

# SATELLITE NAVIGATION SYSTEM

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The Satellite Navigation System emerged with the urgent need for an accurate global navigation system for commercial vessels, oceanographic exploration, geodetic survey and offshore oil exploration.

The U.S. Navy Navigation Satellite System (called TRANSIT) provided intermittent accurate position updates with worldwide coverage irrespective of weather conditions (because high precision signals are transmitted on a direct line-of-sight basis from satellite to the navigation receiver).

There are six operational transit satellites which transmit coherent carrier frequencies at 150 and 400 MHz. Since the transmitted frequencies are derived by direct multiplication of the reference oscillator output frequency, they are very stable (changing no more than one part in 10 during a satellite pass). The six satellites are in circular, polar orbits about 1075 kms high circling the earth every 107 min. It transmits two very stable frequencies, timing marks, and a navigation message describing satellite's position as a function of time. By receiving these signals during a single pass, the system user can calculate an accurate position fix.

The system consists of the following units (as shown in fig. 1) :-

- (1) Antenna
- (2) Receiver/Signal processor
- (3) Digital Computer
- (4) Teletype (Data Terminal)
- (5) High Speed Reader (HSR)

The system receives 400 MHz and 150 MHz signals from the passing satellites, processes these signals and gives the following outputs :

- (a) Doppler Shift (caused by the motion relative to the antenna) which is positive as the satellite approaches the receiver and negative as the satellite moves away from the receiver. The magnitude of the doppler shift is a function of the relative speed and the angle between the satellite and the receiver.
- (b) Orbital and timing data from the satellite (in coded form)
- (c) Two-minute time marks between satellite passes (to keep track of the elapsed time).

