Wilson - Here is the input on JSC processing of SEP data

TN2 March 12, 1973

MEMORANDUM

TO: Distribution

FROM: J. D. Redman

SUBJECT: SEP Data Reduction: From DSEA to Digital Tape

The intention of this memo is to describe in a preliminary fashion the procedures used in processing the SEP data to produce a digital format magnetic tape from the DSEA analogue tape. This memo is meant as an introduction and overview of a more complete report that will be produced in the near future. Particular reference will be made to the SEP flight data from Apollo 17, and to problems involved specifically with the processing of that data. The complete data flow is outlined in Figure #1.

PRODUCTION OF ANALOGUE TAPE COPY OF DSEA CARTRIDGE

The DSEA cartridge was played back at the tape station in building 12 at JSC (Johnson Space Center). Two original copies of the DSEA tape were made with one recorded FM on a 1"-11 track magnetic tape and the other recorded on a 1/2"-7 track tape. The equipment setup employed during the playback is illustrated in Figure 2.

The VCO data (300 Hz to 3000 Hz) and the navigation data (FSK 4175 Hz - 4625 Hz) from the SEP receiver, and the 5.2 KHz reference signal generated internal to the DSEA are recorded together on a single track of the DSEA. Therefore, it is necessary during playback to filter out those three separate frequency bands and record them on separate tracks of the analogue tape.

The tape station has two modes of operation designated the test mode and the operate mode. In the operate mode the 5.2 KHz signal recorded on the DSEA is used as a reference to control its tape speed on playback correcting for tape speed variations that occurred on recording. The test mode allows the system to operate in a condition where the tape speed is uncompensated and moves at a constant velocity over the heads. When the tape station is used in the operate mode the level of the 5.2 KHz signal is monitored and if it drops below a present threshold then the system switches to the test mode. This switching from one mode to the other produces transients in the tape speed that can give effective data losses of approximately 20-30 msec.

These can cause loss of synchronization in the data acquisition system resulting in a loss of a complete record of 6.48 seconds as well as producing false pulses in the navigation data. It was observed during playback of the flight data in the operate mode that this problem did occur; therefore it was played back again in the test mode. It is this latter tape that has been used in the major portion of the data reduction efforts.

PRODUCTION OF MULTIPLEXED DIGITAL TAPE

The second stage in the data reduction process is the playback of the 7 track 1/2" tape on the model 4170 Lockheed recorder and the use of the data acquisition system to digitize the data. The digitized data is written on an 1108 compatible digital tape and as well, is made available to the Wang computer and plotter for the production of plots or other data analysis. A basic data flow diagram for the acquisition system is shown in Figure #3.

The system clock for generating the basic timing in the acquisition system is produced from the 5.2 KHz reference by multiplying that frequency by a variable multiplier from 1.500 to 2.500. This is necessary because the 5.2 KHz which was generated by the DSEA recorder is not linked to the SEP receiver timing and varies as a function of the DSEA temperature at the time of recording. This is a critical adjustment since a variation of .1% in reference frequency is equivalent to a 6 msec error in timing over the duration of the 6.48 sec. record. The multiplier used for the Lunar data for the run from the SEP transmitter site to Station 2 was 1.995 at the beginning and had to be adjusted to 1.984 by the arrival at Station 2. This is related to the temperature rise over the run from 84°F to 105°F which resulted in a variation in the reference frequency. There is the option in the acquisition system to generate the system timing from the navigation data. This has the advantage of being linked directly to the SEP receiver timing but because of the lower frequency involved is more susceptible to errors introduced by false pulses. An attempt will be made to use this timimg.

Once the system timing has been generated it is possible to sample the frequency of the VCO data in each 33 msec. word during the 6.58 sec. record. Because of tape speed variations it is necessary to calibrate this frequency with the 5.2 KHz reference signal. Both these frequencies are measured over the same time period. The position of the sample time (VCO gate) within the word time is adjustable with a 1 msec. to 33 msec. gate delay and a gate duration of 1 to 7 VCO cycles. The VCO gate and 5.2 KHz gate are measured with a 1 μsec accuracy resulting in a worst case VCO frequency error of .15%. The sources of error and error estimates for the measurement of the VCO frequency will be discussed in a future memo. These digital outputs are made available to the Wang Computer and can also be written on digital magnetic tape.

The navigation data is decoded from the two FSK frequencies (4175 Hz - 4625 Hz) into "1" and "0" logic levels. A pulse width discriminator is used to reject pulses that are shorter than 5 msec. since the narrowest pulse width should be 11.25 msec. The bit stream is then demultiplexed to produce the bearing, range and odometer updates. There are accumulators for the range, bearing and one selectable odometer that are output each record.

