

# CERTIFICATE

## of Product Conformity (QAL1)

Certificate No.: 0000062066

**AMS designation:** 43iQ for sulphur dioxide

**Manufacturer:** Thermo Fisher Scientific  
27, Forge Parkway  
Franklin, MA 02038  
USA

**Test Laboratory:** TÜV Rheinland Energy GmbH

This is to certify that the AMS has been tested  
and found to comply with:  
VDI 4202-1 (2018), EN 14212 (2012),  
EN 15267-1 (2009) and DIN EN 15267-2 (2009).

Certification is awarded in respect of the conditions stated in this certificate  
(this certificate contains 10 pages).



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

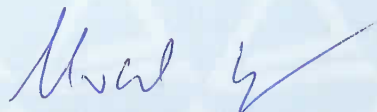
www.tuv.com  
ID 0000062066

Publication in the German Federal Gazette  
(BAnz) of 26 March 2019

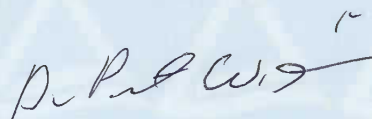
German Federal Environment Agency  
Dessau, 12 June 2019

This certificate will expire on:  
25 March 2024

TÜV Rheinland Energy GmbH  
Cologne, 11 June 2019



Dr Marcel Langner  
Head of Section II 4.1



ppa. Dr Peter Wilbring

[www.umwelt-tuv.eu](http://www.umwelt-tuv.eu)  
[tre@umwelt-tuv.eu](mailto:tre@umwelt-tuv.eu)  
Phone: + 49 221 806-5200

TÜV Rheinland Energy GmbH  
Am Grauen Stein  
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.

<b>Test Report:</b>	936/21242986/B dated 2 October 2018
<b>Initial certification:</b>	26 March 2019
<b>Expiry date:</b>	25 March 2024
<b>Publication:</b>	BAnz AT 26.03.2019 B7, chapter III number 2.1

### Approved application

The certified AMS is suitable for continuous ambient air monitoring of SO<sub>2</sub> (stationary operation).

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

The AMS is approved for an ambient temperature range of +0 °C to +30 °C.

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

Any potential user should ensure, in consultation with the manufacturer, that this AMS is suitable for the intended purpose.

### Basis of the certification

This certification is based on:

- Test report no. 936/21242986/B issued by TÜV Rheinland Energy GmbH dated 2 October 2018
- Suitability announced by the German Federal Environment Agency (UBA) as the relevant body
- The ongoing surveillance of the product and the manufacturing process

Publication in the German Federal Gazette: BAnz AT 26.03.2019 B7, chapter III number 2.1  
UBA announcement dated 27 February 2019:

**AMS designation:**

43iQ for sulphur dioxide

**Manufacturer:**

Thermo Fisher Scientific, Franklin, USA

**Field of application:**

For the continuous measurement of sulphur dioxide concentrations in ambient air in stationary use

**Measuring ranges during performance testing:**

Component	Certification range	Unit
Sulphur dioxide	0–1 000	µg/m <sup>3</sup>

**Software version:**

Version: 1.5.1.32120

**Restrictions:**

None

**Note:**

This report on the performance test is available online at [www.qal1.de](http://www.qal1.de).

**Test Report:**

TÜV Rheinland Energy GmbH, Cologne  
Report no.: 936/21242986/B dated 2 October 2018

### Certified product

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

The 43iQ is a continuous sulphur dioxide analyser. The instrument uses the UV fluorescence method as its measuring principle. It was designed for the continuous measurement of sulphur dioxide in ambient air.

The sample is drawn into the 43iQ through the sample bulkhead. The sample flows through a hydrocarbon “kicker,” which removes hydrocarbons from the sample by forcing the hydrocarbon molecules to permeate through the tube wall. The SO<sub>2</sub> molecules pass through the hydrocarbon “kicker” unaffected.