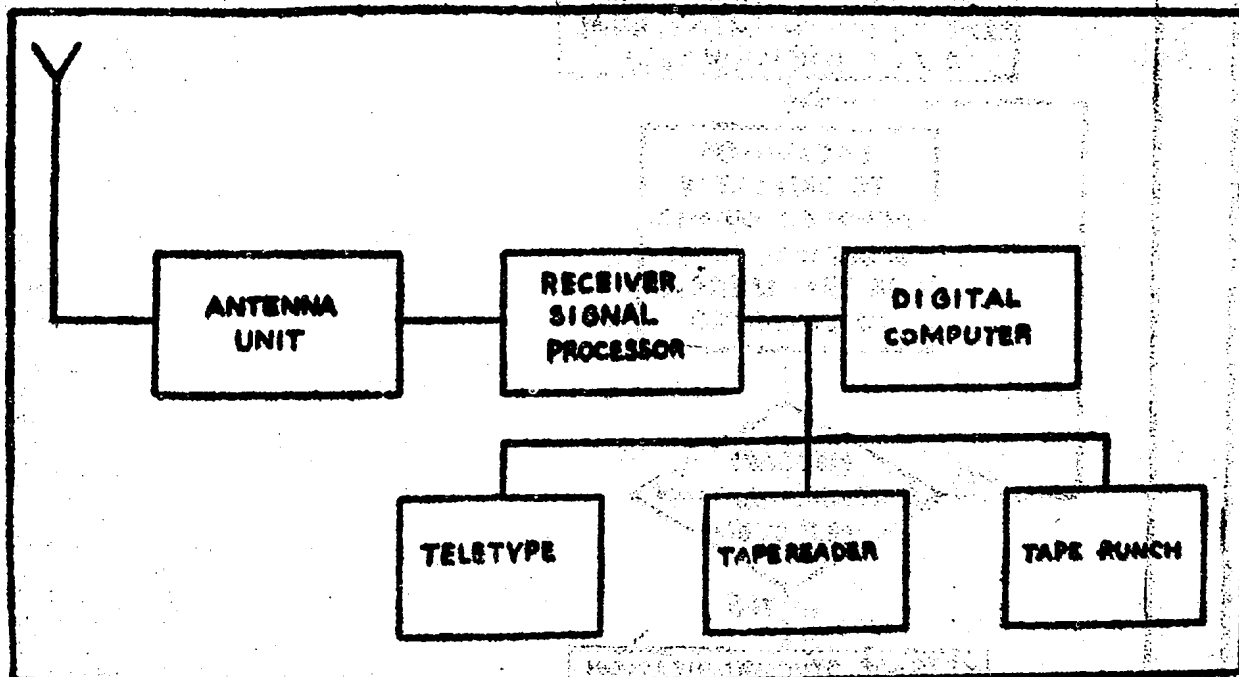
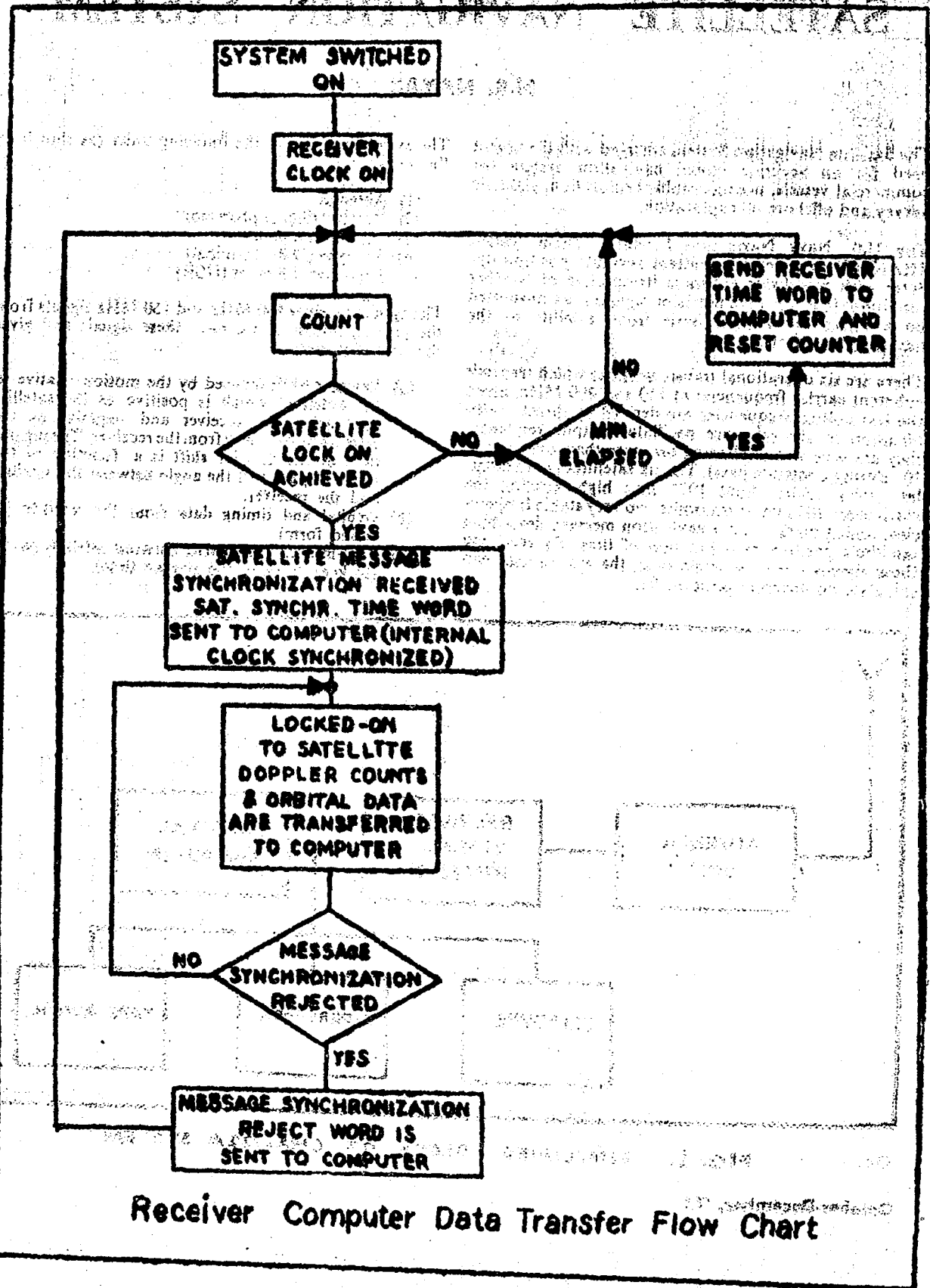


