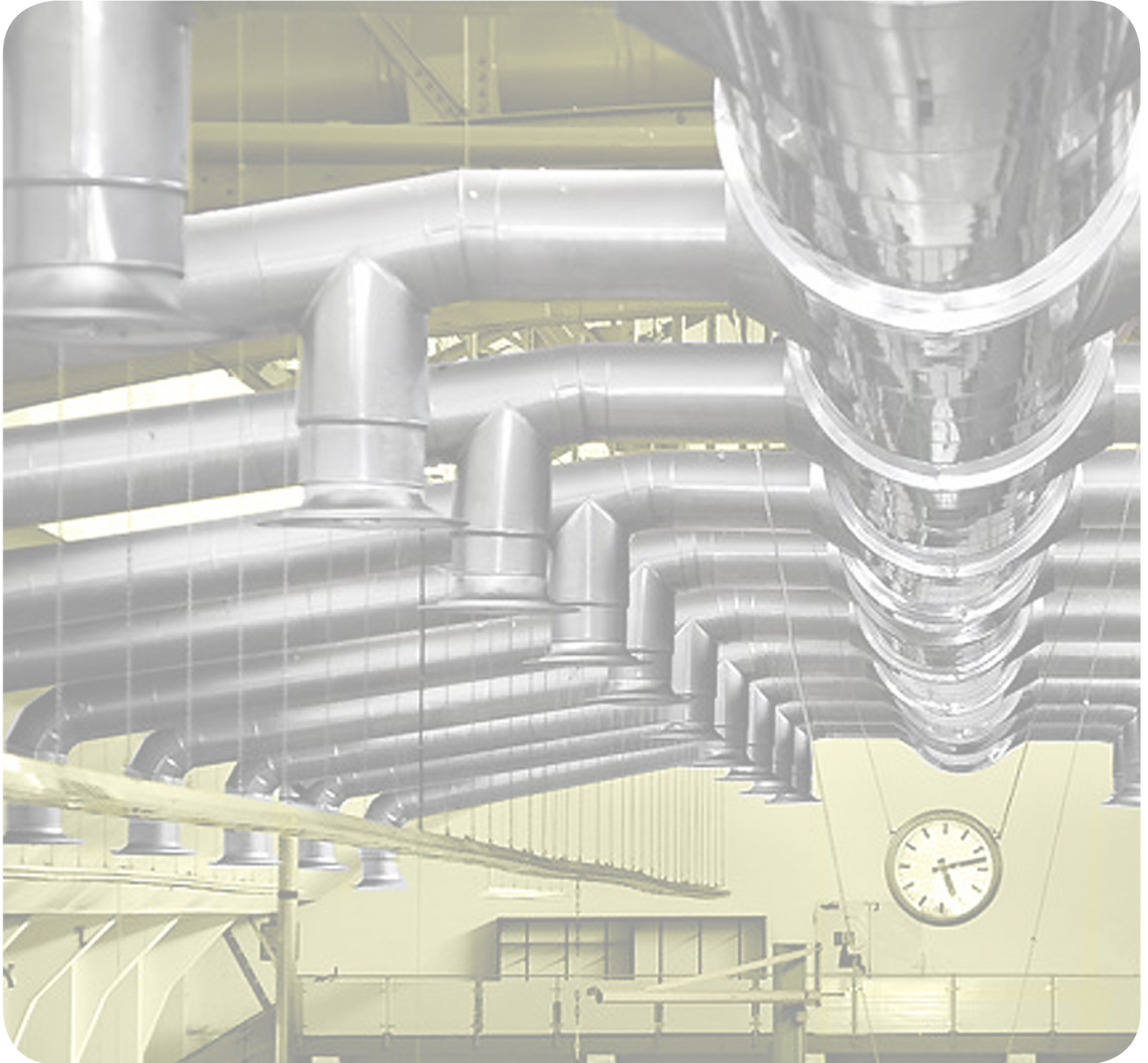


MFS - flow sensors for measuring airflow in ventilation ducts and fan inlets



APPLICATION

Micatrone MFS sensors for airflow measuring is developed and designed in-house. The sensor can easily be installed in both existing ducts as well as in new installations. MFS delivers reliable measuring results within a range of 1 to 50 m/s. The sensors well proven design allow stable measurement in slow moving air.

MFS is suitable for use in all types of air ducts and buildings including hospitals, laboratories and industrial plants.

MFS uses multiple measuring points across the entire duct section to sum an average air velocity. For precise measurement in larger cross section ducts, additional MFS is mounted and connected in parallel.

