## Leica Prism Constant

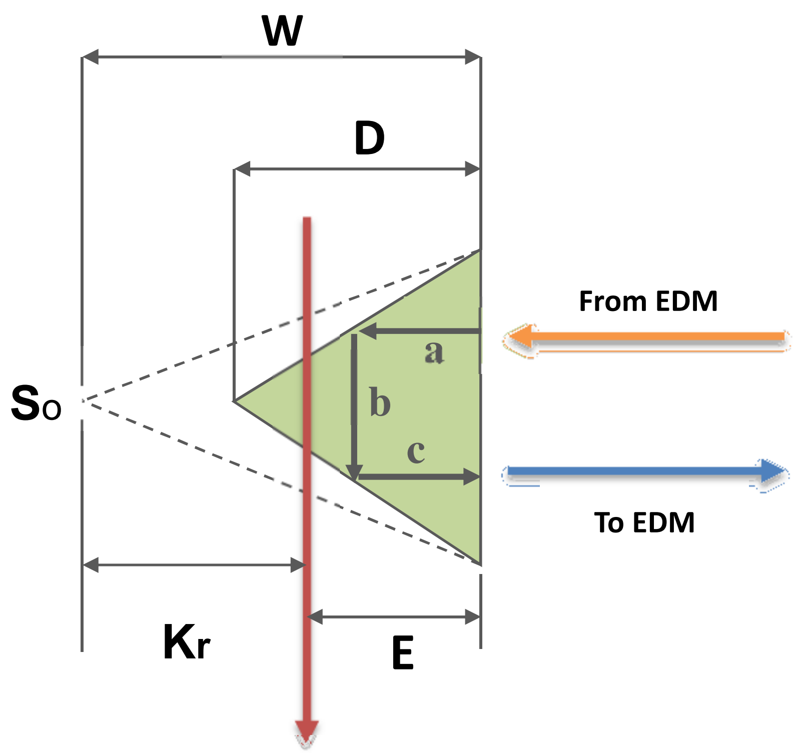
SEP11

Setting the correct prism constant is a simple operation but sometimes leads to some confusion and the cause of systematic errors in survey measurements. The measurements from an EDM using infra-red beams to a corner cube (commonly called a prism) uses a beam emitted from the EDM to the prism and then the beam is returned from the prism to the EDM. The property of the corner cube is such that the beam from the prism to the EDM is returned along the same exact path parallel to the incoming beam. There is some error in this return path called angular beam deviation. So, the distance that the user wants is the distance from the center of the instrument (vertical axis) to the vertical axis (plumb line) of the prism. However, the path of the beam includes the distance the beam must travel through the prism (distance a+b+c in Diagram A) and must be corrected for this "extra" distance and the effect on the speed of light when the beam travels through the glass instead of air.

The design of a prism also needs to consider that the face of the prism may not always be perpendicular to the EDM beam. The design should also ensure that there is minimal effect to angle measurement and distance measurements when the prism is tilted from the plumb line. In other words, the design should minimize errors when the vertical axis of the prism in its housing is titled up or down towards the line of sight and the prisms vertical axis does not coincide with the plumb line.

So, the basic issue for a prism constant is that the beam from the EDM travels to the corner cube (prism), then travels through a short distance through the glass at a different speed (a+b+c in Diagram A), and then is returned to the EDM. If the beam actual traveled a distance equal to distance a+b+c and was compensated for the effect of the traveling slower in the glass the beam would travel to a theoretical reversal point (Point $S_o$ in Diagram A) and then reflect back to the EDM. By the design of the prism and the prism holder the distance from the front surface of the prism to the corner point of the prism (distance D in diagram A) is known and distance from the front surface of the of the prism to the vertical axis of the prism housing (distance E in diagram A) is known by design. The next distance involved is the distance from the front surface of the prism to the to a theoretical reversal Point So (distance W in diagram A) which accounts for the distance a+b+c and the effect of index of refraction of the glass on the beam.

So for common prism with –30 mm offsets or -40 mm offsets the prism offset is the distance from the theoretical reversal Point $S_o$ back to the vertical axis of the prism housing which is distance Kr in Diagram A. <u>This is the prism constant that is labeled on the **non-Leica prisms** that are used with EDMs.</u>




**Vertical Axis of Prism Holder**

**(Plumb Line)**

**Diagram A**

The difference in Leica prisms and third-party prisms for the prism offset is how the value for $K_r$ is handled...

From the explanation above the prism constant by design for a Leica Geosystems standard prism is $K_r$ = -34.4 mm. This is the value that Leica used for many years and is considered the optimal design to eliminate any deviations of the beam when the prism face is tilted or not perpendicular to the path of the EDM beam. Leica Geosystems defines this value…

$K_r = K_{LEICA}$ = 0 mm in the Leica total stations

It is only a matter of understanding that Leica Geosystems has a prism constant to -34.4 mm for their optimal prism design. Within the Leica instruments this value is set to 0 mm ($K_{LEICA}$). Leica builds from defining this as the base point of 0 mm to have Leica Prism offsets for their mini-prism, 360° prisms and reflectorless offsets. A Leica circular prism has a prism offset $K_{LEICA}$ = –34.4mm. To account for this the EDM software in a Leica total station is programmed with a +34.4mm which makes the prism offset 0 when using a Leica circular prism. If a prism has an offset other than 34.4 mm a correction must be applied. The correction is the difference between the – 34.4 mm and the actual offset of the prism being used ($K_r$).

You only need to remember the following equation to use a non-Leica prism with your Leica total station…

Calculating the Prism Offset for Use in a Leica Total Station for a non-Leica Prism

In the firmware the term **Absolute Constant** is used in place of $\mathbf{K_r}$ or prism constant…

$K_r$ = Absolute Constant = Manufacturers Prism Constant

So, to compute the value to be entered in a Leica total station for a non-Leica prism….

Leica Prism Constant for Non-Leica Prism = $K_{LEICA} = K_r + 34.4$ mm

$K_{LEICA}$ = Absolute Constant + 34.4 mm

So for a non-Leica prism that has a design prism offset of -30 mm

Leica Prism Constant = (-30 mm) + 34.4 mm

Leica Prism Constant = **+ 4.4 mm**

The value of + 4.4 mm is the correct value for created a user defined prism in a Leica total station with this design offset.

For a non-Leica prism that has a design prism offset of 0 mm

Leica Prism Constant = (0 mm) + 34.4 mm

Leica Prism Constant = **+34.4 mm**

The value of 0.0 mm is the correct value for created a user defined prism in a Leica total station with this design offset.

There is a very good white paper on the Leica Geosystems Accessories website for Leica Prisms and their design in the downloads section of the web page…

http://accessories.leica-geosystems.com/en/Standard-Reflectors_84830.htm

If you have Technical Support questions, please contact us at G360…..

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