Calibration Gain Optimization

Getting the best performance from your extensometer

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Calibration Overview

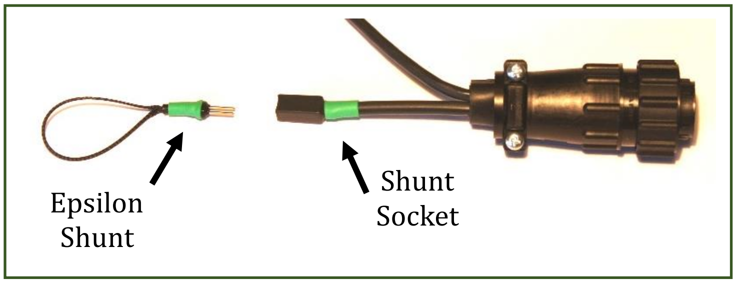
Epsilon's extensometers and other sensors are electro-mechanical *transducers*. The output of the extensometer is a raw analog voltage, roughly proportional to the displacement and excitation voltage.

Conversion of this voltage output to a useful measurement with physical units occurs within the user's electronics system and software. Before using an extensometer, the controller electronics and extensometer must be calibrated together as a system. *Calibration* – sometimes called *rationalization* – is the process of setting/defining the conversion from raw voltage to a measurement with physical units. The linear conversion factor is sometimes called *Gain, Span,* or *Sensitivity*, depending on the nomenclature used by the manufacturer of the electronics.

> *If your measurement error is increasing or decreasing proportionally with displacement, you may need to adjust/repeat your calibration.*

Basic Shunt Calibration Method

The process varies by manufacturer, but most controllers' software provide for two-point calibration using a zero point and a reference point. A common calibration method is *Shunt Calibration*. When the *Epsilon Shunt* is inserted, an electrical *Shunted Output* is produced which is equivalent to mechanically displacing the extensometer by the corresponding *Shunted Displacement*. This provides a convenient calibration method for users who do not have a mechanical extensometer calibrator such as Epsilon's 3590VHR. This method is generally much more accurate than calibrating using calipers or gage blocks.



The Shunted Displacement may be found on the Epsilon Test Certificate. This value has been factory-calibrated to provide the most accurate overall performance for your extensometer. Your Test Certificate may include multiple factory-calibrated Shunted Displacements optimized for different applications.

Detailed procedural instructions for shunt calibration are found in your General Information Manual for Strain-Gaged Extensometers.

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Optimizing Calibration Gain (Advanced techniques)

Most extensometers have slightly nonlinear output. Thus the calibration may be optimized to yield the best accuracy over a specific range, whether for tension and/or compression, or for large or small strain ranges.

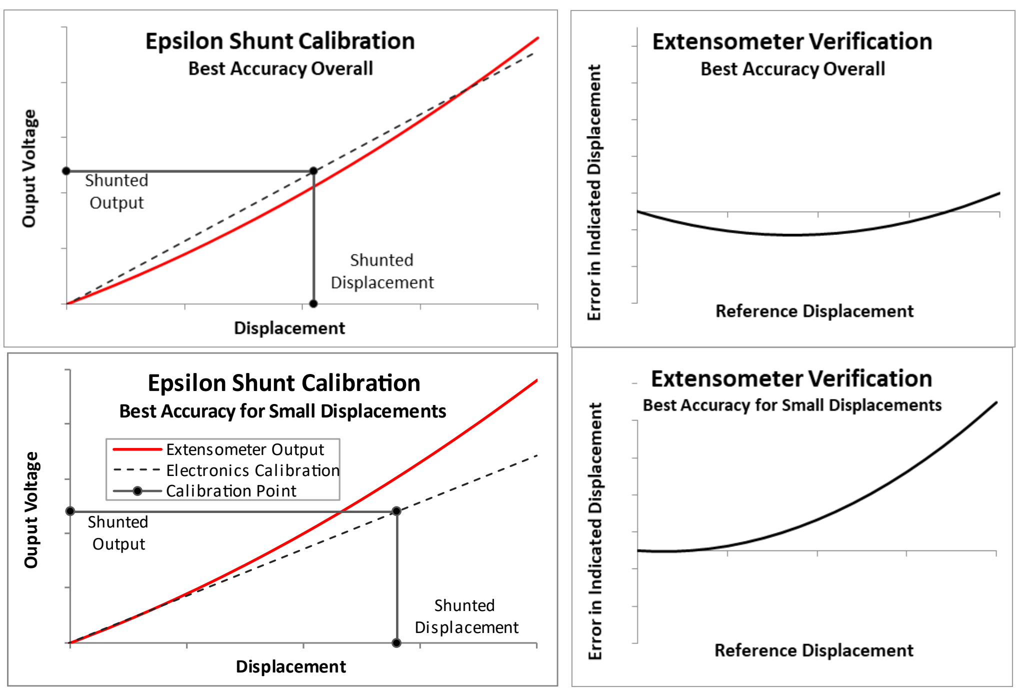
> *Subtle adjustments can be made to the calibration gain (by various methods) to optimize accuracy over a selected range, or to apply a linear scaling adjustment for any reason.*