MFS is available for both circular and rectangular ducts, and also for special applications such as fan inlet cone mounting where standard installation is difficult to apply. MFS is stocked in standard lengths to suit most common duct sizes but can also be custom made in any other length up to 2500 mm. MFS is available for high temperature measurement, epoxy coated or in acid-proof stainless steel for measurement in aggressive air or gas.

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AIRFLOW MEASUREMENT IN DUCTS

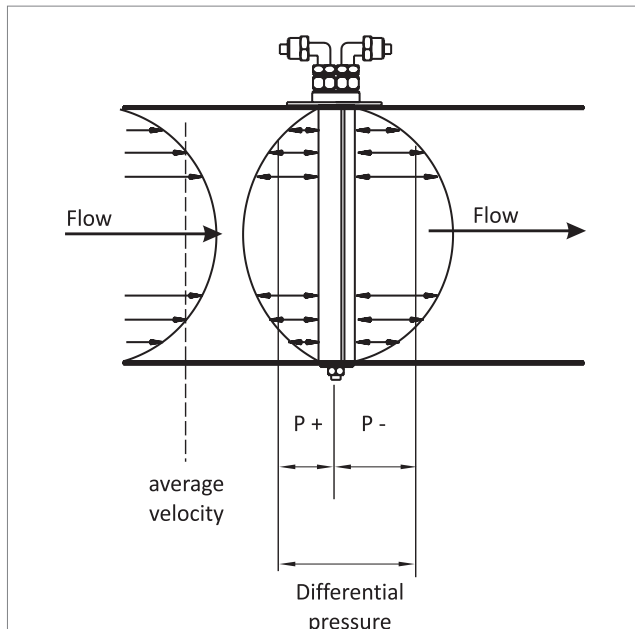
To measure the flow of air and other gases in ventilation ducts, differential pressure measurement is the most commonly used method.

In ventilation ducts, the total pressure consist of a flow pressure and a static pressure. The flow pressure can not be measured directly but must be calculated using the difference between the total pressure and the static pressure.

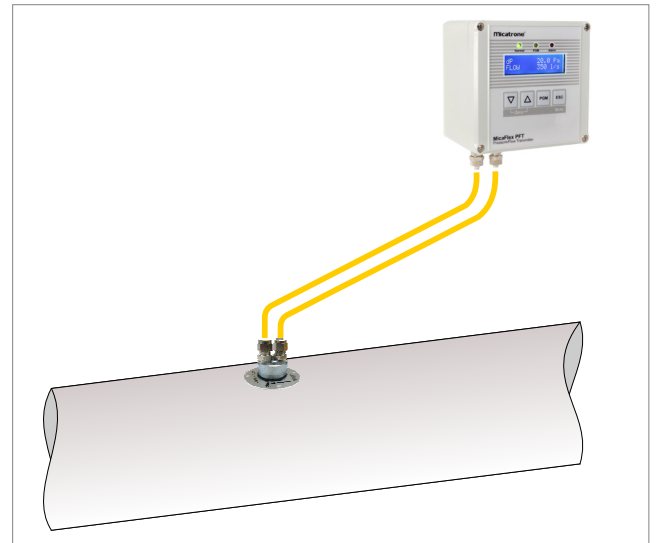
The differential pressure between the total pressure and the static pressure is used in a flow transmitter to calculate the airflow in the duct. The square root of this differential pressure is proportionally linear to the airflow. The flow transmitter converts the measured differential pressure to an output signal that can be used for many purposes, for example control or alarm.

