

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000025930_04

Certified AMS: PowerCEMS100 for CO, NO, NO₂, SO₂, CH₄, N₂O, CO₂ and O₂

Manufacturer: SICK AG
Nimburger Str. 11
79276 Reute
Germany

Test Institute: TÜV Rheinland Energy GmbH

**This is to certify that the AMS has been tested
and found to comply with the standards
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
(this certificate contains 26 pages).
The present certificate replaces certificate 0000025930_03 of 02 February 2015.

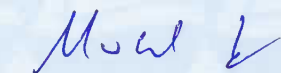


Suitability Tested
EN 15267
QAL1 Certified
Regular Surveillance

www.tuv.com
ID 0000025930

Publication in the German Federal Gazette
(BAnz.) of 02 March 2012

German Federal Environment Agency
Dessau, 12 February 2020



Dr. Marcel Langner
Head of Section II 4.1

This certificate will expire on:
11 February 2025

TÜV Rheinland Energy GmbH
Cologne, 11 February 2020



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51105 Köln

Test institute accredited to EN ISO/IEC 17025:2005 by DAkkS (German Accreditation Body). This accreditation is limited to the accreditation scope defined in the enclosure to the certificate D-PL-11120-02-00.

Certificate:
0000025930_04 / 12 February 2020

Test report: 936/21217568/A of 18 October 2011
Initial certification: 12 February 2010
Expiry date: 11 February 2025
Certificate: renewal (previous 0000025930_03 dated 02 February 2015
with validity up to the 11 February 2020)
Publication: BAnz. 2 March 2012, no. 36, p. 920, chapter I, no. 5.1

Approved application

The tested AMS is suitable for use at large combustion plants according to Directive 2001/80/EC, at waste incineration plants according to Directive 2000/76/EC and other plants requiring official approval. The tested ranges have been chosen with respect to the wide application of the AMS.

The suitability of the AMS for this application was assessed on the basis of a laboratory test and a field test at a municipal 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 values and oxygen concentrations 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 936/21217568/A of 18 October 2011 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. 2 March 2012, no. 36, p. 920, chapter I, no. 5.1, Announcement by UBA from 23 February 2012:

AMS designation:

Modular System MAC GMS800 for CO, NO, NO₂, SO₂, CH₄, N₂O, CO₂ and O₂

Manufacturer:

SICK MAIHAK GmbH, Reute

Field of application:

For measurements at plants requiring official approval (i.e. Directive 2001/80/EC regarding large combustions plants, Directive 2000/76/EC regarding waste incineration plants)

Measuring ranges during the performance test:

Com- ponent	Module	Certification range	Supplementary measuring ranges		Unit
CO	MAC GMS800 UNOR for CO	0 – 75	0 – 750	0 –	mg/m ³
	MAC GMS800 MULTOR for CO	0 – 200	0 – 2000	3000 –	mg/m ³
NO	MAC GMS800 UNOR for NO	0 – 100	0 – 1000	0 –	mg/m ³
	MAC GMS800 MULTOR for NO	0 – 250	0 – 2500	2000 –	mg/m ³
	MAC GMS800 DEFOR for NO	0 – 50	0 – 1000	–	mg/m ³
NO ₂	MAC GMS800 DEFOR for NO ₂	0 – 50	0 – 500	–	mg/m ³
	MAC GMS800 UNOR for NO _x	0 – 100	0 – 1000	0 –	mg/m ³
NO _x	MAC GMS800 MULTOR for NO _x	0 – 250	0 – 2500	2000 –	mg/m ³
	MAC GMS800 UNOR for SO ₂	0 – 75	0 – 287	0 –	mg/m ³
SO ₂	MAC GMS800 MULTOR for SO ₂	0 – 250	0 – 2000	2000 –	mg/m ³
	MAC GMS800 DEFOR for SO ₂	0 – 75	0 – 287	–	mg/m ³
CH ₄	MAC GMS800 UNOR for CH ₄	0 – 50	0 – 500	–	mg/m ³
	MAC GMS800 MULTOR for CH ₄	0 – 286	0 – 500	–	mg/m ³
N ₂ O	MAC GMS800 UNOR for N ₂ O	0 – 50	0 – 500	–	mg/m ³
CO ₂	MAC GMS800 UNOR for CO ₂	0 – 25	–	–	Vol.-%
	MAC GMS800 MULTOR for CO ₂	0 – 25	–	–	Vol.-%
O ₂	MAC GMS800 OXOR-P for O ₂	0 – 25	–	–	Vol.-%
	MAC GMS800 OXOR-E for O ₂	0 – 25	–	–	Vol.-%

Software versions:

T825_090707_1000

PC-Software: Sopas ET 2.22 Build 2938

Restrictions:

1. Functionality of the respective combination of modules shall be verified during the checks for proper installation.
2. The maintenance interval shall be determined during the check for proper installation.

