

# CERTIFICATE

## of Product Conformity (QAL1)

Certificate No. : 0000025927\_02

**Certified AMS:** AR500 with ER120 for NO<sub>2</sub>, SO<sub>2</sub> and O<sub>3</sub>

**Manufacturer:** Opsis AB  
Skytteskogsvägen 16  
244 02 Furulund  
Sweden

**Test Institute:** TÜV Rheinland Energie und Umwelt GmbH

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

**EN 14211: 2005, EN 14212: 2005, EN 14625: 2005,  
EN 15267-1: 2009 and EN 15267-2: 2009**

Certification is awarded in respect of the conditions stated in this certificate  
(see also the following pages).



Suitability Tested  
Complying with  
2008/50/EC  
EN 15267  
Regular  
Surveillance

www.tuv.com  
ID 0000025927

Publication in the German Federal Gazette  
(BAnz.) of 2 March 2012


This certificate will expire on:  
11 February 2020

German Federal Environment Agency  
Dessau, 2 February 2015

TÜV Rheinland Energie und Umwelt GmbH  
Cologne, 30 January 2015



i. A. Dr. Marcel Langner



ppa. Dr. Peter Wilbring

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Am Grauen Stein  
51105 Cologne

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

**Certificate:**  
0000025927\_02 / 2 February 2015

**Test report:** 936/21211350/B of 7 October 2011  
**Initial certification:** 12 February 2010  
**Certificate:** renewal (previous certificate 0000025927\_01 of 16 March 2012  
valid until 11 February 2015)  
**Date of expiry:** 11 February 2020  
**Publication:** BAnz. 2 March 2012, no. 36, p. 920, chapter IV, no. 2.1

#### **Approved application**

The certified AMS is suitable for the continuous monitoring of concentrations of nitrogen dioxide, sulphur dioxide, and ozone in ambient air (stationary operation).

The suitability of the AMS for this application was assessed on the basis of a laboratory test and a three-month field test.

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

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

#### **Basis of the certification**

This certification is based on:

- test report 936/21211350/B dated 7 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 IV, No. 2.1, UBA announcement of 23 February 2012)
- publication in the German Federal Gazette (BAnz AT 5 March 2013 B10, chapter V, notice 11, UBA announcement of 12 February 2013)

**AMS designation:**

AR500 with ER120 for NO<sub>2</sub>, SO<sub>2</sub> and O<sub>3</sub>

**Manufacturer:**

Opsis AB, Furulund, Sweden

**Field of application:**

For the continuous monitoring of concentrations of nitrogen dioxide, sulphur dioxide and ozone in ambient air (stationary operation)

**Measuring ranges during the performance test:**

Component	Certification range	supplementary measurement ranges	Unit
NO <sub>2</sub>	0 - 400	0 - 1800	µg/m <sup>3</sup>
SO <sub>2</sub>	0 - 700	0 - 1000	µg/m <sup>3</sup>
O <sub>3</sub>	0 - 360	0 - 500	µg/m <sup>3</sup>

**Software version:**

7.21

**Restrictions:**

None

**Notes:**

1. The measuring path length during performance testing was 320 m.
2. The maintenance interval is four weeks.
3. Equivalence with the reference measurement methods according to the guideline „Demonstration of Equivalence of Ambient Air Monitoring Methods“ has been demonstrated for the components NO<sub>2</sub>, SO<sub>2</sub> and O<sub>3</sub>.
4. Functional tests by external sample gas feeding are possible.
5. The report on the performance test is available online at [www.qal1.de](http://www.qal1.de).
6. Supplementary testing (Demonstration of Equivalence for the component SO<sub>2</sub> according the guideline “Demonstration of Equivalence of Ambient Air Monitoring Methods”) as regards Federal Environment Agency notices of 25 January 2010 (BAnz. p. 552, chapter III no. 1.1).

**Test report:**

TÜV Rheinland Energie und Umwelt GmbH, Cologne  
Report no.: 936/21211350/B dated 7 October 2011

**11 Notification as regards Federal Environment Agency notices of 23 February 2012 (Federal Gazette (BAnz.) p. 920, chapter IV, no. 2.1)**

The AR500 measuring system with ER120 for NO<sub>2</sub>, SO<sub>2</sub> and O<sub>3</sub> manufactured by Opsis AB can also be operated with the transmitter/receiver units ER 110 and ER150.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 10 October 2012

### **Certified product**

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

The measurement system AR500 operates on the basis of the Differential Optical Absorption Spectroscopy (DOAS). The DOAS measuring principle uses the characteristic radiation absorption by gaseous components for quantification of the respective concentrations.

The DOAS monitor AR500 with ER120 consists of a combined transmitter-receiver unit, a reflector unit and an analyser. The absorbed light is transferred from the transmitter-receiver unit to the analyser via fibre optic cable.