MFS - HOW IT WORKS

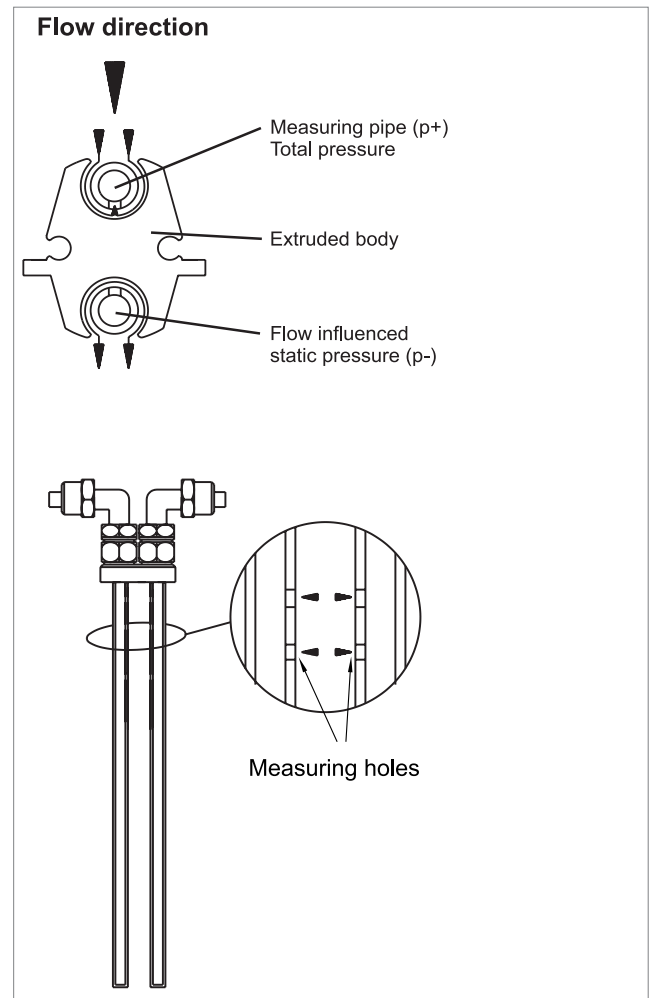
MFS measure both the total pressure ($p+$) and a flow influenced static pressure ($p-$) in the duct. The design of the sensor makes the $p-$ pressure to always be lower than compared with the actual static pressure, which increases the differential pressure between $p+$ and $p-$. The high differential pressure created by the MFS design allows for a more precise measurement of slow moving air compared to other methods, for instance, Prandtl-tube. MFS creates a differential pressure up to 2.5 timer higher than Prandtl tube measurement which is of importance when measuring in slow moving air.



MFS is connected with plastic tube to a flow transmitter (See page 8), which calculate the air flow using the pressure difference that is created between the measuring pipes plus and minus side.



MFS is designed with a rigid extruded aluminium body where two measuring pipes are integrated on the entire length. The pipes are protected by the body and surrounded with an air gap with the measuring holes facing inwards. The placement reduces the risk of clogging the pipe since there is no air velocity at the measuring holes.



MODELS

MFS-Standard is designed in aluminium with connection head and bottom support in steel. MFS-SS is manufactured in stainless steel (EN 1.4404) and used in ducts with aggressive gases and/or high temperature (max 600°C). MFS-FI is specially developed and intended for measuring on air fan inlet cones.

MFS-Standard can be ordered with an epoxy-coated surface treatment. When measuring in duct with high air temperature, MFS-Standard can be ordered with an increased temperature rating for 150°C or 400°C where standard gasket and connections are replaced.

MFS - design and properties

Prod.name X = length	Design	Meas in duct	Meas in fan inlet cone	Aggre- ssive air	Max. temperature °C				
					50	80	150	400	600
MFS-C-X	Standard anodized aluminium for circular duct	✓				✓	✓ ₁	✓ ₂	
MFS-R-X	Standard anodized aluminium för rectangular duct	✓				✓	✓ ₁	✓ ₂	
MFS-C-E-X	Standard epoxy-coated aluminium for circular duct	✓		✓		✓			
MFS-R-E-X	Standard epoxy-coated aluminium för rectangular duct	✓		✓		✓			
MFS-C-SS-X	Stainless-steel for circular duct with aggressive air or high temperature	✓		✓					✓
MFS-R-SS-X	Stainless-steel for rectangular duct with aggressive air or high temperature	✓		✓					✓
MFS-FI	Standard anodized aluminium, mounted in air fan with inlet cone		✓		✓				
1.) with MTS-T150 option mounted									
2.) with MTS-T400 option mounted									

MFS, stock and custom length [mm]

