FINAL REPORT
ABLE-3/4 TELEVISION SYSTEM

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I. INTRODUCTION

Early in the Able-3/4 program, the decision was made to place a low-bandwidth television system aboard the Atlas/Able-4 payload. The original purpose was to obtain an image of Venus; but when the program was re-oriented in April 1959, the purpose was altered to that of obtaining an image of the lunar far side. Plans were made to fly the same television system in the Able-3 payload as a "proof test" for its use on Able-4.

The systems were required to have, in addition to a small video bandwidth, (1) small weight, (2) low power drain, (3) small size, and (4) the ability to withstand the payload environment. The television system designed for the Pioneer II payload* met these requirements, and it was subsequently decided to employ that basic system in the Able-3/4 payloads.

There were several aspects of the Pioneer II TV upon which, it was felt, improvement could be made. These were: (1) module size; a more compact module construction was found, (2) case construction; weight and volume were to be saved by employing a different can and circuit board mounting method, (3) rf filters; a better rf filtering technique was considered necessary, (4) lead connections; plug connections to the harness were considered an improvement over permanent solder connections, (5) bias cells; the use of internal batteries was considered unacceptable for a vehicle with a one-year life expectancy, (6) output circuitry; the use of the pulse stretcher analog circuit was to be eliminated if a suitable digital method could be found for accomplishing the same result, (7) telescope; the rf filtering and shielding problems encountered with the Pioneer II TV telescope were to be overcome, and (8) power; use of a standard voltage was required.

The result was that although for Able-3/4 the basic design of the Pioneer II TV system was not altered, some of the circuitry was modified, and the system was repackaged.

* See "Television System Final Report" (Pioneer II), GM-00-4110-00549, 10 December 1958.

It is the purpose of this report to describe in detail the Able-3/4 TV system, methods of construction and calibration, the pre-flight tests, and the final data yielded from the Explorer VI flight. Since the Able-4/Atlas flight aborted, no TV data were obtained.

II. SYSTEM OPERATION

The motions of the payload are employed to provide optical scanning; vehicle spin furnishes line scanning, and vehicle travel along its trajectory provides "frame" scanning. Light intensities are read by a simple optical device, fixed in the vehicle, and designed to see only a small spot of light in a particular direction.

The "optical beam" provided by the optical system sweeps a full circle in space as the vehicle rotates. Furthermore, as the payload moves along the trajectory, the scanned circle moves forward. As a result, a helix is scanned. When this helix intersects the earth, lines are scanned across the surface by the optical beam, due to payload spin. As the vehicle moves around the earth, the scan lines gradually move across the earth until all the visible surface has been scanned. Figure 1 illustrates this procedure.

During one scan of the optical beam (i.e., one payload rotation), the brightness of a single element of the scanned line is selected for transmission back to earth. During the next revolution, the adjacent element brightness is transmitted. During successive scans, adjacent elements are transmitted until 64 such elements (128 on Able-4/Atlas), forming a line of video information, have been transmitted. While the 64 elements are being collected, the vehicle has traveled sufficiently far in its orbit so that when the process is repeated a new and adjacent video line is obtained. Many video lines make up a frame, or picture.

Since only one brightness element of the picture is transmitted each spin revolution, the video bandwidth required of the telemetry system is very low; in the order of 1.5 cps for a 3-cps spin rate.