Notes:

1. Automatic calibration of zero points shall be carried out with humidified ambient air for all components except for O₂ (OXOR-P and OXOR-E) once a week.
2. Automatic span point calibration for the OXOR-P and OXOR-E (O₂) sensors shall be carried out once a week with humidified ambient air.
3. With the help of external air conditioning the AMS also fulfils the requirements at an ambient air temperature of 50 °C.
4. The measuring system may be operated with cooler type MAK10-2 manufactured by AGT Thermotechnik as well as with type CSS-V2SK manufactured by M&C.
5. With weekly adjustments using the respective internal test gas cell or edge filter (NO₂ (DEFOR)), the maintenance intervals for the modules can be extended as follows:
 - one year for the modules CO (UNOR), CH₄ (UNOR and MULTOR)
 - half a year for the modules CO (MULTOR), NO (MULTOR), SO₂ (DEFOR)
 - three months for the modules NO (UNOR) und NO₂ (DEFOR)
6. Supplementary testing (extension of the maintenance interval by using internal test gas cells) as regards Federal Environment Agency notices of 12 July 2010 (BAnz. p. 2597, chapter I, no. 2.1) and of 10 January 2011 (BAnz. p. 294, chapter IV notifications 2 and 30).

Test report:

TÜV Rheinland Energie und Umwelt GmbH, Cologne

Report No.: 936/21217568/A of 18 October 2011

Publication in the German Federal Gazette: BAnz AT 23 July 2013 B4, chapter V, notification 12 (sequential no. 12), Announcement by UBA from 03 July 2013:

12 Notification as regards Federal Environment Agency notices regarding performance tested measuring systems manufactured by SICK MAIHAK GmbH

Seq. no.	AMS / Manufacturer	Notice	Notification	Statement of test institute
12	MAC GMS800 / SICK AG	of 23 February 2012 (BAnz. p. 920, chapter I no. 5.1)	SICK MAIHAK GmbH merged with its parent company SICK AG as of 1 January 2013. The manufacturer is now registered as SICK AG.	Statement of TÜV Rheinland Energie und Umwelt GmbH of 25 März 2013

Publication in the German Federal Gazette: BAnz AT 23 July 2013 B4, chapter V, notification 13 (sequential no. 13), Announcement by UBA from 03 July 2013:

13 Notification as regards Federal Environment Agency notices regarding performance tested measuring systems manufactured by SICK Engineering GmbH and SICK AG

Seq. no.	AMS / Manufacturer	Notice	Notification	Statement of test institute
13	MAC GMS800 / SICK AG	as regards notification 12 (sequential no. 12) of this notice	The current software version of the SOPAS ET platform for optional AMS control is: SOPAS ET 2.38.	Statement of TÜV Rheinland Energie und Umwelt GmbH of 25 March 2013

Publication in the German Federal Gazette: BAnz AT 05.08.2014 B11, chapter V, notification 13, Announcement by UBA from 17 July 2014:

13 Notification as regards Federal Environment Agency notices of 23 February 2012 (BAnz. p. 920, chapter 1, no. 5.1), of 3 July 2013 (BAnz AT 23 July 2013 B4, chapter V, 12th notification [no.12] and 13th notification [no. 13]) and of 27 February 2014 (BAnz AT 1 April 2014 B12, chapter V, 1st correction)

The modular measuring system MAC GMS800 for CO, NO, NO₂, SO₂, CH₄, N₂O, CO₂ and O₂ manufactured by SICK AG may now also be equipped with the SCU-P100 display unit.

For the DEFOR module, an absorber cartridge is inserted into the measurement cell.

The chopper motor S/N 6026930 is replaced by motor S/N 6030437.

The software versions for the individual modules of the MAC GMS800 modular measuring system for CO, NO, NO₂, SO₂, CH₄, N₂O, CO₂ and O₂ manufactured by SICK AG are:

BCU:	9150883_3.005 Y123
SCU-P100:	9158931_WI82
UNOR/MULTOR:	9137995_3.004 XN94
OXOR:	9138052_3.002 WM48
DEFOR:	9139736_3.003 WM48
Gas module:	9137582_3.002 WM48

Statement of TÜV Rheinland Energie und Umwelt GmbH of 2 April 2014

Publication in the German Federal Gazette: BAnz AT 14.03.2016 B7, chapter V, notification 34, Announcement by UBA from 18 February 2016:

34 Notification as regards Federal Environment Agency (UBA) notices of 23 February 2012 (BAnz. p. 920, chapter I number 5.1) and of 17 July 2014 (BAnz AT 05.08.2014 B11, chapter V notification 13)

The modular measuring equipment MAC GMS800 for CO, NO, NO₂, SO₂, CH₄, N₂O, CO₂ and O₂ of SICK AG is now marketed under the name PowerCEMS100.

For standard applications of the PowerCEMS100, a 19"-rack-housing with (GMS810) or without integrated BCU (GMS811) is used.

In the modular PowerCEMS 100 system control of the entire measuring system will fully be realized via a central BCU as well as a central signal unit downstream. The separate measurement modules will no longer be connected to the SCU/BCU. They will separately be connected to the signal I/O-unit. The BCU is still connected to the measurement and I/O-modules via a CAN-bus.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 9 October 2015

Publication in the German Federal Gazette: BAnz AT 15.03.2017 B6, chapter V, notification 25, Announcement by UBA from 22 February 2017:

25 Notification as regards Federal Environment Agency (UBA) notices of 23 February 2012 (BAnz. p. 920, chapter I number 5.1) and of 18 February 2016 (BAnz AT 14.03.2016 B7, chapter V, 34th notification)

The BCU of the modular PowerCEMS100 measuring system for CO, NO, NO₂, SO₂, CH₄, N₂O, CO₂ and O₂ manufactured by SICK AG now provides a digital Modbus interface (RTU and TCP/IP) in accordance with VDI guideline 4201, parts 1 and 3. Test results are detailed in test report number 936/21236082/A of 10 October 2016 issued by TÜV Rheinland Energy GmbH.

