Umwelt Bundesamt

TÜVRheinland®
Precisely Right.

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000040335_01

Certified AMS:	CEMSelect OEM for CO, NO, SO_2 and O_2
Manufacturer:	Bühler Technologies GmbH Harkortstraße 29 40880 Ratingen Germany
Test Institute:	TÜV Rheinland Energie und Umwelt GmbH

This is to certify that the AMS has been tested and found to comply with:

EN 15267-1: 2009, EN 15267-2: 2009, EN 15267-3: 2007 and EN 14181: 2004

Certification is awarded in respect of the conditions stated in this certificate (see also the following pages).
The present certificate replaces certificate no. 0000040335 of 9 September 2014

TÜVRheinland® CERTIFIED

Suitability Tested
EN 15267
QAL1 Certified
Regular
Surveillance

www.tuv.com
ID 0000040335

Publication in the German Federal Gazette (BAnz.) of 26 August 2015

This certificate will expire on:
4 August 2019

German Federal Environment Agency
Dessau, 30 September 2015

i. A. Dr. Marcel Langner

TÜV Rheinland Energie und Umwelt GmbH
Cologne, 29 September 2015

ppa. Dr. Peter Wilbring

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TÜV Rheinland Energie und Umwelt GmbH
Am Grauen Stein
51105 Cologne

Accreditation according to EN ISO/IEC 17025 and certified according to ISO 9001:2008.

10/221 2.08

Test report:	936/21224909/B of 26 March 2015
Initial certification:	05 August 2014
Expiry date:	04 August 2019
Publication:	BAnz AT 26 August 2015 B4, chapter I number 3.1

Approved application
The tested AMS is suitable for measurements at plants requiring official approval as per Directive 2010/75/EU, chapter III combustions plants. The tested ranges have been chosen with respect to the wide application range of the AMS.

The suitability of the AMS for this application was assessed on the basis of a laboratory test and an eight-month field test at a waste incineration plant.

The AMS is approved for an ambient temperature range of +5 °C to +40 °C.

The notification of suitability of the AMS, performance testing, and the uncertainty calculation have been effected on the basis of the regulations valid at the time of performance testing. As changes in legal regulations are possible, any potential user should ensure that this AMS is suitable for monitoring the limit value relevant to the application.

Any potential user should ensure, in consultation with the manufacturer, that this AMS is suitable for the installation at which it will be installed.

Basis of the certification
This certification is based on:

- test report 936/21224909/B of 26 March 2015 of TÜV Rheinland Energie und Umwelt GmbH
- suitability announced by the German Federal Environment Agency (UBA) as the relevant body
- the ongoing surveillance of the product and the manufacturing process
- publication in the German Federal Gazette (BAnz AT 26 August 2015 B4, chapter I number 3.1: Announcement by UBA from 22 July 2015)

Measuring system:
CEMSelect OEM

Manufacturer:
Bühler Technologies GmbH, Ratingen

Field of application:
Modular measuring system for plants according to Directive 2010/75/EU, chapter III combustion plants, and other plants requiring official approval

Measuring ranges during the performance test of the CEMSelect OEM modular system, module BA5000-7MB2358:

Component	Module version	Certification range	Supplementary ranges		Unit
CO	BA 5000-7MB2358–Z–T13	0 – 250	0 – 1250	-	mg/m³
	BA 5000-7MB2358–Z–T23	0 – 250	0 – 1250	-	mg/m³
NO	BA 5000-7MB2358–Z–T13	0 – 400	0 – 2000	-	mg/m³
	BA 5000-7MB2358–Z–T23	0 – 400	0 – 2000	-	mg/m³
SO_2	BA 5000-7MB2358–Z–T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	BA 5000-7MB2358–Z–T23	0 – 400	0 – 2000	0 – 7000	mg/m³
O_2, paramag-netic	BA 5000-7MB2358–Z–T13	0 – 25	-	-	Vol.-%
O_2, electro-chemical	BA 5000-7MB2358–Z–T23	0 – 25	-	-	Vol.-%

Measuring ranges during the performance test of the CEMSelect OEM modular system, module Ultramat 23-7MB2358:

