The Search for Intelligent Brakes

Figure 1—View of two antenna elements of the Allen Telescope Array at Hat Creek.

The Allen Telescope Array at Hat Creek, CA is a joint venture between the University of California Berkeley and the SETI Institute of Mountain View, CA. SETI has hired Minex Engineering of Antioch, CA to help with the design and installation of state-of-the-art drives and controls for the antenna array. The array will ultimately consist of 350 offset parabolic antennas distributed over an area about 1 kilometer in diameter. The instrument will be used simultaneously for astronomy projects and the search for intelligent life.

The Allen Telescope Array will be an astronomical instrument unlike any other. First and foremost, it is the only major radio telescope purposely built for the search for extraterrestrial intelligence. It is a telescope of unusual design, constructed from a very large number of relatively small antennas. Forming a large radio "mirror" in this way has long been recognized as a technically sound idea, but—until now—an impractical one for an array of such capability. The cost of electronically connecting hundreds of antennas together was prohibitively high. However, thanks to the rapid pace of the digital revolution, what was once impossible is now both feasible and attractive.

The Allen Telescope Array will cost only about one-fifth as much as conventional radio telescopes of similar collecting area. And because it is an array, rather than a single dish, it can rapidly make detailed radio "photographs" of the cosmos. Each antenna is about 6 m in diameter and is positioned using a turntable bearing with pinion and large gear for azimuth moves and a ball screw drive for elevation moves.

This number of antennas yields approximately one hectare (10,000 m^2) of geometric collecting area, about the same amount as the 100-meter telescope at Greenbank, WV.

The azimuth or vertical axis of the antenna has a gear ratio of 4,800:1 from motor to antenna and averages about 8,000:1 on the elevation or horizontal-axis drive. The output pinion on the azimuth drive unit uses a 160:1 harmonic drive to deliver more than 10,000 in.-lbs. of torque with a 2.5" pinion using a motor about 3.3 x 3.3 x 5.8" dimensions. Once this module is installed, the gear train operates with 57% efficiency and can be successfully back-driven. Both axes use the same motor, a Kollmorgen AKM-42 brushless servo motor and Copley Controls amplifiers. On both azimuth and elevation axes, the Ogura SNB Series brake is used to hold antenna position during power failures or other loss of control by the motors. The brake has been sized so that during severe wind conditions, the drive can be back-driven to allow the antenna to point downwind to its designed survival position.

With so many antennas planned, a low-cost design with efficient components is critical to the success of the project. Since wind load on an antenna is one of the main drive system design issues, the wind is allowed to overpower and back-drive the antenna when wind speeds exceed 50 mph. Wind speeds like this are not common but can occur a couple of times per year.

Most spring-set brakes are designed for holding loads at zero rpm or maybe a few emergency stops. Few are rugged enough to be suitable for repeated braking in dynamic situations or applications. In this application the brake's normal function is to hold. But in the event of winds in excess of 50 mph, the antenna begins to move (this is a safety mechanism to prevent damage to the antenna). In the event of high winds, the locked brake acts as a primary dynamic brake, absorbing the energy and dissipating the frictional heat through its flat pancake design. Unique, proprietary, long-life friction materials in the SNB series brake allow aggressive holding power, but with enough low-coefficient materials to allow a steady, controlled slip without damaging the brake or wearing out too rapidly. Braking force is produced via springs, so basic fluctuations in voltage and temperature have no effect on the brake force.

Minex chose the Ogura SNB 0.2G because it provided easy integration into Minex's design, and it came in a range of sizes and friction levels, says Matt Fleming, Minex engineer. Also, Fleming added, the brake allowed for motor replacement during a light wind and was cost effective compared to other options. Finally, the Ogura brake allowed Minex more independent choices of motor suppliers, Fleming said. "We considered motors with integral brake systems but found them less attractive."

Ogura specializes in spring-set, power-off brakes that can take the abuse of multiple dynamic braking events without damage or excessive wear. For this reason, the company's brakes are common in the robotics, semiconductor and machine tool industries.

"Ogura was very pleased to have helped Minex provide a cost-effective, maintenance-free solution to this far-reaching antenna array," says Fred Cacace, Ogura industrial product

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Figure 2—View of several additional antennas with the assembly tent in the background.