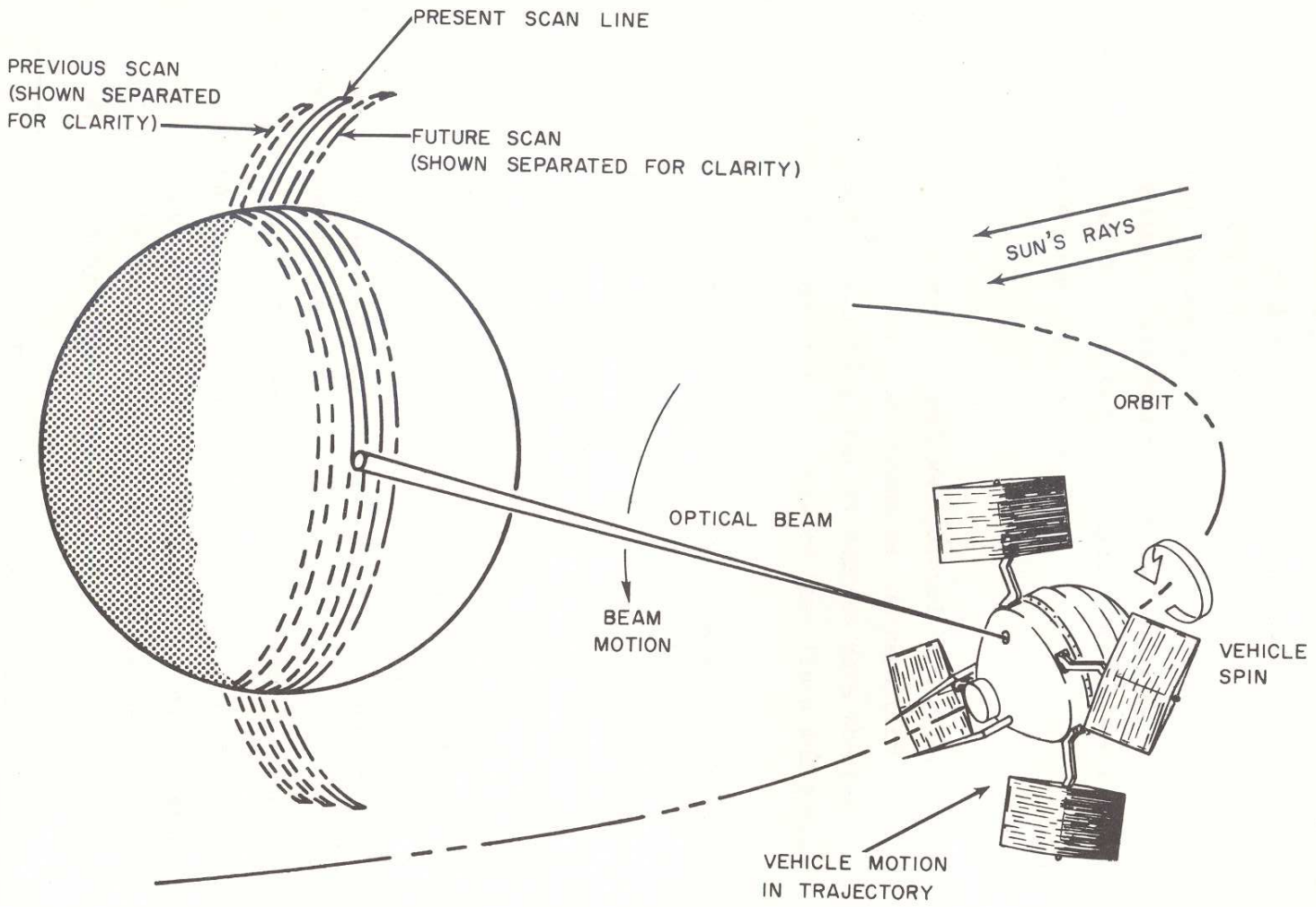

Figure 1. Illustration of Image System Operation.

A block diagram of the TV system is shown in Figure 2. The indexing feature, which selects adjacent elements along a line for transmission, is provided by Scalers A and B and the comparator. The clock, started at the beginning of the video waveform is counted in Scaler A. When the A count agrees with the preset B count, a comparison pulse is generated to command the sampling of the video waveform. In addition, a count is added to Scaler B so that for the next spin cycle, one more clock pulse is required before a comparison pulse.