The sample then flows into the fluorescence chamber, where pulsating UV light excites the SO<sub>2</sub> molecules. As the excited SO<sub>2</sub> molecules decay to lower energy states they emit UV light that is proportional to the SO<sub>2</sub> concentration. The bandpass filter allows only the wavelengths emitted by the excited SO<sub>2</sub> molecules to reach the photomultiplier tube (PMT). The PMT detects the UV light emission from the decaying SO<sub>2</sub> molecules. The photodetector, located at the back of the fluorescence chamber, continuously monitors the pulsating UV light source and is connected to a circuit that compensates for fluctuations in the UV light.

As the sample leaves the optical chamber, it passes through a flow sensor, a capillary, and the “shell” side of the hydrocarbon kicker. The sample then flows to the pump and is exhausted out the EXHAUST bulkhead of the analyser.

The 43iQ outputs the SO<sub>2</sub> concentration to the front panel display and the analogue outputs, and also makes the data available over the serial or Ethernet connection.

The system components include:

- DMC measurement bench: The optical bench contains the main components for the optical measurement that is at the heart of determining the SO<sub>2</sub> concentration. In the reaction chamber pulsating light from the flash lamp excites the SO<sub>2</sub> molecules. A condenser lens collects and focuses light from fluorescing SO<sub>2</sub> molecules onto the PMT assembly.
- HC kicker: The heated hydrocarbon kicker removes hydrocarbons from the gas stream while leaving the SO<sub>2</sub> concentration unaffected. It operates on a selective permeation principle using differential pressure to force hydrocarbon molecules to pass through the tube wall. The differential pressure is created across the tube wall as sample gas passes through a capillary tube which reduces its pressure.
- Optical bench: The optics section provides the light source for the fluorescence reaction and optimizes the reaction with a system of lenses and mirrors. It includes a flash lamp, condensing lens, bandpass mirror assembly and light baffle.
- Flash lamp assembly: The flash lamp trigger assembly pulses the UV flash lamp at a rate of 10 times per second for improved signal-to-noise ratio and long term stability.
- PMT tube: The PMT power supply produces high voltage to operate the photomultiplier tube used in the measurement system. The output voltage is under software control. The PMT converts optical energy from the reaction to an electrical signal. This signal is sent to the input board which transmits it to the processor.
- Common electronics: The common electronics contain the core computational and power routing hardware, and is replicated throughout other iQ series products. It also contains front panel display, the USB ports, the Ethernet port, and the I/O interfaces. All electronics operate from a universal VDC supply. The System Controller Board (SCB) contains the main processor, power supplies, and a sub-processor, and serves as the communication hub for the instrument.

- Peripheral Support System: The peripheral support system operates these additional devices that are needed, but do not require special feedback control or processing. The chassis fan provides air cooling of the active electronic components. Internal vacuum pump for generating air/sample through the instrument.
- Flow/Pressure DMC: The flow/pressure DMC is used to measure instrument pressures that assure proper flow regulation and for sample pressure within the measurement bench for pressure corrections and compensation. The DMC includes two pressure sensors.

### General remarks

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 manufacturing process for 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. Upon revocation of the publication the certificate loses its validity. After the expiration of the certificate and on request of TÜV Rheinland Energy GmbH this document shall be returned and the certificate mark must no longer be used.

The relevant version of this certificate and its expiration date are also accessible on the internet at [gal1.de](http://gal1.de).