In demultiplexing the navigation data it is necessary to make assumptions about the top speed of the LRV. It was assumed in the design of the data acquisition system that the top speed would be less than 17 Km/hr. This allows a maximum of three odometer pulses to be present in any four consecutive 78 msec. navigation data frames. There have been cases observed in the Lunar data of both odometer pulses being "on" for up to twelve consecutive 78 msec. periods. This would be an equivalent LRV speed of 21 Km/hr. The average speed over any 6.48 sec. period as measured from the SEP data was never greater than 12 Km/hr. It is possible that there could have been short bursts with the wheels spinning when this speed could have been achieved but it seems unusual that both the left rear and right front wheels would be turning at this rate simultaneously as it appears in the data. The source of the problem may never be clear; however, it has created difficulties in demultiplexing the navigation data. Another approach is now being used in which the original bit stream is written on the digital tape allowing software in the computer to do the demultiplexing.

The digital tape that is produced in this manner is demultiplexed, and the data is edited and calibrated to produce the final output tape. This tape is then converted to an IBM 360 compatible format for use at MIT. A memo describing the demultiplexing program will be written sometime in the future by Ray Watts.

R. Dave Redman

3 Enclosures

Distribution
Dean Cubley
G. L. Wagner
Gene Simmons
D. W. Strangway
R. D. Watts
A. P. Annan
J. Groener