Figure 3—View of the azimuth drive unit removable module.

How The Ogura SNB Spring-Set Brake Works

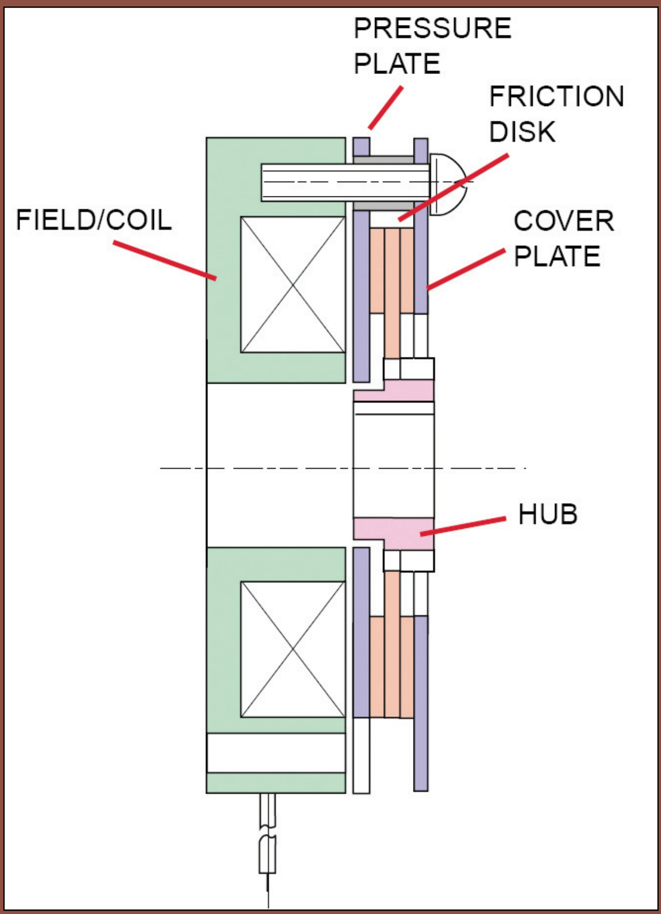

Figure 5—Above is a closer view of the Ogura low-profile SNB Series brake on the azimuth drive unit. In the event of full power loss, the brake can be unplugged and powered by a battery so that the unit can then be driven with an electric drill motor and 3/4 hex socket.

Engagement: When no current/voltage is applied to the brake, a series of springs push against the pressure plate, squeezing the friction disk between the inner pressure plate and the outer cover plate. This frictional clamping force is transferred to the hub, which is mounted to a shaft (customer supplied). The power-off brake is considered engaged when no power is applied to it. It is typically required to hold or stop a load in the event of a loss of power, when power is not available to run a machine.

Disengagement: When the brake is required to release, voltage/current is applied to the coil, creating a magnetic field. This magnetic field pulls in the pressure plate, pulling against the springs, creating an air gap between the pressure plate and the friction disk, and allowing it to turn freely with the shaft.

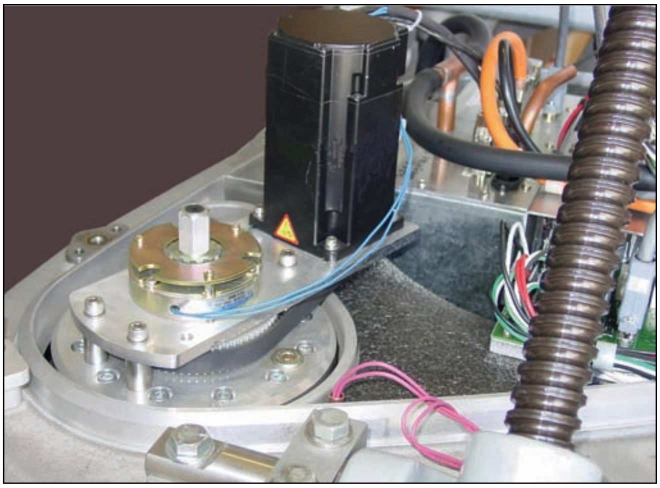

Figure 4—View of the azimuth drive module installed on an antenna.

manager. "Ogura was on time and within budget with 100% quality."

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