Umwelt Bundesamt

TÜVRheinland®
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CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000040335

Certified AMS:	Bühler 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).

TÜVRheinland® CERTIFIED

Suitability Tested
EN 15267
QAL1 Certified
Regular
Surveillance

www.tuv.com
ID 0000040335

Publication in the German Federal Gazette (BAnz.) of 5 August 2014

This certificate will expire on:
4 August 2019

German Federal Environment Agency
Dessau, 9 September 2014

i. A. Dr. Marcel Langner

TÜV Rheinland Energie und Umwelt GmbH
Cologne, 8 September 2014

ppa. Dr. Peter Wilbring

www.umwelt-tuv.de / www.eco-tuv.com teu@umwelt-tuv.de Tel. +49 221 806-5200	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.	

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Umwelt Bundesamt

Certificate:
0000040335 / 9 September 2014

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Test report:	936/21224909/A of 3 April 2014
Initial certification:	5 August 2014
Expiry date:	4 August 2019
Publication:	BAnz AT 5 August 2014 B11, chapter I, no. 5.2

Approved application
The tested AMS is suitable for use at combustion plants according to Directive 2010/75/EU, chapter III and other plants requiring official approval. The tested ranges have been chosen considering 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.

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/A of 3 April 2014 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 5 August 2014 B11, chapter I, no. 5.2
  UBA announcement of 17 July 2014

AMS designation:
Bühler CEMSelect OEM for CO, NO, SO_2 and O_2

Manufacturer:
Bühler Technologies GmbH, Ratingen

Field of application:
For measurements at plants requiring official approval (e.g.Directive 2010/75/EU on industrial emissions, chapter III).

Measuring ranges during the performance test:

Component	Certification range	Supplementary ranges		Unit
CO	0 - 250	0 - 1250	-	mg/m^3
NO	0 - 400	0 - 2000	-	mg/m^3
SO_2	0 - 400	0 - 2000	0 - 7000	mg/m^3
O_2 paramagnetic	0 - 25	-	-	Vol.-%
O_2 electrochemical	0 - 25	-	-	Vol.-%

Measuring ranges during the performance test of the CEMSelect OEM modular system manufactured by Bühler, modules Ultramat 23-7MB2358 respectively BA 5000 EN15267-3IR-:

	Module-Version	Certification range	Supplementary ranges		Unit
CO	Ultramat 23-7MB2358 – Z – T13 / BA 5000 EN15267-3IR-P	0 - 250	0 - 1250	-	mg/m³
	Ultramat 23-7MB2358 – Z – T23 / BA 5000 EN15267-3IR-E	0 - 250	0 - 1250	-	mg/m³
NO	Ultramat 23-7MB2358 – Z – T13 / BA 5000 EN15267-3IR-P	0 - 400	0 - 2000	-	mg/m³
	Ultramat 23-7MB2358 – Z – T23 / BA 5000 EN15267-3IR-E	0 - 400	0 - 2000	-	mg/m³
SO_2	Ultramat 23-7MB2358 – Z – T13 / BA 5000 EN15267-3IR-P	0 - 400	0 - 2000	0 - 7000	mg/m³
	Ultramat 23-7MB2358 – Z – T23 / BA 5000 EN15267-3IR-E	0 - 400	0 - 2000	0 - 7000	mg/m³
O_2 paramagnetic	Ultramat 23-7MB2358 – Z – T13 / BA 5000 EN15267-3IR-P	0 - 25	-	-	Vol.-%
O_2 electrochemical	Ultramat 23-7MB2358 – Z – T23 / BA 5000 EN15267-3IR-E	0 - 25	-	-	Vol.-%

The performance test of the Bühler CEMSelect OEM measuring system encompassed two different types of modules, which are both equipped for the measurement of the following components:

Module-Version	Component 1	Component 2	Component 3	Component 4
Ultramat 23-7MB2358 – Z – T13/ BA 5000 EN15267-3IR-P	CO	NO	SO_2	O_2 paramagnetic
Ultramat 23-7MB2358 – Z – T23/ BA 5000 EN15267-3IR-E	CO	NO	SO_2	O_2 electrochemical

Software versions:

Ultramat 23-7MB2358 / BA 5000 EN15267-3IR: 2.14.07
SPS: Set CEM CERT Rev. 1.0

Restrictions:

