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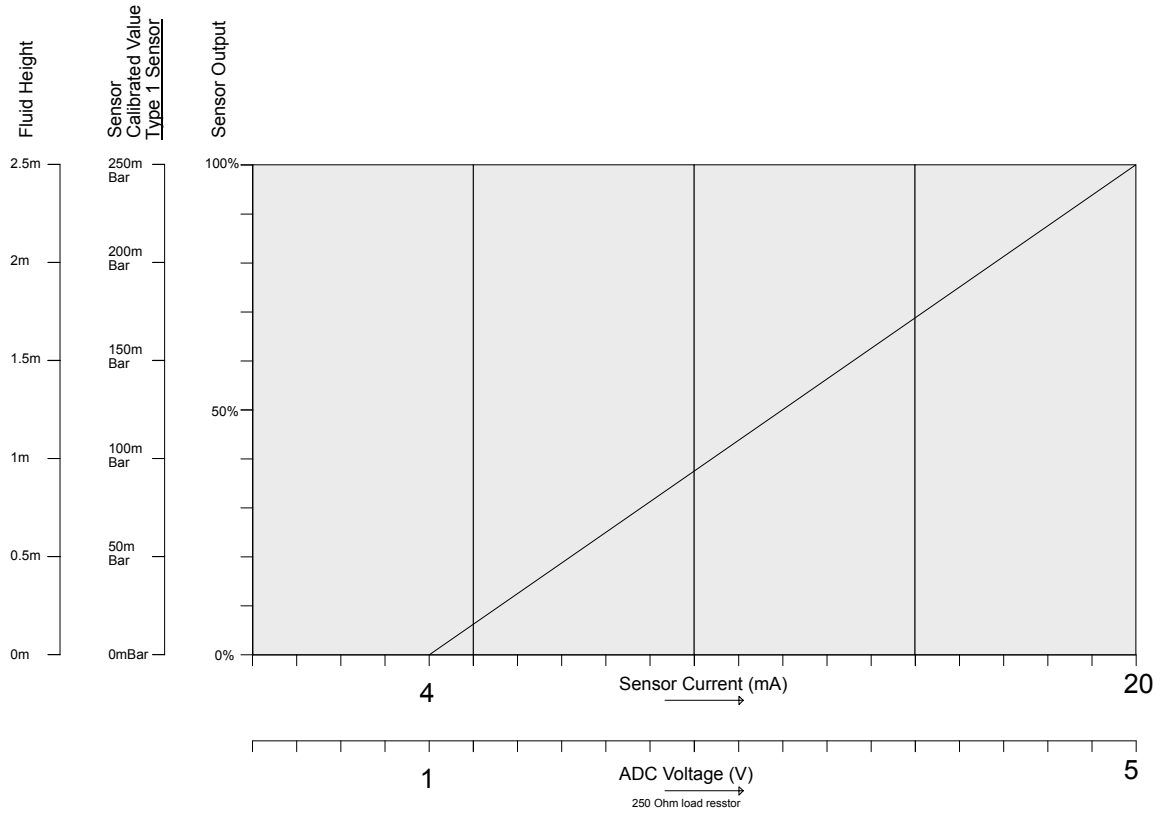
Temperature and Pressure Sensor Considerations

1. Fluid measurement in tanks using a 4-20mA pressure sensor.



Correctly wired a 4-20 mA sensor develops between 1 and 5 volts at the Analogue to Digital Converter (ADC) in a Mitsubishi FX PLC system. The load terminating resistance being 250ohms.

At full scale (20mA or 5Volts) the sensor will be reporting back it's calibrated value. In the case of a 2.5m Water calibrated unit the sensor will be seeing 250mBar at it's sensing element.

If the water is only 1.25m higher than the sensor the sensor will be seeing 125mBar and it will be delivering 50% of it's rated output.

Reading across on the graph, 50% sensor output will be generating a current of 12mA (mid way between the 4 and the 20mA). This will equate to a voltage of 3Volts being seen on the ADC.

Usefully, the voltage measurement can give you the fluid height above the sensor quite simply using the following formula.

Fluid Height = (V_{ADC} - 1) * Calibrated Fluid Height / 4

Basically, subtract one from the voltage measured. Divide by 4 giving you a fraction. Multiply that fraction by the sensor calibrated value in meters.

This works for ALL 4-20 mA sensors. Two other instances are worth looking at. The first being temperature, the second being treatment vessel pressure.

