LI-7500 and Direct Solar Radiation

Specification. The LI-7500 has a direct response to solar radiation in CO_2 and, to a lesser extent, H_2O. Figure 1 illustrates our specification, and the typical response. While we don't spec behavior at incident angles > 90°, we've found the 90 - 180° region somewhat mirrors the 0-90° region, but with reduced amplitude.

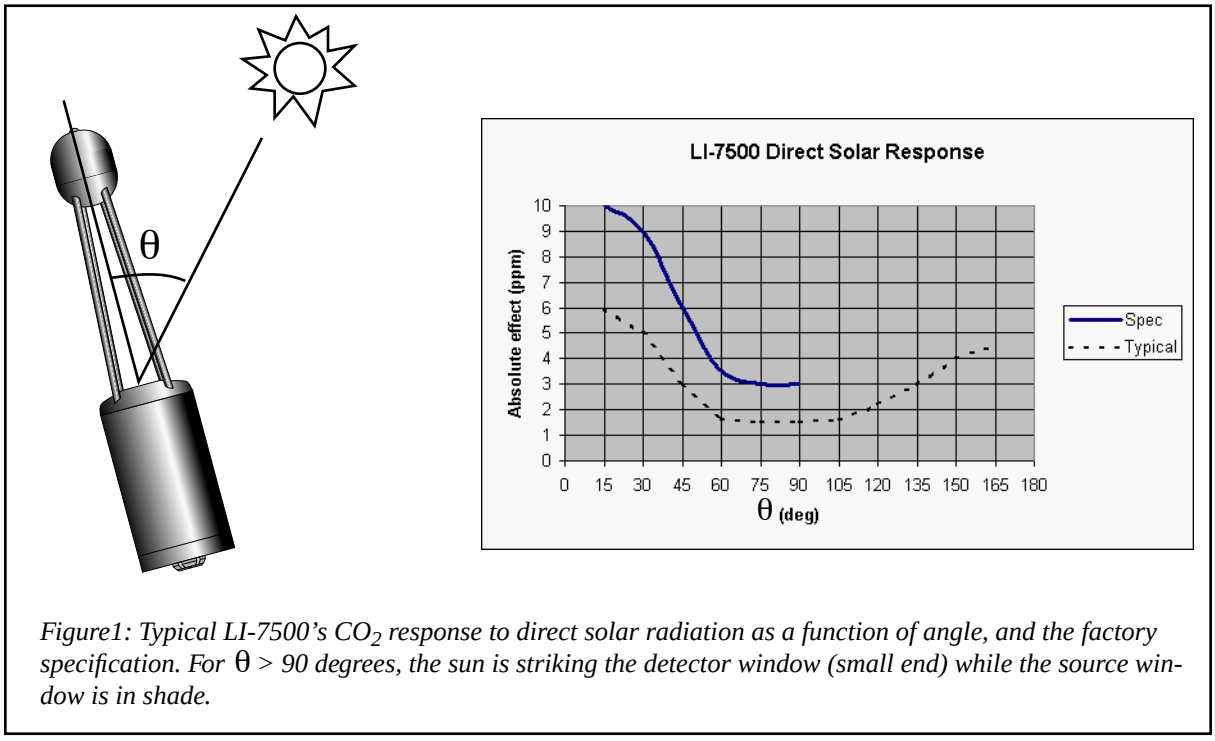

Figure1: Typical LI-7500's CO_2 response to direct solar radiation as a function of angle, and the factory specification. For θ > 90 degrees, the sun is striking the detector window (small end) while the source window is in shade.

Field Check. If you wish to check this response for yourself, pick a sunny day and measure a time series of shaded and unshaded sequences. You can use whatever angle there happens to be between the sensor head and the sun - measure it with a protractor - but the largest (easiest to measure) changes in CO_2 will be at θ <45°. Shading can be done with a piece of cardboard, or anything that is convenient. If a living creature is holding the shading device, that creature should be either downwind of the sensor, or holding its breath (or both); the larger the real fluctuations, the harder it will be to sort out the shaded-unshaded differences. Going from sun to shade might make the reading go up or down, it depends on the instrument, so use the absolute difference. Once you've determined the apparent effect of shading at some incidence angle, compare your measured value with Figure 1. If it exceeds the specification, contact LI-COR.

