

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000040205

Certified AMS: Serinus 50 for SO₂

Manufacturer: Ecotech Pty Ltd.
1492 Ferntree Gully Road
Knoxfield, VIC, 3180
Australia

Test Institute: TÜV Rheinland Energie und Umwelt GmbH

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

**VDI 4202-1: 2010, VDI 4203-3: 2010, EN 14212: 2012,
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 0000040205

Publication in the German Federal Gazette
(BAnz.) of 01 April 2014

German Federal Environment Agency
Dessau, 29 April 2014



i. A. Dr. Marcel Langner

This certificate will expire on:
31 March 2019

TÜV Rheinland Energie und Umwelt GmbH
Cologne, 28 April 2014



ppa. Dr. Peter Wilbring

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TÜV Rheinland Energie und Umwelt GmbH
Am Grauen Stein
51105 Cologne

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

Certificate:
0000040205 / 29 April 2014

Test report: 936/21221977/B of 08 October 2013
Initial certification: 01 April 2014
Date of expiry: 31 March 2019
Publication: BAnz AT 01 April 2014 B12, chapter IV, No. 3.1

Approved application

The tested AMS is suitable for the continuous measurement of concentrations of sulphur dioxide 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 a temperature range of 0 °C to +30 °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 936/21221977/B of 08 October 2013 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 01 April 2014 B12, chapter IV, No. 3.1
Announcement by UBA from 27 February 2014

AMS designation:

Serinus 50 for SO₂

Manufacturer:

Ecotech Pty Ltd., Knoxfield, Australia

Field of application:

Continuous measurement of concentrations of sulphur dioxide in ambient air (stationary operation)

Measuring range during the performance test:

Component	Certification range	Unit
sulfur dioxide	0 - 1000	µg/m ³

Software version:

Firmware: 2.09.0005

Restrictions:

None

Notes:

1. The measuring system has to be operated in a lockable measuring cabinet or container.
2. The test report on the performance test is available online at www.qal1.de.

Test institute:

TÜV Rheinland Energie und Umwelt GmbH, Cologne
Report No.: 936/21221977/B of 8 October 2013

Certified product

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

The Serinus 50 measuring system continuously monitors concentrations of sulphur dioxide by means of the ultraviolet fluorescence method. The instrument is designed for the continuous measuring of sulphur dioxide in ambient air.

The Serinus 50 measures SO₂ with the following components and techniques:

- Hydrocarbon kicker
- UV lamp
- fluorescence cell
- optical band-pass filter
- photomultiplier tube (PMT)

The SO₂ concentration is automatically corrected for gas temperature and pressure changes and referenced to 0 °C, 20 °C or 25 °C at 1 atmosphere. This allows the Serinus 50 to sample in the most useful range of SO₂ ambient measurement (25-500 ppb SO₂ in air.)

The measurement of sulphur dioxide is based on classical fluorescence spectroscopy principles. Sulphur dioxide (SO₂) exhibits a strong ultraviolet (UV) absorption spectrum between 200 and 240nm. When SO₂ absorbs UV from this wavelength, photon emission occurs (300-420nm). The amount of fluorescence emitted is directly proportional to the SO₂ concentration.

The Serinus 50 follows these principles and measurement techniques:

- Sample air is passed through a hydrocarbon kicker which removes hydrocarbons.
- UV energy from zinc discharge lamp is passed through a UV band pass filter are used to produce radiation at 214nm.
- The radiation is focused into the fluorescence cell where it is absorbed by the SO₂ molecules.
- The SO₂ molecules then emit photons (fluorescent light) uniformly in all directions.
- Wavelengths between 310-350nm, which are specific to SO₂, pass through a band pass filter where they reach the photomultiplier and record a signal.
- A reference detector monitors the emission from the zinc lamp and is used to correct for fluctuations in lamp intensity.

Exhaust air is scrubbed with a charcoal scrubber to eliminate hydrocarbons and SO₂. This air is then clean enough for use in the hydrocarbon kicker to remove hydrocarbons from the incoming sample air.