In some cases it may be advantageous to employ *different* calibrations in different applications with the same extensometer:

> *Unique calibrations can be used to correct for effects of gauge length changes and other variables that can affect measurement sensitivity.*

Gain optimization using shunt calibration method

In this example, we see the results of two different *Shunt Calibrations* using the *Epsilon Shunt Calibration method* with the same *Shunted Output* (voltage) and different corresponding *Shunted Displacements* (mm). The first is optimized for best accuracy over the full range (per test certificate) and the second for best accuracy for small displacements near zero. In the first example we are telling the system to *overestimate* the displacement at the shunted voltage; in the latter, we are telling the system to *underestimate* it.



These represent subtle changes in calibration "gain" which are implemented by making adjustments to the shunted displacement. Some testing systems (e.g. Instron test sytems) include adjustable potentiometers which allow for tuning of the *electrical shunted output* rather than the shunted *displacemement*; the methods are similar.

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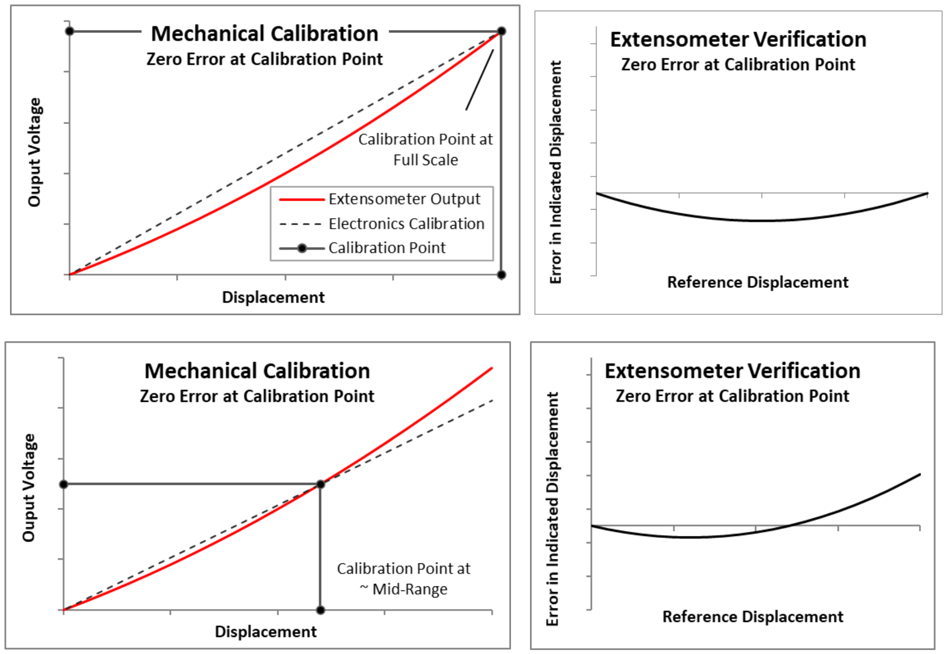
Gain optimization using the manual calibration method

When a mechanical calibrator is used to perform a calibration, the reading error will be zero at the selected calibration point. Any displacement in the extensometer's range can be used for the calibration point. Select a calibration point lower in the range to optimize for smaller displacements.



Gain optimization using direct adjustment of calibration factor; using Δk correction

Some test systems directly expose the calibration gain in software and allow you to adjust it manually (e.g. MTS test systems). Others employ gain tuning potentiometers inside the connector, calibration cable, or other hardware. Some test systems allow for a difference in gain between positive and negative ranges, referred to as Δk, which is a type of limited nonlinear calibration. The details vary between manufacturers.

Nonlinear / multipoint calibration methods

Some testing systems allow for mechanical calibration at more than two points, with polynomial or poly-linear calibrations. Details vary by manufacturer. These methods allow for even greater precision throughout an extensometers's measuring range.

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