PRODUCT CONFORMITY CERTIFICATE

This is to certify that the

N500 CAPS NO_X-NO_2-NO Gas Analyser

Manufactured by:

Teledyne API
9970 Carrol Canyon Road
San Diego
California, 92131
USA

has been assessed by CSA Group
and for the conditions stated on this certificate complies with:

MCERTS Performance Standards for Continuous Ambient Air Quality Monitoring Systems, Version 10 dated June 2016

Certification ranges:

NO	0 - 1,200 µg/m^3
NO_2	0 - 500 µg/m^3

Project No.:	80122943
Certificate No:	Sira MC220407/00
Initial Certification:	30 June 2022
This Certificate issued:	30 June 2022
Renewal Date:	29 June 2027

Andrew Young
Environmental Team Manager

MCERTS is operated on behalf of the Environment Agency by

CSA Group Testing UK Ltd
Unit 6, Hawarden Industrial Park
Hawarden, Deeside, CH5 3US
Tel: +44 (0)1244 670 900

Form 1335
Issue 10

Certificate Contents

Approved Site Application

Any potential user should ensure, in consultation with the manufacturer, that the monitoring system is suitable for the intended application. For general guidance on monitoring techniques refer to the Environment Agency Monitoring Technical Guidance Notes available at www.mcerts.net

All tests have been conducted in accordance with BS EN 14211:2012. On the basis of these tests this certificate is valid when the instrument is used for urban air quality monitoring and similar applications.

The field test site covered an urban background location whereby the measuring system was situated 5m from a six-lane motorway in the Cologne region of Germany.

Basis of Certification

This certification is based on the following test report(s) and on CSA Group's assessment and ongoing surveillance of the product and the manufacturing process:

TÜV Rheinland Energy GmbH, Report no.: 936/21251100/A, Cologne, 30 July 2021

Product Certified

The Teledyne API N500 CAPS measuring system consists of the following parts:

- An optical cell
- A pair of highly reflective mirrors at 405nm
- A light emitting diode (LED) light source
- A vacuum phototube detector

This certificate applies to all instruments fitted with software version rev. 1.6.0 onwards (serial number SN65)

Certified Performance

The instrument was evaluated for use under the following conditions:

Ambient Temperature Range: 0°C to 30°C

Results are expressed as error % of certification range, unless otherwise stated.

Test	Results expressed as % of measured value				Other results	MCERTS specification
	<0.5	<1	<2	<5		
Repeatability at zero NO NO_2					 0.13 nmol/mol 0.11 nmol/mol	≤1.0 nmol/mol
Repeatability at hourly limit value NO NO_2					 1.63 nmol/mol 0.08 nmol/mol	≤3 nmol/mol
Residual lack of fit at zero NO NO_2					 -0.60 nmol/mol -0.49 nmol/mol	≤5 nmol/mol
Lack of fit (largest residual from the linear regression line) NO NO_2		 0.85		 2.24		≤4%
Sensitivity coefficient to sample gas pressure NO NO_2					 0.23 nmol/mol/kPa 0.10 nmol/mol/kPa	≤8 nmol/mol/kPa
Sensitivity coefficient to sample gas temperature NO NO_2					 0.11 nmol/mol/K 0.01 nmol/mol/K	≤3 nmol/mol/K
Sensitivity coefficient to surrounding air temperature NO NO_2					 0.95 nmol/mol/K 0.24 nmol/mol/K	≤3 nmol/mol/K
Sensitivity coefficient to electrical supply voltage NO NO_2					 0.01 nmol/mol/V 0.02 nmol/mol/V	≤0.3 nmol/mol/V
Converter efficiency					99.6 %	>98%
Interference by H_2O (at concentration of 19 nmol/mol) NO NO_2					 1.60 nmol/mol 0.33 nmol/mol	≤5 nmol/mol

Certificate No: Sira MC220407/00
This Certificate issued: 30 June 2022

Test	Results expressed as % of measured value				Other results	MCERTS specification
	<0.5	<1	<2	<5		
Interference by NH_3 (at concentration of 200 nmol/mol) NO NO_2					 1.40 nmol/mol 1.09 nmol/mol	≤5 nmol/mol
Interference by CO_2 at concentration of 500mmol/mol NO NO_2					1.80 nmol/mol 0.76 nmol/mol	≤5 nmol/mol
Averaging effect NO NO_2				 3.1 3.2		≤7%
Short term zero drift (over 12h) NO NO_2					 -0.27 nmol/mol -0.26 nmol/mol	≤2 nmol/mol
Short term span drift (over 12h) NO NO_2					 2.36 nmol/mol 2.76 nmol/mol	≤6 nmol/mol
Response time (rise) NO NO_2					 25 s 25 s	≤180 s
Response time (fall) NO NO_2					 23 s 22 s	≤180 s
Difference between rise and fall time NO NO_2					 2 s 3 s	≤10 s
Residence time in the analyser					1.9 s	≤3 s
Reproducibility under field conditions Note 1 NO NO_2			 1.09	 3.67		≤5% averaged over three-month period
Difference between sampling and calibration port NO NO_2	 0.14 -0.33					≤1%