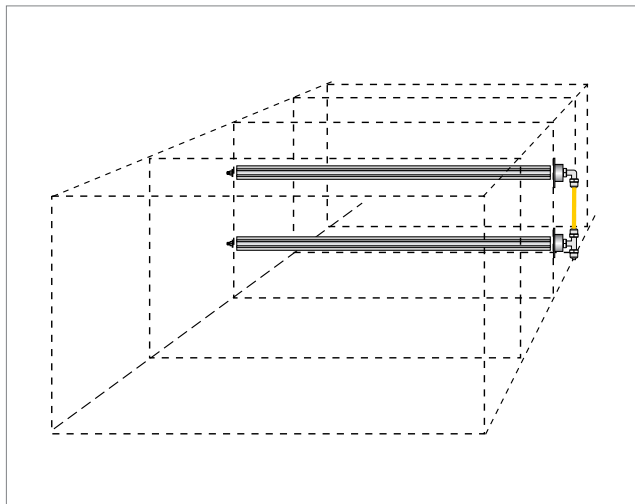
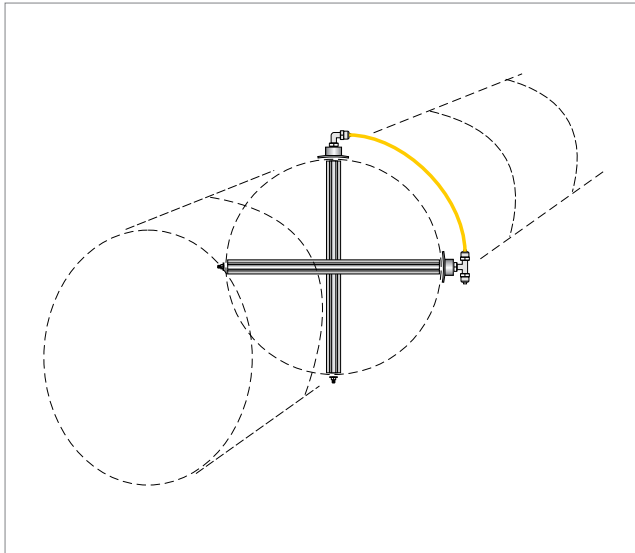
MFS-C (-E)	100	125	150	160	200	250	315	400	500	600	630	800	1000	1250			
MFS-C-Special	custom length between 80 and 2495 mm																
MFS-R (-E)	100	150	200	250	300	400	500	600	700	800	900	1000	1200	1400	1600	1800	2000
MFS-R-Special	custom length between 100 and 2495 mm																
MFS-C-SS	manufactured against order in custom length 80 ... 1700 mm																
MFS-R-SS	manufactured against order in custom length 100 ... 1700 mm																

MOUNTING

Measurement in ventilation ducts

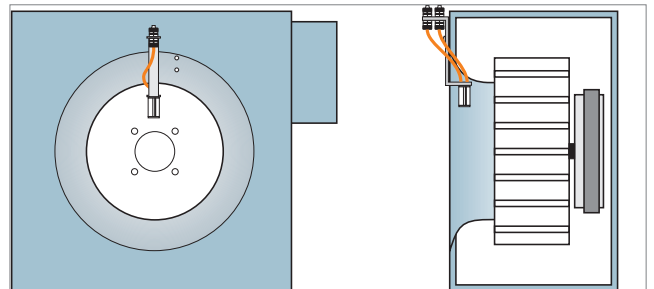
MFS is available for both circular and rectangular ducts – MFS-C and MFS-R. Which length and how many sensors needed is dependent of duct area and dimensions and can be calculated using the online [calculation tool](#) on Micatrone web site.

In circular duct with one sensor, it can be mounted in any position. If two sensors are mounted they must be installed in 90° angle.



Measurement in fan air inlet cone

In certain existing installations it may be difficult to mount the sensor into the duct. In these cases it is possible to install the flow sensor to the fans air inlet cone using the MFS-FI. MFS-FI is connected to a flow transmitter (see page 8).



MFS-FI measure a differential pressure at the air inlet that is converted to a flow output signal using Micatrone flow transmitters.

The position is ideal for the best measuring result of the average inlet air flow. If the fan is of double injection type, the area is multiplied with two. On Micatrone web site you can find a [calculation tool](#) to determine the correct measuring range for the connected flow transmitter. The spread-sheet is based on following formula.

$$Q = K_m \times A \times \sqrt{\Delta p}$$

$$Q = m^3 / s$$

$$\Delta p = Pa$$

$$K_m = 0,86$$

$$A = \left(\frac{D}{2}\right)^2 \times \pi$$

D = inlet diameter in metres closest to the impeller

Fan airflow measurement

Most modern airfans today has integrated measuring outlets to be used for flow measurement. In these cases no further flow sensor needs to be installed. If pressure outlets are available, Micatrone recommends using them first for flow measurement. A flow transmitter with the appropriate pressure range is connected to the fan pressure outlet. In order to select the correct measuring range on the transmitter, the fan must have a pre-known flow coefficient and the formula to calculate the pressure range.

If a preinstalled measurement outlet is missing, it is possible to either measure the flow at the intake cone or at the air outlet duct with sufficient distance to the fan using a standard MFS sensor.

