Schiltknecht
swiss precision

AIRFLOW MEASUREMENT FOR VENTILATION CONTROL IN ROAD TUNNELS

TMS 3000
THE ADVANCED AIRFLOW MEASUREMENT SYSTEM

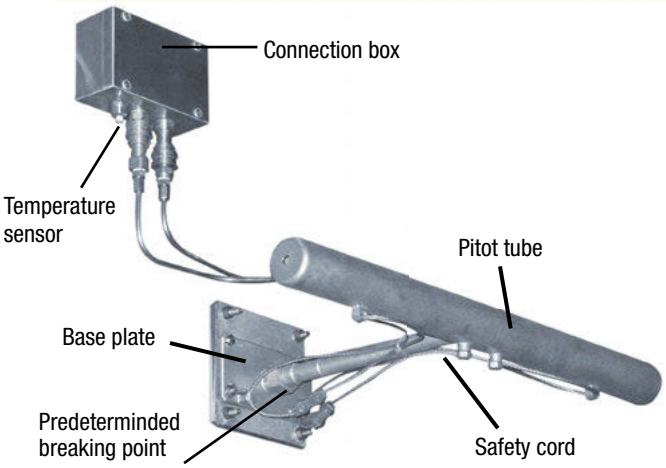
- Robust sensor mechanism without moving parts
- Practically maintenance-free
- Compact or field transmitter version
- Measurement in longitudinal direction of tunnels
- Continuous blower control is possible

THE SYSTEM COMPONENTS

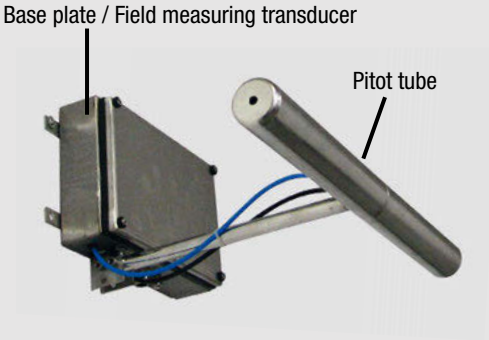
Version A and B	Version C

PILOT TUBES (SENSOR)

Each measuring point requires two sensors in form of Pitot tubes. They are fastened on the base plate on the inner wall of the tunnel (distance from the wall approx. 40 cm).



Remote design in which the measuring transducer is not in the tunnel tube. A predetermined breaking point and a safety cord (leash) are provided.



Compact design in which the pitot tube and the field measuring transducer form a unit. The pitot tube can be folded down 90° during cleaning of the tunnel so that it can be washed over without any problem.

MEASURING TRANSDUCER

The differential pressure transmitter MU3000D can either be mounted in a separated field housing (field transmitter) or as a module into the 19˝ rack of the evaluation unit.

Field measuring transducer (Version A)

Measuring transducer module for installation in the central unit (Version B)

Pitot tube and measuring transducer with folded down pitot tube (Version C)

CENTRALUNIT (EVALUATION UNIT)

For different modules like differential pressure transmitter, barometer module, temperature module in 19˝ rack.

Measuring process Versions

The ventilation of road tunnels ensures that noxic gases (above all carbon monoxide) and dirt particles are removed from the tunnel. The ventilation will become efficient and economic if it can be controlled using the flow rate of the air. Flow measurement systems TMS 3000 measure the exact flow rate in the longitudinal direction of the tunnel. Local turbulences constantly caused by traffic in the tunnel have no influence.

TMS 3000 averages the flow rate v_z in the longitudinal direction of the tunnel (z-direction) through the tunnel cross-section and thus measures the actual volumetric flow rate of the air through the tunnel.

Transversal components v_x and v_y that are not involved in air transportation in the longitudinal direction z of the tunnel don't contribute to the measuring signal.

Even larger traffic density in a tunnel cannot affect the measurement. The former can lead to significant measurement errors in ultrasonic measurements with time-of-flight method.

