Equation when connecting a Load cell to the Auxiliary input of Quattrocento

When force amplifier for load cell is connected to the one auxiliary input of quattrocento, different factors must be considered to convert the value obtained to the force applied to the load cell:

- LC_{SENS} is Load cell sensitivity, it depends on the load cell
- LC_{FS} Load cell full scale, it depends on the load cell
- LC_{SUP} Load cell supply, it depends on the force amplifier
- FA_{GAIN} Force amplifier gain, it depends on the force amplifier
- AUX_{SF} Auxiliary input scale factor, for the quattrocento it is 0.5
- ADC_{RES} Analog to digital converter resolution, it is 16 bits
- ADC_{VR} Analog to digital converter voltage range, for the quattrocento is 5 V

The output of the Load cell is provided by the following equation:

$$\mathrm{VLC_{OUT}} = FORCE\ \frac{LC_{SENS} LC_{SUP}}{LC_{FS}} \qquad [1]$$

Where:

- VLC_{OUT} is the voltage output of the load cell
- FORCE is the force applied to the load cell

The sensitivity is a parameter provided by the Load Cell manufacturer, is generally in the range of 1 to 3 mv/V, the Load Cell supply is usually 5 V or 10 V. If the Force applied and the Load cell full scale are expressed with the same unit (doesn't matter if N, kg, Nm…) the output is expressed in mV.

The output of the Load Cell feeds the input of the Force amplifier. The output of the amplifier is obtained with the equation:

$$VAUX_{IN} = \frac{\mathrm{VLC_{OUT}}\ FA_{GAIN}}{1000} \qquad [2]$$

Where:

- $VAUX_{IN}$ is the output of the force amplifier
- 1000 is needed to get the output in V since the input should be expressed in mV and the gain is a pure number
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The output of the force amplifier feeds one auxiliary input of quattrocento who has an input dynamic of -5V to 5V and a scale factor of 0.5 to adjust this extended voltage range to the voltage range of its analog to digital converter with voltage range from 0 to 5V.

The equation describing the auxiliary input voltage conversion to a numeric value is the following:

$$ADC_{VAL} = VAUX_{IN} \frac{AUX_{SF}\, 2^{ADC_{RES}}}{ADC_{VR}} \quad [3]$$

Since all the values are defined, the equation can be expressed as:

$$ADC_{VAL} = VAUX_{IN}\, AUX_{CONST} \quad [4]$$

Where AUX_{CONST} is equal to 6553.6 V^{-1}

When using OT BioLab+, only equation [1] and [2] must be considered because all the conversion related to the quattrocento are done directly by the software.
When it is required to provide OT BioLab+ with a scaling factor, it is the factor who regulate the conversion between the input force (or torque, angle, speed…) and the voltage at the input of the auxiliary input. Thus, for the load cell and its amplifier the scaling factor can be estimated as:

$$SCAL_{FACT} = \frac{1000\, LC_{FS}}{LC_{SENS}\, LC_{SUP}\ FA_{GAIN}} \quad [5]$$

Example:
Suppose you have a load cell with 100 kg full scale, sensitivity equal to 2 mV/V and using the FORZA amplifier from OT Bioelettronica to amplify the load cell signal with a gain of 100. Since the forza supply the load cell with 5V, the scaling factor results as:

$$SCAL_{FACT} = \frac{1000\ 100}{2\ 5\ 100} = 100\, {}^{kg}/_{V} \quad [6]$$