

# Application Handbook

# Semi-Conductor

## Harmonic Drive LLC

### Crystal Pulling Machine Two-Speed Range Actuator

- Special actuator
- Two-speed range actuator

For the latest generation of 300-mm silicon wafers, special demands are made of the machines used to grow the silicon mono-crystals from which the wafers are ultimately produced. A seed crystal is carefully brought into contact with the surface of the molten silicon and then cautiously withdrawn; the mono-crystal will then grow as a result.

The smooth running of the actuators used to provide this movement is essential to the quality of the crystal and, hence, the quality of the wafer.

The seed crystal is drawn out of the molten silicon with a speed of a few centimeters per hour. Special two-speed range actuators are used for both the rotational movement of the crucible containing the molten silicon as well as the linear movement of the seed crystal. During creep-feed operation while crystal is forming, the extremely slow speed is achieved by a total reduction ratio of 5000:1. This is provided by a FHA hollow-shaft actuator combined with a CSF component set. The innovative combination of brake and clutch makes it possible to operate the actuator in rapid feed with a ratio of 50:1 during the machine set-up.

As can be seen in the diagram, the Circular Spline of the component set is not fixed, but rather can rotate within the housing. In rapid feed mode, the Circular Spline and the Wave Generator are clamped together and rotate with the output speed of the FHA actuator. In creep-feed mode, the Circular Spline is fixed and the Wave Generator is driven by the output of the FHA actuator. In this mode, both the gear reduction ratios are multiplied together.

