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MONTHLY REPORT

for

MARCH 1978

VISSR Atmospheric Sounder (VAS)
Development and Performance Evaluation

Contract No.: NAS5-21965

Prepared by

Space Science and Engineering Center
University of Wisconsin
Madison, WI

for

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD

I. General

Recent work on the VAS program at SSEC has focussed on four areas: (1) implementation of the VAS Data Base Manager and associated peripherals, (2) construction of the TIROS-N receiving system, (3) continuing preparations for the upcoming VAS thermal vacuum test, and (4) applications software development on McIDAS.

Documentation submitted to NASA during the month consisted of "The Videocassette Archive System, 21 Giga Bits on a Videocassette."

II. Data Processing System Development

The videocassette system continues to meet all expectations for quality visible and IR images in operational tests. Work is proceeding on more compact packaging and improved image searching. A description of the concepts of videocassette archiving was written and is enclosed.

The input formatter for the VISSR signal is being checked out. Upon insertion into the VAS antenna system, SSEC will be able to receive simultaneous signals from both geostationary satellites. Until now one formatter has been shared by the two antenna systems.

The VAS Data Base Manager CPU has been brought up to operation. A magnetic tape unit has been attached, the associated 300 MB disc has been checked out, and a CRT has been linked in. Work is starting on generating a system software and operations protocol for insertion into the DBM.

To improve user communications with the appropriate CPU a microprocessor has been interfaced with a card reader (line printer) to allow routing to and from several CPUs. Continued testing of this configuration is planned.

The TIROS-N receiving system antennas have arrived and construction on the roof of the SSEC building will begin shortly. A PSK demod and bit sync have been ordered. The design of the interface between the microprocessor and the attached magnetic tape unit is nearly complete and partially implemented. Insertion of a clock chip, essential for automatic antenna control, is underway. The program language BASIC was established in the microprocessor and software for satellite orbit information is being inserted (Intel PL/M proved to be too unwieldy).

III. VAS Instrument Support

Changes are being made in existing software to evaluate the calibration coefficients from the exact algorithm instead of one that uses approximations that (1) expresses the convolution of the Planck and spectral response function as a single Planck function and (2) expands the Planck function in a Taylor series about the internal blackbody temperature. Preparations are being made for real time data analysis during the next thermal vacuum test.

IV. Development of VAS Data Processing Techniques

The SSEC/NESS development of applications software for sounding continues. Most recently the statistical retrieval technique was modified so that through use of simulated data real time matchups between orbiter overpass and radiosondes are no longer necessary.

SPACE SCIENCE AND ENGINEERING CENTER

UNIVERSITY of WISCONSIN - MADISON
1225 West Dayton Street
Madison, Wisconsin 53706
TWX (910) 286-2771

10 April 1978

Mr. J. B. Connor
Contracting Officer, Code 289
NASA--Goddard Space Flight Center
Greenbelt, MD 20771

Dear Mr. Connor:

In accordance with Article III of Contract NAS5-21965, I am submitting the required Progress Report for the month of March 1978.

If you have any questions or desire further information, please contact me at (608) 262-0118.

Sincerely,

Paul Menzel

Paul Menzel
Program Manager

WPM/rmk

Enclosure

cc: H. Montgomery, Code 942 (10 copies)

THE VIDEOCASSETTE ARCHIVE SYSTEM

21 Giga Bits On A Videocassette

By

Eric W. Suomi

Design Engineer

Space Science and Engineering Center

University of Wisconsin-Madison

14 February 1978

INTRODUCTION

The videocassette archive system was developed to solve the difficult problem of recording high-speed digital data from the GOES (Geostationary Operational Environmental Satellite) series of satellites. The VISSR (Visible and Infra Red Spin-Scan Radiometer) data from GOES are received at a rate of 1.7472 MBS and is continuous for 18 minutes. This amount of data, representing full hemispheric coverage, will fill a 200 Megabyte disk. While instrumentation recorders have been used for data archiving, they are expensive to operate and maintain. Multiple tracks are needed to achieve the high data rates and therefore the associated electronics become complex.

ADAPTING A VIDEOCASSETTE RECORDER

Video recorders have high bandwidths and long recording times (up to one hour typically). Thus, the use of a video cassette recorder as a data recorder is attractive, especially since GOES data have characteristics similar to those of a television signal. GOES data have sectors that are equivalent to "fields" and dead times, like the vertical interval in TV. Dead times are necessary to allow switchover of the scanning heads. By scaling the signal parameters, one can see the adaptability of the videocassette machine toward recording GOES data.