Component	Module version	Certification range	Supplementary ranges		Unit
CO	Ultramat 23-7MB2358–Z–T13	0 – 250	0 – 1250	-	mg/m³
	Ultramat 23-7MB2358–Z–T23	0 – 250	0 – 1250	-	mg/m³
NO	Ultramat 23-7MB2358–Z–T13	0 – 400	0 – 2000	-	mg/m³
	Ultramat 23-7MB2358–Z–T23	0 – 400	0 – 2000	-	mg/m³
SO_2	Ultramat 23-7MB2358–Z–T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2358–Z–T23	0 – 400	0 – 2000	0 – 7000	mg/m³
O_2, paramag-netic	Ultramat 23-7MB2358–Z–T13	0 – 25	-	-	Vol.-%
O_2, electro-chemical	Ultramat 23-7MB2358–Z–T23	0 – 25	-	-	Vol.-%

Measuring ranges during the performance test of the CEMSelect OEM modular system, module BA5000-7MB2357:

Component	Module version	Certification range	Supplementary ranges		Unit
CO[1]	BA 5000-7MB2357–Z–T13	0 – 200	0 – 1250	-	mg/m³
	BA 5000-7MB2357–Z–T23	0 – 200	0 – 1250	-	mg/m³
	BA 5000-7MB2357–Z–T33	0 – 200	0 – 1250	-	mg/m³
NO[1]	BA 5000-7MB2357–Z–T13	0 – 150	0 – 750	0 – 2000	mg/m³
	BA 5000-7MB2357–Z–T23	0 – 150	0 – 750	0 – 2000	mg/m³
	BA 5000-7MB2357–Z–T33	0 – 150	0 – 750	0 – 2000	mg/m³
SO_2[1]	BA 5000-7MB2357–Z–T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	BA 5000-7MB2357–Z–T23	0 – 400	0 – 2000	0 – 7000	mg/m³
	BA 5000-7MB2357–Z–T33	0 – 400	0 – 2000	0 – 7000	mg/m³
O_2, paramag-netic	BA 5000-7MB2357–Z–T13	0 – 25	-	-	Vol.-%
O_2, electro-chemical	BA 5000-7MB2357–Z–T23	0 – 25	-	-	Vol.-%

[1] The combinations CO/NO, CO/SO_2 and NO/SO_2 can be measured.

Measuring ranges during the performance test of the CEMSelect OEM modular system, module Ultramat 23-7MB2357:

Component	Module version	Certification range	Supplementary ranges		Unit
CO[1]	Ultramat 23-7MB2357–Z–T13	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2357–Z–T23	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2357–Z–T33	0 – 200	0 – 1250	-	mg/m³
NO[1]	Ultramat 23-7MB2357–Z–T13	0 – 150	0 – 750	0 – 2000	mg/m³
	Ultramat 23-7MB2357–Z–T23	0 – 150	0 – 750	0 – 2000	mg/m³
	Ultramat 23-7MB2357–Z–T33	0 – 150	0 – 750	0 – 2000	mg/m³
SO_2[1]	Ultramat 23-7MB2357–Z–T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2357–Z–T23	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2357–Z–T33	0 – 400	0 – 2000	0 – 7000	mg/m³
O_2, paramag-netic	Ultramat 23-7MB2357–Z–T13	0 – 25	-	-	Vol.-%
O_2, electro-chemical	Ultramat 23-7MB2357–Z–T23	0 – 25	-	-	Vol.-%

[1] The combinations CO/NO, CO/SO_2 and NO/SO_2 can be measured.

Measuring ranges during the performance test of the CEMSelect OEM modular system, module BA5000-7MB2355:

Component	Module version	Certification range	Supplementary ranges		Unit
CO_2	BA 5000-7MB2355–Z–T13	0 – 200	0 – 1250	-	mg/m³
	BA 5000-7MB2355–Z–T23	0 – 200	0 – 1250	-	mg/m³
	BA 5000-7MB2355–Z–T33	0 – 200	0 – 1250	-	mg/m³
NO_2	BA 5000-7MB2355–Z–T13	0 – 150	0 – 750	0 – 2000	mg/m³
	BA 5000-7MB2355–Z–T23	0 – 150	0 – 750	0 – 2000	mg/m³
	BA 5000-7MB2355–Z–T33	0 – 150	0 – 750	0 – 2000	mg/m³
SO_2[2]	BA 5000-7MB2355–Z–T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	BA 5000-7MB2355–Z–T23	0 – 400	0 – 2000	0 – 7000	mg/m³
	BA 5000-7MB2355–Z–T33	0 – 400	0 – 2000	0 – 7000	mg/m³
O_2, paramag-netic	BA 5000-7MB2355–Z–T13	0 – 25	-	-	Vol.-%
O_2, electro-chemical	BA 5000-7MB2355–Z–T23	0 – 25	-	-	Vol.-%

[2] Either CO, NO or SO_2 can be measured.

