Question:
Why do I experience incorrect and unstable measurements – especially at low flows?

Answer:
Typically the reason is an unstable zero point in the sensor due to:

1. Incorrect installation
2. Air bubbles in the liquid
3. Vibrations/Cross talk
4. Solid particles in the liquid

Below you will find useful “service tips “on how to easily trace the reason for incorrect measurements and ways to improve the application.

The formula below enables you to calculate the measurement accuracy / error you can expect from a certain application without having to carry out time consuming control measurements first.

Service tips (liquid applications).

The sensor measures incorrectly

General:

Check whether the sensor is well and stably installed into the application, and that the sensor is filled with liquid and liquid only. Air or gas bubbles in the liquid cause instability and can result in measurement errors.

Please note that the liquid must be homogeneous in order to measure with high accuracy. If the liquid contains solid particles of greater density than the liquid, then these solids can precipitate, especially at low flow rates, which will also cause instability in the sensor and lead to measurement errors.

Apart from the above, it is also important to install the sensor in a solid and stable fashion, as described in the Instruction / Manual / Handbook delivered with the product.
The sensor must be located in a vibration-free position, as vibrations can disturb the sensor and therefore cause measurement error.

Check the stability of the sensor and the application.

1. Rinse the pipe systems and the sensor for several minutes at maximum flow rate to remove any air bubbles which may be present.

2. First, close the outlet valve after the sensor, then the valve before the sensor, and finally, stop the pump. In this way the liquid will stand still but remain pressurized within the pump, which hinders de-gassing of the liquid, i.e. the release of air or other gas from the liquid. (First investigate whether the pump is equipped with a bypass, to avoid damaging the pump). Another option could be to regulate the final flow rate down, by reducing the pump pressure just before closing the valves before and after the flowmeter.

3. Perform a zero point adjustment in ”RESET MODE”. Please refer to pages 62-63 in the Handbook.

4. Then read the ”ZERO SIGMA” value in ”RESET MODE“. This value indicates whether the zero point was set under good and stable conditions.
The lower the value of ZERO SIGMA, the lower the measuring error achievable.

For a well-installed flowmeter, the ZERO SIGMA value is approximately the same order of magnitude as the specified zero point error for the sensor size.

Sensor size	**Zero point error/ ZERO SIGMA value.**
Di 1.5	0.001 kg/ h
Di3	0.010 kg/h
DN4	0.010 kg/h
Di6	0.050 kg/h
Di15	0.2 kg/h
Di25	1.5 kg/h
Di40	6 kg/h
DN50	5.5 kg/h
DN65	11.5 kg/h
DN80	15 kg/h
DN100	25 kg/h
DN150	66 kg/h

Given the ZERO SIGMA value reading, it is possible to calculate the error which can be expected for different flow rates, without performing time-consuming measurements. So using this formula, one can assess whether the application can be used as–is, or whether to use more time improving the installation.

$$E = Z \times 100\% / Qm$$

E = measurement error in % of flow rate
Z= Zero Sigma value in kg/h
Qm = current Flow rate in (kg/h)

Example: Low flow rate application

Di 15 sensor. The sensor is specified to max. 5600 kg/h!
Zero point error/ Zero sigma value is specified as 0.2 kg/h

Flow: Min. 10 kg/h - Max. 100 kg/h

After the zero point adjustment, the ZERO SIGMA value "Z" is read as 1 kg/h !
i.e. 5 times greater than that specified for the sensor.

The error for a flow rate of 10 kg/h is estimated as:
E = 1 kg/h x 100%/ 10 kg/h = 10%.

For a flow rate of 100 kg/h the error is estimated as:
E = 1 kg/h x 100% / 100 kg/h = 1 %

For this application it is necessary to investigate more closely what the cause of the relatively high ZERO SIGMA value is, in order to establish what needs to be done to improve the measurement accuracy.

Is the sensor properly fastened in place, are air or gas bubbles present in the liquid, are solid particles present, or is vibration the cause of the unstable zero point?

<u>Example : High flow rate application</u>

Di 15 sensor. The sensor flow rate is specified as max. 5600 kg/h
The zero point error/Zero sigma value is specified as 0.2 kg/h

Flow rate: Min. 1000 kg/h - Max. 3000 kg/h

After the zero point adjustment, the ZERO SIGMA value " Z " is read as 1 kg/h, i.e. 5 times greater value than that we specify for the sensor !