### **Combined transmitter-receiver Unit ER 120**

The combined transmitter-receiver unit ER120 comprises the optical components, the xenon light-source and the power supply PS150 for igniting the xenon light-source.

The used high-pressure xenon lamp is a point light source. The light is generated by ignition of ultra pure xenon gas at a pressure of approx. 30 bar. The lamp is powered by a stabilised D.C. voltage source and requires a short high-voltage ignition pulse.

The radiation of the lamp includes the ultraviolet, the visible, and the infrared range. The wavelengths are continuously distributed over the entire spectrum, with the exception of some peaks in the near infrared range.

### **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 is presented on page 1 of this certificate.

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 the validity is also accessible on the internet: [qal1.de](http://qal1.de).

**Certificate:**  
0000025927\_02 / 2 February 2015

Certification of the AR500 with ER120 for NO<sub>2</sub>, SO<sub>2</sub> and O<sub>3</sub> 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. 0000025927: 10 March 2010

Validity of the certificate: 11 February 2015

Test report: 936/21211350/A of 26 October 2009,  
TÜV Rheinland Energie und Umwelt GmbH, Cologne

Publication: BAnz. 12 February 2010, no. 24, p. 552, chapter III, no. 1.1  
UBA announcement of 25 January 2010

**Supplementary testing according to EN 15267:**

Certificate No. 0000025927\_01: 16 March 2012

Validity of the certificate: 11 February 2015

Test report: 936/21211350/B of 7 October 2011,  
TÜV Rheinland Energie und Umwelt GmbH, Cologne

Publication: BAnz. 2 March 2012, no. 36, p. 920, chapter IV, no. 2.1  
UBA announcement of 23 February 2012

**Notifications**

Statement of TÜV Rheinland Energie und Umwelt GmbH of 10 October 2012  
Publication: BAnz AT 5 March 2013 B10, chapter V, notification 11 (additional transmitter/receiver)  
UBA announcement of 12 February 2013

**Renewal of the certificate**

Certificate No. 0000025927\_02 2 February 2015

Expiry date of the certificate: 11 February 2020

**Table 1:** Total expanded uncertainty with the results of the laboratory test according to EN 14211 (component NO<sub>2</sub>) for system 1329

Device:		AR500		Serial No:		1329		nmol/mol	
Component:		NO <sub>2</sub>		1h-limit value:		104,6			
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty	u <sub>r,z</sub>	u <sub>r,h</sub>	u <sub>gp</sub>	u <sub>gt</sub>
1	Repeatability at zero	≤ 1,0 nmol/mol	0,000	0,00	0,0000				
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	2,000	0,04	0,0015				
3	"lack of fit"	≤ 4,0% of measured value	0,800	0,48	0,2334				
4	Sensitivity coefficient of sample gas pressure	≤ 8,0 nmol/mol/kPa	0,000	0,00	0,0000				
5	Sensitivity coefficient of sample gas temperature	≤ 3,0 nmol/mol/K	0,026	0,04	0,0016				
6	Sensitivity coefficient of surrounding temperature	≤ 3,0 nmol/mol/K	-0,050	-0,06	0,0036				
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	-0,021	-0,07	0,0046				
8a	H2O with concentration 21 mmol/mol	≤ 5,0 nmol/mol	0,000	0,00	0,0000				
8b	CO2 with concentration 500 µmol/mol	≤ 5,0 nmol/mol	0,001						
8c	O3 with concentration 200 nmol/mol	≤ 2,0 nmol/mol	0,002	0,48	0,2304				
8d	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,002						
9	Averaging effect	≤ 7,0% of measured value	-0,600	-0,36	0,1313				
18	Difference sample/calibration port	≤ 1,0%	0,000	0,00	0,0000				
21	Converter efficiency	≥ 98%	100,000	0,00	0,0000				
22	Increase of NO2 concentration due to residence time	≤ 4,0 nmol/mol	0,000	0,00	0,0000				
23	Uncertainty calibration gas	≤ 3,0%	2,000	1,05	1,0941				
		combined standard uncertainty	expanded uncertainty	u <sub>c</sub>	1,3046				
		expanded uncertainty actual	expanded uncertainty required	U <sub>c</sub>	2,6092				
				U <sub>c,rel</sub>	2,49				
				U <sub>req,rel</sub>	15				

**Table 2:** Total expanded uncertainty with the results of the laboratory test and field test according to EN 14211 (component NO<sub>2</sub>) for system 1329