FIG. 1. SIMPLIFIED BLOCK OF CMA-722A SYSTEM



Receiver Computer Data Transfer Flow Chart

(1) **Antenna** : The shipborne antenna provides full hemispheric coverage at 150 MHz and 400 MHz. The antenna signals are amplified in a low-noise filter — preamplifier assembly (fig. 2).

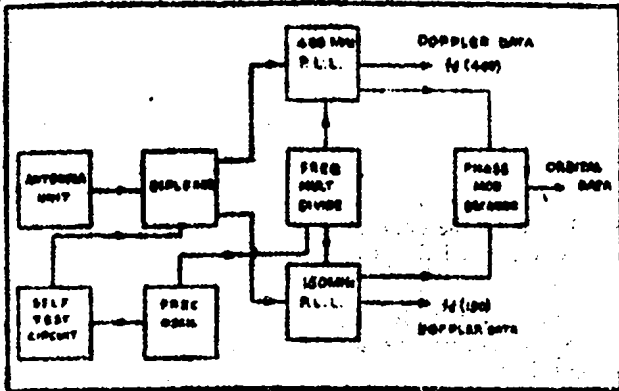


FIG. 2. SCHEMATIC OF THE RECEIVER.

(2) **Receiver/Signal Processor** : Processes the signals received from the low-noise, preamplifier in the antenna, to produce digital outputs of integer Doppler counts and orbital data, for processing by Computer. It comprises

