RELEASE	U1 3-way valve	X
I2 release	X	MEASURING	U2 red light	
I3 pump pressure	X	FAN ACTIVATED	U3 Burn. saf. circ. Ok	X
I4 text valve/fan		0000 PPM	U4 pump activated	X
I5 ES6			U5 chimney v. open	
IB sensor	X		U6 chimney v. closed	X
ID reset			U7 alarm	X
			U8 no alarm	

5 CO2 demand lost

I1 CO2 demand		NO CO2 DEMAND	U1 3-way valve	
I2 release			U2 red light	
I3 pump pressure	X	CHIMNEY VALVE CLOSED	U3 Burn. saf. circ. Ok	X
I4 text valve/fan	X	0000 PPM FLUSH	U4 pump activated	X
I5 ES6			U5 chimney v. open	
IB sensor	X		U6 chimney v. closed	X
ID reset			U7 alarm	X
			U8 no alarm	

6) 5 minutes after no demand for CO2

I1 CO2 demand		CHIMNEY VALVE	U1 3-way valve	
I2 release		NOT CLOSED FAULT	U2 red light	X
I3 pump pressure			U3 Burn. saf. circ. Ok	
I4 text valve/fan	X		U4 pump activated	
I5 ES6			U5 chimney v. open	
IB sensor	X		U6 chimney v. closed	X
ID reset			U7 alarm	
			U8 no alarm	X

7)30 sec. after a CO2 demand

I1 CO2 demand	X	CO2 DEMAND/RELEASE	U1 3-way valve	
I2 release	X	PUMP MALFUNCTION	U2 red light	X
I3 pump pressure		CHIMNEY VALVE CLOSED	U3 Burn. saf. circ. Ok	X
I4 text valve/fan	X	0000 PPM FLUSH	U4 pump activated	X
I5 ES6			U5 chimney v. open	
IB sensor	X		U6 chimney v. closed	X
ID reset			U7 alarm	
			U8 no alarm	X

8 Device has started

I1 CO2 demand	X	CO LEVEL TOO HIGH	U1 3-way valve	
I2 release	X		U2 red light	X
I3 pump pressure	X	CHIMNEY VALVE CLOSED	U3 Burn. saf. circ. Ok	X
I4 text valve/fan	X	0043 PPM FLUSH	U4 pump activated	X
I5 ES6			U5 chimney v. open	
IB sensor	X		U6 chimney v. closed	X
ID reset			U7 alarm	
			U8 no alarm	X

9 sensor not connected/defective

I1 CO2 demand		NO CO2 DEMAND	U1 3-way valve	
I2 release		SENSOR MALFUNCTION	U2 red light	X
I3 pump pressure		CHIMNEY VALVE CLOSED	U3 Burn. saf. circ. Ok	X
I4 text valve/fan	X	0000 PPM	U4 pump activated	
I5 ES6	X		U5 chimney v. open	
IB sensor			U6 chimney v. closed	X
ID reset			U7 alarm	
			U8 no alarm	X