



EMISSION INSTRUMENTS

AVL PARTICLE COUNTER™

Description

Particle number measurement is the new requirement for Euro 5 certification of passenger cars with diesel engines (UNECE-R83), as well as within the proposal regarding the certification of heavy-duty engines for EURO VI and later.

AVL, the world leader in the field of emissions particulate measurement, has developed the AVL Particle Counter (APC), a compact, flexible and easily integrable device to measure particle number concentrations of diluted exhaust gas in a reliable and compliant way.

The AVL Particle Counter Advanced can be used for undiluted measurements in the field of development without any additional efforts.

The APC consists of a conditioning component (volatile particle remover VPR) and the actual particle number counter (PNC). The VPR consists of the first dilution step (particle number diluter 1 PND1), an evaporation tube (evaporation tube ET), and a secondary dilution (particle number diluter 2 PND2). The PNC is a n-butanol based condensation particle counter with a cut-off diameter of 23 nm.



Functionality Overview

- Complies with all PMP (Particle Measurement Programme) requirements and the UNECE-R83
- Continuous measurement of the number concentration of all non-volatile particles
- Robust and precise dilution system
- Automated start-up procedure provides rapid system initialization
- Easy and intuitive operation including a remote control option
- Integrated self-diagnostic features including: leakage test, response check, CPC flow check, zero point check

Applications

AVL Particle Counter

Allows for certification according to UNECE-R83. The AVL Particle Counter has been designed exclusively for diluted measurements with samples being taken from the CVS tunnel. Three fixed pcrf (particle concentration reduction factor) can be set: 100, 500 and 2.000.

AVL Particle Counter Advanced

This device has been designed for diluted and undiluted measurements and can be used both for certification as well as for research and development purposes. Samples can be taken from the CVS tunnel, the partial flow dilution tunnel, or directly from the raw exhaust gas. The pcrf can be set freely in a range from 10 to 20.000.

Benefits of the AVL Particle Counters

- Calibration with combustion aerosol to achieve realistic results
- Excellent long-term stability and high reproducibility shown at official and customer test campaigns
- Robust and precise dilution system without particle size dependency
- Highly accurate measurements due to immediate dilution at the sampling position
- Very low particle deposits thanks to the patented design of the primary diluter and the innovative material composition
- Easily transported with low space requirements due to compact design

The System in Detail

In order to count non-volatile particles, a special sampling method has been developed. A pump draws the exhaust gas into a sampling probe (available optionally) which eliminates all particles $>2.5 \mu\text{m}$ due to its special shape. The sampled exhaust gas is then diluted with cleaned hot air at a temperature of 150°C . This stabilizes the particle number concentration and reduces the concentration according to the pcrf, so that agglomerations and particle deposits are largely prevented.



The primary diluter is designed as a patented “Chopper Diluter”. Thanks to its compact design, the diluter can be installed directly at the sampling point of the CVS tunnel which, as a result of its innovative material composition, largely minimizes the “particulate losses”.

The selected arrangement of the transfer volumes and the constant sampling flow guarantee dilution independent of the particle size. An automatic back purging procedure also prevents particle deposits that would bias the measurement results.

After the hot primary dilution, the diluted exhaust gas is further heated up to a temperature of 300°C to 400°C in the evaporation tube in order to convert all volatile particles into the gaseous phase. Afterwards, a secondary dilution is performed to prevent further condensation or adsorption of volatile substances and to ensure that the maximum inlet temperature of the PNC of 35°C is not exceeded.

The particle number concentration is measured in the Condensation Particle Counter (PNC) (with a size range of 23nm to 2.5µm according to UNECE-R83 specifications). The particles are enlarged due to the condensation of butanol and are detected and counted using the light-scattering method.

