Scanning Lens Selection

In many laser applications, galvanometer scanners are used with scanning lenses to produce a focused spot. The galvanometer scanner deflects the beam entering the scanning lens moving the focused spot within a defined area. The size of the spot and the size of the field area are determined by factors such as the laser wavelength, the diameter of the laser beam, the scan angle, and the properties of the lens.

Scanning lenses are constructed to produce a focused spot in a flat field, the position of the spot being proportional to the focal length (f) of the lens and the angle (theta) of the beam entering the lens, giving them the name f-theta lenses. Ideally the size of the focused spot is constant throughout the field.

F-theta lenses can be constructed in several forms. One of the basic distinctions is between telecentric f-theta lenses and non-telecentric f-theta lenses. Telecentric lenses have the special property that the laser beam is perpendicular to the flat field at all field locations (see figure 1). This has both benefits and consequences. The laser spot will be the same diameter at every location. Maintaining perpendicularity can be important when drilling or cutting thick materials since the resulting feature will be perpendicular to the work surface. The energy density within the spot is also constant throughout the field. This design requires that the lens be larger than the scan field driving up the cost and limiting the size of the scan area.

Non-telecentric lenses are required to produce a flat field of focus but allow that the beam can strike the surface at an angle. This increases the field area and reduces the cost of the lens. However, it also means that the spot will become increasingly elliptical as it is moved away from the center of the field. This ellipticity results in lower energy density due to increased spot area. It also means that the feature created by the laser will be elliptical in the corners of the marking field. These effects are minimized by limiting the non-telecentric angle, typically to less than 15 degrees.

F-theta lenses can be single or multi-element. Telecentric lenses generally require more elements in order to achieve their specifications.

The selection of one of these lenses is based upon the application requirements. Primary considerations in any application are the size of the focused spot and the size of the working field. Non-telecentric lenses are suitable for many applications including marking, engraving, imaging and product identification. Telecentric lenses are often required in micromachining, drilling, cutting and other applications requiring perpendicularity or great consistency throughout the scan filed.