The current BCU software version is 9150883_4.003 Aug 22 2016 1449.

Statement issued by TÜV Rheinland Energy GmbH dated 10 October 2016

Publication in the German Federal Gazette: BAnz AT 26.03.2018 B8, chapter V, notification 47, Announcement by UBA from 21 February 2018:

47 Notification as regards Federal Environment Agency (UBA) notices of 23 February 2012 (BAnz. p. 920, chapter I no. 5.1) and of 22 February 2017 (BAnz AT 15.03.2017 B6, chapter V 25th notification)

The current software versions of the modular PowerCEMS100 measuring system for CO, NO, NO₂, SO₂, CH₄, N₂O, CO₂ and O₂ manufactured by SICK AG are as follows:

BCU:	9150883_4.003
SCU-P100:	9158931_YQK5
UNOR/MULTOR:	9137995_4.000
DEFOR:	9139736_4.002
OXOR	9138052_4.000
Gas module:	9134803_4.002

Statement issued by TÜV Rheinland Energy GmbH dated 2 October 2017

Publication in the German Federal Gazette: BAnz AT 26.03.2019 B7, chapter IV, notification 59, Announcement by UBA from 27 February 2019:

59 Notification as regards Federal Environment Agency notices of 23 February 2012 (BAnz. p. 920, chapter I number 5.1) and of 21 February 2018 (BAnz AT 26.03.2018 B6, chapter V 47th notification)

The current software versions of the modular PowerCEMS100 measuring system for CO, NO, NO₂, SO₂, CH₄, N₂O, CO₂ and O₂ manufactured by SICK AG are:

BCU:	9150883_4.003
UNOR/MULTOR:	9137995_4.001
DEFOR:	9139736_4.002
OXOR:	9138052_4.000
Gas module:	9134803_4.002

Statement issued by TÜV Rheinland Energy GmbH dated 2 October 2018

Certified product

This certificate applies to automated measurement systems conforming to the following description:

The multi-component measuring system PowerCEMS100 is a modular sensor system. The essential part is the instrument cabinet including the interface modules, measuring gas pump, test gas supply unit, electronic unit and SCU/BCU control unit. It is possible to place up to three different measurement modules in this instrument cabinet. All gas sensors are able to work independently from other sensors.

Thus, the modular measuring system can be equipped according to different requirements, each with appropriate measurement modules.

The following gas sensor modules have been certified so far: UNOR, MULTOR, DEFOR, OXOR.

All gas sensor modules are connected by a BUS-system. The BUS system continuously outputs the measured values determined. It also allows to activate control functions of the sensor modules or read and, where necessary, change sensor parameters.

The following components are part of the complete system:

- heated probe (M&C SP 2000) with heated filter, test gas supply function and back purging,
- heated sample gas line (a heated line with a length of 10 m was used during the laboratory test, during the field test a heated line with a length of 50 m was used),
- instrument cabinet with interface modules, measuring gas pump, sample gas cooler, test gas supply unit, sensor modules with gas sensors, electronic unit and SCU/BCU control unit.

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 Energy 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 certification mark may be applied to the product or used in advertising materials for the certified product.

This document as well as the certification mark remains property of TÜV Rheinland Energy GmbH. With revocation of the publication the certificate loses its validity. After the expiration of the certificate and on requests of the TÜV Rheinland Energy 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: gal1.de.

History of documents

Certification of PowerCEMS100 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. 0000025930_00: 12 February 2010
Expiry date of the certificate: 11 February 2015
Test report 936/21211670/A dated 29 October 2009
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne
Publication: BAnz 12 February 2010, no. 24, p. 553, chapter I no. 1.2
Announcement by UBA dated 25 January 2010

Supplementary testing according to EN 15267

Certificate No. 0000025930_01: 02 August 2010
Expiry date of the certificate: 11 February 2015
Test report 936/21211670/B dated 26 March 2010
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne
Publication: BAnz 28 July 2010, no. 111, p. 2597, chapter I no. 2.1
Announcement by UBA dated 12 July 2010

Notifications according to EN 15267

Statement of TÜV Rheinland Energy GmbH dated 24 September 2010
Publication: BAnz 26 January 2011, no. 14, p. 294, chapter IV notification 2
Announcement by UBA dated 10 January 2011
(new name, additional components)

Statement of TÜV Rheinland Energy GmbH dated 8 November 2010
Publication: BAnz 26 January 2011, no. 14, p. 294, chapter IV notification 30
Announcement by UBA dated 10 January 2011
(new software version)

Supplementary testing according to EN 15267

Certificate No. 0000025930_02: 16 March 2012
Expiry date of the certificate: 11 February 2015
Test report 936/21217568/A dated 18 October 2011
TÜV Rheinland Energie und Umwelt GmbH, Cologne
Publication: BAnz 02 March 2012, no. 36, p. 920, chapter I no. 5.1
Announcement by UBA dated 23 February 2012
(extension maintenance interval)

Notifications according to EN 15267

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 25 March 2013
Publication: BAnz AT 23.07.2013 B4, chapter V notification 12
Announcement by UBA dated 03 July 2013
(new manufacturer name)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 25 March 2013
Publication: BAnz AT 23.07.2013 B4, chapter V notification 13
Announcement by UBA dated 03 July 2013
(new software version)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 02 April 2014
Publication: BAnz AT 05.08.2014 B11, chapter V notification 13
Announcement by UBA dated 17 July 2014
(new software version, new chopper motor)