Measuring ranges during the performance test of the CEMSelect OEM modular system, module Ultramat 23-7MB2355:

Compo-nent	Module version	Certification range	Supplementary ranges		Unit
CO[2]	Ultramat 23-7MB2355–Z–T13	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2355–Z–T23	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2355–Z–T33	0 – 200	0 – 1250	-	mg/m³
NO[2]	Ultramat 23-7MB2355–Z–T13	0 – 150	0 – 750	0 – 2000	mg/m³
	Ultramat 23-7MB2355–Z–T23	0 – 150	0 – 750	0 – 2000	mg/m³
	Ultramat 23-7MB2355–Z–T33	0 – 150	0 – 750	0 – 2000	mg/m³
SO_2[2]	Ultramat 23-7MB2355–Z–T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2355–Z–T23	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2355–Z–T33	0 – 400	0 – 2000	0 – 7000	mg/m³
O_2, para-magnetic	Ultramat 23-7MB2355–Z–T13	0 – 25	-	-	Vol.-%
O_2, electro-chemical	Ultramat 23-7MB2355–Z–T23	0 – 25	-	-	Vol.-%

[2] Either CO, NO or SO_2 can be measured.

Software versions:

Ultramat 23-7MB2358 / BA 5000-7MB2358: 2.15.05
Ultramat 23-7MB2357 / BA 5000-7MB2357: 2.15.00
Ultramat 23-7MB2355 / BA 5000-7MB2355: 2.15.00

SPS: Set CEM CERT Rev. 1.0

Restrictions:

1. Requirements with regards to the total uncertainty for component CO in accordance with EN 15267 were not fulfilled during performance testing. They were fulfilled partially for component SO_2.
2. The degree of protection for the enclosure is only rated as IP20. If the operating conditions require an enclosure with a higher degree of protection, the analysis modules shall be placed in a measuring cabinet with an adequate degree of protection.

Notes:

1. The measuring systems are to be operated with a 24-hour interval for automatic adjustments.
2. In order to optimise the cross-sensitivity of the CO measurement channel in relation to CO_2, the modules Ultramat 23-7MB2358, Ultramat 23-7MB2357 and Ultramat 23-7MB2355 as well as BA 5000-7MB2358, BA 5000-7MB2357 and BA 5000-7MB2355 of the CEMSelect OEM measuring system will be distributed with a modified CO-receptor starting from the production month April 2014. A serial number starting with E4 in the central block will be used for identification purposes.
3. The analyser shall be operated with the Thermo-AUTOCAL function activated.
4. The CEMSelect OEM modular measuring system can be equipped with a test gas cooler manufactured by Bühler Technologies GmbH.
5. The maintenance interval of the Ultramat 23-7MB2357, Ultramat 23-7MB2355, BA 5000-7MB2357 and BA 5000-7MB2355 modules is four weeks. The maintenance interval of the Ultramat 23-7MB2358 and BA 5000-7MB2358 modules is three months. If further modules are added to the CEMSelect OEM measuring system, the functionality of the particular combination has to be tested when checking for proper installation and the maintenance interval has to be determined accordingly.
6. The name of the Bühler CEM Select OEM measuring system was changed to CEM Select OEM. The BA5000-EN15267-3IR-P and BA5000-EN15267-3IR-E were renamed BA 5000-7MB2358–Z–T13 and BA 5000-7MB2358–Z–T23, respectively.
7. Supplementary testing (additional module, name change) to Federal Environment Agency notice of 17 July 2014 (BAnz AT 05 August 2014 B11, chapter I number 5.2).

Test report:

TÜV Rheinland Energie und Umwelt GmbH, Cologne
Report no.: 936/21224909/B of 26 March 2015

Certified product

This certificate applies to automated measurement systems conforming to the following description:
The measuring system is used for the simultaneous measurement of the following type-approved measured components: CO, NO, SO_2 and O_2.
The complete modular measuring system tested consists of a sampling probe, a heated sample gas line, a sample gas cooler with two individual gas streams, a gas pump, and the multi-component analysers BA 5000 or Ultramat 23.
For measuring oxygen either an electrochemical or a paramagnetic oxygen measuring cell is used.
The gas line downstream of the sample gas cooler is divided into two parallel lines so that each analyser module is supplied with sample gas separately. For maintenance purposes each analysis device can be maintained individually without affecting the other. The sample gas cooler used is equipped with moisture detectors, which set off an alarm in the case of malfunction. In addition to that, each analysis device is protected by a condensate cover, which seals off the gas lines if moisture enters. Thus, good protection of the gas analysers is ensured.

