NASA TECH BRIEF

A Proposed Laser Measurement System For Determining Surface Contour

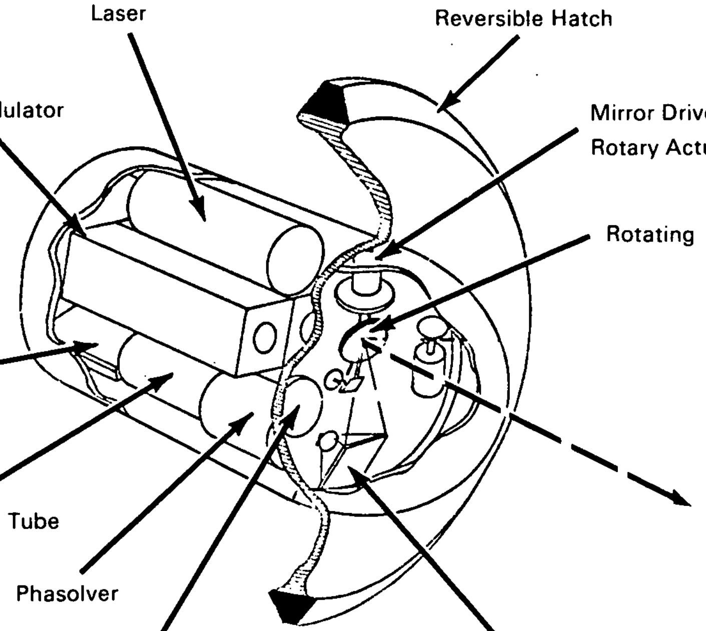

Figure 1. Laser Measurement Unit

The problem:

Many advanced communication systems currently being developed have requirements for large antenna systems. When the antenna is not properly aligned, beam pointing errors result in a severe loss of rf gain. Antenna surface contour measurements must also be made in order to determine the effects of the environment and to establish a correlation between antenna pattern measurements and surface distortion. Contour deviations are a result of the combined effects of manufacturing tolerances, mechanical misalignments, stress relief of structural members, and unequal solar heating. The development of a technique for determining the surface contour in a rapid and accurate manner is a complex problem and no satisfactory method is presently available.

The solution:

An electro-optical concept has been proposed which has the capability of scanning a large (100 ft.) antenna in 30 seconds. The conceptual system incorporates a laser beam amplitude modulated by a Pockel-cell modulator. A comparison of the reflected signal with a reference signal from the modulator driver yields a signal which can be correlated with the distance

(continued overleaf)

covered by the laser beam. A scanning arrangement then enables the contour to be measured.

How it's done:

Details of the instrumentation and flow diagram are shown in Figures 1 and 2. Coherent light from the laser passes through a set of KDP (potassium dihydrogen phosphate) amplitude modulators which modulate the light. These devices consist of an optical cavity which functions on the same principle as a traveling wave tube. The light beam is polarized when it passes through angled windows that form the ends of the tube. Modulation of an applied electric field modulates the polarization angle of the light, hence giving the laser beam amplitude modulation. The modulated light beam is then directed towards a set of mirrors which reflect the beam toward the antenna surface. The antenna mesh surface diffusely scatters the incident light energy; however, sufficient reflection is returned to the collecting mirror since the mesh is woven of wire with a circular cross section. The weak reflection is then directed to a collecting lens, passed through a narrow band pass filter, and focused on the photomultiplier tube detector. The photomultiplier amplifies the signal which is then compared to the reference signal from the modulation driver in a phase sensitive detector. Cancellation of the phase modulation yields a voltage which is directly proportional to the distance covered by the laser light beam. Since the frequency of the laser is known, distance measurements are straightforward and consist of making phase comparisons at the selected frequency between the reference and the probing beam.

The scan technique proposed for measurement of the reflector surface, based on a spherical coordinate system, incorporates a device which converts minute mechanical movements into electrical phase shifts. These phase shifts can be displayed in analog or digital form to provide the instantaneous position of the antenna.

The laser measurement technique is capable of any degree of precision in the number of sweeps since targets are not required. Also, the laser beam may scan the surface at any rate consistent with the detector bandwidth, or it can be pointed at a single point on the surface.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Headquarters
National Aeronautics
and Space Administration
Washington, D.C. 20546
Reference: TSP70-10263

Patent status:

No patent action is contemplated by NASA.

Source: Hans D. Neubert of
General Dynamics
under contract to
NASA Headquarters
(HQN-10326)

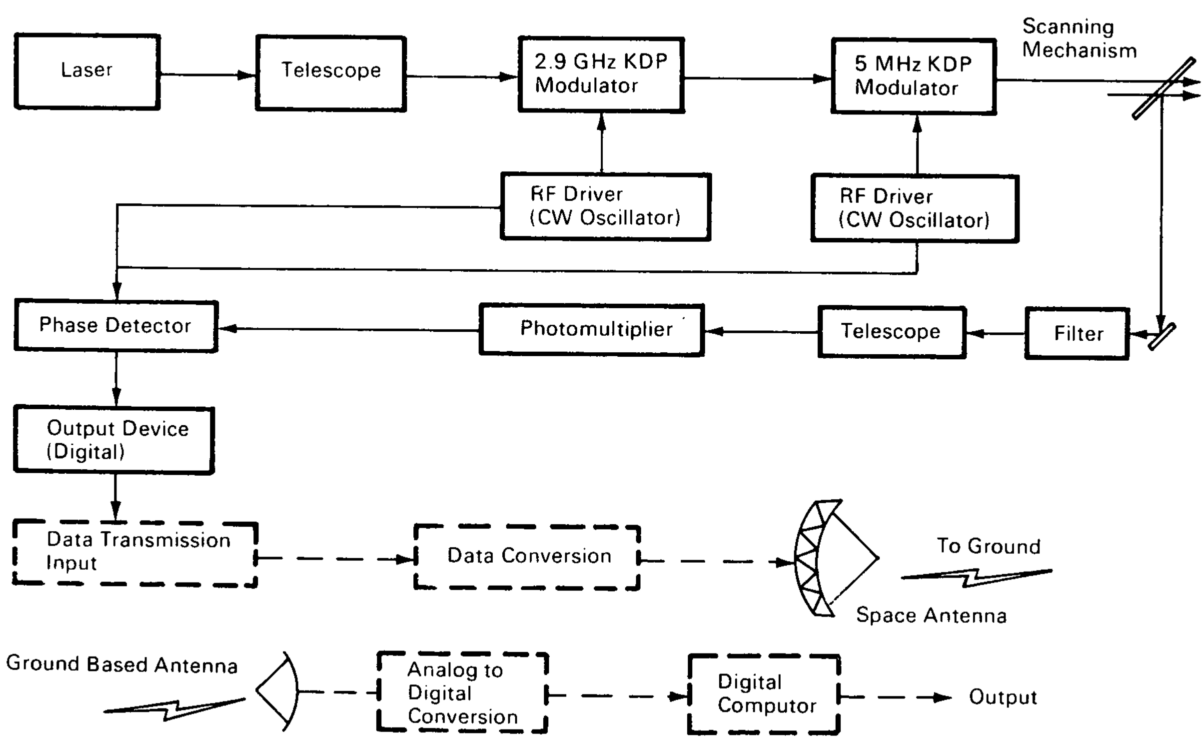

Figure 2. Antenna Tolerance Measurement Diagram