Renewal of the certificate

Certificate No. 0000025930_03: 02 February 2015
Expiry date of the certificate: 11 February 2020

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 09 October 2015
Publication: BAnz AT 14.03.2016 B7, chapter V notification 34
Announcement by UBA dated 18 February 2016
(new name, hardware changes)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 10 October 2016
Publication: BAnz AT 15.03.2017 B6, chapter V notification 25
Announcement by UBA dated 22 February 2017
(software changes, Modbus RTU and TCP/IP)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 02 October 2017
Publication: BAnz AT 26.03.2018 B8, chapter V notification 47
Announcement by UBA dated 21 February 2018
(software changes)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 02 October 2018
Publication: BAnz AT 26.03.2019 B7, chapter IV notification 59
Announcement by UBA dated 27 February 2019
(software changes)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated xx October 2018
Publication: BAnz AT xx.xx.2019 Bx, chapter xx notification xx
Announcement by UBA dated xx February 2020
(software changes)

Renewal of the certificate

Certificate No. 0000025930_04: 12 February 2020
Expiry date of the certificate: 11 February 2025

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 UNOR for CO
Serial number of the candidates	TÜV 1 / TÜV 3
Measuring principle	NDIR

Test report

Test laboratory	936/21217568/A
Date of report	TÜV Rheinland 2011-10-18

Measured component

Certification range	CO 0 - 75 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	1.80 mg/m ³
Sum of negative CS at zero point	-1.30 mg/m ³
Sum of positive CS at reference point	1.07 mg/m ³
Sum of negative CS at reference point	0.00 mg/m ³
Maximum sum of cross sensitivities	1.80 mg/m ³
Uncertainty of cross sensitivity	1.039 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 0.747 mg/m ³	0.558 (mg/m ³) ²
Lack of fit	u _{lof} 0.289 mg/m ³	0.084 (mg/m ³) ²
Zero drift from field test	u _{d,z} 0.346 mg/m ³	0.120 (mg/m ³) ²
Span drift from field test	u _{d,s} 0.866 mg/m ³	0.750 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.751 mg/m ³	0.564 (mg/m ³) ²
Influence of supply voltage	u _v 0.115 mg/m ³	0.013 (mg/m ³) ²
Cross sensitivity (interference)	u _i 1.039 mg/m ³	1.080 (mg/m ³) ²
Influence of sample gas flow	u _b -0.029 mg/m ³	0.001 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.606 mg/m ³	0.368 (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)	$u_c = \sqrt{\sum (u_{max,i})^2}$	1.88 mg/m ³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	3.69 mg/m ³

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC	U in % of the ELV 50 mg/m ³	7.4
Requirement of EN 15267-3	U in % of the ELV 50 mg/m ³	10.0
	U in % of the ELV 50 mg/m ³	7.5

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 MULTOR for CO
Serial number of the candidates	TÜV 1 / TÜV 3
Measuring principle	NDIR

Test report

Test laboratory	TÜV Rheinland
Date of report	2011-10-18

Measured component

CO	
Certification range	0 - 200 mg/m ³

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.00 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at reference point	6.76 mg/m ³
Sum of negative CS at reference point	0.00 mg/m ³
Maximum sum of cross sensitivities	6.76 mg/m ³
Uncertainty of cross sensitivity	3.903 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 1.588 mg/m ³	2.522 (mg/m ³) ²
Lack of fit	u _{lof} 1.155 mg/m ³	1.334 (mg/m ³) ²
Zero drift from field test	u _{d,z} 0.924 mg/m ³	0.854 (mg/m ³) ²
Span drift from field test	u _{d,s} -3.002 mg/m ³	9.012 (mg/m ³) ²
Influence of ambient temperature at span	u _t 2.406 mg/m ³	5.789 (mg/m ³) ²
Influence of supply voltage	u _v 0.157 mg/m ³	0.025 (mg/m ³) ²
Cross sensitivity (interference)	u _i 3.903 mg/m ³	15.233 (mg/m ³) ²
Influence of sample gas flow	u _b 0.127 mg/m ³	0.016 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 1.617 mg/m ³	2.613 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 6.12 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 11.99 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 160 mg/m³ **7.5**

Requirement of 2000/76/EC and 2001/80/EC

U in % of the ELV 160 mg/m³ **10.0**

Requirement of EN 15267-3

U in % of the ELV 160 mg/m³ **7.5**

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 UNOR for NO
Serial number of the candidates	TÜV 1 / TÜV 3
Measuring principle	NDIR

Test report

Test laboratory	TÜV Rheinland
Date of report	2011-10-18

Measured component

Measured component	NO
Certification range	0 - 100 mg/m ³

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	1.56 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at reference point	2.46 mg/m ³
Sum of negative CS at reference point	-0.73 mg/m ³
Maximum sum of cross sensitivities	2.46 mg/m ³
Uncertainty of cross sensitivity	1.420 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 1.191 mg/m ³	1.418 (mg/m ³) ²
Lack of fit	u _{lof} 0.231 mg/m ³	0.053 (mg/m ³) ²
Zero drift from field test	u _{d,z} -1.212 mg/m ³	1.469 (mg/m ³) ²
Span drift from field test	u _{d,s} 1.732 mg/m ³	3.000 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.529 mg/m ³	0.280 (mg/m ³) ²
Influence of supply voltage	u _v 0.142 mg/m ³	0.020 (mg/m ³) ²
Cross sensitivity (interference)	u _i 1.420 mg/m ³	2.017 (mg/m ³) ²
Influence of sample gas flow	u _b -0.104 mg/m ³	0.011 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.808 mg/m ³	0.653 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 2.99 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 5.85 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 50 mg/m³ 11.7