Device: AR500		Serial No: 1329		1h-limit value: 104,6		nmol/mol
Component: NO <sub>2</sub>		Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty
1	Repeatability at zero	≤ 1,0 nmol/mol	0,000	u <sub>r,z</sub>	0,00	0,0000
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	2,000	u <sub>r,th</sub>	not respected because, u <sub>r,th</sub> = 0,075 < u <sub>r,f</sub>	-
3	"lack of fit"	≤ 4,0% of measured value	0,800	u <sub>l,th</sub>	0,48	0,2334
4	Sensitivity coefficient of sample gas pressure	≤ 8,0 nmol/mol/kPa	0,000	u <sub>gp</sub>	0,00	0,0000
5	Sensitivity coefficient of sample gas temperature	≤ 3,0 nmol/mol/K	0,026	u <sub>gt</sub>	0,04	0,0016
6	Sensitivity coefficient of surrounding temperature	≤ 3,0 nmol/mol/K	-0,050	u <sub>st</sub>	-0,06	0,0036
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	-0,021	u <sub>v</sub>	-0,07	0,0046
8a	H2O with concentration 21 nmol/mol	≤ 5,0 nmol/mol	0,000	u <sub>H2O</sub>	0,00	0,0000
8b	CO2 with concentration 500 µmol/mol	≤ 5,0 nmol/mol	0,001	u <sub>CO2</sub>		
8c	O3 with concentration 200 nmol/mol	≤ 2,0 nmol/mol	0,002	or	0,48	0,2304
8d	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,002	u <sub>NH3,neg</sub>		
9	Averaging effect	≤ 7,0% of measured value	-0,600	u <sub>av</sub>	-0,36	0,1313
10	Reproducibility under field conditions	≤ 5,0% of the average of 3 Mon.	4,720	u <sub>r,f</sub>	4,94	24,3752
11	Long term drift at zero level	≤ 5,0 nmol/mol	-1,420	u <sub>d,l,z</sub>	-0,82	0,6721
12	Long term drift at span level	≤ 5,0% of max. of certification range	0,430	u <sub>d,l,th</sub>	0,26	0,0674
18	Difference sample/calibration port	≤ 1,0%	0,000	u <sub>Dsc</sub>	0,00	0,0000
21	Converter efficiency	≥ 98%	100,000	u <sub>CE</sub>	0,00	0,0000
22	Increase of NO2 concentration due to residence time	≤ 4,0 nmol/mol	0,000	u <sub>ctr</sub>	0,00	0,0000
23	Uncertainty calibration gas	≤ 3,0%	2,000	u <sub>cg</sub>	1,05	1,0941
combined standard uncertainty				u <sub>c</sub>		7,1546
expanded uncertainty				U <sub>c</sub>		14,3093
expanded uncertainty actual				U <sub>c,rel</sub>		13,68
expanded uncertainty required				U <sub>req,rel</sub>		15

**Table 3:** Total expanded uncertainty with the results of the laboratory test according to EN 14211 (component NO<sub>2</sub>) for system 1330

Device: AR500		Serial No: 1330	nmol/mol		
Component: NO <sub>2</sub>		1h-limit value: 104,6			
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty
1	Repeatability at zero	≤ 1,0 nmol/mol	0,100	0,02	0,0003
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	0,900	0,02	0,0004
3	"lack of fit"	≤ 4,0% of measured value	0,000	0,36	0,1313
4	Sensitivity coefficient of sample gas pressure	≤ 8,0 nmol/mol/kPa	0,000	0,00	0,0000
5	Sensitivity coefficient of sample gas temperature	≤ 3,0 nmol/mol/K	0,000	-0,05	0,0025
6	Sensitivity coefficient of surrounding temperature	≤ 3,0 nmol/mol/K	0,000	0,00	0,0000
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	0,000	0,24	0,0553
8a	H2O with concentration 21 mmol/mol	≤ 5,0 nmol/mol	0,000	0,00	0,0000
8b	CO2 with concentration 500 µmol/mol	≤ 5,0 nmol/mol	0,000		
8c	O3 with concentration 200 nmol/mol	≤ 2,0 nmol/mol	0,000		
8d	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,000	0,42	0,1764
9	Averaging effect	≤ 7,0% of measured value	0,000	-0,18	0,0328
18	Difference sample/calibration port	≤ 1,0%	0,000	0,00	0,0000
21	Converter efficiency	≥ 98%	100,000	0,00	0,0000
22	Increase of NO2 concentration due to residence time	≤ 4,0 nmol/mol	0,000	0,00	0,0000
23	Uncertainty calibration gas	≤ 3,0%	2,000	1,05	1,0941
combined standard uncertainty			U <sub>c</sub>	U <sub>c</sub>	1,2222
expanded uncertainty			U <sub>c</sub>	U <sub>c</sub>	2,4445
expanded uncertainty actual			U <sub>c,rel</sub>	U <sub>c,rel</sub>	2,34
expanded uncertainty required			U <sub>req,rel</sub>	U <sub>req,rel</sub>	15



**Table 4:** Total expanded uncertainty with the results of the laboratory test and field test according to EN 14211 (component NO<sub>2</sub>) for system 1330

