



**Optical
Gaging
Products Inc.**



A Quality Vision International Company

Interpreting Accuracy Specifications

Accuracy: The degree of conformity of a measured or calculated value to its actual or specified value

In OGP measuring machines, the error of indication for size measurement, E_x , is related to MPE E , which is from ISO 10360-2 where it is referred to as the maximum permissible error of indication for size measurement. However, due to the unidirectional nature of some sensors i.e. video and laser, multi-sensing systems require an axis-dependent specification. OGP uses subscript 1, 2, and 3 as such designators. Thus the convention OGP uses is derived from ISO, but more specifically takes into account the number of axes relevant to the sensor.

OGP accuracy specifications are expressed in the following form:

$$E_x = [k + (\text{multiplier} * L) / 1000] \mu\text{m}$$

Where:

E = the maximum measuring error, in microns, under the given conditions

$x = 1, 2, \text{ or } 3$ referring to a linear accuracy, planar accuracy, or volumetric accuracy, respectively (see below)

k = systemic or inherent machine error that is not length dependent

multiplier = a constant that defines the travel-dependent error

L = the length of travel over which the accuracy specification is desired, in millimeters

μm = microns, the accuracy unit of measurement

In all cases, the result is +/-

OGP conventions for accuracy specifications:

E₁ is the linear accuracy in a particular axis - X, Y, or Z

NOTE: A specification shown as “E₁ X,Y” with a comma delimiter between axes, means a linear accuracy specification that is the same in the X and Y axes

E₂ is the accuracy within a plane, typically the XY plane

E₃ is the accuracy within an XYZ volume; sometimes referred to as volumetric accuracy

Calculating Accuracy - An Example

Example of a typical single axis accuracy specification:

$$E_1 = (1.5 + 6L/1000) \mu\text{m}$$

E_1 = the linear measurement error in a particular axis

1.5 = the constant; in this case there is a 1.5 micron uncertainty in this axis that is independent of the length of travel in the axis

6 = the stated multiplier; the travel-dependent component of the Z-axis measurement error

L = the length of travel for the measurement, in millimeters

For a stage movement of 150 mm:

Substituting into the equation:

$$E_1 = (1.5 + 6L/1000) \mu\text{m}$$

$$E_1 = (1.5 + (6 * 150)/1000) \mu\text{m}$$

$$E_1 = (1.5 + (900)/1000) \mu\text{m}$$

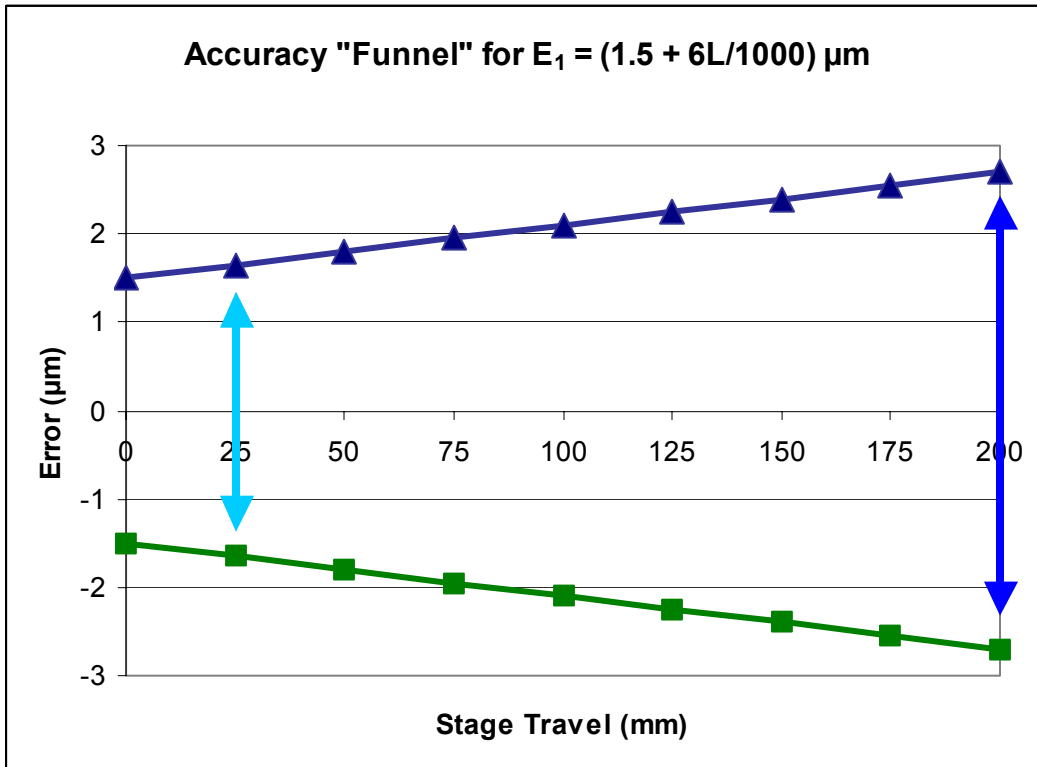
$$E_1 = (1.5 + 0.9) \mu\text{m}$$

$$E_1 = 2.4 \mu\text{m}$$

Therefore, measurements over 150 mm of travel in the Z-axis are accurate to within +/- 2.4 μm .

The “Accuracy Funnel”

Graphing the calculated accuracy results across the range of travels for a given system results in a funnel-shaped plot as shown in the example below (Using our earlier equation plotting points every 25 mm over 200 mm of travel).



Notice that the highest accuracy is with no stage travel, and that accuracy decreases with the amount of travel (compare the error values in the vertical scale for the light blue line at 25 mm of travel compared to the dark blue line at 200 mm).

When specifications are graphed this way, actual system accuracy should fall within the “funnel”.