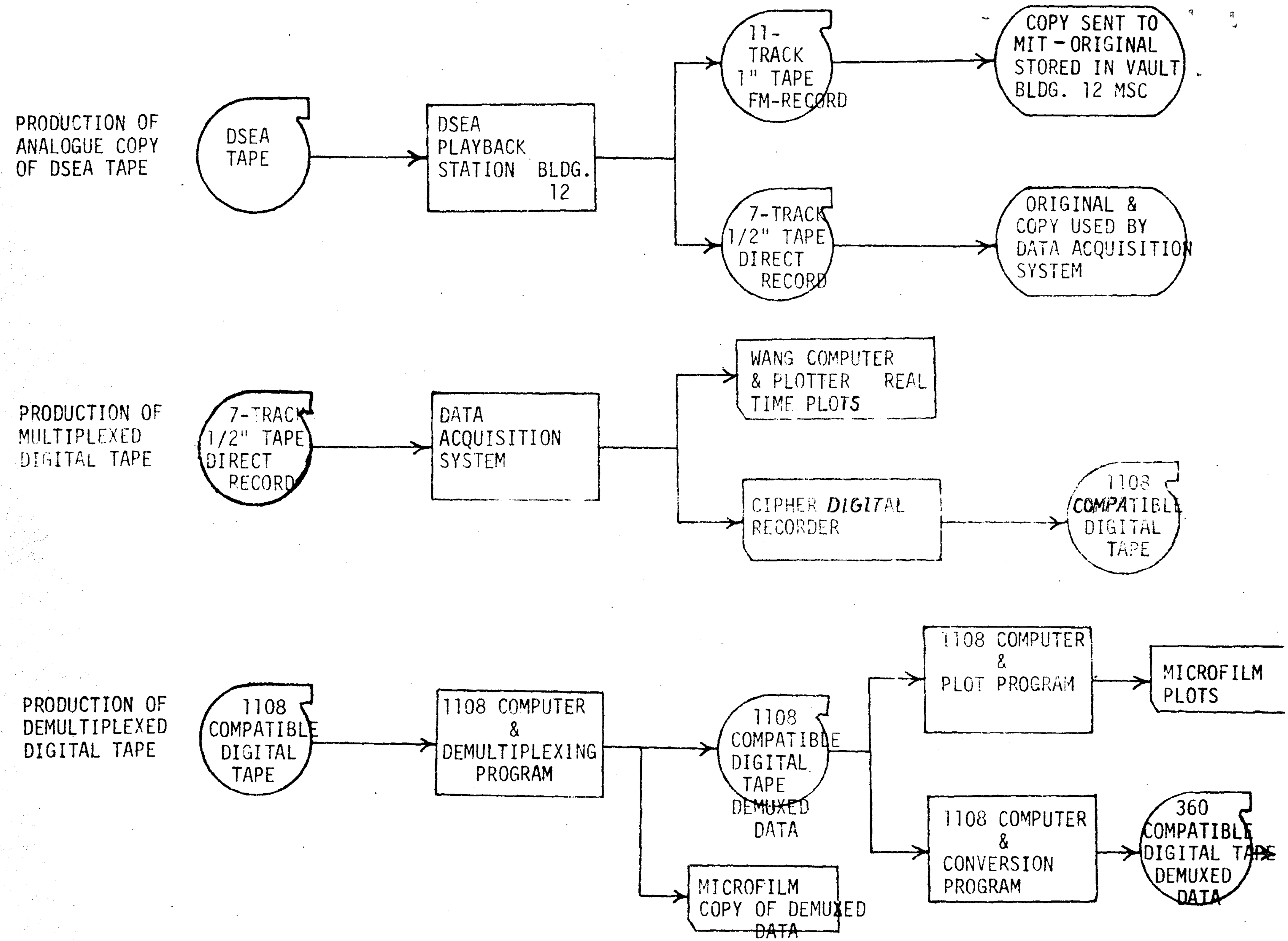
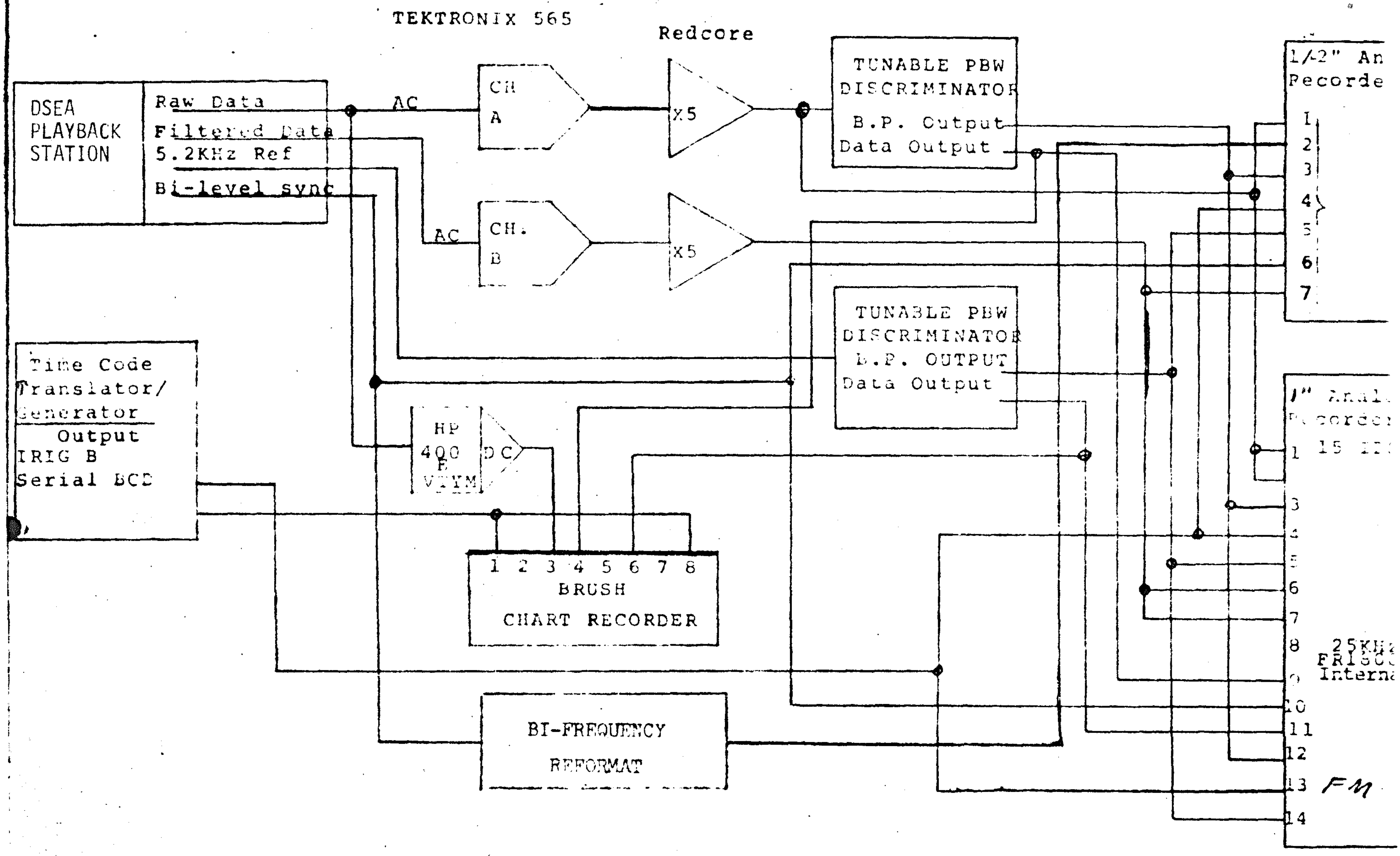