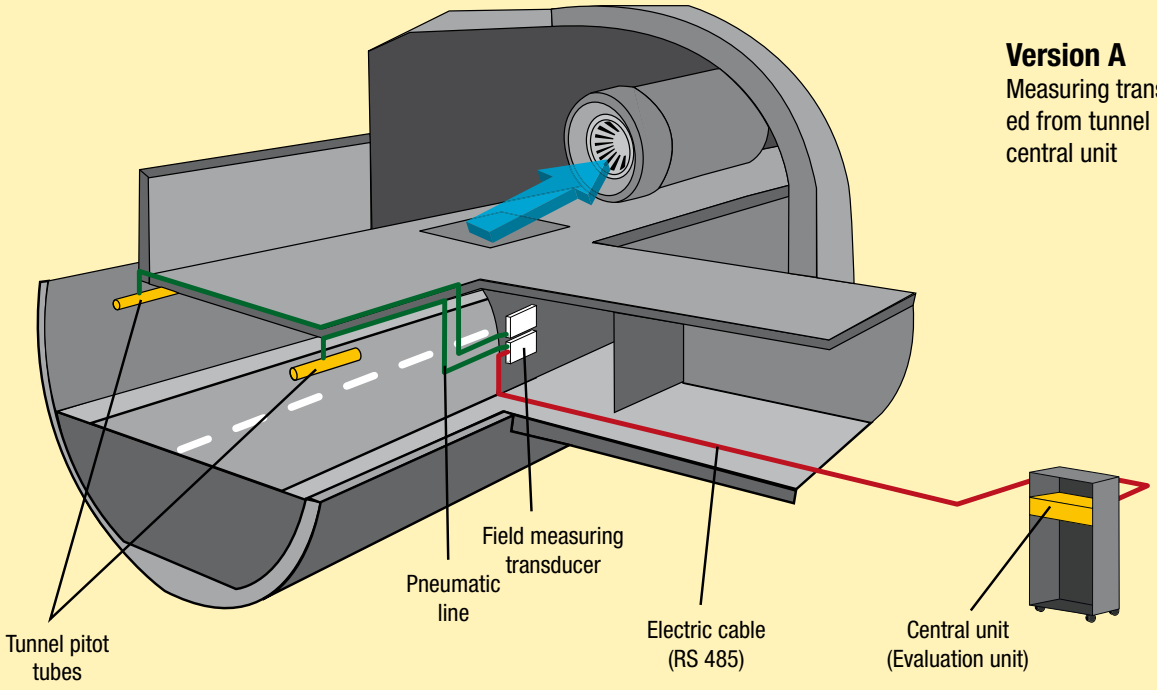
The measurement is implemented with the help of two special differential pressure chambers made of stainless steel that are measuring the flow velocity in z-direction due to their shape.

The differential pressure which according to Bernoulli equation is proportional to the squared flow velocity is fed through two pressure lines to the electronic evaluation unit that calculates the flow rate.

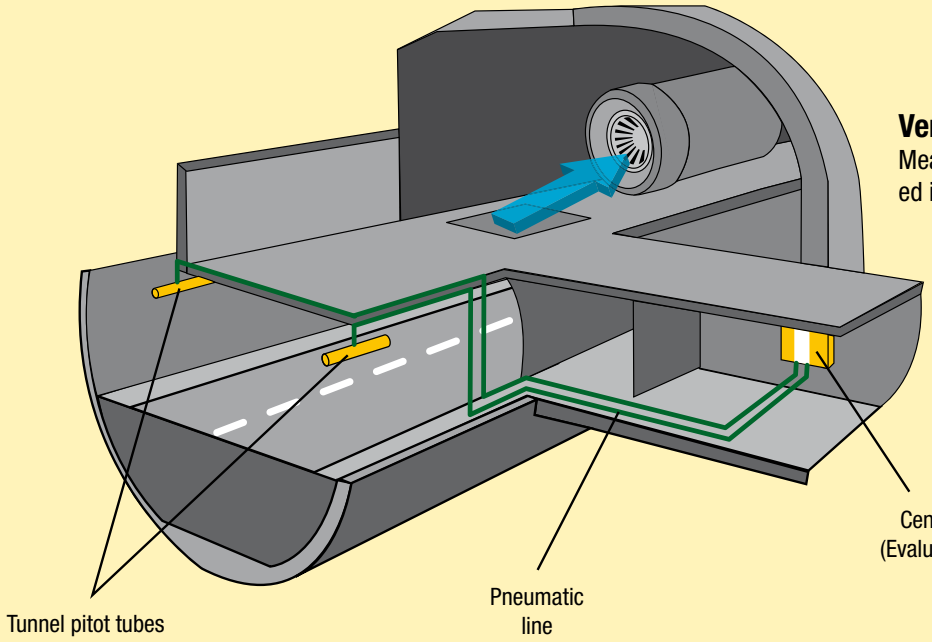
High-precision measurement of differential pressure is based on recurring automatic reset (autozero method) as well as on a high-resolution digital to analog converter. Therefore, the flow rate can be measured with a very high resolution (< 0.1 m/s).

The differential pressure measurement in the transducer is made in different places according to the design A, B or C (see fig.):
Design A: "remote"
Design B: «transducer in the central unit»
Design C: "compact"