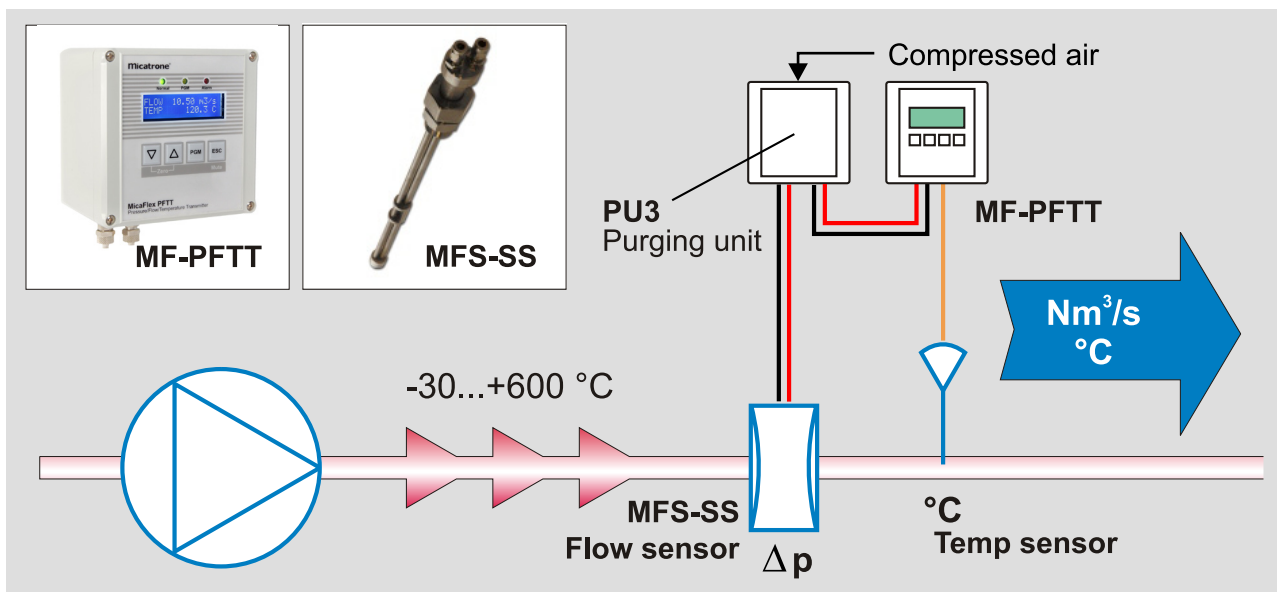
Measuring sensor i stainless steel

MFS-SS is designed in the same way as the standard MFS but in acid-proof stainless steel to withstand aggressive air and high temperatures (max 600°C). Sensorlength exceeding 1200 mm need a support-stand at the other end for stable installation.



MFS-SS flow sensor

Measuring in aggressive and polluted gases with high and shifting temperature



In certain industrial plants, e.g. Bio-mass firing boiler plant, the air temperature is high and shifting and air is aggressive and polluted. These plants require equipment of higher grade for the air measurement.

For this purpose, Micatrone offer following system components:

- MFS-SS flow sensor in acid-proof stainless steel
- Flow transmitter Micaflex PFTT with purging control
- MTS-HT pressure tubing for increased duct temperature
- PU3 Purging unit

The PFTT flow transmitter converts the measured air flow to a temperature compensated air flow at normal temperature (0° C), therefore the transmitter can maintain the accuracy of the measurement and control within a temperature range between -30°C and +600°C.

FLOW CALCULATION – SELECT CORRECT MEASURING RANGE OF TRANSMITTER

To convert the measured differential pressure to airflow, the flowsensor, MFS, is connected to a flow transmitter (See Micaflex-series). The pressure range of the transmitter is determined by the max flow inside the duct and calculated with the formula to a flow linear output signal. See page 8 .

On www.micatrone.se you can find a [calculation tool](#) to assist you in calculating the differential pressure corresponding to the max flow inside a defined duct. The tool works for both circular and rectangular ducts and makes it easy to select the appropriate measuring range.

You need to know the diameter of a circular duct or width and height of a rectangular duct. Furthermore you need to know the max velocity or the max flow in the duct. If the temperature inside the duct deviates from ambient room temperature, this must be considered in the calculation. You may also change the static pressure and current barometric pressure if needed. These changes will only have a minor affect on the end result.

The values are entered into the spread sheet tool and the result will show the differential pressure corresponding to the max flow. You should select a measuring range above the result plus approximately 20 % margin.

Contact Micatrone if you need assistance finding a suitable transmitter for your desired function.

Example 1 – Circular duct with Micatrone calculation tool:

In a circular duct with a diameter of 500 mm and a max flow of 2,15 m3/s, the differential pressure will be 165 Pa. Using a 20 % margin, the selected flow transmitter should have a measuring range of 0 - 200 Pa (165 Pa * 1,20 = 198 Pa).

