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TO: Distribution

FROM: Mr. P. Grant

SUBJECT: AN INTRODUCTION TO THE ELECTRONIC COUPLING DATA UNIT (ECDU) (PAPER I)

A series of papers is being written on the electronic CDU and these papers will be supported by informal hourly talks. They will continue and progressively become more detailed as long as interest continues. The papers will be distributed a day or two before the talk. The first talk is scheduled for 9:00-10:00 AM Monday, September 28 in Conference Room 4. The title of the first talk is 'An Introduction to the Electronic CDU'.

Development of the electronic CDU began in May of '63 and is to replace the mechanical gear box of Block I. Development continued to October and at this time three different systems were operating. Two of the approaches were then discarded and the third was further developed to its present configuration.

The CDU's perform the following functions:

1) They provide a means of coupling to the computer the mechanical orientation of the three gimbals of the IMU with respect to the stable member, and also the shaft and trunnion orientation of the optics with respect to the spacecraft. These orientations are taken as analog signals from resolvers and converted to digital information by the ECDU's and then sent to the computer for processing.

2) The ECDU's provide for attitude steering error generation for spacecraft control. This is accomplished by establishing a reference for the spacecraft and recording the deviation from this reference in an error counter in the ECDU. This error information is then used to activate the stabilization and control system to steer the spacecraft, correct the deviation and null the error.

3) Coarse alignment of the IMU is also provided by the ECDU. In coarse align, it is desired to have the gimbal angle orientation changed by computer command. This is accomplished by feeding the error counter AGC pulses equal to the required change in gimbal angle rotation.

4) Visual display of the ECDU angles must also be provided. The conversion from binary to decimal for readout is accomplished by the computer and displayed on the DSKY.

The conversion of analog signals to digital information is performed by solving the following identity.

$$\pm \sin(\theta - \psi) = \pm \sin\theta \cos\psi \mp \cos\theta \sin\psi$$

In the above equation θ is the gimbal angle and ψ are attenuation values which are selected sequentially in incremental steps by the ECDU. Obviously, when θ equals ψ the equation goes to zero and the system is said to be nulled.

In an elementary form the equation may be implemented as depicted in Figure 1. The sin θ and cos θ windings of the resolver are the only source of information to the system. The information is contained in the amplitude and phase of these analog voltages and the task of the CDU is to interpret this information and solve for the angle θ.

The operation of the loop is explained quite simply. When $\theta = \psi$ the system is nulled and there results zero error signal. However, when $\theta \neq \psi$ an error signal results which controls the on-off up-down logic and causes pulses to be accumulated in the counter. The contents of the counter controls the selection of ψ and completes the loop. The accumulation of these pulses is a measure of the gimbal angle. Hence, as long as an error voltage exists pulses will be sent by the up-down logic, changing the 'read' counter and the selection of ψ. The phase of the error signal determines the direction in which the counter will count.

In summary the basic digitizing loop for the resolver signals is the 'heart' of the electronic CDU and the comprehending of its' principal is fundamental to the understanding of the system.

The next paper will be entitled, 'The Coarse System of the Electronic CDU'.

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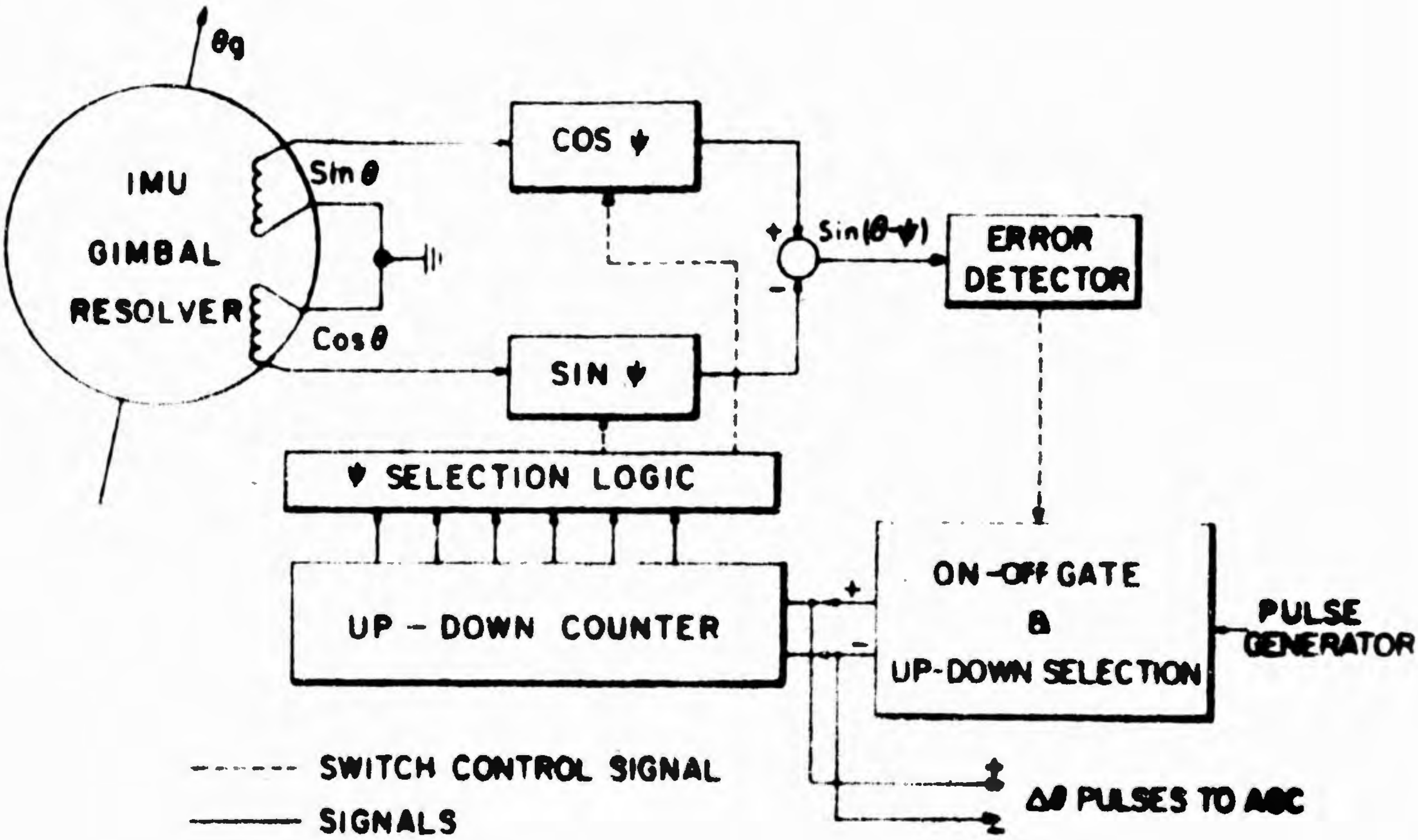

Fig. 1 Elementary CDU digitizer loop.

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