A typical GOES sector is 60 mS in duration. Of this, 6 mS is the synchronization interval of the sector and therefore represents dead time. By comparison, a TV field is 16.67 mS in duration and has a dead time of 1.33 mS, the vertical interval. The scaling factor is 60/16.67 or a ratio of 3.6 : 1. As 1.33 x 3.6 ≈ 4.78 mS, 6 mS is adequate time for head switchover.

The video signal is recorded as an FM carrier varying from 3.5 to 6 MHz. Scaling 6 MHz by 3.6 : 1 yields an equivalent bandwidth of about 1.6 MHz.

Actually, the measured performance exceeds 2 MHz after equalization; this is more than adequate for NRZ or Miller phase encoding techniques.

A videocassette machine has a scanner with two opposed heads, by reducing the scanner speed from 1800 RPM to 500 RPM, an effective rate of 1000 RPM or a 60 mS scan period will be achieved (Figure 1). Furthermore, the scanner can be phased so that head crossover occurs during the dead time in the signal (Figure 2). Tape speed is reduced from 3.75 ips to 1.04 ips in order to maintain the original scan-to-tape geometry, thus preserving the necessary guard bands in between the scans.

DATA RECORDING SCHEME

Group-coded NRZ(M) was chosen as the encoding scheme because NRZ has no ambiguities and less phase sensitivity than most other encoding schemes, making equalization less demanding. The group coding process ensures minimal DC components in a long string of zeros by mapping 4 bits into 5 bits with no more than two zeros in a row. The group coding scheme requires more bandwidth (20%), but, as mentioned before, obtaining adequate bandwidth is not a problem. As 1.7472 MBS x 5/4 ≈ 2.18 MBS, 2.2 MBS was chosen as the bite rate to be recorded on tape. A commercial bit sync is used to recover the data and clock information from the tape. By using a ones fill pattern during the dead times, quick clock recovery after head switchover is ensured.

An actual tape record or slant consists of a 24-bit start-of-record sync pattern followed by a 4-bit record or sector identifier and then followed by the data (Figure 2). A GOES visible sector is 94,800 bits long, while a GOES infrared (IR) sector is only 35,550 bits long. But the IR sector presents a problem; it is 75 mS long and is transmitted at a 524kBS rate. To take care of this, a small buffer first-in first-out (FIFO) memory is used to translate the data rates. The buffer memory also provides a means for delaying the data stream to allow insertion of the sync word and sector identifier at the beginning, as well as buffering necessary for the group coding process. A programmable read only memory (PROM) is used for group code conversion and sync word generation.

DATA CAPACITY

The visible sector actually uses only 53.8 mS of the slant recording time. In reality, up to 58 mS could be used for data recording. (The remainder must be left for head crossover.) At a bit rate of 2.2 MBS, an interval of 58 mS equates to 127.6 kilobits. Allowing for the group coding process, however, it is really only 102 kilobits. Since there are 16.67 slants per second and the tape moves at 1.04 ips, the effective packing density is about 1.6 megabits per inch or 200 kilobytes/in. This is <u>two</u> orders of magnitude over a conventional 9-track tape unit!

At present, there are no error correction schemes applied. Viewing the data, however, shows that even after reuse of the tapes, the visible and infrared pictures are identical in quality to real time pictures. So in practice, error correction schemes have not been necessary.

The information storage capacity of the videocassette machine is immense. The recording time of a 60-minute cassette is: 3600 sec x 3.6 = 12,960 sec. Moving the tape at 1.04 ips results in an effective length of: 1.04 ips x 1.296×10^4 sec or about 1.35×10^4 in/tape. At a packing density 1.6×10^6 bit per inch, $1.35 \times 10^4 \times 1.6 \times 10^6 \approx$ <u>21 Giga Bits</u> or <u>2.5 Giga Bytes</u> per videocassette. That is equivalent to the capacity of <u>seven</u> 300 MByte disks!

SEARCH TRACK

With such a large volume of data, a means to facilitate location of a particular data segment is highly desirable. For a GOES picture, the satellite identifier, scan number, julian day, hour and minute adequately describe any data segment. These data words are latched from the IR documentation and buffered in a small FIFO. A UART (Universal Asynchronous Receiver/Transmitter) formats the data in a serial asynchronous format (Figure 3). This data stream then amplitude modulates a carrier whose frequency is the UART 16x clock, the resulting modulated tone is recorded on one of the audio tracks. In this way, the UART Rx clock can be easily reconstructed during playback and data reconstruction is, therefore, independent of tape speed. The original tape speed of 3.75 ips serves as the search speed. A second UART reformats the data to a standard 1200 baud rate to be acceptable by a computer.