The Serinus 50 sulphur dioxide analyser consists of five main assemblies:

- The pneumatics to transfer sample and exhaust gas.
- The sensors for the measurement of SO₂ (optical cell) and other relevant parameters.
- The control system which encompasses all circuit boards which are used to control all sensors and pneumatic components.
- The power supply which supplies power for all the instrument processors.
- The communication module to access data.

Particulate Filter

The particulate filter is a Teflon 5 micron (μm) filter with a diameter of 47 mm. This filter eliminates all particles larger than 5 μm that could interfere with sample measurement.

Hydrocarbon Kicker

The hydrocarbon kicker removes interfering hydrocarbons from the sample air. This is achieved by using counter current exchange, where an air with a lower concentration of hydrocarbons moves in an opposite direction to air with a higher concentration. The high concentrations of hydrocarbons diffuse through a selective permeation membrane to the low concentration exhaust air and are removed. Increasing the flow of the low concentration air also increases the rate of diffusion.

Sample gas pump

Manufacturer: Thomas, type: 617CD22-194 C

During performance testing the above-mentioned sample gas pump was used in the laboratory as well as in the field test. As far as the models Serinus 10 (ozone), Serinus 30 (CO) and Serinus 50 (SO₂) are concerned, one pump can be operated with up to two analysers. However, for the Serinus 40 (NO_x) one sample gas pump per analyser is required.

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.

Certification of Serinus 50 sulphur dioxide Analyzer 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. 0000040205: 29 April 2014

Validity of the certificate until: 31 March 2019

Test report: 936/21221977/B of 08 October 2013
TÜV Rheinland Energie und Umwelt GmbH, Köln

Publication: BAnz AT 01 April 2014 B12, chapter IV, No. 3.1
Announcement by UBA from 27 February 2014

Expanded uncertainty based on the results of the laboratory testing of Device 1

Measuring device: Ecotech Serinus 50		Serial-No.: 13-0096 (Device 1)	1h-limit value: 132		nmol/mol
Measured component: SO ₂					
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.050	U _{r,z} 0.02	0.0002
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.240	U _{r,h} 0.07	0.0050
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	2.620	U _{lf} 2.00	3.9868
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0.340	U _{sp} 2.70	7.2852
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.050	U _{gt} 0.40	0.1609
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.305	U _{st} 2.47	6.1146
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.027	U _v 0.25	0.0608
8a	Interferent H ₂ O with 21 nmol/mol	≤ 10 nmol/mol (Zero)	0.010	U _{H2O} 2.25	5.0688
8b	Interferent H ₂ S with 200 nmol/mol	≤ 10 nmol/mol (Span)	3.040		
8c	Interferent NH ₃ with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	1.600	U _{int,pos}	
8d	Interferent NO with 500 nmol/mol	≤ 5.0 nmol/mol (Span)	2.390		
8e	Interferent NO ₂ with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	-0.290		
8f	Interferent m-Xylene with 1 µmol/mol	≤ 5.0 nmol/mol (Span)	1.080		
9	Averaging effect	≤ 5.0 nmol/mol (Zero)	3.420	5.83	34.0086
18	Difference sample/calibration port	≤ 5.0 nmol/mol (Span)	2.850		
21	Uncertainty of test gas	≤ 5.0 nmol/mol (Span)	0.100		
		≤ 10 nmol/mol (Zero)	0.740		
		≤ 10 nmol/mol (Span)	1.250		
		≤ 7.0% of measured value	3.050	U _{int,neg}	
		≤ 1.0%	-2.930	U _{av} -2.23	4.9861
		≤ 3.0%	0.220	U _{asc} 0.29	0.0843
			2.000	U _{cg} 1.32	1.7424
		Combined standard uncertainty		U _c	7.9689
		Expanded uncertainty		U	15.9379
		Relative expanded uncertainty		W	12.07
		Maximum allowed expanded uncertainty		W _{req}	15