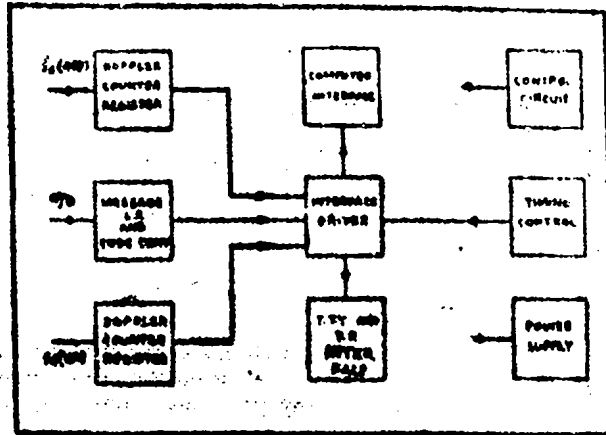
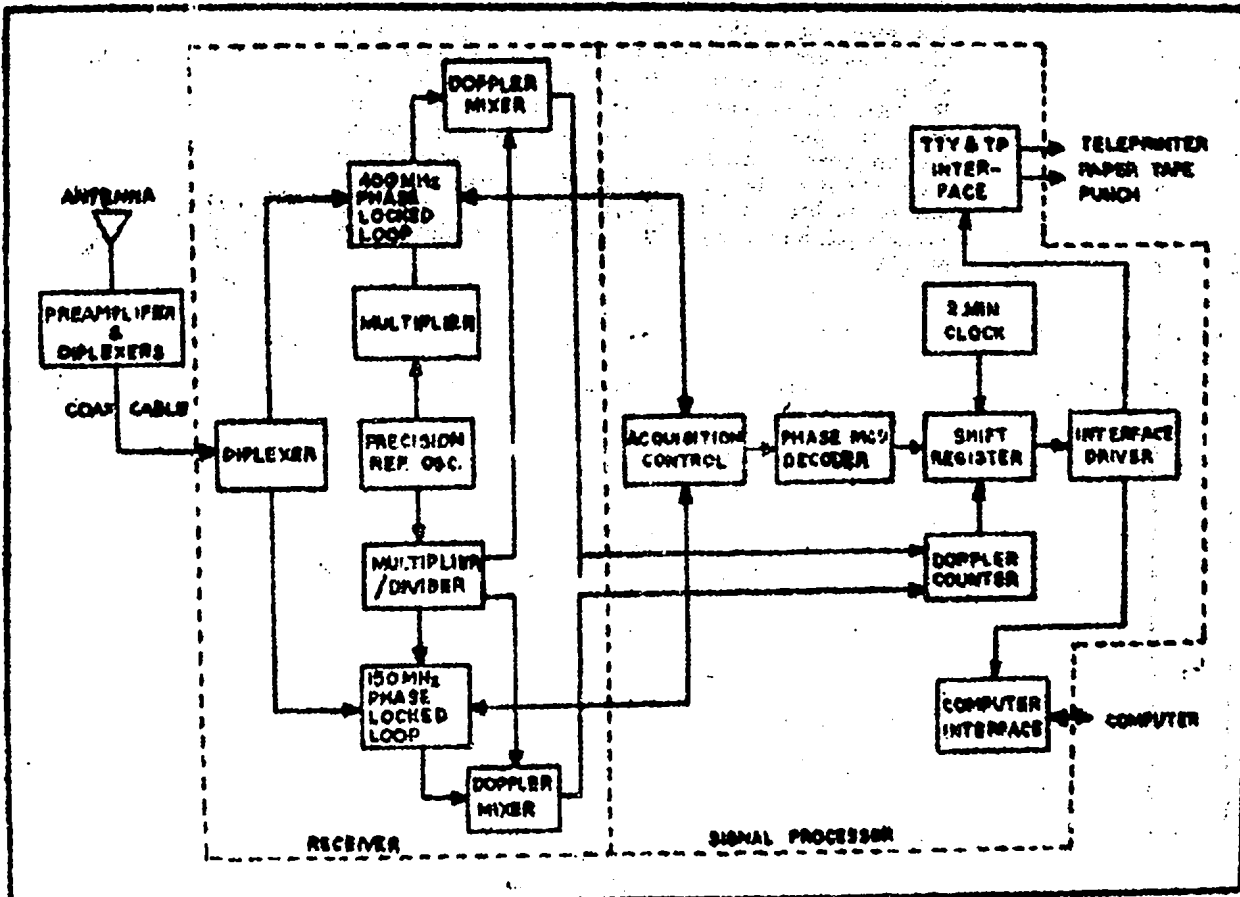


FIG. 3. SCHEMATIC OF THE SIGNAL PROCESSOR.

a precision oscillator, self test circuitry, signal processor, control circuits and power supplies.

The signal processor (fig. 3) converts the orbital and Doppler data signals from the receiver, and generates the synchronisation and timing for proper formatting of the data, for the computer.

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(3) Digital Computer (HP2100A) : Processes the data for giving the position fix in addition to giving Dead-Reckoning positions (using output from Gyro & log).

(4) Teletype (ASR 33) : It gives, as an input device, commands and answers initialising questions. As an output device, it prints out position data.

(5) High Speed Reader (HP 2740B) : Is a binary tape reader which provides a means of transferring information from program (paper) tape at high speed to the computer. It detects coded data characters punched on perforated tapes photo-electrically. Reader accepts 8-track, 1-inch tape at a speed of 500 characters for second.

The main use of the satellite navigation system is its ability to provide world-wide fixes to a high degree of accuracy ( $\pm 150$  metres). Its drawback is the fact that these fixes are not continuously available. As long as the accurate inputs of speed and heading are available to the computer, the accuracy of the dead reckoning is quite high, but it is always time-dependent. Hence, satellite navigation becomes of less and less use as the vehicle velocity gets higher (e.g. Aircraft does not use this system at all).