CONTROLS

The recorder transport is controlled by the satellite signal. Presence of SECTOR START pulses places the recorder in the record mode, threading the tape. The unit then waits in pause mode until reception of FRAME CODE, indicating actual picture transmission. Then the pinch roller engages, and data is recorded on tape. Absence of FRAME CODE disengages the pinch roller, while absence of SECTOR START pulses causes the tape to be unthreaded, thereby preventing excessive tape wear between pictures.

The player can be used manually or it can be controlled with a computer via a standard 300 baud asynchronous line. ASCII control characters are used for the transport functions. ASCII "ENQ" character causes the transport status to be sent back to the hose computer via another 300 baud asynchronous line. In this way, automated control is possible.

SYSTEM CONFIGURATION

Figure 4 and 5 show the configuration of the recorder and player, respectively. Note the bit rate feedback to the Motor Drive Amplifier in the player (Figure 5). The bit rate from the bit synchronizer is compared to a crystal oscillator and the playback speed is adjusted to correspond to that rate. Thus, the playback rate is maintained at the bit rate of the bit synchronizer and any tape aging effects are compensated for by the playback system.

While the recorder was designed to archive GOES data, it could be readily used as a computer mass storage "9 track" with the introduction of error reduction coding. This would reduce storage capacity, but even if the storage capacity were halved, operational costs are substantially less than conventional storage means. After all, 10^{10} bits for twenty dollars is a bargain!