Requirement of 2000/76/EC and 2001/80/EC

U in % of the ELV 50 mg/m³ 20.0

Requirement of EN 15267-3

U in % of the ELV 50 mg/m³ 15.0

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 MULTOR for NO
Serial number of the candidates	TÜV 1 / TÜV 3
Measuring principle	NDIR

Test report

Test laboratory	TÜV Rheinland
Date of report	2011-10-18

Measured component

Certification range	NO 0 - 250 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	8.95 mg/m ³
Sum of negative CS at zero point	-4.43 mg/m ³
Sum of positive CS at reference point	3.45 mg/m ³
Sum of negative CS at reference point	-3.65 mg/m ³
Maximum sum of cross sensitivities	8.95 mg/m ³
Uncertainty of cross sensitivity	5.167 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 2.241 mg/m ³	5.022 (mg/m ³) ²
Lack of fit	u _{lof} -1.155 mg/m ³	1.334 (mg/m ³) ²
Zero drift from field test	u _{d,z} 2.742 mg/m ³	7.519 (mg/m ³) ²
Span drift from field test	u _{d,s} 4.186 mg/m ³	17.523 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.950 mg/m ³	0.903 (mg/m ³) ²
Influence of supply voltage	u _v 0.737 mg/m ³	0.543 (mg/m ³) ²
Cross sensitivity (interference)	u _i 5.167 mg/m ³	26.701 (mg/m ³) ²
Influence of sample gas flow	u _b 0.277 mg/m ³	0.077 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 2.021 mg/m ³	4.083 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 7.98 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 15.64 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 131 mg/m³ 11.9

Requirement of 2000/76/EC and 2001/80/EC

U in % of the ELV 131 mg/m³ 20.0

Requirement of EN 15267-3

U in % of the ELV 131 mg/m³ 15.0

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 DEFOR for NO
Serial number of the candidates	TÜV 2 / TÜV 4
Measuring principle	UVRAS

Test report

Test laboratory	TÜV Rheinland
Date of report	2011-10-18

Measured component

Measured component	NO
Certification range	0 - 50 mg/m ³

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	1.86 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at reference point	1.06 mg/m ³
Sum of negative CS at reference point	-0.94 mg/m ³
Maximum sum of cross sensitivities	1.86 mg/m ³
Uncertainty of cross sensitivity	1.074 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 0.751 mg/m ³	0.564 (mg/m ³) ²
Lack of fit	u _{lof} -0.115 mg/m ³	0.013 (mg/m ³) ²
Zero drift from field test	u _{d,z} 0.375 mg/m ³	0.141 (mg/m ³) ²
Span drift from field test	u _{d,s} 0.866 mg/m ³	0.750 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.153 mg/m ³	0.023 (mg/m ³) ²
Influence of supply voltage	u _v 0.233 mg/m ³	0.054 (mg/m ³) ²
Cross sensitivity (interference)	u _i 1.074 mg/m ³	1.153 (mg/m ³) ²
Influence of sample gas flow	u _b 0.052 mg/m ³	0.003 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.404 mg/m ³	0.163 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 1.69 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 3.32 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 30 mg/m³ 11.1

Requirement of 2000/76/EC and 2001/80/EC

U in % of the ELV 30 mg/m³ 20.0

Requirement of EN 15267-3

U in % of the ELV 30 mg/m³ 15.0

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 DEFOR for NO ₂
Serial number of the candidates	TÜV 2 / TÜV 4
Measuring principle	UVRAS

Test report

Test laboratory	TÜV Rheinland
Date of report	2011-10-18

Measured component

Certification range	NO ₂ 0 - 50 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	1.72 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at reference point	1.93 mg/m ³
Sum of negative CS at reference point	-0.26 mg/m ³
Maximum sum of cross sensitivities	1.93 mg/m ³
Uncertainty of cross sensitivity	1.114 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Repeatability standard deviation at set point *	u _r 0.520 mg/m ³	0.270 (mg/m ³) ²
Lack of fit	u _{lof} -0.231 mg/m ³	0.053 (mg/m ³) ²
Zero drift from field test	u _{d,z} -0.693 mg/m ³	0.480 (mg/m ³) ²
Span drift from field test	u _{d,s} 0.866 mg/m ³	0.750 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.458 mg/m ³	0.210 (mg/m ³) ²
Influence of supply voltage	u _v 0.110 mg/m ³	0.012 (mg/m ³) ²
Cross sensitivity (interference)	u _i 1.114 mg/m ³	1.242 (mg/m ³) ²
Influence of sample gas flow	u _b 0.030 mg/m ³	0.001 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.404 mg/m ³	0.163 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 1.78 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 3.50 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 50 mg/m³ **7.0**

Requirement of 2000/76/EC and 2001/80/EC

U in % of the ELV 50 mg/m³ **20.0**

Requirement of EN 15267-3

U in % of the ELV 50 mg/m³ **15.0**

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 UNOR for SO ₂
Serial number of the candidates	TÜV 2 / TÜV 4
Measuring principle	NDIR

