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JES smart/AQM Air Quality Monitor

Features

• Smart IoT-enabled combined visibility and gas sensor
• Scattered light visibility sensor with dual beam method
• Dust concentration measurement after gravimetric calibration possibe
• Optional up to 3 electrochemical gas sensor modules (CO, NO, NO2, SO2)
• Installation in-situ (in the tunnel's driving area) or with suction line up to 10 m
• Active extraction of sample air by integrated fan
• Integrated purge air system
• Optional sample heater to eliminate fog from measurement
• Stainless steel housing 1.4404 (AISI 316L)
• IP rating IP69
• Connection to tunnel control system by
  ◦ MODBUS RTU (RS-485)
  ◦ MODBUS/TCP (Ethernet)
  ◦ Analogue and relay outputs
  ◦ JSON Web service (Ethernet)
• Integrated web server for visualisation, configuration, data logging, remote maintenance1)
• Optional smart/HUB IoT operating and control unit with touch display
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System

• smart/AQM sensor to be mounted either
  ◦ in-situ (directly in the tunnel's driving area) or
  ◦ extractive in a niche, cross-cut, etc.
• Terminal box with 24 VDC power supply for connection of supply and signal cables
• System cable with quick connectors between sensor and terminal box for quick and easy sensor exchange
• Optional smart/HUB with touch display

Operation

Visibility and gas monitoring during normal operation is used to control the tunnel ventilation at normal operation. If and with how much power artificial ventilation by jet fans is operated depends on the measured visibility and gas concentration.
Visibility is expressed by the extinction coefficient, which describes the light attenuation caused by particles in the air. The sensor extracts air from the tunnel by an integrated fan and feeds it into the measuring cell which detects the intensity of light scattered by this sample, sets it into relation with the light passing through and calculates the extinction coefficient.
Optional electrochemical gas sensor cells induce currents proportional to the prevailing gas concentration. With these currents and the measured temperature, the gas sensor modules calculate the gas concentrations.

Advantanges

• Specifically designed for application in tunnels
• Single sensor instead of transmitter/receiver pair requiring exact alignment
• Effective fog elimination by optional heater
• Easy recalibration by calibration plug
• Internally generated purge air keeps optics clean and prevents long-term drift
• Low maintenance requirements, stable, accurate
• Smart IoT enabled solution from sensor over hub to asset management
• Condition monitoring
• Remote maintenance
• Flexible integration into tunnel control system
• Pre-calibrated gas sensor modules for easy exchange

Application

Tunnels are important infrastructure elements in road networks and facilitate the connection of regions. Environmental conditions in tunnels are influenced by fog, particles and emissions and need to be monitored to protect people on their passage through the tunnel from danger and impacts on their health. Accidents in tunnels, and particularly fires, can have dramatic consequences and can prove extremely costly in terms of human life, increased congestion, pollution and repair costs. At every time people in the tunnel need to be supplied with breathable air and sufficient visibility.
Since 1990 JES Elektrotechnik GmbH develops, installs and maintains systems to monitor air characteristics and lighting conditions in tunnels. Our systems are robust, durable and resistant against the corrosive atmosphere in a tunnel. They operate reliably and have a high accuracy in measurement.
All systems fulfil the requirements of the EC guideline 2004/54/EC (Minimum safety requirements for tunnels in the trans-European road network) and the more detailed national guidelines and provisions:
• Austria: RVS 09.02 Tunnelausrüstung
• Germany: RABT Richtlinien für die Ausstattung und den Betrieb von Straßentunneln
• Switzerland: ASTRA Richtlinien und Fachhandbuch Betriebs- und Sicherheitsausrüstungen (BSA)
Our range of products for tunnel covers systems for monitoring of
• Visibility (extractive or in-situ)
• Toxic gases like CO, NO, NO2 (extractive or in-situ)
• Air velocity, direction and temperature
• Luminance (access, threshold and interior zone)
• Illuminance