Device: AR500		Serial No: 1330		1h-limit value: 104,6		nmol/mol	
Component: NO <sub>2</sub>		1h-limit value: 104,6		1h-limit value: 104,6		nmol/mol	
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
1	Repeatability at zero	≤ 1,0 nmol/mol	0,100	u <sub>r,z</sub>	0,0003		
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	0,900	u <sub>r,th</sub>	-		
3	"lack of fit"	≤ 4,0% of measured value	0,600	u <sub>l,th</sub>	0,1313		
4	Sensitivity coefficient of sample gas pressure	≤ 8,0 nmol/mol/kPa	0,000	u <sub>gp</sub>	0,0000		
5	Sensitivity coefficient of sample gas temperature	≤ 3,0 nmol/mol/K	-0,032	u <sub>gt</sub>	0,0025		
6	Sensitivity coefficient of surrounding temperature	≤ 3,0 nmol/mol/K	0,000	u <sub>st</sub>	0,0000		
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	0,073	u <sub>v</sub>	0,0553		
8a	H2O with concentration 21 mmol/mol	≤ 5,0 nmol/mol	0,000	u <sub>H2O</sub>	0,0000		
8b	CO2 with concentration 500 µmol/mol	≤ 5,0 nmol/mol	0,001	u <sub>fin,pos</sub>			
8c	O3 with concentration 200 nmol/mol	≤ 2,0 nmol/mol	0,002	or	0,1764		
8d	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,000	u <sub>fin,neg</sub>			
9	Averaging effect	≤ 7,0% of measured value	-0,300	u <sub>av</sub>	0,0328		
10	Reproducibility under field conditions	≤ 5,0% of the average of 3 Mon.	4,720	u <sub>rf</sub>	24,3752		
11	Long term drift at zero level	≤ 5,0 nmol/mol	1,620	u <sub>d,z</sub>	0,8748		
12	Long term drift at span level	≤ 5,0% of max. of certification range	0,500	u <sub>d,th</sub>	0,0912		
18	Difference sample/calibration port	≤ 1,0%	0,000	u <sub>Dsc</sub>	0,0000		
21	Converter efficiency	≥ 0,98	100,000	u <sub>CE</sub>	0,0000		
22	Increase of NO2 concentration due to residence time	≤ 4,0 nmol/mol	0,000	u <sub>ctr</sub>	0,0000		
23	Uncertainty calibration gas	≤ 3,0%	2,000	u <sub>cg</sub>	1,0941		
				combined standard uncertainty		nmol/mol	
				expanded uncertainty		7,1561	
				expanded uncertainty actual		nmol/mol	
				U <sub>c,rel</sub>		14,3121	
				expanded uncertainty required		%	
				U <sub>req,rel</sub>		13,68	
						15	

**Table 5:** Total expanded uncertainty with the results of the laboratory test according to EN 14212 (component SO<sub>2</sub>) for system 1329

Device: AR500		Serial-No.: Gerät 1 (1329)		1h-limit value: 132		nmol/mol
Component: SO <sub>2</sub>						
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty	
1	Repeatability at zero	≤ 1,0 nmol/mol	0,100	u <sub>1,z</sub> 0,02	0,0003	
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	0,100	u <sub>1,v</sub> 0,22	0,0003	
3	"lack of fit"	≤ 4,0% of measured value	1,600	u <sub>1,v</sub> 1,22	1,4868	
4	Sensitivity coefficient of sample gas pressure	≤ 3,0 nmol/mol/kPa	0,000	u <sub>1,p</sub> 0,00	0,0000	
5	Sensitivity coefficient of sample gas temperature	≤ 1,0 nmol/mol/K	0,071	u <sub>1,t</sub> 0,54	0,2908	
6	Sensitivity coefficient of surrounding temperature	≤ 1,0 nmol/mol/K	-0,030	u <sub>1,t</sub> -0,23	0,0523	
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	-0,010	u <sub>1,v</sub> -0,10	0,0103	
8a	H2O with concentration 21 mmol/mol	≤ 10 nmol/mol	0,000	u <sub>H2O</sub> 0,00	0,0000	
8b	H2S with concentration 200 nmol/mol	≤ 5,0 nmol/mol	-0,409	u <sub>int, pos</sub>		
8c	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,406			
8d	NO with concentration 500 nmol/mol	≤ 5,0 nmol/mol	-0,604	0,40	0,1600	
8e	NO2 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	-0,404			
8f	m-Xylol with concentration 1 µmol/mol	≤ 10 nmol/mol	1,421	u <sub>int, neg</sub>		
9	Averaging effect	≤ 7,0% of measured value	-0,100	u <sub>av</sub> -0,08	0,0058	
18	Difference sample/calibration port	≤ 1,0%	0,000	u <sub>bsc</sub> 0,00	0,0000	
23	Uncertainty calibration gas	≤ 3,0%	2,000	ucg 1,32	1,7424	
		combined standard uncertainty		u <sub>c</sub>	1,9363	nmol/mol
		expanded uncertainty		U <sub>c</sub>	3,8726	nmol/mol
		expanded uncertainty actual		U <sub>c,rel</sub>	2,93	%
		expanded uncertainty required		U <sub>req,rel</sub>	15	%