FIGURE 1
BASIS FOR SYNCHRONISM

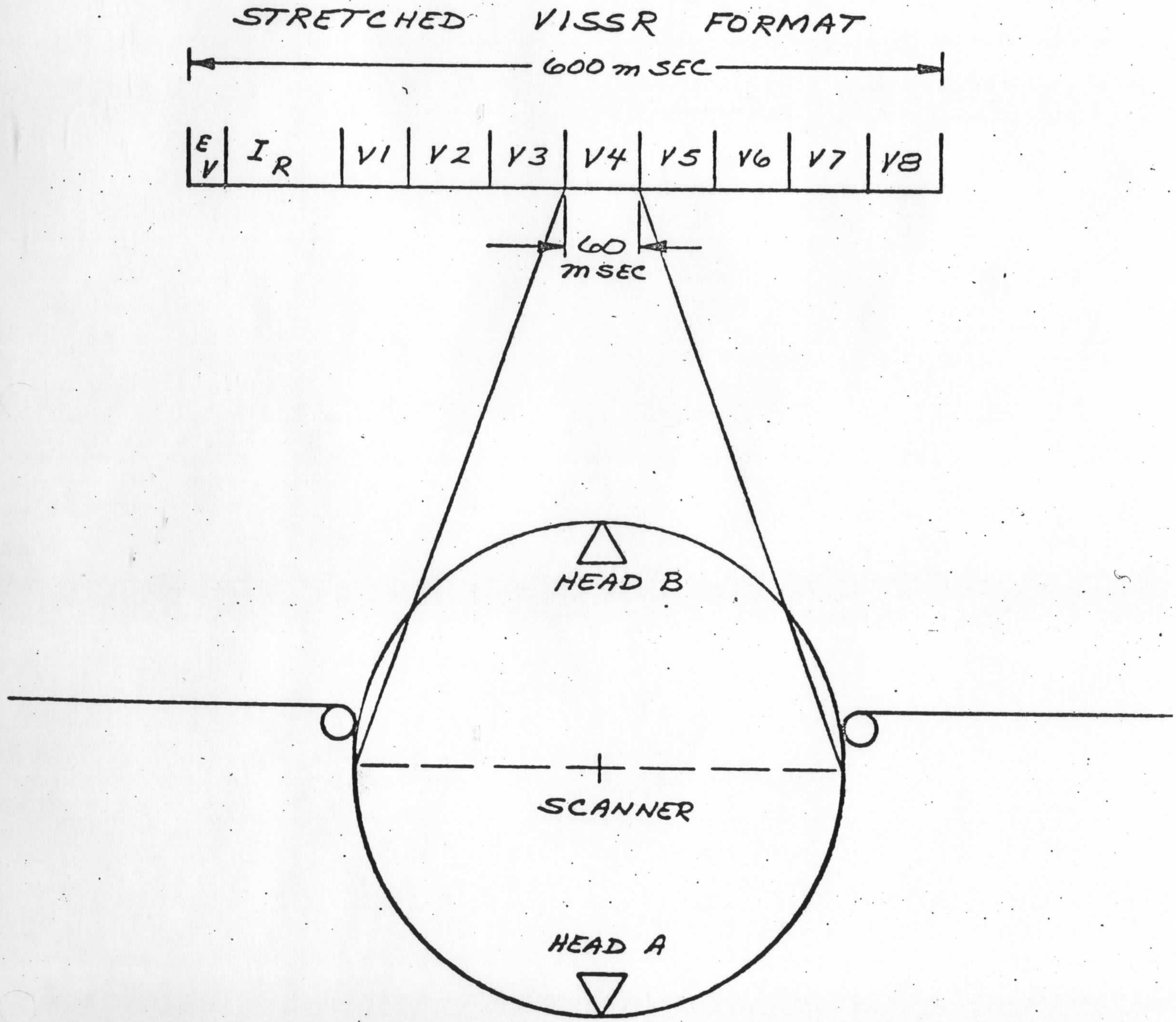


FIGURE 2
DATA FORMAT