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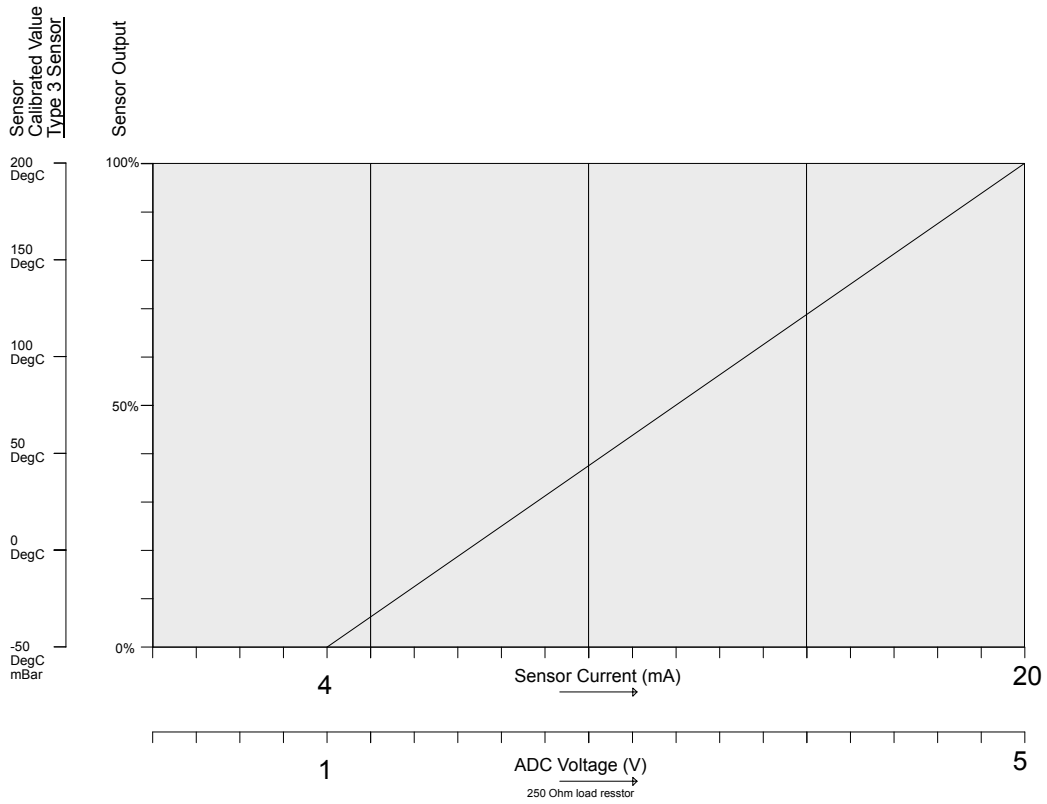
2. Temperature measurement using a 4-20mA temperature sensor.



A temperature sensor does not necessarily start from 0 Degrees @ 4mA. More likely there will be a negative number associated with that output.

In the above case we have chosen a sensor that at -50DegC provides 0% output (ie. 4mA) but at 200DegC provides 100% output (ie. 20mA)

The formula we used earlier can be adjusted so that the ADC voltage can be used to give a direct reading of temperature at the sensor. The formula needs to become.

Temp = ((V_{ADC}-1) * (T_{20} - T_4) / 4) + T_4

T_{20} = is the calibration in degree's at 20mA Output
T_4 = the calibration in degree's at 4mA output

Worked example using the above characteristics ...

V_{ADC} = 2.25V
T_{20} = 200 deg
T_4 = -50 deg

Temp = ((2.25-1) * (200 - (-50)) / 4) + (-50)
= ((1.25) * (200 + 50) / 4) - 50
= 28.125 DegC

As T_{20} and T_4 are constants for this sensor you could simplify the equation to ...

Temp = (V_{ADC}-1) * 62.5 - 50

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Temperature and Pressure Sensor Considerations

3. Treatment Vessel pressure measurement using a 4-20mA pressure sensor

There are three types of air pressure sensor on the market. One is called an Absolute (abs) sensor, the second and third are Relative (rel) sensors, sometimes called Gauge (gau) sensors.

An absolute sensor defines the 0% reading as an absolute vacuum. No air pressure being sensed at all ie. 0 Bar pressure. We refer to this below and in section 2 as a Type 3 sensor.

With the relative sensors everything is relative to the prevailing atmospheric pressure. 0 Bar is defined in this case as one atmosphere of pressure. We will refer to these as a Type 1 and 2 sensors.

The two configurations of relative sensor that are available are ...

Type 1 sensor 0 to 25Bar
Type 2 sensor -1 to 24Bar

Both Type 1 and 2 have a 25 Bar range but different calibration points for 0 Bar in terms of delivered output current.

The Type 2 sensor can be used in place of a Type 3 sensor (abs). The type 1 cannot be used as a type 3 sensor because it is unable to record negative pressures within it's 0 to 25 Bar calibrated range. There has to be a -1 figure in the specification of a relative sensor in order for it to be able to record vacuum.

Referring back to section 1 regarding fluid measurement in tanks, clearly this is going to be a Type 1 sensor as 0 Bar atmospheric is calibrated at 4mA, and if atmospheric pressure changes the reading from the sensor will not change as it is relative to atmospheric pressure at all times.