III. ORBIT

For Able-3, the optical unit was pointed 45 degrees from the tail end of the payload. This angle was chosen as the result of extensive calculations by Coleman* indicating that 45 degrees gave the best compromise between having the proper overlap between scan lines and seeing a maximum amount of lighted earth.

A simplified diagram of the orbit and look-angle geometry is shown in Figure 3. There are two places in orbit where the earth was viewed by the TV, once near perigee and once part of the way out toward apogee. At perigee, the vehicle velocity and distance from earth is such that the TV lines are separated by a distance about equal to their length; hence no picture is obtainable.

At a geocentric radius between 20,000 to 30,000 km, the range and velocity were such to produce scan lines which just overlap. A picture could then be reconstructed. Unfortunately, there appears to have been a tip down of the spin axis at burnout, with the result that the place in orbit where the earth is viewed is closer to apogee than predicted.

This malfunction had three adverse effects. The first is that the vehicle was further away from the earth and therefore larger elements were sampled on the earth's surface. Also, since the length of a scan line is represented by a fixed angle in space, an earth diameter did not

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* "Orientation of Able-3 TV", P. J. Coleman, Jr., GM 41.1-561, 30 January 1959.

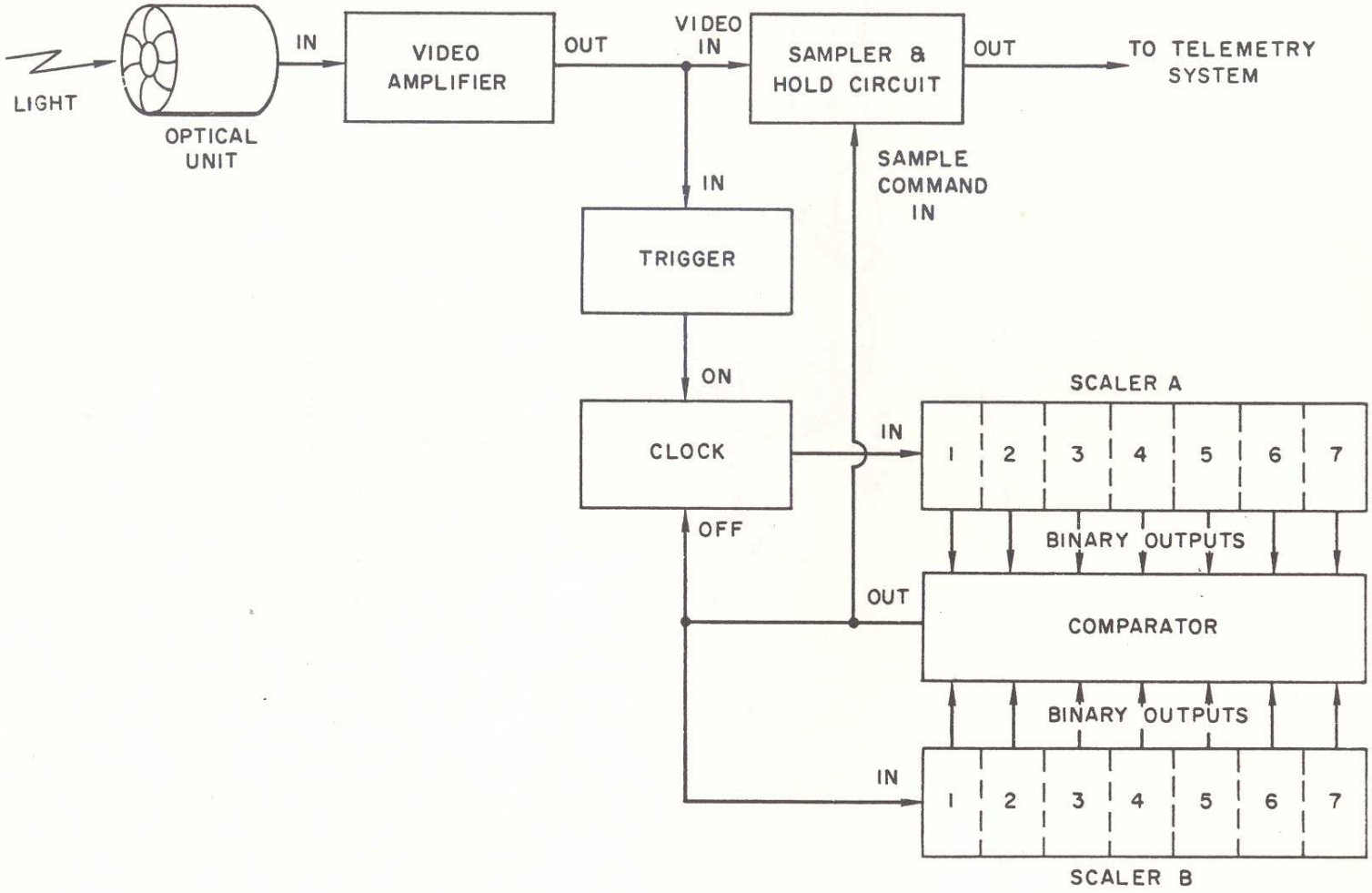

Figure 2. Block Diagram of the TV System.

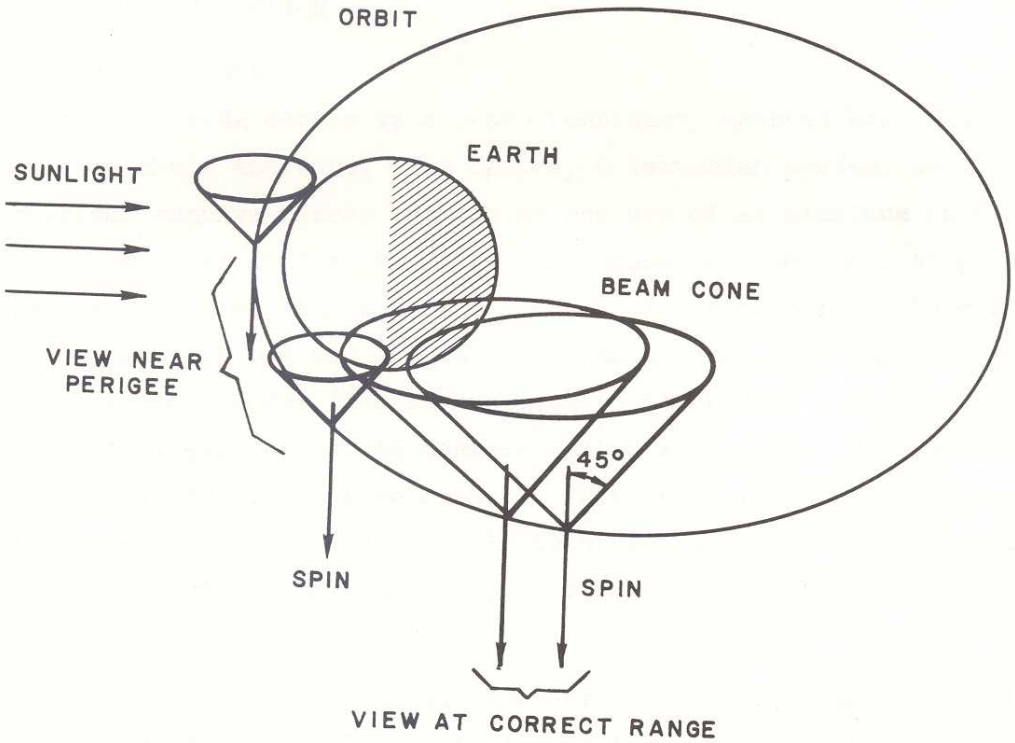

Figure 3. TV View of the Earth (Explorer VI).

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