Circular Duct		Customer Ref:	
At Duct diameter >2500 mm, contact Micatrone AB			
	Input data		Achieved data
Diameter of the duct (mm)	500	Area	0,196 m2
Flow sensor constant		Km	0,852
Static pressure Pa	0		
Actual barometric pressure mBar	1013	Actual density	1,20
Actual temperature °C	20	Rec. Material	
Density at 0 °C	1,293	Qty of sensors	2 pcs. MFS-C-500
		Con.kit	1 pcs. MTS-F2
Normal = Normal m3 at 0 °C 1013 mBar			
Specify max flow m3/s	2,15	Δp	165,0 Pa
		Normal	2,003 m3/s
		Actual velocity	10,950 m/s

Example 2 – Rectangular duct with Micatrone calculation tool:

In a rectangular duct with the width 400 mm, length 800 mm and a max flow of 2,45 m3/s, the differential pressure will be 80,6 Pa. Using a 20% margin, the selected flow transmitter should have a measuring range of 0 - 100 Pa (80,6 Pa * 1,20 = 96,72 Pa).

Rectangular duct		Customer Ref:	
At duct width > 2500 mm, contact Micatrone AB			
	Input data		Achieved data
Duct width (mm)	400	Area	0,320 m2
Duct length (mm)	800	Km	0,853
Flow sensor constant			
Static pressure Pa	0	Actual density	1,20
Actual barometric pressure mBar	1013	Rec. Material	
Actual temperature °C	20	Qty of sensors	2 pcs. MFS-R-800
Density at 0 °C	1,293	Con.kit	1 pcs. MTS-F2
Normal = Normal m3 at 0 °C 1013 mBar			
Specify max flow m3/s	2,45	Δp	80,6 Pa
		Normal	2,283 m3/s
		Actual velocity	7,656 m/s

SUITABLE TRANSMITTER

Micatrone stock a wide range of transmitters and controllers for different needs of flow measurement.



Which model to best suit your needs is determined by what to measure and how to use the result, - e.g. control, alarm or HVAC application.

Consult Micatrone and let us advise you to choose the right transmitter for your application.

Function	FD	PFT	PFTT	PFC	PFA	PFA PU	PFCA
Output signal flow	✓	✓	✓	✓	✓	✓	✓
Controller		✓	✓	✓	✓	✓	✓
Display	✓	✓	✓	✓	✓	✓	✓
Alarm	✓ ₃				✓	✓	✓
2-set point				✓			✓
Temperature			✓				
Aut. zero set.		✓ ₁	✓ ₁	✓ ₁	✓ ₁	✓ ₁	✓ ₁
Purging			✓ ₂			✓ ₂	

1) require Auto-Zero MFM-ZP
 2) require Purging unit PU-3
 3) require alarm module MFM-L1 with relay output

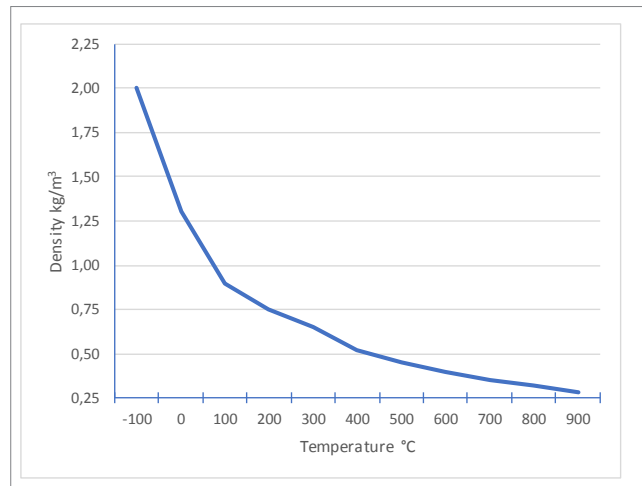
Auto Zero – automatic zero setting when measuring airflow in slow moving air

To measure the flow in slow moving air requires equipment with high accuracy as well as careful installation. It is important that each measuring point cover the entire area inside the duct. The sensor must be connected to a reliable flow transmitter which can handle the low airflow (Differential pressure below 20 Pa). Most Micatrone transmitters can be fitted with a auto-zero module (MFM-ZP), which in set intervals adjusts the zero-point from drift and by that secures the flow measurement to be accurate over time.

Temperature compensation at high and varying air temperatures

The air density is of importance when calculating airflow. The density is determined of the temperature, the static pressure at the measuring point and the barometric pressure. Of these three variables, the air temperature is the most significant influence for the density and therefore the airflow measurement.