Expanded uncertainty based on the results of the laboratory testing of Device 2

Measuring device: Ecotech Serinus 50		Serial-No.: 13-0097 (Device 2)		132		nmol/mol	
Measured component: SO ₂		1h-limit value:					
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty		
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.000	U _{r,z}	0.00	0.0000	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.230	U _{r,h}	0.07	0.0048	
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	1.590	U _{lf,h}	1.21	1.4683	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0.270	U _{sp}	2.14	4.5625	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.030	U _{gt}	0.24	0.0587	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.152	U _{st}	1.24	1.5295	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.028	U _v	0.26	0.0701	
8a	Interferent H ₂ O with 21 mmol/mol	≤ 10 nmol/mol (Zero)	-0.510	U _{h2o}	2.11	4.4660	
		≤ 10 nmol/mol (Span)	3.060				
8b	Interferent H ₂ S with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	1.410	U _{h2s,pos}			
		≤ 5.0 nmol/mol (Span)	2.210				
8c	Interferent NH ₃ with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	-0.310				
		≤ 5.0 nmol/mol (Span)	0.230				
8d	Interferent NO with 500 nmol/mol	≤ 5.0 nmol/mol (Zero)	3.670		5.48	30.0628	
		≤ 5.0 nmol/mol (Span)	4.160	or			
8e	Interferent NO ₂ with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	1.000				
		≤ 5.0 nmol/mol (Span)	0.310				
8f	Interferent m-Xylene with 1 µmol/mol	≤ 10 nmol/mol (Zero)	0.860	U _{h2n,neg}			
		≤ 10 nmol/mol (Span)	2.660				
9	Averaging effect	≤ 7.0% of measured value	-2.620	U _{av}	-2.00	3.9868	
18	Difference sample/calibration port	≤ 1.0%	0.280	U _{sc}	0.37	0.1366	
21	Uncertainty of test gas	≤ 3.0%	2.000	U _{cg}	1.32	1.7424	
						nmol/mol	
						U _c	
						6.9346	
						U	
						13.8692	
						W	
						10.51	
						W _{req}	
						15	
						%	
						%	

Expanded uncertainty based on the results of the laboratory and field testing of Device 1

Measuring device: Ecotech Serinus 50		Serial-No.: 13-0096 (Device 1)		132		nmol/mol	
Measured component: SO ₂		1h-limit value:		1h-limit value:		1h-limit value:	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty		
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.050	U _{r,z}	0.002		
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.240	U _{r,1h}	not considered, as U _{r,1h} = 0.07 < U _{r,f}		
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	2.620	U _{1h}	2.00	3.9868	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0.340	U _{sp}	2.70	7.2852	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.050	U _{gt}	0.40	0.1609	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.305	U _{st}	2.47	6.1146	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.027	U _v	0.25	0.0608	
8a	Interferent H ₂ O with 21 nmol/mol	≤ 10 nmol/mol (Zero)	0.010				
8b	Interferent H ₂ S with 200 nmol/mol	≤ 10 nmol/mol (Span)	3.040	U _{H2O}	2.25	5.0688	
8c	Interferent NH ₃ with 200 nmol/mol	≤ 5.0 nmol/mol (Span)	1.600	U _{NH3,pos}			
8d	Interferent NO with 500 nmol/mol	≤ 5.0 nmol/mol (Zero)	2.390				
8e	Interferent NO ₂ with 200 nmol/mol	≤ 5.0 nmol/mol (Span)	-0.290				
8f	Interferent m-Xylene with 1 µmol/mol	≤ 5.0 nmol/mol (Zero)	1.080				
9	Averaging effect	≤ 5.0 nmol/mol (Span)	3.420	or	5.83	34.0086	
10	Reproducibility standard deviation under field conditions	≤ 5.0 nmol/mol (Span)	2.850				
11	Long term drift at zero level	≤ 5.0 nmol/mol (Zero)	0.100				
12	Long term drift at span level	≤ 5.0 nmol/mol (Span)	0.740				
18	Difference sample/calibration port	≤ 10 nmol/mol (Span)	1.250	U _{sp,neg}			
21	Uncertainty of test gas	≤ 7.0% of measured value	3.050	U _{sp}	-2.23	4.9861	
		≤ 5.0% of average over 3 months	3.740	U _{r,f}	4.94	24.3720	
		≤ 5.0% of max. of certification range	-0.940	U _{d1,z}	-0.54	0.2945	
		≤ 1.0%	3.810	U _{d1,h}	2.90	8.4310	
		≤ 3.0%	0.220	U _{acc}	0.29	0.0843	
			2.000	U _{cg}	1.32	1.7424	
Combined standard uncertainty						U _c	9.8283
Expanded uncertainty						U	19.6567
Relative expanded uncertainty						W	14.89
Maximum allowed expanded uncertainty						W _{res}	15