Technical Specifications

Sensor device

Sensor device smart/AQM (Basic variant)	
Type	smart/AQM
Variant	Basic (visibility only, no Ethernet connectivity)
Measuring method	Dual beam scattered light
Light source	Laser, class 2 in accordance with EN 60825-1 < 1 mW at 650 nm
Measured value	Scattered light intensity expressed as extinction coefficient, transmission, etc.
Measuring range	Configurable typically 0 .. 15 / km
Resolution	0.001 / km
Accuracy	0.01 / km
Power supply	24 VDC ± 10 %
Current consumption	max. 800 mA (without heater) @ 24 VDC max. 2 A @ 24 VDC (with heater)
Appliance class	Class III (PELV)
Material	Stainless steel 1.4404 (AISI 316L)
IP rating	IP 69
Dimensions	300 x 220 x 100 mm
Weight	approx. 5.8 kg
Analogue/relay outputs (standard)	3 x 4 – 20 mA (2-wire, active) 3 x SPST-NO (max. 60 VDC / 25 VAC, max. 0.5 A)
Temperature range	-40 .. +60 °C
Pressure range	640 .. 1060 hPa
Humidity range	0 .. 100% relative humidity (non-condensing)
Storage temperature	-40 .. +85 °C (without gas sensor modules)

Sensor device smart/AQM (Standard and Smart variant)	
Type	smart/AQM
Variants	Standard / Smart
Gas sensor ports	up to 3 (to be specified on order)
Measuring method	Visibility: Dual beam scattered light Gas: electrochemical gas sensor cells
Light source	Laser, class 2 in accordance with EN 60825-1 < 1 mW at 650 nm
Measured values	Visibility: Scattered light intensity expressed as extinction coefficient, transmission, etc. Gas: concentration
Measuring range	Visibility: Configurable, typically 0 .. 15 / km Gas: depending on installed gas sensor modules
Resolution	Visibility: 0.001 / km Gas: depending on installed gas sensor modules
Accuracy	Visibility: 0.01 / km Gas: depending on installed gas sensor modules
Power supply	24 VDC ± 10 %
Current consumption	max. 1.1 A @ 24 VDC (without heater) max. 2.3 A @ 24 VDC (with heater)
Appliance class	Class III (PELV)
Material	Stainless steel 1.4404 (AISI 316L)
IP rating	IP 69
Dimensions	300 x 220 x 100 mm
Weight	approx. 6.2 kg
Digital interfaces (standard)	MODBUS RTU (RS-485) MODBUS/TCP (Ethernet) Webserver for configuration (Ethernet)
Analogue/relay outputs (standard)	3 x 4 – 20 mA (2-wire, active) 3 x SPST-NO (max. 60 VDC / 25 VAC, max. 0.5 A)
Additional analogue/relay outputs (optional)	up to 2 analogue / relay output modules, each: 3 x 4 – 20 mA (2-wire, active) 3 x SPST-NO (max. 60 VDC / 25 VAC, max. 0.5 A)
Temperature range	-40 .. +60 °C
Pressure range	640 .. 1060 hPa (visbility only) 900 .. 1060 hPa (with gas sensor modules)
Humidity range	0 .. 100% relative humidity, non-condensing (visbility only) 15 .. 95% relative humidity, non-condensing (with gas sensor modules)
Storage temperature	-40 .. +85 °C (without gas sensor modules)

Terminal box

Terminal box - smart/AQM-TBX	
Type	smart/AQM-TBX
System cable port	1 (for smart/AQM)
Power supply	100 to 240 VAC, 50/60 Hz
Supply voltage fluctuations	± 10 %
Overvoltage category	II
Power rating	60 W
Appliance class	Class I
Material	Stainless steel 1.4404 (AISI 316L)
Mounting	incl. mounting clamp made from Stainless steel 1.4404 for wall mounting
IP rating	IP 69
Dimensions	250 x 160 x 110 mm
Weight	approx. 3.2 kg
Indoor/Outdoor use	Indoor use (tunnel)
Altitude	up to 2,000 m
Temperature range	-40 .. +60 °C
Humidity range	0 .. 100% relative humidity (non-condensing)
Pollution degree	4 (intended environment) / 2 (when cover removed)

