

XL-80 +/- 0.5ppm uncertainty breakdown

Overview

The purpose of this application note is to provide a breakdown of the XL-80 uncertainty (accuracy) and provide clarity on the error budget which the system components meet.

Uncertainty breakdown

The specification covers entire system (XL-80, XC-80 compensator and sensors)

Each component is tested in house to ensure it meets particular test specifications which are in place to ensure the product performance is in line with the uncertainty (accuracy) quoted.

The greatest uncertainty in most laser measurements arises from variations in environmental conditions (air temperature, pressure and humidity) compared to nominal values. Even small variations in the environment will alter the laser wavelength. For example, the following changes will increase the laser wavelength by 0.25 ppm (parts per million).

0.26 °C air temperature increase

0.93 mbar air pressure decrease

When variations of temperature, humidity and pressure from nominal values are combined they can cause 20-30 ppm uncertainty in measurement (even if the test conditions remain stable).

+/- 0.5 ppm linear measurement accuracy can be achieved from 0- 40 °C and over the full air pressure range using the XC-80 compensation system.

The stated XL-80 laser performance is as follows:

+/- 0.5 ppm linear measurement accuracy

+/- 0.05 ppm laser frequency accuracy

The XC-80 compensator performance is as follows:

Material temperature 0-55 °C (range), +/- 0.1 °C (accuracy)

Air temperature 0-40 °C (range), +/- 0.2 °C (accuracy)

Air pressure 650-1150 mbar (range), +/- 1 mbar (accuracy)

Relative humidity 0-95% non-condensing (range), +/- 6 % RH (accuracy)

All of the above compensator uncertainty is combined to give an uncertainty of +/- 0.38 ppm which is shown in the table on the following page.

The table defines the breakdown of the error budget relating to the uncertainty of the system as a whole. The combined uncertainty is the square root of the sum of the squares of all the uncertainties. The expanded uncertainty is double the combined uncertainty, it is this value which is used to judge the overall uncertainty (accuracy) for the product.

This value should not exceed the published specification for the product.

Source of uncertainty	Uncertainty	Probability distribution	Multiplier	Uncertainty ppm
XC-80 Unit	+/- 0.38 ppm	Normal (k=2)	0.5	0.19
Laser Frequency	+/- 0.05 ppm	Normal (k=2)	0.5	0.025
Inhomogeneity of air	+/- 0.3 ppm	Normal (k=2)	0.5	0.15
Combined uncertainty (k=1)				0.24
Expanded uncertainty (k=2)				0.49

The laser measurement system accuracy value makes no allowance for uncertainties associated with the set-up and alignment of the system and excludes the errors and uncertainties associated with normalisation of readings to a material temperature of 20 °C.

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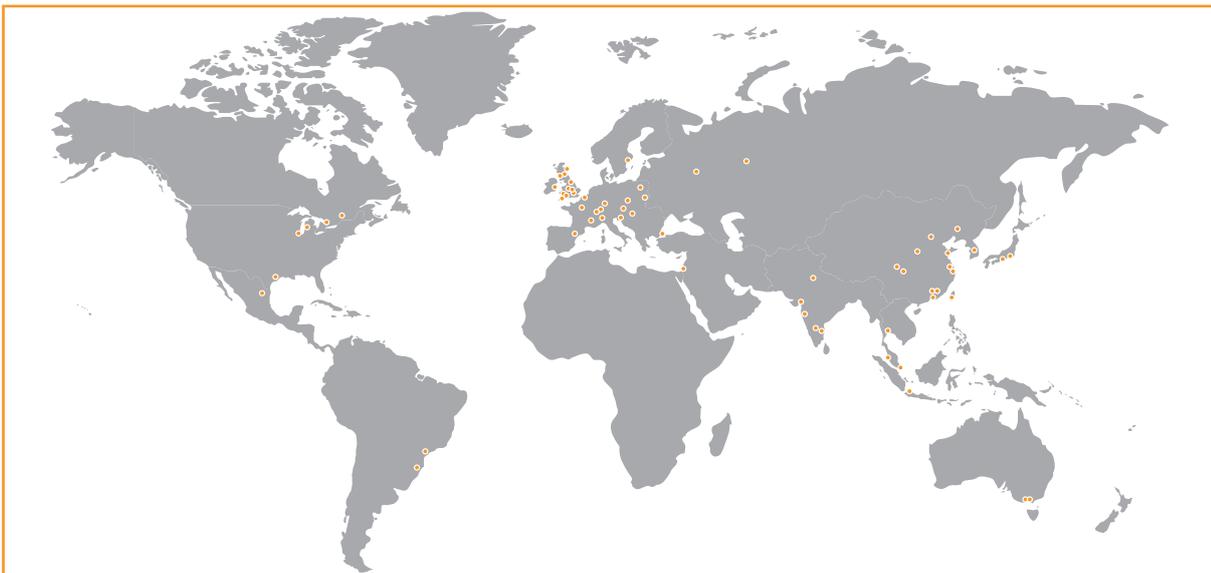
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