For the semi-automated switching between zero and sample gas a 3/2-way solenoid valve is installed between the first and second cooling stage. This valve may also be used for AUTOCAL-adjustments of the Ultramat 23 or BA 5000 (fully automatic timing) and can also be controlled by means of the integrated PLC (LOGO-module).

The measuring system consists of the following main components:

- sample gas probe GAS 222.20-Cal-twin with ceramic filter
- compressor gas cooler EGK 2-19
- sample gas pump P2.3
- analysers BA 5000-7MB2358/ BA 5000-7MB2357/ BA 5000-7MB2355 or Ultramat 23-7MB2358/ 23-7MB2357/ 23-7MB2355
- LOGO control unit
- Software:
  Ultramat 23-7MB2358 / BA 5000-7MB2358: 2.15.05
  Ultramat 23-7MB2357 / BA 5000-7MB2357: 2.15.00
  Ultramat 23-7MB2355 / BA 5000-7MB2355: 2.15.00
  SPS: Set CEM CERT Rev. 1.0

General notes
This certificate is based upon the equipment tested. The manufacturer is responsible for ensuring that on-going production complies with the requirements of the EN 15267. The manufacturer is required to maintain an approved quality management system controlling the manufacture of the certified product. Both the product and the quality management systems shall be subject to regular surveillance.

If a product of the current production does not conform to the certified product, TÜV Rheinland Energie und Umwelt GmbH must be notified at the address given on page 1.

A certification mark with an ID-Number that is specific to the certified product is presented on page 1 of this certificate. This can be applied to the product or used in publicity material for the certified product.

This document as well as the certification mark remains property of TÜV Rheinland Energie und Umwelt GmbH. With revocation of the publication the certificate loses its validity. After the expiration of the certificate and on requests of the TÜV Rheinland Energie und Umwelt GmbH this document shall be returned and the certificate mark must not be employed anymore.

The relevant version of this certificate and its expiration is also accessible on the internet: **qal1.de**.

Certification of CEMSelect OEM for CO, NO, SO_2 and O_2 is based on the documents listed below and the regular, continuous monitoring of the Quality Management System of the manufacturer:

Initial certification according to EN 15267

Certificate No. 0000040335: 9 September 2014

Expiry date of the certificate: 4 August 2019

Test report: 936/21224909/A of 3 April 2014
TÜV Rheinland Energie und Umwelt GmbH, Cologne

Publication: BAnz AT 5 August 2014 B11, chapter I, no. 5.2
UBA announcement of 17 July 2014

Supplementary testing according to EN 15267

Certificate No. 0000040335_01: 30 September 2015

Expiry date of the certificate: 04 August 2019

Test report: 936/21224909/B of 26 March 2015
TÜV Rheinland Energie und Umwelt GmbH, Cologne

Publication: BAnz AT 26 August 2015 B4, chapter I number 3.1
Announcement by UBA from 22 July 2015

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			Bühler Technologies GmbH		
AMS designation			CEMSelect OEM (Module Ultramat 23-7MB2358-Z-T13)***		
Serial number of units under test			N1-A8-778 / N1-A2-026		
Measuring principle			NDIR		
Test report			936/21224909/B		
Test laboratory			TÜV Rheinland		
Date of report			2015-03-26		
Measured component			CO		
Certification range			0 - 250	mg/m³	
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			3.75	mg/m³	
Sum of negative CS at zero point			-1.00	mg/m³	
Sum of postive CS at span point			2.00	mg/m³	
Sum of negative CS at span point			0.00	mg/m³	
Maximum sum of cross-sensitivities			0.00	mg/m³	
Uncertainty of cross-sensitivity		u_i	2.165	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	1.656	mg/m³	2.742	(mg/m³)²
Lack of fit	u_{lof}	0.678	mg/m³	0.460	(mg/m³)²
Zero drift from field test	$u_{d,z}$	1.443	mg/m³	2.082	(mg/m³)²
Span drift from field test	$u_{d,s}$	1.443	mg/m³	2.082	(mg/m³)²
Influence of ambient temperature at span	u_t	0.781	mg/m³	0.610	(mg/m³)²
Influence of supply voltage	u_v	1.392	mg/m³	1.938	(mg/m³)²
Cross-sensitivity (interference)	u_i	2.165	mg/m³	4.687	(mg/m³)²
Influence of sample gas flow	u_p	-0.217	mg/m³	0.047	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	2.021	mg/m³	4.083	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	4.33	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	8.48	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 100 mg/m³**	**8.5**
Requirement of 2010/75/EU	**U in % of the ELV 100 mg/m³**	**10.0**
Requirement of EN 15267-3	U in % of the ELV 100 mg/m³	7.5