Minimizing the Effect. The effects of direct solar radiation can be minimized by mounting the sensor head at an angle; tilt the head away from the equator (i.e. North in the northern hemisphere) by an amount that keeps the sun-source window angle θ in excess of 45 degrees. At solar noon, θ is given by

$$\theta = \Phi + L - \delta$$

where L is latitude, ϕ is the tilt of the sensor head from the vertical (away from the equator), and δ is the solar declination (latitude where the sun is directly overhead at solar noon). The worst-case declination is 23.5 degrees. Therefore, if you wish to mount the sensor head so that $\theta \geq \theta_{min}$ all year long, pick $\delta = 23.5$ and compute ϕ given L and θ_{min}:

$$\phi = \theta_{min} + 23.5 - L$$

Figure 2 plots ϕ as a function of latitude for several θ_{min} values, and $\delta = 23.5$. For example, at a latitude of 40°, to maintain $\theta > 45°$, the sensor head would have to be tilted 28°.

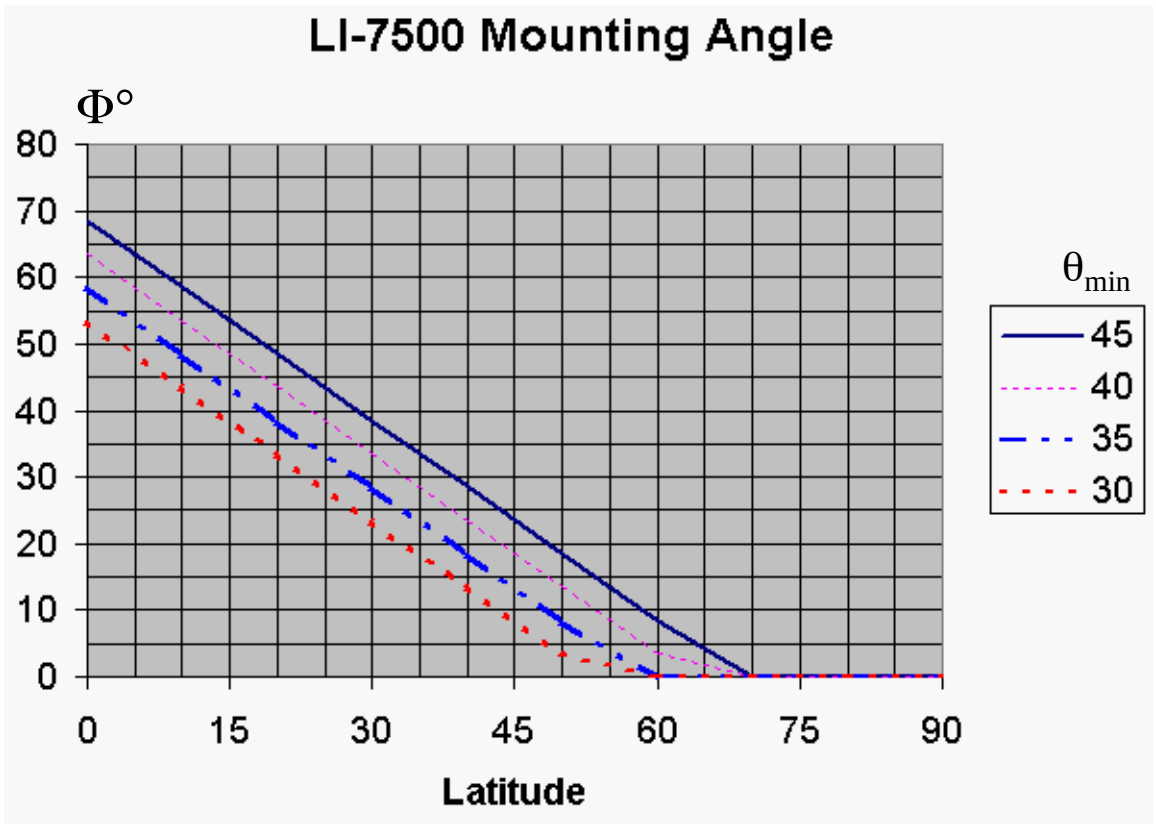

Figure2: The mounting angle required to maintain at least a minimum angle between the source window and the sun year round. Tilt angle ϕ is degrees from the vertical toward the North (northern hemisphere) or South (southern hemisphere).

Caution. If you are tilting the sensor in (or with) the direction of the mean flow, excessive tilt may introduce anomalies involving flow disturbance and/or heat shedding from the body of the sensor into the optical path.