Graph of the relation between air temperature and density:



In most cases, the airflow is calculated in room tempered air (approx. 20°C). When measuring the airflow in high or varying temperature conditions, changes in air density must be taken into consideration.

At constant high temperatures, density must be included in the formula when determining the type and pressure range of a flow transmitter. Use the calculation tool to see how air temperature can affect the flow in the duct.

On volatile temperatures, the current airflow is recalculated to normal cubic meter (m³h) regardless of the actual temperature. A normal cubic meter is defined as a barometric pressure of 101 325 Pa and an air temperature of 0°C.

Micatrone flow transmitter, Micaflex PFTT, can calculate and control a temperature compensated flow measurement. PFTT has a temperature input signal that can handle Pt-100 / Pt-1000-sensors or V and mA input signal and recalculate the current airflow to a normal airflow within a temperature range of -30° to +600°C

Purging (cleaning) the flowsensor

Even though the MFS is designed to reduce the risk of clogged measuring pipes, the sensor should be connected to a purging unit if mounted in duct containing polluted air with high degree of particles. Micatrone flow transmitter MF-PFTT and MF-PFA/PU has built-in function to control the purging unit PU3 in set intervals and duration.

FORMULA TO CALCULATE AIR FLOW

Micatrone calculation tool is based on the following formula, valid at 20° C air temperature and a barometric pressure of 1013 mBar.

Flow coefficient K_m :

$$v = K_m \times \sqrt{\Delta p} \quad \text{m/s}$$

$$Q = A \times K_m \times \sqrt{\Delta p} \quad \text{m}^3/\text{s}$$

Variables:

v	velocity in m/s
Q	flow in m ³ /s
K_m	sensor flow coefficient
Δp	pressure in Pa
A	duct area in m ²
ρ	air density in kg/m ³
B	current barometric pressure in mbar
t	current temperature in °C

Adjustment for different air temperature and/or barometric pressure should be calculated with the following formula:

$$\rho = 1,293 \times \frac{B}{1013} \times \frac{273}{273 + t} \quad \text{kg/m}^3$$

$$v = K_m \times \sqrt{\Delta p \times \frac{12}{\rho}} \quad \text{m/s}$$

$$Q = A \times K_m \times \sqrt{\Delta p \times \frac{12}{\rho}} \quad \text{m}^3/\text{s}$$

Flow coefficient K_m is a factor used in the formula where the measured differential pressure is converted to correspond air flow.

The flow coefficient K_m for MFS-C (circular duct) is printed on an attached label with the sensor. K_m -value for MFS-R used in rectangular duct is dependent of the duct proportion and can only be calculated if the length of each side are known. Then you can use the Micatrone calculation tool.

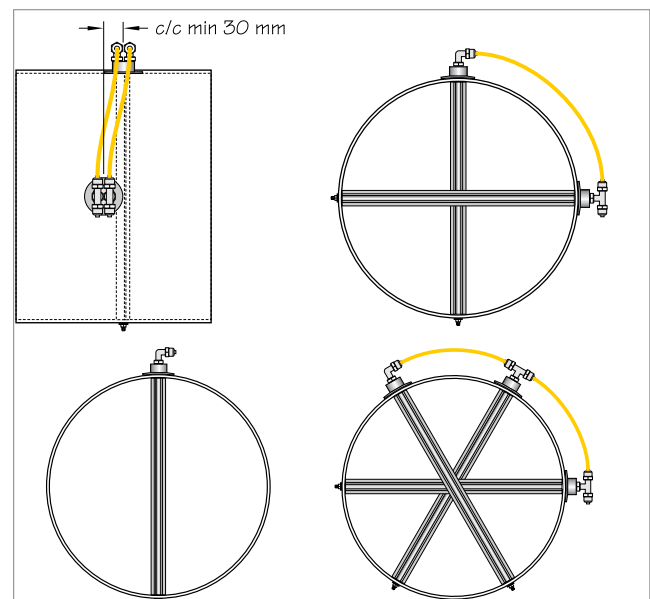
HOW MANY SENSORS ARE NEEDED?

When measuring air flow in ducts with greater size than 400 mm (width or diameter) multiple sensors should be installed for each measuring point to cover the entire duct area in order to achieve a good average measurement.

