satellite receiver in addition to being the relative time reference for the GeoNav system.

Figure 2 is a block diagram of the GeoNav velocity measurement subsystem. The sonar transducer and associated electronics are the Edo Western 435C pulse-frequency tracking system modified by Texas Instruments to yield only the frequencies of the four sonar beams (Figure 2 shows only one channel) and the time of arrival of their echoes.

The GeoNav velocity measurement subsystem provides parameters for computing the vessel's velocity in a plane tangent to the earth's surface. Components of this velocity are the projections of the ship's fore-aft and port-starboard axes on this tangent plane. To permit navigation from these data, these velocity vectors must be resolved into velocity components in northerly and easterly directions.

Figure 3 is a block diagram of the GeoNav azimuth measurement subsystem. Basic to it is the Sperry MK227-0 gyrocompass which provides X1 and X36 synchro outputs of vessel azimuth in addition to a 400-Hz reference, the amplitude of which is modulated by control from the computer, utilizing an amplitude modulator built by Texas Instruments. This external control from the computer is derived from an algorithm which compensates the gyrocompass for the effects of vessel dynamics on the compass.

A synchro-to-digital converter, Astrosystems A603-5-S149, translates the X1 and X36 information from the gyrocompass to digital form for transfer to the computer. Now available is the information necessary to resolve the data from the velocity measurement subsystem into components of velocity in northerly and easterly directions in the local earth-tangent plane. Basic instrument accuracies are shown in Table I.