Gas sensor modules

Gas sensor module CO-500	
Type	smart/ECS-CO-500
Measuring method	Electrochemical cell
Measured value	Gas concentration in ppm
Measuring range	Configurable within 0 .. 500 ppm CO typically 0 .. 300 ppm CO
Maximum overload	1,000 ppm CO
Lower detectable limit	< 0.5 ppm CO
Resolution	0.1 ppm CO
Accuracy	± 2 ppm or 2 % reading[2)]
Temperature compensation	yes
T90 time	< 40 s
Long term drift	< 2 % signal loss per month
Dimensions	∅ 38 x 74 mm
Weight	88 g
Expected operation life	3 years in air
Storage life	6 months in packaging
Storage temperature	5 .. 20 °C

Gas sensor module NO2-2	
Type	smart/ECS-NO2-2
Measuring method	Electrochemical cell
Measured value	Gas concentration in ppm
Measuring range	Configurable within 0 .. 2 ppm NO_2 typically 0 .. 2 ppm NO_2
Maximum overload	10 ppm NO_2
Lower detectable limit	0.05 ppm NO_2
Resolution	0.02 ppm NO_2
Accuracy	± 0.05 ppm or 5 % reading[3)]
Temperature compensation	yes
T90 time	< 60 s
Long term drift	< 2 % signal loss per month
Dimensions	∅ 38 x 74 mm
Weight	88 g
Expected operation life	2 years in air
Storage life	6 months in packaging
Storage temperature	5 .. 20 °C

Gas sensor module NO2-20	
Type	smart/ECS-NO2-20
Measuring method	Electrochemical cell
Measured value	Gas concentration in ppm
Measuring range	Configurable within 0 .. 20 ppm NO_2 typically 0 .. 10 ppm NO_2
Maximum overload	200 ppm NO_2
Lower detectable limit	< 0.15 ppm NO_2
Resolution	0.05 ppm NO_2
Accuracy	± 0.5 ppm or 2 % reading[4)]
Temperature compensation	yes
T90 time	< 60 s
Long term drift	< 2 % signal loss per month
Dimensions	∅ 38 x 74 mm
Weight	88 g
Expected operation life	2 years in air
Storage life	6 months in packaging
Storage temperature	5 .. 20 °C

Gas sensor module NO-100	
Type	smart/ECS-NO-100
Measuring method	Electrochemical cell
Measured value	Gas concentration in ppm
Measuring range	Configurable within 0 .. 100 ppm NO typically 0 .. 30 ppm NO
Maximum overload	200 ppm NO
Lower detectable limit	1 ppm NO
Resolution	0.05 ppm NO
Accuracy	± 0.5 ppm or 2 % reading[5)]
Temperature compensation	yes
T90 time	< 10 s
Long term drift	< 2 % signal loss per month
Dimensions	∅ 38 x 74 mm
Weight	88 g
Expected operation life	3 years in air
Storage life	6 months in packaging
Storage temperature	5 .. 20 °C

Gas sensor module NO-25	
Type	smart/ECS-NO-25
Measuring method	Electrochemical cell
Measured value	Gas concentration in ppm
Measuring range	Configurable within 0 .. 25 ppm NO overload up to 0 .. 30 ppm NO
Maximum overload	50 ppm NO
Lower detectable limit	< 0.4 ppm NO
Resolution	0.05 ppm NO
Accuracy	± 0.2 ppm or 2 % reading[6)]
Temperature compensation	yes
T90 time	< 10 s
Long term drift	< 2 % signal loss per month
Dimensions	∅ 38 x 74 mm
Weight	88 g
Expected operation life	3 years in air
Storage life	6 months in packaging
Storage temperature	5 .. 20 °C

