PDF



# JES smart/AQM Air Quality Monitor

## Features

• Smart IoT-enabled combined visibility and gas sensor
• Scattered light visibility sensor with dual beam method
• Reliable early detection of fires through cold smoke detection1)
• Dust concentration measurement after gravimetric calibration possible
• 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 maintenance2)
• Optional smart/HUB IoT operating and control unit with touch display
•

## 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<br>< 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<br>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)<br>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<br>Gas: electrochemical gas sensor cells |
| Light source | Laser, class 2 in accordance with EN 60825-1<br>< 1 mW at 650 nm |
| Measured values | Visibility: Scattered light intensity expressed as extinction coefficient, transmission, etc.<br>Gas: concentration |
| Measuring range | Visibility: Configurable, typically 0 .. 15 / km<br>Gas: depending on installed gas sensor modules |
| Resolution | Visibility: 0.001 / km<br>Gas: depending on installed gas sensor modules |
| Accuracy | Visibility: 0.01 / km<br>Gas: depending on installed gas sensor modules |
| Power supply | 24 VDC ± 10 % |
| Current consumption | max. 1.1 A @ 24 VDC (without heater)<br>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)<br>MODBUS/TCP (Ethernet)<br>Webserver for configuration (Ethernet) |
| Analogue/relay outputs (standard) | 3 x 4 – 20 mA (2-wire, active)<br>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:<br>3 x 4 – 20 mA (2-wire, active)<br>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)<br>900 .. 1060 hPa (with gas sensor modules) |
| Humidity range | 0 .. 100% relative humidity, non-condensing (visbility only)<br>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<br>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[3)] |
| 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 $NO_2$<br>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[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 NO2-20 | |
|---|---|
| Type | smart/ECS-NO2-20 |
| Measuring method | Electrochemical cell |
| Measured value | Gas concentration in ppm |
| Measuring range | Configurable within 0 .. 20 ppm $NO_2$<br>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[5)] |
| 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<br>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[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 |

| 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<br>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[7)] |
| 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<br>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<br>Relative humidity: 0 .. 100 % |
| Accuracy | Temperature: ±(0,2 °C + 0,67 % * abs (reading - 20 °C))<br>Relative humidity:<br>-15 .. 40 °C: ± (1.3 + 0.3 % reading) %RH for RH ≤ 90 %, ± 2.3 % %RH for RH > 90 %<br>-40 .. 80 °C: ± (1.5 + 1.5 % reading) %RH |
| Resolution | Temperature: 0.01 °C<br>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)<br>2014/30/EU Electromagnetic compatibility (EMC)<br>EN IEC 61000-6-2:2019 Immunity standard for industrial environments<br>EN IEC 61000-6-3:2007 + A1: 2011 Emission standard for residential, commercial and light-industrial environments<br>EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use<br>EN 61326-1 Electrical equipment for measurement, control and laboratory use - EMC requirements |
| Tunnel safety standards | Austria: RVS 09.02.22<br>Germany: RABT 2006<br>Schweiz: ASTRA 13001 Lüftung der Strassentunnel (2021), ASTRA 13004 Branddetektion in Strassentunneln (2007), ASTRA 23001 Fachhandbuch Betriebs- und Sicherheitsausrüstungen<br>Norway: Norwegian Public Roads Administration Handbook No. 021 Road Tunnels<br>International: ISO 23431 Measurement of road tunnel air quality |
| Gas monitoring | Europe: EN 50545-1<br>Austria: ÖNORM M9419<br>Germany: VDI 2053 |

[1)]

Does not comply to smoke detectors according to EN 54-7 Fire detection and fire alarm systems - Part 7: Smoke detectors - Point-type smoke detectors using the scattered light, transmitted light or ionisation principle

[2)]

only Standard and Smart variant

[3)], [4)], [5)], [6)], [7)]

whichever is greater