The error at a flow rate of 1000 kg/h is estimated as:
E = 1 kg/h x 100%/ 1000 kg/h = 0.1%

At a flow rate of 3000 kg/h the error is estimated to be:
E = 1 kg/h x 100% / 3000 kg/h = 0.03 %

Plus the linearity error of 0.1 %

As can be seen, in this case it is not so important that the zero point, i.e. Zero Sigma Value is 1kg/h, i.e. 5 times greater value than that we specify as a good zero point for this sensor size !

Here, the error due to the zero point is only 0.1 % for a flow rate of 1000 kg/h, and even less for a higher flow rate.

So for this installation with the given flow rate and zero point error (ZERO SIGMA value), I would typically choose not to spend more time finding ways to improve the application.

Therefore, assess each case carefully on the basis of the customer's information and the zero point error measurements, to establish whether it is worthwhile investing more of the customer's time and money to improve the installation and thus the measurement accuracy.

<u>Check where the "zero point error (ZERO SIGMA value)" originates from:</u>

Is it a bad installation, air or gas bubbles, vibrations ,cross talk or solid particles giving a bad zero point stability and a bad measuring accuracy ?
Below is giving guidelines how to investigate !

Stop flow in the sensor as described above under the heading "<u>Check the stability of the sensor and the application"</u>.

In the "BASIC SETTINGS" menu, set "Low flow cut off" to 0.0%.
Now it is possible to see the instability directly from the mass flow in kg/h in the display, and the display can be used to troubleshoot, i.e. to see whether the zero point becomes more stable when making changes / adjustments. For example, tightening the brackets which hold the sensor, or turning off the pump to check whether vibrations from the pump are disturbing the sensor, etc.

1. **Installation**
   Has the sensor been correctly installed, i.e. fastened to the floor / wall or frame with good mounting brackets as shown in the Instructions?
   Especially for low flow rates, i.e. flow rates less than 10% of the maximum capacity of the flowmeter, it is important that the sensor is correctly and stably installed.
   If the sensor is not correctly fixed in place, the zero point of the sensor will move, leading to measuring errors.
   Try to tighten up the sensor brackets to see whether the flow instability is reduced and now more stable.

2. **Air in the liquid**
   When air is present in the liquid, the zero point becomes unstable, which leads to a poorer measurement accuracy.

   Check for air:
   Check for the presence of air in the liquid in the sensor by checking the Driver Current.

   Enter ”Service mode” under the heading ”Special information”, and check whether the ”Driver current” varies more than ± 1 mA. If this is the case, it is usually due to the presence of air or gas bubbles in the liquid in the sensor.
   This can be checked by increasing the pressure in the sensor, creating a larger back pressure upon the sensor by reducing the opening of the outlet valve or by increasing the pump pressure, thereby minimizing the size of air bubbles inside the sensor. If the value or stability of “Driver current” falls, it is proof that the liquid contains air or gas bubbles.

   Cause of bubbles in the liquid – Examples:
   The entry pipe and sensor have not been properly bled, i.e. not properly filled with liquid.
   The pump cavitates, the rotary speed of the pump is too high in relation to the supply of liquid to the pump.
   The flow rate in the pipe is too high, so components sitting in front of the flowmeter can cause cavitation.
   If there is a filter installed before the flowmeter, it may be close to blocking, which also can cause cavitation.

3. **Vibrations and cross-talk.**
   Vibrations in the pipe system are normally generated by pumps.
   Cross–talk arises typically when two sensors are positioned in close proximity in the same pipe, or installed upon the same rail or frame.
   These vibrations have a greater or lesser effect upon the zero point stability and therefore also the measurement accuracy.

   a. Check whether there are vibrations.
   Turn off the pump and check whether the zero point stability improves, i.e. whether the flow rate fluctuation in kg/h is reduced.
   If the sensor is disturbed by vibration from the pump, the installation should be improved or the pump should be exchanged, e.g. to another type.

   b. Check for cross – talk .
   Turn off the power to the other flowmeter(s) and wait approximately 2 minutes, so the vibrating tubes in the sensor have ceased vibration. Then check whether the zero point stability has improved, i.e. that the fluctuation in kg/h has become less. If this is the case, the sensors disturb one another and the installation should be changed.

4. Solid particles in the liquid.

If the solid particles in a liquid have a density higher than that of the liquid, they can precipitate inside the sensor and cause instability which leads to a measurement error.

If solid particles are present in the liquid, they must be homogeneously distributed and have the same density as the liquid, or they can cause relatively large measurement errors. It is important that the sensor is installed such that these solid particles can easily run out of the sensor. For MASS 2100 this is achieved by a nearly horizontal installation with the entry highest and the outlet lowest.

Check whether solid particles are present in the liquid.

Take a sample of the liquid, fill a glass and see whether the solids precipitate.