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer		Bühler Technologies GmbH	
AMS designation		CEMSelect OEM (Module Ultramat 23-7MB2358-Z-T23)***	
Serial number of units under test		N1-A2-028 / N1-A8-780	
Measuring principle		NDIR	
Test report		936/21224909/B	
Test laboratory		TÜV Rheinland	
Date of report		2015-03-26	
Measured component		CO	
Certification range		0 - 250	mg/m³
Evaluation of the cross-sensitivity (CS)			
(system with largest CS)			
Sum of positive CS at zero point		3.75	mg/m³
Sum of negative CS at zero point		-1.00	mg/m³
Sum of postive CS at span point		2.00	mg/m³
Sum of negative CS at span point		0.00	mg/m³
Maximum sum of cross-sensitivities		0.00	mg/m³
Uncertainty of cross-sensitivity	u_i	2.165	mg/m³

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	1.656	mg/m³	2.742	(mg/m³)²
Lack of fit	u_{lof}	0.678	mg/m³	0.460	(mg/m³)²
Zero drift from field test	$u_{d,z}$	1.443	mg/m³	2.082	(mg/m³)²
Span drift from field test	$u_{d,s}$	1.443	mg/m³	2.082	(mg/m³)²
Influence of ambient temperature at span	u_t	1.285	mg/m³	1.651	(mg/m³)²
Influence of supply voltage	u_v	1.568	mg/m³	2.459	(mg/m³)²
Cross-sensitivity (interference)	u_i	2.165	mg/m³	4.687	(mg/m³)²
Influence of sample gas flow	u_p	-0.303	mg/m³	0.092	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	2.021	mg/m³	4.083	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	4.51	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	8.84	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 100 mg/m³**	**8.8**
Requirement of 2010/75/EU	**U in % of the ELV 100 mg/m³**	**10.0**
Requirement of EN 15267-3	U in % of the ELV 100 mg/m³	7.5

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer		Bühler Technologies GmbH	
AMS designation		CEMSelect OEM (Module Ultramat 23-7MB2358-Z-T13)***	
Serial number of units under test		N1-A8-778 / N1-A2-026	
Measuring principle		NDIR	
Test report		936/21224909/B	
Test laboratory		TÜV Rheinland	
Date of report		2015-03-26	
Measured component		NO	
Certification range		0 - 400	mg/m³
Evaluation of the cross-sensitivity (CS)			
(system with largest CS)			
Sum of positive CS at zero point		5.60	mg/m³
Sum of negative CS at zero point		-3.20	mg/m³
Sum of postive CS at span point		5.60	mg/m³
Sum of negative CS at span point		-12.00	mg/m³
Maximum sum of cross-sensitivities		-12.00	mg/m³
Uncertainty of cross-sensitivity	u_i	-6.928	mg/m³

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	1.750	mg/m³	3.063	(mg/m³)²
Lack of fit	u_{lof}	-0.393	mg/m³	0.154	(mg/m³)²
Zero drift from field test	$u_{d,z}$	3.233	mg/m³	10.452	(mg/m³)²
Span drift from field test	$u_{d,s}$	3.695	mg/m³	13.653	(mg/m³)²
Influence of ambient temperature at span	u_t	2.177	mg/m³	4.739	(mg/m³)²
Influence of supply voltage	u_v	1.688	mg/m³	2.849	(mg/m³)²
Cross-sensitivity (interference)	u_i	-6.928	mg/m³	47.997	(mg/m³)²
Influence of sample gas flow	u_p	0.277	mg/m³	0.077	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	3.236	mg/m³	10.472	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max\ j})^2}$	9.67	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	18.95	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 130.4 mg/m³**	**14.5**
Requirement of 2010/75/EU	**U in % of the ELV 130.4 mg/m³**	**20.0**
Requirement of EN 15267-3	U in % of the ELV 130.4 mg/m³	15.0