**Table 6:** Total expanded uncertainty with the results of the laboratory test and field test according to EN 14212 (component SO<sub>2</sub>) for system 1329

Device: AR500		Serial-No.: Gerät 1 (1329)		132		nmol/mol
Component: SO <sub>2</sub>		1h-limit value:				
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty	
1	Repeatability at zero	≤ 1,0 nmol/mol	0,100	u <sub>r,z</sub> 0,02	0,0003	
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	0,100	u <sub>r,v</sub> not respected because, u <sub>r,v</sub> = 0,01 < u <sub>r,f</sub>	-	
3	"lack of fit"	≤ 4,0% of measured value	1,600	u <sub>lv</sub> 1,22	1,4868	
4	Sensitivity coefficient of sample gas pressure	≤ 3,0 nmol/mol/kPa	0,000	u <sub>gp</sub> 0,00	0,0000	
5	Sensitivity coefficient of sample gas temperature	≤ 1,0 nmol/mol/K	0,071	u <sub>gt</sub> 0,54	0,2908	
6	Sensitivity coefficient of surrounding temperature	≤ 1,0 nmol/mol/K	-0,030	u <sub>st</sub> -0,23	0,0523	
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	-0,010	u <sub>v</sub> -0,10	0,0103	
8a	H2O with concentration 21 nmol/mol	≤ 10 nmol/mol	0,000	u <sub>H2O</sub> 0,00	0,0000	
8b	H2S with concentration 200 nmol/mol	≤ 5,0 nmol/mol	-0,409	u <sub>H2S, pos</sub>		
8c	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,406			
8d	NO with concentration 500 nmol/mol	≤ 5,0 nmol/mol	-0,604	or	0,1600	
8e	NO2 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	-0,404			
8f	m-Xylol with concentration 1 µmol/mol	≤ 10 nmol/mol	1,421	u <sub>m, neg</sub>		
9	Averaging effect	≤ 7,0% of measured value	-0,100	u <sub>av</sub> -0,08	0,0058	
10	Reproducibility under field conditions	≤ 5,0% of the average of 3 Mon.	4,830	u <sub>r,f</sub> 6,38	40,6483	
11	Long term drift at zero level	≤ 5,0 nmol/mol	-0,920	u <sub>dl,z</sub> -0,53	0,2821	
12	Long term drift at span level	≤ 5,0% of max. of certification range	1,490	u <sub>dl,v</sub> 1,14	1,2894	
18	Differenz Proben-/Kalibrierungsgang	≤ 1,0%	0,000	u <sub>bsc</sub> 0,00	0,0000	
23	Unsicherheit Prüfgas	≤ 3,0%	2,000	ucg 1,32	1,7424	
				combined standard uncertainty	u <sub>c</sub>	6,7800 nmol/mol
				expanded uncertainty	U <sub>c</sub>	13,5600 nmol/mol
				expanded uncertainty actual	U <sub>c,rel</sub>	10,27 %
				expanded uncertainty required	U <sub>req,rel</sub>	15 %

**Table 7:** Total expanded uncertainty with the results of the laboratory test according to EN 14212 (component SO<sub>2</sub>) for system 1330

Device: AR500		Serial-No.: Gerät 2 (1330)		1h-limit value: 132		nmol/mol	
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
1	Repeatability at zero	≤ 1,0 nmol/mol	0,000	u <sub>z</sub> 0,00	0,0000		
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	0,100	u <sub>rlv</sub> 0,02	0,0003		
3	"lack of fit"	≤ 4,0% of measured value	1,400	u <sub>lv</sub> 1,07	1,1384		
4	Sensitivity coefficient of sample gas pressure	≤ 3,0 nmol/mol/kPa	0,000	u <sub>gp</sub> 0,00	0,0000		
5	Sensitivity coefficient of sample gas temperature	≤ 1,0 nmol/mol/K	0,011	u <sub>gt</sub> 0,08	0,0070		
6	Sensitivity coefficient of surrounding temperature	≤ 1,0 nmol/mol/K	-0,060	u <sub>st</sub> -0,46	0,2091		
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	0,010	u <sub>v</sub> 0,10	0,0103		
8a	H2O with concentration 21 nmol/mol	≤ 10 nmol/mol	0,000	u <sub>H2O</sub> 0,00	0,0000		
8b	H2S with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,503	u <sub>H2S,pos</sub>	1,5129		
8c	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,203	or			
8d	NO with concentration 500 nmol/mol	≤ 5,0 nmol/mol	0,202				
8e	NO2 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,401				
8f	m-Xylol with concentration 1 µmol/mol	≤ 10 nmol/mol	0,809	u <sub>H2,neg</sub>			
9	Averaging effect	≤ 7,0% of measured value	0,100	u <sub>av</sub> 0,08	0,0058		
18	Difference sampler/calibration port	≤ 1,0%	0,000	u <sub>disc</sub> 0,00	0,0000		
23	Uncertainty calibration gas	≤ 3,0%	2,000	0	1,7424		
combined standard uncertainty						u <sub>c</sub>	2,1509
expanded uncertainty						U <sub>c</sub>	4,3017
expanded uncertainty actual						U <sub>crel</sub>	3,26
expanded uncertainty required						U <sub>req,rel</sub>	15