Test report

Test laboratory	TÜV Rheinland
Date of report	2011-10-18

Measured component

Certification range	SO ₂ 0 - 75 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	2.75 mg/m ³
Sum of negative CS at zero point	-1.75 mg/m ³
Sum of positive CS at reference point	2.30 mg/m ³
Sum of negative CS at reference point	-1.82 mg/m ³
Maximum sum of cross sensitivities	2.75 mg/m ³
Uncertainty of cross sensitivity	1.585 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 1.228 mg/m ³	1.508 (mg/m ³) ²
Lack of fit	u _{lof} 0.410 mg/m ³	0.168 (mg/m ³) ²
Zero drift from field test	u _{d,z} -1.212 mg/m ³	1.469 (mg/m ³) ²
Span drift from field test	u _{d,s} 1.299 mg/m ³	1.687 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.929 mg/m ³	0.863 (mg/m ³) ²
Influence of supply voltage	u _v 0.227 mg/m ³	0.052 (mg/m ³) ²
Cross sensitivity (interference)	u _i 1.585 mg/m ³	2.512 (mg/m ³) ²
Influence of sample gas flow	u _b 0.057 mg/m ³	0.003 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.606 mg/m ³	0.368 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 2.94 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 5.76 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 50 mg/m³ 11.5

Requirement of 2000/76/EC and 2001/80/EC

U in % of the ELV 50 mg/m³ 20.0

Requirement of EN 15267-3

U in % of the ELV 50 mg/m³ 15.0

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 MULTOR for SO ₂
Serial number of the candidates	TÜV 1 / TÜV 3
Measuring principle	NDIR

Test report

Test laboratory	TÜV Rheinland
Date of report	2011-10-18

Measured component

Certification range	SO ₂ 0 - 250 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	9.63 mg/m ³
Sum of negative CS at zero point	-2.65 mg/m ³
Sum of positive CS at reference point	5.93 mg/m ³
Sum of negative CS at reference point	-1.20 mg/m ³
Maximum sum of cross sensitivities	9.63 mg/m ³
Uncertainty of cross sensitivity	5.557 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 1.546 mg/m ³	2.390 (mg/m ³) ²
Lack of fit	u _{lof} -2.714 mg/m ³	7.366 (mg/m ³) ²
Zero drift from field test	u _{d,z} 2.115 mg/m ³	4.473 (mg/m ³) ²
Span drift from field test	u _{d,s} -3.002 mg/m ³	9.012 (mg/m ³) ²
Influence of ambient temperature at span	u _t 2.901 mg/m ³	8.416 (mg/m ³) ²
Influence of supply voltage	u _v 0.839 mg/m ³	0.704 (mg/m ³) ²
Cross sensitivity (interference)	u _i 5.557 mg/m ³	30.880 (mg/m ³) ²
Influence of sample gas flow	u _b -0.410 mg/m ³	0.168 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 2.021 mg/m ³	4.083 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 8.22 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 16.10 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 150 mg/m³ 10.7

Requirement of 2000/76/EC and 2001/80/EC

U in % of the ELV 150 mg/m³ 20.0

Requirement of EN 15267-3

U in % of the ELV 150 mg/m³ 15.0

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 DEFOR for SO ₂
Serial number of the candidates	TÜV 2 / TÜV 4
Measuring principle	UVRAS

Test report

Test laboratory	TÜV Rheinland
Date of report	2011-10-18

Measured component

Certification range	SO ₂ 0 - 75 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.00 mg/m ³
Sum of negative CS at zero point	-0.81 mg/m ³
Sum of positive CS at reference point	0.35 mg/m ³
Sum of negative CS at reference point	-2.91 mg/m ³
Maximum sum of cross sensitivities	-2.91 mg/m ³
Uncertainty of cross sensitivity	-1.680 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 1.206 mg/m ³	1.454 (mg/m ³) ²
Lack of fit	u _{lof} -0.404 mg/m ³	0.163 (mg/m ³) ²
Zero drift from field test	u _{d,z} -0.606 mg/m ³	0.367 (mg/m ³) ²
Span drift from field test	u _{d,s} 1.299 mg/m ³	1.687 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.964 mg/m ³	0.929 (mg/m ³) ²
Influence of supply voltage	u _v 0.067 mg/m ³	0.004 (mg/m ³) ²
Cross sensitivity (interference)	u _i -1.680 mg/m ³	2.823 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.606 mg/m ³	0.368 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 2.79 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 5.47 \text{ mg/m}^3$$

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC

Requirement of EN 15267-3

U in % of the ELV 50 mg/m³ 10.9

U in % of the ELV 50 mg/m³ 20.0

U in % of the ELV 50 mg/m³ 15.0

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 UNOR for CH ₄
Serial number of the candidates	TÜV 2 / TÜV 4
Measuring principle	NDIR

Test report

Test laboratory	936/21217568/A
Date of report	TÜV Rheinland
	2011-10-18

Measured component

Certification range	CH ₄	0 - 50 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.48 mg/m ³
Sum of negative CS at zero point	-1.77 mg/m ³
Sum of positive CS at reference point	0.00 mg/m ³
Sum of negative CS at reference point	-0.63 mg/m ³
Maximum sum of cross sensitivities	-1.77 mg/m ³
Uncertainty of cross sensitivity	-1.022 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Repeatability standard deviation at set point *	u _r 0.630 mg/m ³	0.397 (mg/m ³) ²
Lack of fit	u _{inf} 0.231 mg/m ³	0.053 (mg/m ³) ²
Zero drift from field test	u _{d,z} 0.520 mg/m ³	0.270 (mg/m ³) ²
Span drift from field test	u _{d,s} 0.635 mg/m ³	0.403 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.416 mg/m ³	0.173 (mg/m ³) ²
Influence of supply voltage	u _v 0.306 mg/m ³	0.094 (mg/m ³) ²
Cross sensitivity (interference)	u _i -1.022 mg/m ³	1.044 (mg/m ³) ²
Influence of sample gas flow	u _d -0.035 mg/m ³	0.001 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.404 mg/m ³	0.163 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 1.61 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 3.16 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 20 mg/m³ 15.8

Requirement of 2000/76/EC and 2001/80/EC

U in % of the ELV 20 mg/m³ 30.0 **

Requirement of EN 15267-3

U in % of the ELV 20 mg/m³ 22.5

** For this component no requirements in the EC-directives 2001/80/EG und 2000/76/EG are given.

A value of 30 % was used for this.