Expanded uncertainty based on the results of the laboratory and field testing of Device 2

Measuring device: Ecotech Serinus 50		Serial-No.: 13-0097 (Device 2)		132		nmol/mol	
Measured component: SO ₂		1h-limit value:		0.000		0.0000	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty		
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.000	U _{r,z}	0.000		
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.230	U _{r,h}	not considered, as U _{r,h} = 0.06 < U _{r,f}		
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	1.590	U _h	1.21	1.4683	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0.270	U _{pp}	2.14	4.5625	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.030	U _{gt}	0.24	0.0587	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.152	U _{st}	1.24	1.5295	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.028	U _v	0.26	0.0701	
8a	Interferent H ₂ O with 21 nmol/mol	≤ 10 nmol/mol (Zero)	-0.510				
		≤ 10 nmol/mol (Span)	3.060				
8b	Interferent H ₂ S with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	1.410	U _{g20}	2.11	4.4660	
		≤ 5.0 nmol/mol (Span)	2.210	U _{fit,pos}			
8c	Interferent NH ₃ with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	-0.310				
		≤ 5.0 nmol/mol (Span)	0.230				
8d	Interferent NO with 500 nmol/mol	≤ 5.0 nmol/mol (Zero)	3.670				
		≤ 5.0 nmol/mol (Span)	4.160	or	5.48	30.0628	
8e	Interferent NO ₂ with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	1.000				
		≤ 5.0 nmol/mol (Span)	0.310				
8f	Interferent m-Xylene with 1 µmol/mol	≤ 10 nmol/mol (Zero)	0.860	U _{int,neg}			
		≤ 10 nmol/mol (Span)	2.660				
9	Averaging effect	≤ 7.0% of measured value	-2.620	U _{av}	-2.00	3.9868	
10	Reproducibility standard deviation under field conditions	≤ 5.0% of average over 3 months	3.740	U _{r,f}	4.94	24.3720	
11	Long term drift at zero level	≤ 4.0 nmol/mol	1.470	U _{l,z}	0.85	0.7203	
12	Long term drift at span level	≤ 5.0% of max. of certification range	3.540	U _{l,h}	2.70	7.2784	
18	Difference sample/calibration port	≤ 1.0%	0.280	U _{sec}	0.37	0.1366	
21	Uncertainty of test gas	≤ 3.0%	2.000	U _{sg}	1.32	1.7424	
Combined standard uncertainty						U _c	8.9696
Expanded uncertainty						U	17.9393
Relative expanded uncertainty						W	13.59
Maximum allowed expanded uncertainty						W _{req}	15

CONFIRMATION

Notification: 0000040205_00_01_rev1
on changes according to EN 15267 regarding certificate 0000040205 dated 29 April 2014

Measuring system: Serinus 50 for SO₂

Manufacturer: Ecotech PTY Ltd.
1492 Ferntree Gully Road
Knoxfield, VIC, 3180
Australia

German Federal Environmental Agency (UBA)

Announcement about the uniform practice in
monitoring emissions and ambient air.
25 February 2015
Federal Gazette BAnz AT 02 April 2015 B5

IV. Notifications to the uniform practice for the continuous monitoring of emission and ambient air:

7 Notification as regards Federal Environment Agency (UBA) notice of 27 February 2014 (Federal Gazette (BAnz) AT 1 April 2014 B12, chapter IV number 3.1)

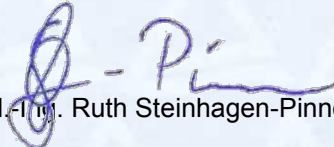
Hereafter, the Serinus 50 measuring system for SO₂, manufactured by Ecotech Pty Ltd., will be equipped with a new microprocessor board (C010014). This results in modifications of the power plug as well as software changes.