**Table 8:** Total expanded uncertainty with the results of the laboratory test and field test according to EN 14212 (component SO<sub>2</sub>) for system 1330

Device: AR500		Serial-No.: Gerät 2 (1330)		1h-limit value: 132		nmol/mol
Component: SO <sub>2</sub>		Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty
1	Repeatability at zero	≤ 1,0 nmol/mol	≤	0,000	u <sub>r,z</sub> 0,00	0,0000
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	≤	0,100	u <sub>r,lv</sub> not respected because, u <sub>r,lv</sub> = 0,01 < u <sub>r,f</sub>	-
3	"lack of fit"	≤ 4,0% of measured value	≤	1,400	u <sub>lv</sub> 1,07	1,1384
4	Sensitivity coefficient of sample gas pressure	≤ 3,0 nmol/mol/kPa	≤	0,000	u <sub>gp</sub> 0,00	0,0000
5	Sensitivity coefficient of sample gas temperature	≤ 1,0 nmol/mol/K	≤	0,011	u <sub>gt</sub> 0,08	0,0070
6	Sensitivity coefficient of surrounding temperature	≤ 1,0 nmol/mol/K	≤	-0,060	u <sub>st</sub> -0,46	0,2091
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	≤	0,010	u <sub>v</sub> 0,10	0,0103
8a	H2O with concentration 21 nmol/mol	≤ 10 nmol/mol	≤	0,000	u <sub>h2o</sub> 0,00	0,0000
8b	H2S with concentration 200 nmol/mol	≤ 5,0 nmol/mol	≤	0,503	u <sub>h2so3</sub>	
8c	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	≤	0,203		
8d	NO with concentration 500 nmol/mol	≤ 5,0 nmol/mol	≤	0,202	1,23	1,5129
8e	NO2 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	≤	0,401	or	
8f	m-Xylol with concentration 1 µmol/mol	≤ 10 nmol/mol	≤	0,809	u <sub>int,neg</sub>	
9	Averaging effect	≤ 7,0% of measured value	≤	0,100	u <sub>av</sub> 0,08	0,0058
10	Reproducibility under field conditions	≤ 5,0% of the average of 3 Mon.	≤	4,830	u <sub>r,f</sub> 6,38	40,6483
11	Long term drift at zero level	≤ 5,0 nmol/mol	≤	1,160	u <sub>dl,z</sub> 0,67	0,4485
12	Long term drift at span level	≤ 5,0% of max. of certification range	≤	-2,070	u <sub>dl,lv</sub> -1,58	2,4887
18	Differenz Proben-/Kalibriergaseingang	≤ 1,0%	≤	0,000	u <sub>pac</sub> 0,00	0,0000
23	Unsicherheit Prüfgas	≤ 3,0%	≤	2,000	0	1,7424
				combined standard uncertainty	u <sub>c</sub>	6,9434
				expanded uncertainty	U <sub>c</sub>	13,8869
				expanded uncertainty actual	U <sub>c,rel</sub>	10,52
				expanded uncertainty required	U <sub>req,rel</sub>	15

**Table 9:** Total expanded uncertainty with the results of the laboratory test according to EN 14625 (component O<sub>3</sub>) for system 1329