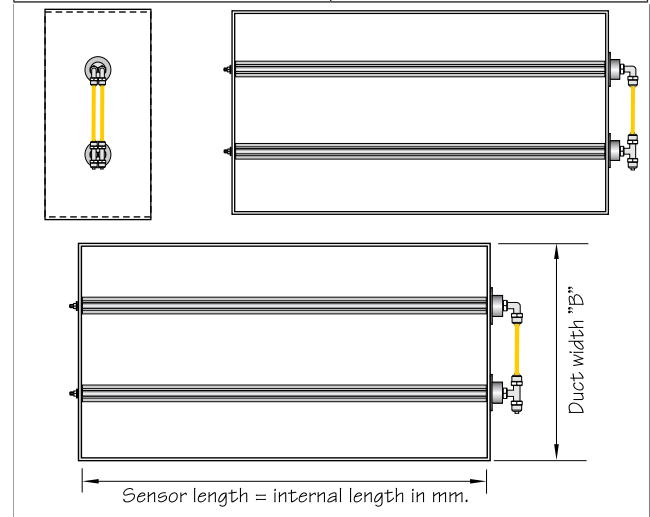
Exactly how many sensors are needed is shown in the table below or in the calculation tool.

The sensors are interconnected using the MTS F2/3/4 kit depending on selected number.

Circular duct	
Diameter "D"	Number of sensors for each measuring point
100 ... 400 mm	1
400 ... 900 mm	2
900 ... 1250 mm	3

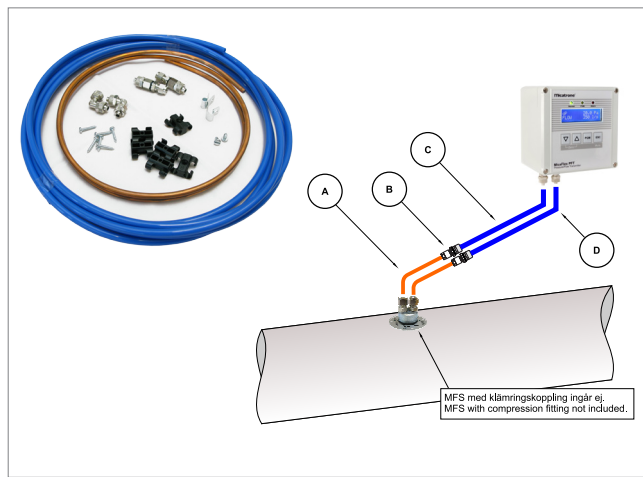


Rectangular duct	
Width "B"	Number of sensors for each measuring point
100 ... 400 mm	1
400 ... 600 mm	2
600 ... 900 mm	3
900 ... 2500 mm	4

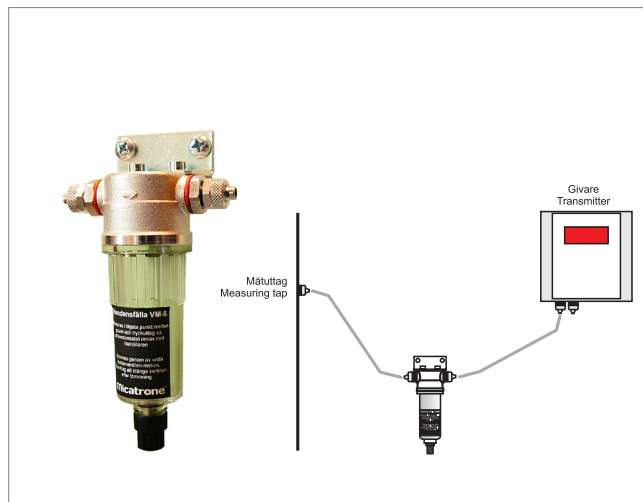


ACCESSORIES FOR INSTALLATION

- 1. MTS F2/F3/F4** interconnection kit for two, three or four sensors
- 2. 8/6 HT-tube** available per metre or in 50-metre roll for connection between the MFS (standard temperature) and Micaflex flow transmitter. 8/6 HT-tube is available in 80°C and 100°C version.
- 3. MTS-HT** pressure connection kit between sensors with extended temperature grade and Micaflex flow transmitter.
The kit include:
 - 1,5 m \varnothing 6 mm copper pipe
 - 6 m 8/6 HT-plastic tube max 100° C
 - 2 pcs transition adapters for copper pipe and 8/6 HT-plastic tube
 - 2 pcs 90°-coupling for 8/6 HT-tube
- 4. Water trap.** If the pressure tube between sensor and transmitter is installed in a lower horizontal plane (see image) there is a risk that condensate may build up inside the tube and obstruct the passage.
- 5. Connections** optional connectors outside standard
 - 6 mm Copper pipe
 - 6 mm Swagelok compression fittings
- 6. PU3** purging unit connected to compressed air for automatic purging of the sensor in set intervals controlled by the PFTT or PFA-PU transmitter.



3. Connection kit MTS-HT



4. Water trap VM-5



6. Purging unit PU3

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