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

Measuring system

Manufacturer	Sick Maihak
Name of measuring system	MAC GMS800 MULTOR for CH ₄
Serial number of the candidates	TÜV 2 / TÜV 4
Measuring principle	NDIR

Test report

Test laboratory	936/21217568/A TÜV Rheinland
Date of report	2011-10-18

Measured component

Certification range	CH ₄ 0 - 286 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.00 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at reference point	1.06 mg/m ³
Sum of negative CS at reference point	-1.49 mg/m ³
Maximum sum of cross sensitivities	-1.49 mg/m ³
Uncertainty of cross sensitivity	-0.859 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Repeatability standard deviation at set point *	u _r 0.620 mg/m ³	0.384 (mg/m ³) ²
Lack of fit	u _{lof} -1.501 mg/m ³	2.253 (mg/m ³) ²
Zero drift from field test	u _{d,z} 1.156 mg/m ³	1.336 (mg/m ³) ²
Span drift from field test	u _{d,s} -2.972 mg/m ³	8.833 (mg/m ³) ²
Influence of ambient temperature at span	u _t 2.843 mg/m ³	8.083 (mg/m ³) ²
Influence of supply voltage	u _v 0.532 mg/m ³	0.283 (mg/m ³) ²
Cross sensitivity (interference)	u _i -0.859 mg/m ³	0.737 (mg/m ³) ²
Influence of sample gas flow	u _n 0.370 mg/m ³	0.137 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 2.312 mg/m ³	5.344 (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)	$u_c = \sqrt{\sum (u_{max,j})^2}$	5.23 mg/m ³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	10.26 mg/m ³

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC

Requirement of EN 15267-3

U in % of the ELV 100 mg/m³	10.3
U in % of the ELV 100 mg/m³	30.0**
U in % of the ELV 100 mg/m ³	22.5

** For this component no requirements in the EC-directives 2001/80/EG und 2000/76/EG are given.
A value of 30 % was used for this.

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 UNOR for N ₂ O
Serial number of the candidates	TÜV 2 / TÜV 4
Measuring principle	NDIR

Test report

Test laboratory	936/21217568/A
Date of report	TÜV Rheinland
	2011-10-18

Measured component

Certification range	N ₂ O	0 - 50 mg/m ³
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Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.93 mg/m ³
Sum of negative CS at zero point	-1.41 mg/m ³
Sum of positive CS at reference point	0.00 mg/m ³
Sum of negative CS at reference point	-0.65 mg/m ³
Maximum sum of cross sensitivities	-1.41 mg/m ³
Uncertainty of cross sensitivity	-0.814 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u _D 0.410 mg/m ³	0.168 (mg/m ³) ²
Lack of fit	u _{inf} 0.231 mg/m ³	0.053 (mg/m ³) ²
Zero drift from field test	u _{d,z} -0.318 mg/m ³	0.101 (mg/m ³) ²
Span drift from field test	u _{d,s} 0.866 mg/m ³	0.750 (mg/m ³) ²
Influence of ambient temperature at span	u _t 0.436 mg/m ³	0.190 (mg/m ³) ²
Influence of supply voltage	u _v 0.172 mg/m ³	0.030 (mg/m ³) ²
Cross sensitivity (interference)	u _i -0.814 mg/m ³	0.663 (mg/m ³) ²
Influence of sample gas flow	u _b 0.052 mg/m ³	0.003 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.404 mg/m ³	0.163 (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)	$u_c = \sqrt{\sum (u_{max,i})^2}$	1.46 mg/m ³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	2.85 mg/m ³

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC

Requirement of EN 15267-3

U in % of the range 50 mg/m³	5.7
U in % of the range 50 mg/m³	20.0 **
U in % of the range 50 mg/m³	15.0

** For this component no requirements in the EC-directives 2001/80/EG und 2000/76/EG are given.

A value of 20 % was used for this.

