

## Reflective Surface Orientation Accuracy

Solar thermal conversion technologies rely upon extremely accurate reflective surface orientation. The efficiency of a solar thermal conversion system demands positioning of reflective surfaces to within milliradians. Even a minute angle error can result in the reflected beam widely missing its aim point. In addition to accuracy, stiffness of the system must be maintained under strong winds, even as great as 26 m/s (58 mph) for some system designs.

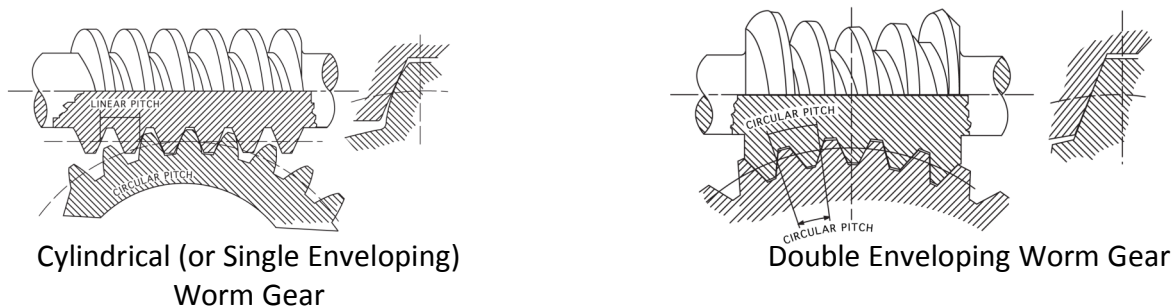
Solar tracking applications require high resolution motion control and output speeds of 0.1 rpm and below. To accomplish this, large overall reduction ratios are needed. Depending on the motion profile and motor speed, overall ratios as high as 50,000:1 may be necessary. Multiple stages of gearing are required to achieve such high ratios.

A cost effective solution for this motion control problem is a gear train divided into two discrete drive segments;

- a primary drive utilizing helical gearing in an epicyclic arrangement
- a secondary drive consisting of a high ratio single worm gear set.

The higher efficiency of helical gearing benefits the overall gear train efficiency. The worm gear secondary drive provides several benefits to the overall gear train. A single stage of worm gearing can be designed with a very high ratio reducing gear train cost. Additionally, high ratio single stage worm gearing has the unique characteristic of not allowing the system to be backdriven by the output under most circumstances. This self locking trait helps the drive system maintain position under static conditions. The worm gear drive also provides all the accuracy the drive system requires. Worm gearing can be manufactured with high torsional stiffness, extremely low backlash, and very precise transmission ratio. Also, the control system can be configured to monitor position at the worm gear drive enabling the use of a low cost helical primary drive.

There are different geometry designs of worm gearing that are widely used in motion control applications. The most common are cylindrical and double enveloping worm gear designs. The two geometries are illustrated in the diagram below.



Double enveloping worm gearing has more gear teeth engaged with the threads of the worm than cylindrical worm gearing. Typical cylindrical designs have 1 to 1 ½ gear teeth engaged compared to up to 10 of the gear teeth engaged in a double enveloping design. The increased tooth engagement decreases the material stresses at area of contact. By reducing the contact stresses in the mesh of the gear set the wear life is significantly improved. In identical applications, the double enveloping gear set will handle more torque and experience less wear than a similar size cylindrical gear set. The optimal gear train design for both performance and cost is attained utilizing a double enveloping worm gear.

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