Device: AR500		Serial No. Gerät 1 (1329)		120		nmol/mol	
Measured component: O <sub>3</sub>		hourly alert threshold					
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
1	Repeatability standard deviation at zero	1,0 nmol/mol	0,200	u <sub>r,z</sub>	0,0013		
2	Repeatability standard deviation at ct	3,0 nmol/mol	0,600	u <sub>r,v</sub>	0,0120		
3	"lack of fit" at the hourly alert threshold value	4,0% of measured value	0,400	u <sub>lv</sub>	0,0768		
4	Variations in sample gas pressure	2,0 nmol/mol/kPa	0,000	u <sub>gp</sub>	0,0000		
5	Variations in sample gas temperature	1,0 nmol/mol/K	0,014	u <sub>gt</sub>	0,0212		
6	Variations in surrounding temperature	1,0 nmol/mol/K	0,150	u <sub>st</sub>	0,2700		
7	Variations in electrical voltage	0,30 nmol/mol/V	-0,010	u <sub>v</sub>	0,0147		
8a	Interference H2O with 21 mmol/mol	10 nmol/mol	0,000	u <sub>H2O</sub>	0,0000		
8b	Interference Toluol with 0,5 µmol/mol	5,0 nmol/mol	2,147	u <sub>tol,pos</sub>	2,1573		
8c	Interference Xylol with 0,5 µmol/mol	5,0 nmol/mol	0,397	or u <sub>tol,neg</sub>			
9	Averaging effect	7,0% of measured value	0,200	u <sub>av</sub>	0,0192		
18	Difference sample/calibration port	1,0%	0,000	u <sub>bac</sub>	0,0000		
23	Uncertainty test gas	3,0%	2,000	ucg	1,4400		
				Combined standard uncertainty		u <sub>c</sub>	2,0031
				Expanded uncertainty		U <sub>c</sub>	4,0062
				Expanded uncertainty actual		U <sub>c,rel</sub>	3,34
				Expanded uncertainty required		U <sub>req,rel</sub>	15

**Table 10** Total expanded uncertainty with the results of the laboratory test and field test according to EN 14625 (component O<sub>3</sub>) for system 1329

Device: AR500		Serial No. Gerát 1 (1329)		120		nmol/mol	
Measured component: O <sub>3</sub>		hourly alert threshold		Square of uncertainty			
No.	Performance characteristic	Criterion	Result	Uncertainty	U <sub>r,z</sub>	U <sub>r,iv</sub>	U <sub>r,f</sub>
1	Repeatability standard deviation at zero	1,0 nmol/mol	0,200	U <sub>r,z</sub>	0,04	0,0013	
2	Repeatability standard deviation at ct	3,0 nmol/mol	0,600	U <sub>r,iv</sub>	not respected because, $u_{r,iv} = 0,1 < u_{r,f}$	-	
3	"lack of fit" at the hourly alert threshold value	4,0% of measured value	0,400	U <sub>iv</sub>	0,28	0,0768	
4	Variations in sample gas pressure	2,0 nmol/mol/kPa	0,000	U <sub>gp</sub>	0,00	0,0000	
5	Variations in sample gas temperature	1,0 nmol/mol/K	0,014	U <sub>gt</sub>	0,15	0,0212	
6	Variations in surrounding temperature	1,0 nmol/mol/K	0,150	U <sub>st</sub>	0,52	0,2700	
7	Variations in electrical voltage	0,30 nmol/mol/V	-0,010	U <sub>v</sub>	-0,12	0,0147	
8a	Interference H2O with 21 nmol/mol	10 nmol/mol	0,000	U <sub>H2O</sub>	0,00	0,0000	
8b	Interference Toluol with 0,5 µmol/mol	5,0 nmol/mol	2,147	U <sub>int,pos</sub>	1,47	2,1573	
8c	Interference Xylol with 0,5 µmol/mol	5,0 nmol/mol	0,397	or U <sub>int,neg</sub>			
9	Averaging effect	7,0% of measured value	0,200	U <sub>av</sub>	0,14	0,0192	
10	Reproducibility standard deviation in field	5,0% of average of 3 month	2,410	U <sub>r,f</sub>	2,89	8,3637	
11	Long term drift at zero	5,0 nmol/mol	1,460	U <sub>d,z</sub>	0,84	0,7105	
12	Long term drift at span level	5,0% of range	-2,450	U <sub>d,iv</sub>	-1,70	2,8812	
18	Difference sample/calibration port	1,0%	0,000	uDsc	0,00	0,0000	
23	Uncertainty test gas	3,0%	2,000	ucg	1,20	1,4400	
Combined standard uncertainty				U <sub>c</sub>	U <sub>c</sub>	3,9945	nmol/mol
Expanded uncertainty				U <sub>e</sub>	U <sub>e</sub>	7,9890	nmol/mol
Expanded uncertainty actual				U <sub>c,rel</sub>	U <sub>c,rel</sub>	<b>6,66</b>	%
Expanded uncertainty required				U <sub>req,rel</sub>	U <sub>req,rel</sub>	15	%

**Table 11:** Total expanded uncertainty with the results of the laboratory test according to EN 14625 (component O<sub>3</sub>) for system 1330