1. Requirements with regard to the determination coefficient R^2 of the component NO in accordance with EN 15267-3 were not fulfilled during performance testing.
2. Requirements with regard to the total uncertainty for the component CO in accordance with EN 15267-3 were not fulfilled during performance testing. It is fulfilled partially for the component SO_2.
3. The degree of protection for the enclosure is only rated as IP 20. 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 h-interval for automatic adjustments.
2. In order to optimise the cross-sensitivity of the CO measurement channel in relation to CO_2, the Ultramat 23-7MB2358 or BA 5000 EN15267-3IR modules of the Bühler CEMSelect OEM measuring system will be distributed with a modified CO_2-receptor starting from the production month April 2014 and marked by the serial number starting from E4 in the central block.
3. The analyser shall be operated with the thermo-AUTOCAL-function activated.
4. The Bühler CEMSelect OEM modular measuring system can be equipped with a test gas cooler manufactured by Bühler Technologies GmbH (EGK 2-19).
5. The maintenance interval of the BA 5000 EN15267-3IR-/Ultramat 23-7MB2358 module is three months. If further modules are added to the Bühler CEMSelect OEM measuring system, the functionality of the particular combination of modules has to be tested when checking for proper installation and the maintenance interval has to be determined accordingly.

Test report:

TÜV Rheinland Energie und Umwelt GmbH, Cologne
Report no.: 936/21224909/A of 3 April 2014

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 Ultramat 23 or BA 5000.

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 Ultramat 23-7MB2358 or BA 5000 EN15267-3IR
- LOGO control unit
- Software: Ultramat 23-7MB2358 / BA 5000 EN15267-3IR: 2.14.07
  PLC: 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 Bühler 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

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

Measuring system			
Manufacturer		Bühler Technologies GmbH	
AMS designation		Bühler CEMSelect OEM ***	
Serial number of units under test		N1-A8-778 / N1-A2-026	
Measuring principle		NDIR	
Test report		936/21224909/A	
Test laboratory		TÜV Rheinland	
Date of report		2014-04-03	
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		Bühler CEMSelect OEM ***	
Serial number of units under test		N1-A2-028 / N1-A8-780	
Measuring principle		NDIR	
Test report		936/21224909/A	
Test laboratory		TÜV Rheinland	
Date of report		2014-04-03	
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		Bühler CEMSelect OEM ***	
Serial number of units under test		N1-A8-778 / N1-A2-026	
Measuring principle		NDIR	
Test report		936/21224909/A	
Test laboratory		TÜV Rheinland	
Date of report		2014-04-03	
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		Bühler CEMSelect OEM ***	
Serial number of units under test		N1-A2-028 / N1-A8-780	
Measuring principle		NDIR	
Test report		936/21224909/A	
Test laboratory		TÜV Rheinland	
Date of report		2014-04-03	
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.

Umwelt Bundesamt

Certificate:
0000040335 / 9 September 2014

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

Measuring system					
Manufacturer			Bühler Technologies GmbH		
AMS designation			Bühler CEMSelect OEM ***		
Serial number of units under test			N1-A8-778 / N1-A2-026		
Measuring principle			paramagnetic		
Test report			936/21224909/A		
Test laboratory			TÜV Rheinland		
Date of report			2014-04-03		
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.
The chosen value is recommended by the certification body.

Umwelt Bundesamt

Certificate:
0000040335 / 9 September 2014

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

Measuring system					
Manufacturer			Bühler Technologies GmbH		
AMS designation			Bühler CEMSelect OEM ***		
Serial number of units under test			N1-A2-028 / N1-A8-780		
Measuring principle			electrochemical		
Test report			936/21224909/A		
Test laboratory			TÜV Rheinland		
Date of report			2014-04-03		
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.
The chosen value is recommended by the certification body.

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

Measuring system			
Manufacturer		Bühler Technologies GmbH	
AMS designation		Bühler CEMSelect OEM ***	
Serial number of units under test		N1-A8-778 / N1-A2-026	
Measuring principle		NDIR	
Test report		936/21224909/A	
Test laboratory		TÜV Rheinland	
Date of report		2014-04-03	
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	6.498	mg/m³	42.224	(mg/m³)²
Influence of supply voltage	u_v	2.217	mg/m³	4.915	(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}	3.233	mg/m³	10.453	(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)	$u_c = \sqrt{\sum (u_{max,j})^2}$	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.

Umwelt Bundesamt

Certificate:
0000040335 / 9 September 2014

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

Measuring system			
Manufacturer		Bühler Technologies GmbH	
AMS designation		Bühler CEMSelect OEM ***	
Serial number of units under test		N1-A2-028 / N1-A8-780	
Measuring principle		NDIR	
Test report		936/21224909/A	
Test laboratory		TÜV Rheinland	
Date of report		2014-04-03	
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.