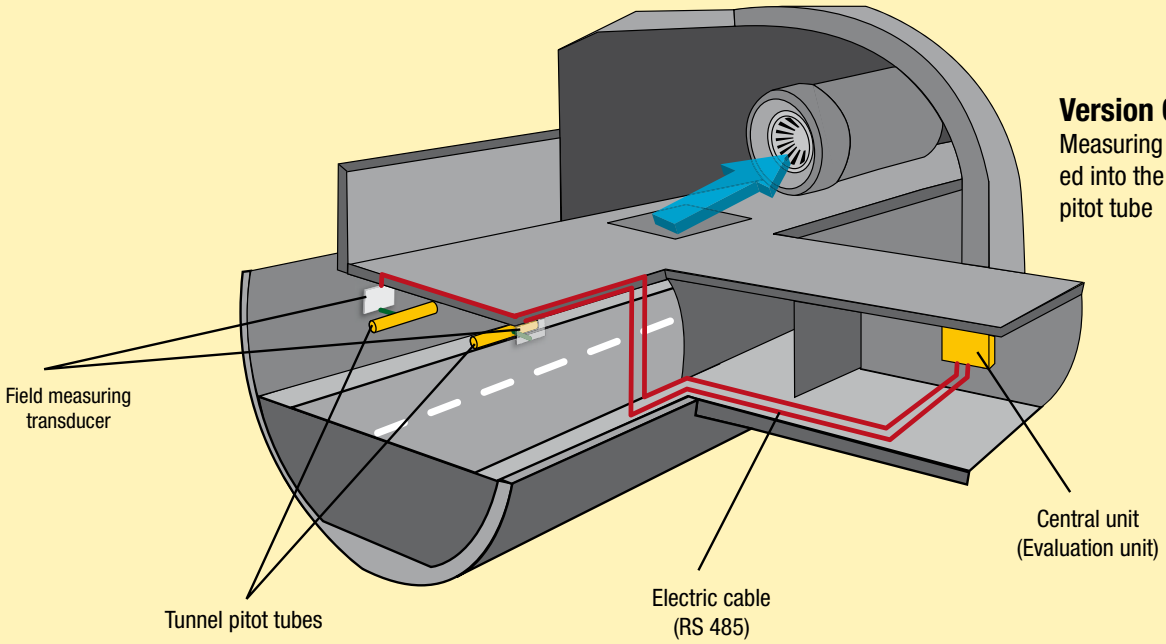
Pitot tubes are designed in such a way that infiltrating soiling or water cannot interfere with the measurement. Even in an extreme case of fire the measurement is not disturbed and resists hot gases with the temperature of 1200 °C up to. This guarantees safe and continuous control of the fan almost under any operating conditions.



Version A
Measuring transducer separated from tunnel pitot tube and central unit



Version B
Measuring transducer integrated into the central unit



Version C
Measuring transducer integrated into the base plate of the pitot tube

The figures show a typical installation in a tunnel with a ceiling diffuser. The tunnel Pitot tubes are placed at the height of approx. 3 m on the left and right of the tunnel wall (distance to the wall approx. 40 cm).

Airflow measurement system TMS 3000

Airflow measurement systems TMS 3000 are specifically designed for working under conditions prevailing in road tunnels. In the driving area there are only robust mechanical sensors made of stainless steel, the evaluation electronics is located in a separate control room.

The high-resolution measurement allows continuous blower control and thus an effective optimization of fans and power consumtion. Our devices have been successfully used in the longest tunnels (e.g. the St.Gotthard Tunnel in Switzerland or Plabutsch in Austria) or shorter tunnels (e.g. University Tunnel in Düsseldorf, Germany).

Measurement is based on high-precision differential pressure measurement which results in accurate flow measurement of the air through the tunnel. The data from the separately mounted field transmitters are transferred digitally into the evaluation unit (RS 485).

St. Gotthard, Schweiz

Plabutsch, Österreich

For new tunnels or for retrofitting this system provides essential advantages:

- Optimal fit to tunnel geometry due to field transmitter version.
- Robust sensors made of stainless steel.
- No moving parts.
- In the driving area there are no active electronic components (at version A and B).
- Excellent measurement is still guaranteed even in case of fire (at version A and B).
- The measuring system is practically maintenance-free (recommended inspection interval 5 years).
- High resolution of less than 0.1 m/s in both flow directions.
- Calibration by our accredited test rig installation for airflow (ISO 17025).
- Information on flow rate through the tunnel cross-section gives precise flow measurement without any impact of road traffic.
- An absolute zero-point stability thanks to autozero method (automatically recurring “reset” of differential pressure measuring cells).
- Air pressure measurement is already included.
- The Pitot tube sensors protrude only for approx. 40 cm into the driving area.
- The easiest dismounting of the Pitot tubes without tools during recurring cleaning of the tunnel walls.

Important Technical Data:

Measurement of the flow rate through the tunnel (in the longitudinal direction)	
2 Pitot tubes for differential pressure per measuring point, mounted on opposite tunnel walls	
Measuring ranges:	-10 ... 0 ... +10 m/s -15 ... 0 ... +15 m/s -20 ... 0 ... +20 m/s
Accuracy:	<0,1 m/s
Outputs:	4 ... 20 mA for the parameters: - Flow rate at the Pitot tube A incl. polarity - Flow rate at the Pitot tube B incl. polarity - Average value of the flow rate (averaging over tunnel cross-section) incl. polarity - Air temperature at the measuring point (-30 … +140 °C, optionally -30 ... +600 °C) - Barometer pressure at the measuring point (600 ... 1100 mbar) - Status signals
Control input:	Reduction of the averaging interval in the event
Service and parametrizing interface:	I²C, on the front side of the evaluation unit

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