### **Document history**

Certification of the 43iQ measuring system is based on the documents listed below and the regular, continuous surveillance of the manufacturer's quality management system:

### **Initial certification according to EN 15267**

Certificate no. 0000062066: 12 June 2019  
Expiry date of the certificate: 25 March 2024  
Test report no. 936/21242986/B dated 2 October 2018  
TÜV Rheinland Energy GmbH, Cologne  
Publication: BAnz AT 26.03.2019 B7, chapter III number 2.1  
UBA announcement dated 27 February 2019

Expanded uncertainty laboratory, system 1

Measuring device:		43iQ		Serial-No.:		1180540005		nmol/mol		
Measured component:		SO <sub>2</sub>		1h-limit value:		132				
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty					
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.210	u <sub>r,z</sub>	0.06	0.0040				
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.420	u <sub>r,lh</sub>	0.12	0.0155				
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	2.400	u <sub>l,lh</sub>	1.83	3.3454				
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0.380	u <sub>sp</sub>	3.00	8.9751				
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.120	u <sub>gt</sub>	0.98	0.9601				
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.339	u <sub>st</sub>	2.67	7.1429				
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.020	u <sub>v</sub>	0.19	0.0363				
8a	Interferent H <sub>2</sub> O with 19 nmol/mol	≤ 10 nmol/mol (Zero) ≤ 10 nmol/mol (Span)	0.160 -3.840	u <sub>H2O</sub>	-2.91	8.4754				
8b	Interferent H <sub>2</sub> S with 200 nmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	0.320 1.370	u <sub>int,pos</sub>						
8c	Interferent NH <sub>3</sub> with 200 nmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	0.790 -1.010							
8d	Interferent NO with 500 nmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	-0.080 -0.460	or	5.04	25.4455				
8e	Interferent NO <sub>2</sub> with 200 nmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	1.760 4.170							
8f	Interferent m-Xylene with 1 µmol/mol	≤ 10 nmol/mol (Zero) ≤ 10 nmol/mol (Span)	1.570 3.120	u <sub>int,neg</sub>						
9	Averaging effect	≤ 7.0% of measured value	1.600	u <sub>av</sub>	1.22	1.4868				
18	Difference sample/calibration port	≤ 1.0%	-0.490	u <sub>asc</sub>	-0.65	0.4184				
21	Uncertainty of test gas	≤ 3.0%	2.000	u <sub>cg</sub>	1.32	1.7424				
Combined standard uncertainty						u <sub>c</sub>	7.6189	nmol/mol		
Expanded uncertainty						U	15.2378	nmol/mol		
Relative expanded uncertainty						W	11.54	%		
Maximum allowed expanded uncertainty						W <sub>req</sub>	15	%		

Expanded uncertainty laboratory, system 2

Measuring device:		43IQ		Serial-No.:		1180540006			
Measured component:		SO <sub>2</sub>		1h-limit value:		132		nmol/mol	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty				
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.260	u <sub>r,z</sub>	0.08	0.0062			
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.550	u <sub>r,jh</sub>	0.16	0.0267			
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	2.200	u <sub>lf,jh</sub>	1.68	2.8111			
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0.320	u <sub>gp</sub>	2.52	6.3646			
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.150	u <sub>gt</sub>	1.22	1.5002			
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.274	u <sub>st</sub>	2.16	4.6663			
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.020	u <sub>v</sub>	0.19	0.0363			
8a	Interferent H <sub>2</sub> O with 19 nmol/mol	≤ 10 nmol/mol (Zero)	0.120	u <sub>H2O</sub>	-0.20	0.0381			
8b	Interferent H <sub>2</sub> S with 200 nmol/mol	≤ 10 nmol/mol (Span)	-3.640	u <sub>int,pos</sub>					
8c	Interferent NH <sub>3</sub> with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	0.590						
8d	Interferent NO with 500 nmol/mol	≤ 5.0 nmol/mol (Span)	0.020						
8e	Interferent NO <sub>2</sub> with 200 nmol/mol	≤ 5.0 nmol/mol (Span)	0.900						
8f	Interferent m-Xylene with 1 µmol/mol	≤ 5.0 nmol/mol (Zero)	-2.740						
9	Averaging effect	≤ 5.0 nmol/mol (Zero)	0.080						
18	Difference sample/calibration port	≤ 5.0 nmol/mol (Span)	-1.680						
21	Uncertainty of test gas	≤ 5.0 nmol/mol (Span)	2.200						
		≤ 10 nmol/mol (Zero)	3.170						
		≤ 10 nmol/mol (Span)	1.450						
		≤ 7.0% of measured value	4.230	u <sub>int,neg</sub>					
		≤ 1.0%	2.100	u <sub>av</sub>	1.60	2.5613			
		≤ 3.0%	-0.380	u <sub>ssc</sub>	-0.50	0.2516			
			2.000	u <sub>cg</sub>	1.32	1.7424			
		Combined standard uncertainty		u <sub>c</sub>		6.2129			
		Expanded uncertainty		U		12.4257			
		Relative expanded uncertainty		W		9.41			
		Maximum allowed expanded uncertainty		W <sub>req</sub>		15			