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			Bühler Technologies GmbH		
AMS designation			CEMSelect OEM (Module Ultramat 23-7MB2358-Z-T23)***		
Serial number of units under test			N1-A2-028 / N1-A8-780		
Measuring principle			NDIR		
Test report			936/21224909/B		
Test laboratory			TÜV Rheinland		
Date of report			2015-03-26		
Measured component			NO		
Certification range			0 - 400	mg/m³	
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			5.60	mg/m³	
Sum of negative CS at zero point			-3.20	mg/m³	
Sum of postive CS at span point			5.60	mg/m³	
Sum of negative CS at span point			-12.00	mg/m³	
Maximum sum of cross-sensitivities			-12.00	mg/m³	
Uncertainty of cross-sensitivity		u_i	-6.928	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	1.750	mg/m³	3.063	(mg/m³)²
Lack of fit	u_{lof}	-0.393	mg/m³	0.154	(mg/m³)²
Zero drift from field test	$u_{d,z}$	3.233	mg/m³	10.452	(mg/m³)²
Span drift from field test	$u_{d,s}$	3.695	mg/m³	13.653	(mg/m³)²
Influence of ambient temperature at span	u_t	2.177	mg/m³	4.739	(mg/m³)²
Influence of supply voltage	u_v	1.688	mg/m³	2.849	(mg/m³)²
Cross-sensitivity (interference)	u_i	-6.928	mg/m³	47.997	(mg/m³)²
Influence of sample gas flow	u_p	0.277	mg/m³	0.077	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	3.236	mg/m³	10.472	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	9.67	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	18.95	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 130.4 mg/m³**	**14.5**
Requirement of 2010/75/EU	**U in % of the ELV 130.4 mg/m³**	**20.0**
Requirement of EN 15267-3	U in % of the ELV 130.4 mg/m³	15.0

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer		Bühler Technologies GmbH	
AMS designation		CEMSelect OEM (Module Ultramat 23-7MB2358-Z-T13)***	
Serial number of units under test		N1-A8-778 / N1-A2-026	
Measuring principle		paramagnetic	
Test report		936/21224909/B	
Test laboratory		TÜV Rheinland	
Date of report		2015-03-26	
Measured component		O_2	
Certification range		0 - 25	Vol.-%
Evaluation of the cross-sensitivity (CS)			
(system with largest CS)			
Sum of positive CS at zero point		0.28	Vol.-%
Sum of negative CS at zero point		0.00	Vol.-%
Sum of postive CS at span point		0.28	Vol.-%
Sum of negative CS at span point		0.00	Vol.-%
Maximum sum of cross-sensitivities		0.28	Vol.-%
Uncertainty of cross-sensitivity	u_i	0.162	Vol.-%

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	0.081	Vol.-%	0.007	(Vol.-%)²
Lack of fit	u_{lof}	0.017	Vol.-%	0.000	(Vol.-%)²
Zero drift from field test	$u_{d,z}$	-0.092	Vol.-%	0.008	(Vol.-%)²
Span drift from field test	$u_{d,s}$	-0.081	Vol.-%	0.007	(Vol.-%)²
Influence of ambient temperature at span	u_t	0.044	Vol.-%	0.002	(Vol.-%)²
Influence of supply voltage	u_v	0.051	Vol.-%	0.003	(Vol.-%)²
Cross-sensitivity (interference)	u_i	0.162	Vol.-%	0.026	(Vol.-%)²
Influence of sample gas flow	u_p	-0.017	Vol.-%	0.000	(Vol.-%)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.230	Vol.-%	0.053	(Vol.-%)²

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.33	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.64	Vol.-%

Relative total expanded uncertainty	**U in % of the range 25 Vol.-%**	**2.6**
Requirement of 2010/75/EU	**U in % of the range 25 Vol.-%**	**10.0 ****
Requirement of EN 15267-3	U in % of the range 25 Vol.-%	7.5

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system.
** For this component no requirements in the EC-directives 2010/75/EU on industrial emissions are given.
A value of 10 % was chosen.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			Bühler Technologies GmbH		
AMS designation			CEMSelect OEM (Module Ultramat 23-7MB2358-Z-T23)***		
Serial number of units under test			N1-A2-028 / N1-A8-780		
Measuring principle			electrochemical		
Test report			936/21224909/B		
Test laboratory			TÜV Rheinland		
Date of report			2015-03-26		
Measured component			O_2		
Certification range			0 - 25	Vol.-%	
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			0.00	Vol.-%	
Sum of negative CS at zero point			0.00	Vol.-%	
Sum of postive CS at span point			0.29	Vol.-%	
Sum of negative CS at span point			0.00	Vol.-%	
Maximum sum of cross-sensitivities			0.29	Vol.-%	
Uncertainty of cross-sensitivity		u_i	0.167	Vol.-%	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	0.056	Vol.-%	0.003	(Vol.-%)²
Lack of fit	u_{lof}	0.035	Vol.-%	0.001	(Vol.-%)²
Zero drift from field test	$u_{d,z}$	0.167	Vol.-%	0.028	(Vol.-%)²
Span drift from field test	$u_{d,s}$	0.098	Vol.-%	0.010	(Vol.-%)²
Influence of ambient temperature at span	u_t	0.021	Vol.-%	0.000	(Vol.-%)²
Influence of supply voltage	u_v	0.009	Vol.-%	0.000	(Vol.-%)²
Cross-sensitivity (interference)	u_i	0.167	Vol.-%	0.028	(Vol.-%)²
Influence of sample gas flow	u_p	-0.029	Vol.-%	0.001	(Vol.-%)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.230	Vol.-%	0.053	(Vol.-%)²