Compatibility and Integration

Optionally, the AVL Particle Counter offers an AK interface using either TCP/IP or RS232. Additionally, an innovative device control software application is available that is based on the AVL interface technology RSI (Remote Service Interface). All required software packages are integrated into the device. The device control software provides the user with different functionalities for displaying the measurement values and controlling the device. The maintenance technician is provided with detailed status displays.

Compatibility to AVL PUMA Automation Systems:

PUMA5: Hybrid Interface, analog and digital I/O
PUMA Open 1.2, 1.2.1, 1.3: Hybrid Interface, analog and digital I/O
PUMA Open 1.3.1 HF 5: via RS232C
PUMA Open 1.3.2 und >1.4: via Ethernet
GEM201L Advanced: via Ethernet

Compatibility to non AVL Automation Systems:

VETS ONE 3.2 or EURO5 / 5+: package via Ethernet
Flexible interface in other customer specific automation systems can also be achieved by using the hybrid interface.

The system can be completely integrated into the PSS i60, so that valuable testbed space can be saved.

The AVL Particle Counter Advanced can also be used in combination with the AVL Smart Sampler Partial Flow Dilution Tunnel. This solution gives the user an efficient way to measure both particle mass and particle number at the same time.



Service

Calibration (UNECE R83 Validation)

The calibration procedure must be carried out once a year according to the ECE-R83 recommendation. Since radioactive material and many sensitive measurement devices are used, we recommend sending the AVL Particle Counter to the AVL Graz Calibration Center for annual calibration. If the required calibration equipment is available onsite, the calibration can be carried out by the customer. In order to achieve realistic results, we exclusively use thermally treated CAST (Combustion Aerosol Standard) Aerosol for the calibration of the measurement devices (according to the AEA group a sodium chloride NaCl solution should not be used to calibrate a particle counting device).

Adjustment (UNECE R83 Calibration)

If the measured values happen to be outside the specified tolerances, an appropriate differentiation adjustment between VPR and PNC will be carried out after written confirmation by the customer. The customer can minimize the downtime of the testbed by renting a calibration device for the period of service.

Preventive Maintenance (1000 H Service)

Every year or after 1000 operating hours, depending on whichever comes first, complete maintenance is recommended. Preventive maintenance can be executed on site or in Graz in combination with other services. As part of this maintenance the following tasks are typically performed: filter replacement, internal tubing changeout, temperature sensor calibration, etc.

Scope of Supply

- 1 Primary diluter
- 1 Conditioning unit (Evaporation Tube and 2nd dilution stage)
- 1 Condensation Particle Counter (CPC)
- 1 Main connection 110/115V or 230 V
- 1 Interface link 15 m
- 1 User manual AVL Particle Counter
- 4 Spare HEPA Filters
- 2 Spare Particulate Filters (box of 10)
- 1 Application Kit (connection between 1st diluter and sample probe)
- 1 Transportation box

Options/Add-Ons

Sample Probe Kit CVS

The Sample Probe Kit CVS provides a complete solution for mounting the AVL Particle Counter at the CVS-tunnel, sample the exhaust gas with a standard probe and verify the gas dilution ratio. Following articles are included in this kit: CVS Mounting Kit, European Standard Probe Kit and Gas Check Valve.



CVS Mounting Kit

To ensure a proper function of the primary diluter, it has to be mechanically mounted using a stressless connection for the sampling probe. The kit consists of variable clamp rings, a mounting plate for the primary diluter and adjustable bars for an optimal application at the various CVS tunnels.

European Standard Probe Kit

According to the latest UNECE R83 regulation, only solid particles, which are smaller than 2.5 µm, should be counted. This requires a particle size pre-classification. To meet this requirement we provide a Euro Norm standard sampling probe kit which can be used on different CVS tunnels.

Gas Check Valve

The gas check function is designed for verification of the gas dilution ratio via the gas analyzers on a testbed. With the gas check valve, connected at the inlet of the primary diluter, the gas dilution ratio check can be performed without disconnecting the diluter from the CVS-tunnel.