Certificate No: Sira MC220407/00
This Certificate issued: 30 June 2022

Test	Results expressed as % of measured value				Other results	MCERTS specification
	<0.5	<1	<2	<5		
Long term zero drift (over 3 months) Note 1 NO NO_2					 1.08 nmol/mol 0.87 nmol/mol	≤5 nmol/mol
Long term span drift (over 3 months) Note 1 NO NO_2					 1.02 nmol/mol 2.29 nmol/mol	≤5% of the max of certification range
Period of unattended operation Note 1					14 days	3 months or less if indicated by the manufacturer
Availability (data capture)					100%	>90%
Total expanded uncertainty NO NO_2					 10.15% 10.13%	≤15%

Note 1: The field trial was performed in an urban background environment for a period of at least 3 months. The N500 measuring system has a maintenance interval of 14 days. The work detailed below has to be carried out at regular intervals, depending on local conditions:

- Visual inspections/telemetric inspections
- Checking the operational status of the system
- No error messages
- Checking of the particle filter at the sample gas inlet. The replacement interval of the particle filter depends on the dust content of the ambient air.
- Performing zero and span checks using suitable test gas every two weeks in accordance with standard EN 14211.

In addition, follow the manufacturer's instructions indicated in the user manual.

Description

The Cavity Attenuated Phase Shift (CAPS) NO_X monitor operates as an optical absorption spectrometer that yields measurements down to sub ppb concentrations. The CAPS method uses light from a blue ultraviolet (UV) light emitting diode (LED) centred at 405 nm, a measurement cell with high reflectivity mirrors located at either end to provide an extensive optical path length, and a vacuum phototube detector. These components are assembled into the optical cell which resides in a temperature-controlled oven. The oven raises the ambient temperature of the sample gas to 45 degrees Celsius. This mitigates the formation of moisture on the surfaces of the mirrors while also minimizing changes in the absorption coefficient due to temperature fluctuations.
Optical absorption is well-defined and is described by Beer's Law, where the absorbance (lost light) is directly proportional to both the path-length and concentration of the absorbing gas.

$$A = \varepsilon\, l\, c$$

(A = Absorbance, ε = Molar absorptivity, l = Mean path Length, c = concentration)

The CAPS method employed in the N500 applies this fundamental optical absorption law in the frequency domain, rather than using relative changes in light intensity as the primary signal. Ultraviolet light (UV) from the modulating high intensity LED enters a near confocal optical cell (Figure 6-1) through the rear of mirror A. The intensity of the light, as observed by the detector, which is also modulating at a slightly different frequency, located behind Mirror B, builds exponentially in the cell while the LED is 'ON'. The opposite is true when the LED is 'OFF'. Because both mirrors are highly reflective at 405 nm, a prominent absorption band for NO_2, the light takes a considerable amount of time to plateau in the absence of the absorbing gas. However, when NO_2 is present, the mean path length travelled by the light is significantly reduced. This has two effects on the observed intensity as measured by the detector:

- The light plateau intensity level is lower
- The light intensity plateaus sooner

Thus, an observed phase shift from the modulating LED is detected. The phase shift is largest when measuring zero air, decreases when NO_2 is present, and is proportionate to the concentration of the NO_2.

Both the LED and the detector are modulated 'ON' and 'OFF' such that the observed signal has a much lower frequency, equal to the difference between the modulated frequencies and is referred to as a beat frequency. The system hardware and software take advantage of this to post process the signal using a micro controller. The technique is known as heterodyning.

The instrument translates the phase shift from the presence of absorbing gas into a concentration measurement. Using the CAPS technique, the amount of phase shift remains constant for a given concentration, even if the LED drifts over time.

General Notes

1. This certificate is based upon the equipment tested. The Manufacturer is responsible for ensuring that on-going production complies with the standard(s) and performance criteria defined in this certificate. 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 system shall be subject to regular surveillance according to 'Regulations Applicable to the Holders of CSA Group Testing UK Ltd Certificates'.

2. The design of the product certified is held and maintained by TÜV Rheinland for certificate No. Sira MC220407/00.

3. If a certified product is found not to comply, CSA Group should be notified immediately at the address shown on this certificate.

4. The certification marks that can be applied to the product or used in publicity material are defined in 'Regulations Applicable to the Holders of CSA Group Testing UK Ltd Certificates'.

5. This document remains the property of CSA Group and shall be returned when requested by CSA Group.