Combined uncertainty, laboratory and field, system 1

Measuring device:		43IQ		Serial-No.:		1180640005		132		nmol/mol																	
Measured component:		SO <sub>2</sub>		1h-limit value:		0.0040		-		-																	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	Partial uncertainty	U <sub>r,z</sub>	U <sub>r,h</sub>	U <sub>r,h</sub>	U <sub>r,z</sub>	U <sub>r,h</sub>																
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.210	U <sub>r,z</sub>	0.0040	0.06																					
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.420	U <sub>r,h</sub>	-	not considered, as U <sub>r,h</sub> = 0.12 < U <sub>r,f</sub>																					
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	2.400	U <sub>l,h</sub>	3.3454	1.83																					
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0.380	U <sub>gp</sub>	8.9751	3.00																					
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.120	U <sub>gt</sub>	0.9601	0.98																					
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.339	U <sub>st</sub>	7.1429	2.67																					
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.020	U <sub>v</sub>	0.0363	0.19																					
8a	Interferent H <sub>2</sub> O with 19 nmol/mol	≤ 10 nmol/mol (Zero)	0.160																								
		≤ 10 nmol/mol (Span)	-3.840																								
8b	Interferent H <sub>2</sub> S with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	0.320	U <sub>H2O</sub>	8.4754	-2.91																					
		≤ 5.0 nmol/mol (Span)	1.370	U <sub>int,pos</sub>																							
8c	Interferent NH <sub>3</sub> with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	0.790																								
		≤ 5.0 nmol/mol (Span)	-1.010																								
8d	Interferent NO with 500 nmol/mol	≤ 5.0 nmol/mol (Zero)	-0.080																								
		≤ 5.0 nmol/mol (Span)	-0.460																								
8e	Interferent NO <sub>2</sub> with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	1.760																								
		≤ 5.0 nmol/mol (Span)	4.170																								
8f	Interferent m-Xylene with 1 µmol/mol	≤ 10 nmol/mol (Zero)	1.570																								
		≤ 10 nmol/mol (Span)	3.120	U <sub>int,neg</sub>																							
9	Averaging effect	≤ 7.0% of measured value	1.600	U <sub>gv</sub>	1.4868	1.22																					
10	Reproducibility standard deviation under field conditions	≤ 5.0% of average over 3 months	0.460	U <sub>r,f</sub>	0.3687	0.61																					
11	Long term drift at zero level	≤ 4.0 nmol/mol	0.580	U <sub>cl,z</sub>	0.1121	0.33																					
12	Long term drift at span level	≤ 5.0% of max. of certification range	0.550	U <sub>cl,h</sub>	0.1757	0.42																					
18	Difference sample/calibration port	≤ 1.0%	-0.490	U <sub>asc</sub>	0.4184	-0.65																					
21	Uncertainty of test gas	≤ 3.0%	2.000	U <sub>cg</sub>	1.7424	1.32																					
<table border="1"> <tr> <td>Combined standard uncertainty</td> <td>u<sub>c</sub></td> <td>7.6609</td> <td>nmol/mol</td> </tr> <tr> <td>Expanded uncertainty</td> <td>U</td> <td>15.3217</td> <td>nmol/mol</td> </tr> <tr> <td>Relative expanded uncertainty</td> <td>W</td> <td>11.61</td> <td>%</td> </tr> <tr> <td>Maximum allowed uncertainty</td> <td>W<sub>req</sub></td> <td>15</td> <td>%</td> </tr> </table>												Combined standard uncertainty	u <sub>c</sub>	7.6609	nmol/mol	Expanded uncertainty	U	15.3217	nmol/mol	Relative expanded uncertainty	W	11.61	%	Maximum allowed uncertainty	W <sub>req</sub>	15	%
Combined standard uncertainty	u <sub>c</sub>	7.6609	nmol/mol																								
Expanded uncertainty	U	15.3217	nmol/mol																								
Relative expanded uncertainty	W	11.61	%																								
Maximum allowed uncertainty	W <sub>req</sub>	15	%																								