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 UNOR for CO ₂
Serial number of the candidates	TÜV 1 / TÜV 3
Measuring principle	NDIR

Test report

Test laboratory	936/21217568/A
Date of report	TÜV Rheinland
	2011-10-18

Measured component

Certification range	CO ₂	0 - 25 Vol.-%
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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	-0.47	Vol.-%
Sum of positive CS at reference point	0.00	Vol.-%
Sum of negative CS at reference point	0.00	Vol.-%
Maximum sum of cross sensitivities	-0.47	Vol.-%
Uncertainty of cross sensitivity	-0.271	Vol.-%

Calculation of the combined standard uncertainty

Tested parameter

	u		u ²
Standard deviation from paired measurements under field conditions *	u _D 0.156	Vol.-%	0.024 (Vol.-%) ²
Lack of fit	u _{inf} -0.144	Vol.-%	0.021 (Vol.-%) ²
Zero drift from field test	u _{d,z} -0.188	Vol.-%	0.035 (Vol.-%) ²
Span drift from field test	u _{d,s} 0.346	Vol.-%	0.120 (Vol.-%) ²
Influence of ambient temperature at span	u _t 0.300	Vol.-%	0.090 (Vol.-%) ²
Influence of supply voltage	u _v 0.049	Vol.-%	0.002 (Vol.-%) ²
Cross sensitivity (interference)	u _i -0.271	Vol.-%	0.074 (Vol.-%) ²
Influence of sample gas flow	u _b 0.017	Vol.-%	0.000 (Vol.-%) ²
Uncertainty of reference material at 70% of certification range	u _{rm} 0.202	Vol.-%	0.041 (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)	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.64	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	1.25	Vol.-%

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC

Requirement of EN 15267-3

U in % of the ELV 25 Vol.-%	5.0
U in % of the ELV 25 Vol.-%	10.0 **
U in % of the ELV 25 Vol.-%	7.5

** For this component no requirements in the EC-directives 2001/80/EG und 2000/76/EG are given.

A value of 10 % was used for this.

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 OXOR-P for O ₂
Serial number of the candidates	TÜV 1 / TÜV 3
Measuring principle	paramagnetic

Test report

Test laboratory	936/21217568/A TÜV Rheinland
Date of report	2011-10-18

Measured component

Certification range	O ₂ 0 - 25 Vol.-%
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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 positive CS at reference point	0.00 Vol.-%
Sum of negative CS at reference point	0.00 Vol.-%
Maximum sum of cross sensitivities	0.00 Vol.-%
Uncertainty of cross sensitivity	0.000 Vol.-%

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u_D 0.084 Vol.-%	0.007 (Vol.-%) ²
Lack of fit	u_{lof} -0.040 Vol.-%	0.002 (Vol.-%) ²
Zero drift from field test	$u_{d,z}$ 0.120 Vol.-%	0.014 (Vol.-%) ²
Span drift from field test	$u_{d,s}$ 0.120 Vol.-%	0.014 (Vol.-%) ²
Influence of ambient temperature at span	u_t 0.110 Vol.-%	0.012 (Vol.-%) ²
Influence of supply voltage	u_v 0.003 Vol.-%	0.000 (Vol.-%) ²
Cross sensitivity (interference)	u_i 0.000 Vol.-%	0.000 (Vol.-%) ²
Influence of sample gas flow	u_b -0.023 Vol.-%	0.001 (Vol.-%) ²
Uncertainty of reference material at 70% of certification range	u_{rm} 0.202 Vol.-%	0.041 (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) $u_c = \sqrt{\sum (u_{max,i})^2}$ 0.30 Vol.-%

Total expanded uncertainty $U = u_c * k = u_c * 1.96$ 0.59 Vol.-%

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC

Requirement of EN 15267-3

U in % of the range 25 Vol.-%	2.4
U in % of the range 25 Vol.-%	10.0 **
U in % of the range 25 Vol.-%	7.5

** For this component no requirements in the EC-directives 2001/80/EG und 2000/76/EG are given.

A value of 10 % was used for this.

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

Measuring system

Manufacturer	Sick Maihak GmbH
Name of measuring system	MAC GMS800 OXOR-E for O ₂
Serial number of the candidates	TÜV 2 / TÜV 4
Measuring principle	electrochemical cell

Test report

Test laboratory	936/21217568/A
Date of report	TÜV Rheinland
	2011-10-18

Measured component

Certification range	O ₂	0 - 25 Vol.-%
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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 positive CS at reference point	0.33 Vol.-%
Sum of negative CS at reference point	0.00 Vol.-%
Maximum sum of cross sensitivities	0.33 Vol.-%
Uncertainty of cross sensitivity	0.191 Vol.-%

Calculation of the combined standard uncertainty

Tested parameter

	u	u ²
Standard deviation from paired measurements under field conditions *	u_D 0.108 Vol.-%	0.012 (Vol.-%) ²
Lack of fit	u_{lof} 0.058 Vol.-%	0.003 (Vol.-%) ²
Zero drift from field test	$u_{d,z}$ 0.120 Vol.-%	0.014 (Vol.-%) ²
Span drift from field test	$u_{d,s}$ 0.120 Vol.-%	0.014 (Vol.-%) ²
Influence of ambient temperature at span	u_t 0.127 Vol.-%	0.016 (Vol.-%) ²
Influence of supply voltage	u_v 0.030 Vol.-%	0.001 (Vol.-%) ²
Cross sensitivity (interference)	u_i 0.191 Vol.-%	0.036 (Vol.-%) ²
Influence of sample gas flow	u_b 0.029 Vol.-%	0.001 (Vol.-%) ²
Uncertainty of reference material at 70% of certification range	u_{rm} 0.202 Vol.-%	0.041 (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) $u_c = \sqrt{\sum (u_{max,i})^2}$ 0.37 Vol.-%

Total expanded uncertainty $U = u_c * k = u_c * 1.96$ 0.73 Vol.-%

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC	U in % of the range 25 Vol.-%	2.9
Requirement of EN 15267-3	U in % of the range 25 Vol.-%	10.0 **
	U in % of the range 25 Vol.-%	7.5

** For this component no requirements in the EC-directives 2001/80/EG und 2000/76/EG are given.

A value of 10 % was used for this.