Probe heater

smart/AQM-PHT Probe heater option	
Type	smart/AQM-PHT
Control	Controlled by outside temperature (if smart/AQM-TMP installed), otherwise by internal temperature (offset configurable)
Fog concentration	max. 5 g/m^3 in saturated air
Temperature range	-40 .. 60 °C
Material	Stainless steel 1.4404 (AISI 316L)
IP rating	IP 69
Dimensions	∅ 64 x 335 mm
Weight	Heater 1.5 kg Holder 0.4 kg

Analogue / relay output module

Analogue / relay output module ARO	
Type	smart/CORE-ARO
Analogue outputs	3 x 4 - 20 mA
Analogue output type	2-wire, active
Relay outputs	3 x SPST-NO
Max. contact rating	max. 60 VDC / 25 VAC, max. 0.5 A

2.4" Touch display

2.4“ Internal touch display D2	
Type	smart/CORE-D2
Display type	TFT colour
Diagonal screen size	2.4” (60.96 mm)
Display area	49.96 x 37.72 mm
Resolution	320 x 240 px
Touch type	capacitive
Backlight	LED - white

Temperature sensor option

smart/AQM-TMP Temperature sensor option

Type	smart/AQM-TMP
Temperature sensor	Pt100 DIN B, R_0: 100 Ω, Temperature coefficient: 3.850 x 10^{-3}/°C, Standard: DIN EN 60751
Sensor sleeve material	Stainless steel 1.4571 (AISI 316Ti)
Cable material	Silicon
IP rating	IP 69 (installed in smart/AQM)
Cable length	30 cm (longer on request)
Temperature range	-60 .. +180 °C
Humidity range	5 .. 95% relative humidity (non-condensing)
Storage temperature	-30 .. +70 °C

Temperature and humidity sensor

Temperature and humidity sensor	
Type	smart/CORE-TRH
Measured values	Temperature, Relative humidity
Calculated variables	Dew point, Frost point, Wet bulb temperature, Ice bulb temperature, Water vapour partial pressure, Mixture ratio, Absolute humidity, Specific enthalpy
Measuring ranges	Temperature: -40 .. 80 °C Relative humidity: 0 .. 100 %
Accuracy	Temperature: ±(0,2 °C + 0,67 % * abs (reading - 20 °C)) Relative humidity: -15 .. 40 °C: ± (1.3 + 0.3 % reading) %RH for RH ≤ 90 %, ± 2.3 % %RH for RH > 90 % -40 .. 80 °C: ± (1.5 + 1.5 % reading) %RH
Resolution	Temperature: 0.01 °C Relative humidity: 0.01 %RH
T90 time	< 15 s with stainless steel grid filter at 20 °C
Current consumption	3 mA
Housing material	Stainless steel 1.4404 (AISI 316L)

Conformities

Conformities	
Markings	
Electrical standards	2014/35/EU Low Voltage Directive (LVD) 2014/30/EU Electromagnetic compatibility (EMC) EN IEC 61000-6-2:2019 Immunity standard for industrial environments EN IEC 61000-6-3:2007 + A1: 2011 Emission standard for residential, commercial and light-industrial environments EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use EN 61326-1 Electrical equipment for measurement, control and laboratory use - EMC requirements
Tunnel safety standards	Austria: RVS 09.02.22 Germany: RABT 2006 Schweiz: ASTRA 13001 Lüftung der Strassentunnel (2021), ASTRA 13004 Branddetektion in Strassentunneln (2007), ASTRA 23001 Fachhandbuch Betriebs- und Sicherheitsausrüstungen Norway: Norwegian Public Roads Administration Handbook No. 021 Road Tunnels International: ISO 23431 Measurement of road tunnel air quality
Gas monitoring	Europe: EN 50545-1 Austria: ÖNORM M9419 Germany: VDI 2053

[1)]

only Standard and Smart variant

[2)], [3)], [4)], [5)], [6)]

whichever is greater