Combined uncertainty, laboratory and field, system 2

Measuring device:		43IQ		Serial-No.:		1180540006		nmol/mol	
Measured component:		SO <sub>2</sub>		1h-limit value:		132			
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty				
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.260	u <sub>r,z</sub>	0.0082				
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.550	u <sub>r,lh</sub>	not considered, as u <sub>r,lh</sub> = 0, 16 < u <sub>r,f</sub>				
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	2.200	u <sub>l,lh</sub>	1.68	2.8111			
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0.320	u <sub>gp</sub>	2.52	6.3646			
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.150	u <sub>gt</sub>	1.22	1.5002			
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0.274	u <sub>st</sub>	2.16	4.6663			
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.020	u <sub>v</sub>	0.19	0.0363			
8a	Interferent H <sub>2</sub> O with 19 nmol/mol	≤ 10 nmol/mol (Zero)	0.120						
8b	Interferent H <sub>2</sub> S with 200 nmol/mol	≤ 5.0 nmol/mol (Span)	-3.640	u <sub>H2O</sub>	-0.20	0.0381			
8c	Interferent NH <sub>3</sub> with 200 nmol/mol	≤ 5.0 nmol/mol (Span)	0.590	u <sub>NH3,pos</sub>					
8d	Interferent NO with 500 nmol/mol	≤ 5.0 nmol/mol (Span)	0.020	or	4.31	18.5949			
8e	Interferent NO <sub>2</sub> with 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	0.900						
8f	Interferent m-Xylene with 1 µmol/mol	≤ 5.0 nmol/mol (Span)	-2.740						
9	Averaging effect	≤ 5.0 nmol/mol (Zero)	0.080						
10	Reproducibility standard deviation under field conditions	≤ 5.0 nmol/mol (Span)	-1.680	u <sub>int,neg</sub>					
11	Long term drift at zero level	≤ 5.0 nmol/mol (Span)	2.200	u <sub>av</sub>	1.60	2.5613			
12	Long term drift at span level	≤ 10 nmol/mol (Zero)	3.170	u <sub>r,f</sub>	0.61	0.3687			
18	Difference sample/calibration port	≤ 5.0% of max. of certification range	1.450	u <sub>d,l,z</sub>	0.59	0.3536			
21	Uncertainty of test gas	≤ 1.0%	2.200	u <sub>d,l,lh</sub>	-0.39	0.1511			
		≤ 3.0%	3.170	u <sub>hsc</sub>	-0.50	0.2516			
			4.230	u <sub>cg</sub>	1.32	1.7424			
		Combined standard uncertainty	2.100	u <sub>c</sub>	6.2806	nmol/mol			
		Expanded uncertainty	0.460	U	12.5613	nmol/mol			
		Relative expanded uncertainty	1.030	W	9.52	%			
		Maximum allowed uncertainty	-0.510	W <sub>req</sub>	15	%			