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.35	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.69	Vol.-%

Relative total expanded uncertainty	**U in % of the range 25 Vol.-%**	**2.8**
Requirement of 2010/75/EU	**U in % of the range 25 Vol.-%**	**10.0 ****
Requirement of EN 15267-3	U in % of the range 25 Vol.-%	7.5

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system.
** For this component no requirements in the EC-directives 2010/75/EU on industrial emissions are given.
A value of 10 % was chosen.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			Bühler Technologies GmbH		
AMS designation			CEMSelect OEM (Module Ultramat 23-7MB2358-Z-T13)***		
Serial number of units under test			N1-A8-778 / N1-A2-026		
Measuring principle			NDIR		
Test report			936/21224909/B		
Test laboratory			TÜV Rheinland		
Date of report			2015-03-26		
Measured component			SO_2		
Certification range			0 - 400	mg/m³	
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			5.20	mg/m³	
Sum of negative CS at zero point			-11.20	mg/m³	
Sum of postive CS at span point			12.00	mg/m³	
Sum of negative CS at span point			-1.60	mg/m³	
Maximum sum of cross-sensitivities			12.00	mg/m³	
Uncertainty of cross-sensitivity		u_i	6.928	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	2.475	mg/m³	6.126	$(mg/m^3)^2$
Lack of fit	u_{lof}	2.102	mg/m³	4.418	$(mg/m^3)^2$
Zero drift from field test	$u_{d,z}$	6.235	mg/m³	38.875	$(mg/m^3)^2$
Span drift from field test	$u_{d,s}$	4.850	mg/m³	23.523	$(mg/m^3)^2$
Influence of ambient temperature at span	u_t	6.498	mg/m³	42.224	$(mg/m^3)^2$
Influence of supply voltage	u_v	2.217	mg/m³	4.915	$(mg/m^3)^2$
Cross-sensitivity (interference)	u_i	6.928	mg/m³	47.997	$(mg/m^3)^2$
Influence of sample gas flow	u_p	-2.215	mg/m³	4.906	$(mg/m^3)^2$
Uncertainty of reference material at 70% of certification range	u_{rm}	3.233	mg/m³	10.453	$(mg/m^3)^2$

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	13.54	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	26.55	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 200 mg/m³**	**13.3**
Requirement of 2010/75/EU	**U in % of the ELV 200 mg/m³**	**20.0**
Requirement of EN 15267-3	U in % of the ELV 200 mg/m³	15.0

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			Bühler Technologies GmbH		
AMS designation			CEMSelect OEM (Module Ultramat 23-7MB2358-Z-T23)***		
Serial number of units under test			N1-A2-028 / N1-A8-780		
Measuring principle			NDIR		
Test report			936/21224909/B		
Test laboratory			TÜV Rheinland		
Date of report			2015-03-26		
Measured component			SO_2		
Certification range			0 - 400	mg/m³	
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			5.20	mg/m³	
Sum of negative CS at zero point			-11.20	mg/m³	
Sum of postive CS at span point			12.00	mg/m³	
Sum of negative CS at span point			-1.60	mg/m³	
Maximum sum of cross-sensitivities			12.00	mg/m³	
Uncertainty of cross-sensitivity	u_i		6.928	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	2.475	mg/m³	6.126	(mg/m³)²
Lack of fit	u_{lof}	2.102	mg/m³	4.418	(mg/m³)²
Zero drift from field test	$u_{d,z}$	6.235	mg/m³	38.875	(mg/m³)²
Span drift from field test	$u_{d,s}$	4.850	mg/m³	23.523	(mg/m³)²
Influence of ambient temperature at span	u_t	9.960	mg/m³	99.202	(mg/m³)²
Influence of supply voltage	u_v	2.564	mg/m³	6.574	(mg/m³)²
Cross-sensitivity (interference)	u_i	6.928	mg/m³	47.997	(mg/m³)²
Influence of sample gas flow	u_p	-2.215	mg/m³	4.906	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	3.236	mg/m³	10.472	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	15.56	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	30.50	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 200 mg/m³**	**15.2**
Requirement of 2010/75/EU	**U in % of the ELV 200 mg/m³**	**20.0**
Requirement of EN 15267-3	U in % of the ELV 200 mg/m³	15.0