Device: AR500		Serial No. Gerät 2 (1330)		120		nmol/mol	
Measured component: O <sub>3</sub>		hourly alert threshold					
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
1	Repeatability standard deviation at zero	1,0 nmol/mol	0,200	u <sub>r,z</sub> 0,04	0,0013		
2	Repeatability standard deviation at ct	3,0 nmol/mol	0,400	u <sub>r,lv</sub> 0,07	0,0063		
3	"lack of fit" at the hourly alert threshold value	4,0% of measured value	-0,300	u <sub>lv</sub> -0,21	0,0432		
4	Variations in sample gas pressure	2,0 nmol/mol/kPa	0,000	u <sub>gp</sub> 0,00	0,0000		
5	Variations in sample gas temperature	1,0 nmol/mol/K	0,007	u <sub>gt</sub> 0,07	0,0063		
6	Variations in surrounding temperature	1,0 nmol/mol/K	-0,120	u <sub>st</sub> -0,42	0,1728		
7	Variations in electrical voltage	0,30 nmol/mol/V	0,010	u <sub>v</sub> 0,12	0,0147		
8a	Interference H2O with 21 mmol/mol	10 nmol/mol	0,000	u <sub>H2O</sub> 0,00	0,0000		
8b	Interference Toluol with 0,5 µmol/mol	5,0 nmol/mol	0,396	u <sub>int,pos</sub>	2,9416		
8c	Interference Xylol with 0,5 µmol/mol	5,0 nmol/mol	2,574	or u <sub>int,neg</sub>			
9	Averaging effect	7,0% of measured value	-0,900	u <sub>av</sub> -0,62	0,3888		
18	Difference sample/calibration port	1,0%	0,000	u <sub>disc</sub> 0,00	0,0000		
23	Uncertainty test gas	3,0%	2,000	0	1,4400		
				Combined standard uncertainty	u <sub>c</sub>	nmol/mol	
				Expanded uncertainty	U <sub>c</sub>	nmol/mol	
				Expanded uncertainty actual	U <sub>c,rel</sub>	%	
				Expanded uncertainty required	U <sub>req,rel</sub>	%	
						3,73	
						15	



**Table 12** Total expanded uncertainty with the results of the laboratory test and field test according to EN 14625 (component O<sub>3</sub>) for system 1330

Device: AR500		Serial No. Gerät 2 (1330)		hourly alert threshold		120		nmol/mol	
Measured component: O <sub>3</sub>		Performance characteristic		Criterion	Result	u <sub>r,z</sub>	Uncertainty	Square of uncertainty	
1	Repeatability standard deviation at zero	1,0 nmol/mol	0,200				0,04	0,0013	
2	Repeatability standard deviation at ct	3,0 nmol/mol	0,400			u <sub>r,lv</sub>	not respected, because u <sub>r,lv</sub> = 0,07 < u <sub>r,f</sub>	-	
3	"lack of fit" at the hourly alert threshold value	4,0% of measured value	-0,300			u <sub>lv</sub>	-0,21	0,0432	
4	Variations in sample gas pressure	2,0 nmol/mol/kPa	0,000			u <sub>gp</sub>	0,00	0,0000	
5	Variations in sample gas temperature	1,0 nmol/mol/K	0,007			u <sub>gt</sub>	0,07	0,0053	
6	Variations in surrounding temperature	1,0 nmol/mol/K	-0,120			u <sub>st</sub>	-0,42	0,1728	
7	Variations in electrical voltage	0,30 nmol/mol/V	0,010			u <sub>v</sub>	0,12	0,0147	
8a	Interference H2O with 21 mmol/mol	10 nmol/mol	0,000			u <sub>H2O</sub>	0,00	0,0000	
8b	Interference Toluol with 0,5 µmol/mol	5,0 nmol/mol	0,396			u <sub>tol</sub>	1,72	2,9416	
8c	Interference Xylol with 0,5 µmol/mol	5,0 nmol/mol	2,574			u <sub>tol,neg</sub> or u <sub>tol,neg</sub>			
9	Averaging effect	7,0% of measured value	-0,900			u <sub>av</sub>	-0,62	0,3888	
10	Reproducibility standard deviation in field	5,0% of average of 3 month	2,410			u <sub>rf</sub>	2,89	8,3637	
11	Long term drift at zero	5,0 nmol/mol	-1,840			u <sub>d,z</sub>	-1,06	1,1285	
12	Long term drift at span level	5,0% of range	2,900			u <sub>d,lv</sub>	2,01	4,0368	
18	Difference sample/calibration port	1,0%	0,000			u <sub>Dsc</sub>	0,00	0,0000	
23	Uncertainty test gas	3,0%	2,000			0	1,20	1,4400	
				Combined standard uncertainty			u <sub>c</sub>	4,3054	nmol/mol
				Expanded standard uncertainty			U <sub>c</sub>	8,6109	nmol/mol
				Expanded uncertainty actual			U <sub>c,rel</sub>	7,18	%
				Expanded uncertainty required			U <sub>req,rel</sub>	15	%