Switching drive for the Gas Check Valve

In addition to manual operation, the 3-way valve of the AVL Particle Counter can be operated automatically via a switching drive and AVL Particle Counter software.

Tailpipe-Sampling Kit

The AVL Particle Counter Advanced is also suitable for tailpipe-measurements without any adaptation steps. The tailpipe sampling kit represents the optimal solution for tailpipe measurements and consists of a multiple-hole sampling probe and an additional heated sample line with a length of 500 mm. The additional heated sample line minimizes particle deposits and guarantees more reliable measurement results.

Trolley with conditioning unit

The instrument carrier, equipped with wheels, is built in a 19" rack. A conditioning unit and a compressed air preparation module are included making measurements up to 45°C ambient air possible. For transportation, the primary diluter can be fixed on the top of the carrier.

High pressure Option

The High pressure option allows the AVL Particle Counter Advanced to be used during measurements with an exhaust gas backpressure of up to 2000mbar (relative), e.g. before a Diesel Particle Filter (DPF).

AVL InScreen

With AVL InScreen, one or more AVL measurement devices can be controlled via Ethernet. The AVL devices can be monitored and if needed, controlled with the touch sensitive display. The peripheral equipment (mouse, keyboard) can be connected via USB interfaces. For easy mounting on the testbed we also offer a bench cabinet and a 19" rack mounting frame.



Specifications

	AVL Particle Counter (upgradeable to AVL Particle Counter Advanced)	AVL Particle Counter Advanced
Measurement:	Particle number concentration of non-volatile particles (#/cm ³)	Particle number concentration of non-volatile particles (#/cm ³)
Legal basis:	Compliant with UNECE-R83 and PMP	Compliant with UNECE-R83 and PMP
PNC measuring range:	0 to 10,000 #/cm ³ (calibrated), up to 50,000 #/cm ³ in single count mode	0 to 10,000 #/cm ³ (calibrated), up to 50,000 #/cm ³ in single count mode
PNC (t90) rise time:	≤ 5 s	≤ 5 s
Operation temperature:	5°C to 25°C (up to 45°C with optional conditioning)	5°C to 25°C (up to 45°C with optional conditioning)
Maximum sampling temperature:	< 52°C (according to PMP – sample taken from CVS)	Max. 200 °C (up to max. 400 °C with Tailpipe Sampling Kit Option, up to max. 1000 °C with High Pressure Option)
Pressure differential between measurement channel and ambient pressure:	+/- 20 mbar	+/- 200 mbar (Max. 2000 mbar with high pressure option)
Sample flow rate:	5 l/min	1–5 l/min adjustable
Particle Concentration Reduction Factor (PCRF):	Complies with the requirements in accordance with the latest UNECE-R83 specifications Adjustable in 3 calibrated steps 100/500/2000	Complies with the requirements in accordance with the latest UNECE-R83 specifications Freely adjustable 10–20,000 (thereof 14 steps calibrated) • primary dilution (hot): 10–1000 • secondary dilution (cold): 1, 10, 15, 20
Temperature evaporation tube:	350°C	300–400°C adjustable
Removal efficiency for non-volatile particles:	99% or higher for tetracontane (according to PMP)	99% or higher for tetracontane (according to PMP)
Interfaces:	<ul style="list-style-type: none"> • TCP/IP via AK protocol • RS232 via AK protocol • Hybrid interface (digital, analog I/O) 	<ul style="list-style-type: none"> • TCP/IP via AK protocol • RS232 via AK protocol • Hybrid interface (digital, analog I/O)
Power supply:	90 ... 240 VAC, 50/60 Hz, ~1kW	90 ... 240 VAC, 50/60 Hz, ~1kW
Dimensions (W x H x D):	482 (19") x 445 (10HU) x 650mm	482 (19") x 445 (10HU) x 650 mm
Weight:	~ 46kg (55 lbs)	~ 47kg (55 lbs)