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer		Bühler Technologies GmbH	
AMS designation		CEM Select OEM (Module Ultramat 23-7MB2357-Z-T33)***	
Serial number of units under test		N1-B5-208 / N1-B5-210	
Measuring principle		NDIR	
Test report		936/21224909/B	
Test laboratory		TÜV Rheinland	
Date of report		2015-03-26	
Measured component		CO	
Certification range		0 - 200	mg/m³
Evaluation of the cross-sensitivity (CS)			
(system with largest CS)			
Sum of positive CS at zero point		0.00	mg/m³
Sum of negative CS at zero point		0.00	mg/m³
Sum of postive CS at span point		0.00	mg/m³
Sum of negative CS at span point		0.00	mg/m³
Maximum sum of cross-sensitivities		0.00	mg/m³
Uncertainty of cross-sensitivity	u_i	1.988	mg/m³

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	0.588	mg/m³	0.346	(mg/m³)²
Lack of fit	u_{lof}	-0.254	mg/m³	0.065	(mg/m³)²
Zero drift from field test	$u_{d.z}$	1.155	mg/m³	1.334	(mg/m³)²
Span drift from field test	$u_{d.s}$	1.270	mg/m³	1.613	(mg/m³)²
Influence of ambient temperature at span	u_t	0.578	mg/m³	0.334	(mg/m³)²
Influence of supply voltage	u_v	0.484	mg/m³	0.234	(mg/m³)²
Cross-sensitivity (interference)	u_i	1.988	mg/m³	3.952	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	1.617	mg/m³	2.613	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max\ j})^2}$	3.24	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	6.35	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 100 mg/m³**	**6.3**
Requirement of 2010/75/EU	**U in % of the ELV 100 mg/m³**	**10.0**
Requirement of EN 15267-3	U in % of the ELV 100 mg/m³	7.5

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system . The calculation of the measurement uncertainty is as well valid for the modules BA-5000-7MB2355 and Ultramat 23-7MB2355.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer	Bühler Technologies GmbH		
AMS designation	CEM Select OEM (Module Ultramat 23-7MB2357-Z-T33)***		
Serial number of units under test	N1-B5-208 / N1-B5-210		
Measuring principle	NDIR		
Test report	936/21224909/B		
Test laboratory	TÜV Rheinland		
Date of report	2015-03-26		
Measured component	NO		
Certification range	0 - 150	mg/m³	

Evaluation of the cross-sensitivity (CS)
(system with largest CS)

Sum of positive CS at zero point	0.00	mg/m³	
Sum of negative CS at zero point	0.00	mg/m³	
Sum of postive CS at span point	0.00	mg/m³	
Sum of negative CS at span point	0.00	mg/m³	
Maximum sum of cross-sensitivities	0.00	mg/m³	
Uncertainty of cross-sensitivity u_i	-3.464	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	0.619	mg/m³	0.383	(mg/m³)²
Lack of fit	u_{lof}	-0.719	mg/m³	0.517	(mg/m³)²
Zero drift from field test	$u_{d.z}$	0.779	mg/m³	0.607	(mg/m³)²
Span drift from field test	$u_{d.s}$	2.252	mg/m³	5.072	(mg/m³)²
Influence of ambient temperature at span	u_t	0.585	mg/m³	0.342	(mg/m³)²
Influence of supply voltage	u_v	1.108	mg/m³	1.228	(mg/m³)²
Cross-sensitivity (interference)	u_i	-3.464	mg/m³	11.999	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	1.212	mg/m³	1.470	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max\ j})^2}$	4.65	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	9.11	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 65,2 mg/m³**	**14.0**
Requirement of 2010/75/EU	**U in % of the ELV 65,2 mg/m³**	**20.0**
Requirement of EN 15267-3	U in % of the ELV 65,2 mg/m³	15.0

*** During performance testing, the tests were carried out with the Siemens Set CEM CERT 7MB1957 measuring system . The calculation of the measurement uncertainty is as well valid for the modules BA-5000-7MB2355 and Ultramat 23-7MB2355.