FIG. 1 SEP DATA REDUCTION



SCHEMATIC

FIGURE 2

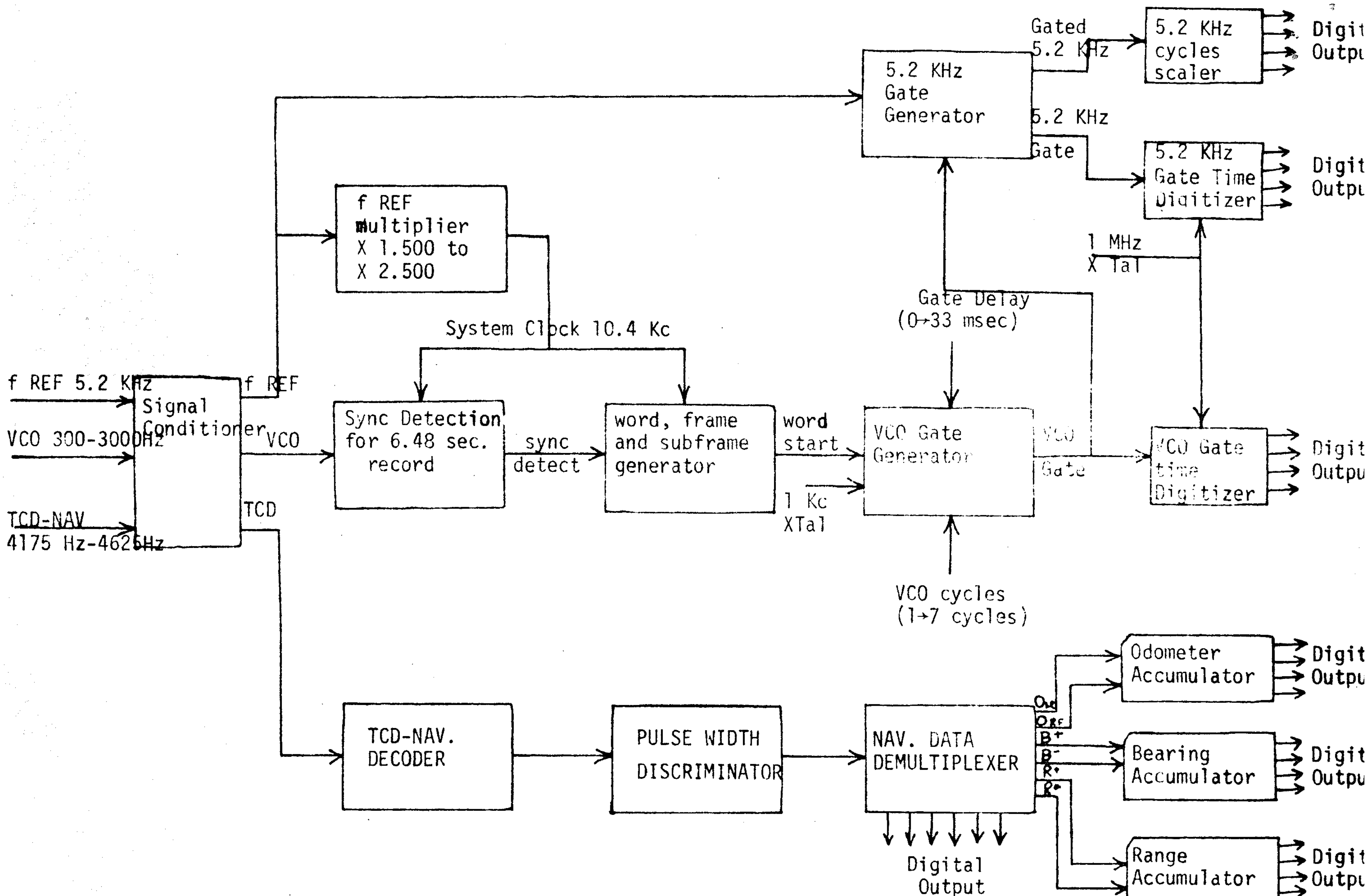


FIG 3 SEP DATA ACQUISITION SYSTEM