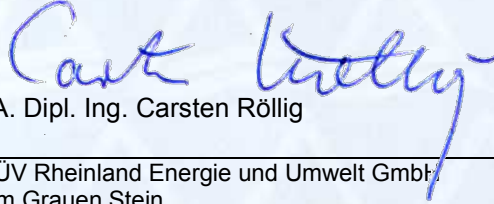
The current two software versions are designated as follows:

- 2.20.0009 for systems using the old microprocessor board (C010001)
- 3.10.001 for systems using the new microprocessor board (C010014).

Statement of TÜV Rheinland Energie und Umwelt GmbH of 12 September 2014

TÜV Rheinland Energie und Umwelt GmbH
Cologne, 30. April 2015


i. A. Dipl.-Ing. Ruth Steinhausen-Pinnow


i. A. Dipl. Ing. Carsten Röllig

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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.

CONFIRMATION

Notification: 0000040205_00_02
on changes according to EN 15267 regarding certificate 0000040205_00 dated 29 April 2014

Measuring system: Serinus 50 for SO₂

Manufacturer: Ecotech PTY Ltd.
1492 Ferntree Gully Road
Knoxfield, VIC, 3180
Australia

German Federal Environmental Agency (UBA)

**Announcement about the uniform practice in
monitoring emissions and ambient air
dated 22 February 2017
Federal Gazette: BAnz AT 15.03.2017 B6**

**V Notifications to the uniform practice for the continuous monitoring
of emission and ambient air:**

- 8 Notification as regards Federal Environment Agency notices
of 27 February 2014 (BAnz AT 01.04.2014 B12, chapter IV number 3.1) and
of 25 February 2015 (BAnz AT 02.04.2015 B5 chapter IV 7th notification)

The current software version of the Serinus 50 for SO₂ manufactured by Ecotech Pty
Ltd. for systems with micro processor board (C010001) is: V 2.31.0004.

The following software versions are approved for this instrument version: V 2.21.0000,
V 2.22.0000, V 2.23.0000, V 2.24.0000, V 2.25.0004, V 2.26.0000, V 2.27.0000,
V 2.28.0000, V 2.29.0003 and V 2.30.0000.

The current software version of the Serinus 50 for SO₂ manufactured by Ecotech Pty
Ltd. for systems with micro processor board (C010014) is: V 3.48.011.

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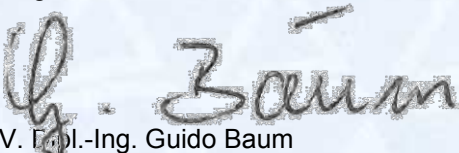
TÜV Rheinland Energy GmbH
Am Grauen Stein
51105 Cologne

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.

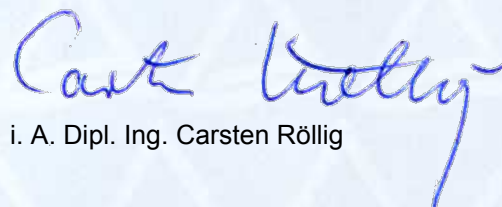
The following software versions are approved for this instrument version: V 3.13.000, V 3.14.001, V 3.15.010, V 3.16.001, V 3.18.003, V 3.20.000, V 3.22.000, V 3.23.015, V 3.24.000, V 3.26.000, V 3.27.000, V 3.28.000, V 3.29.013, V 3.30.005, V 3.31.002, V 3.32.003, V 3.33.004, V 3.34.000, V 3.35.004, V 3.36.000, V 3.37.004, V 3.38.006, V 3.39.000, V 3.40.001, V 3.41.004, V 3.42.000, V 3.43.000, V 3.44.004, V 3.45.011, V 3.46.002, V 3.47.006.

Statement issued by TÜV Rheinland Energy GmbH dated 13 October 2016

TÜV Rheinland Energy GmbH
Cologne, 28 March 2017



i. V. Dipl.-Ing. Guido Baum



i. A. Dipl. Ing. Carsten Röllig

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