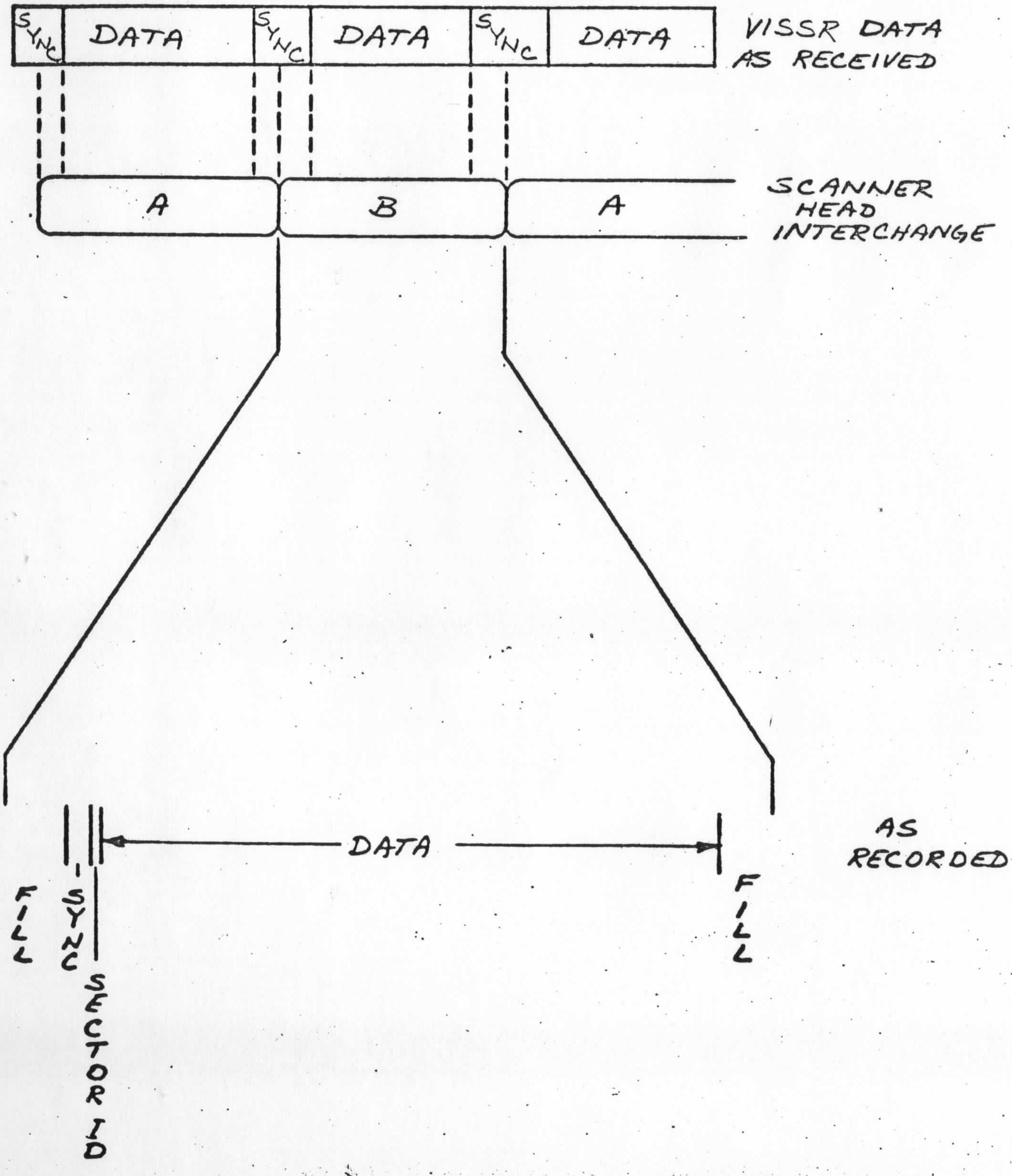


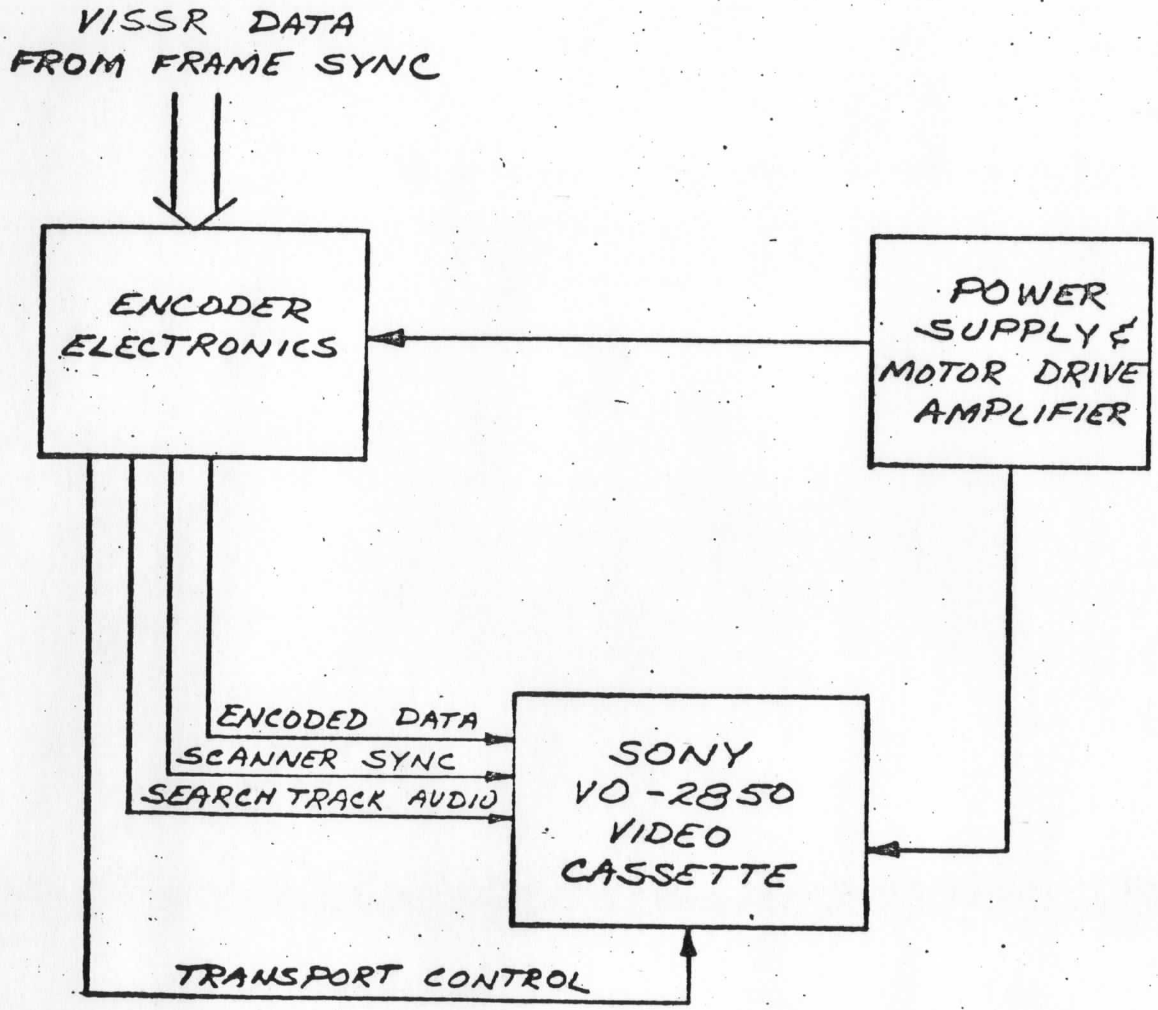
FIGURE 3

SEARCH TRACK

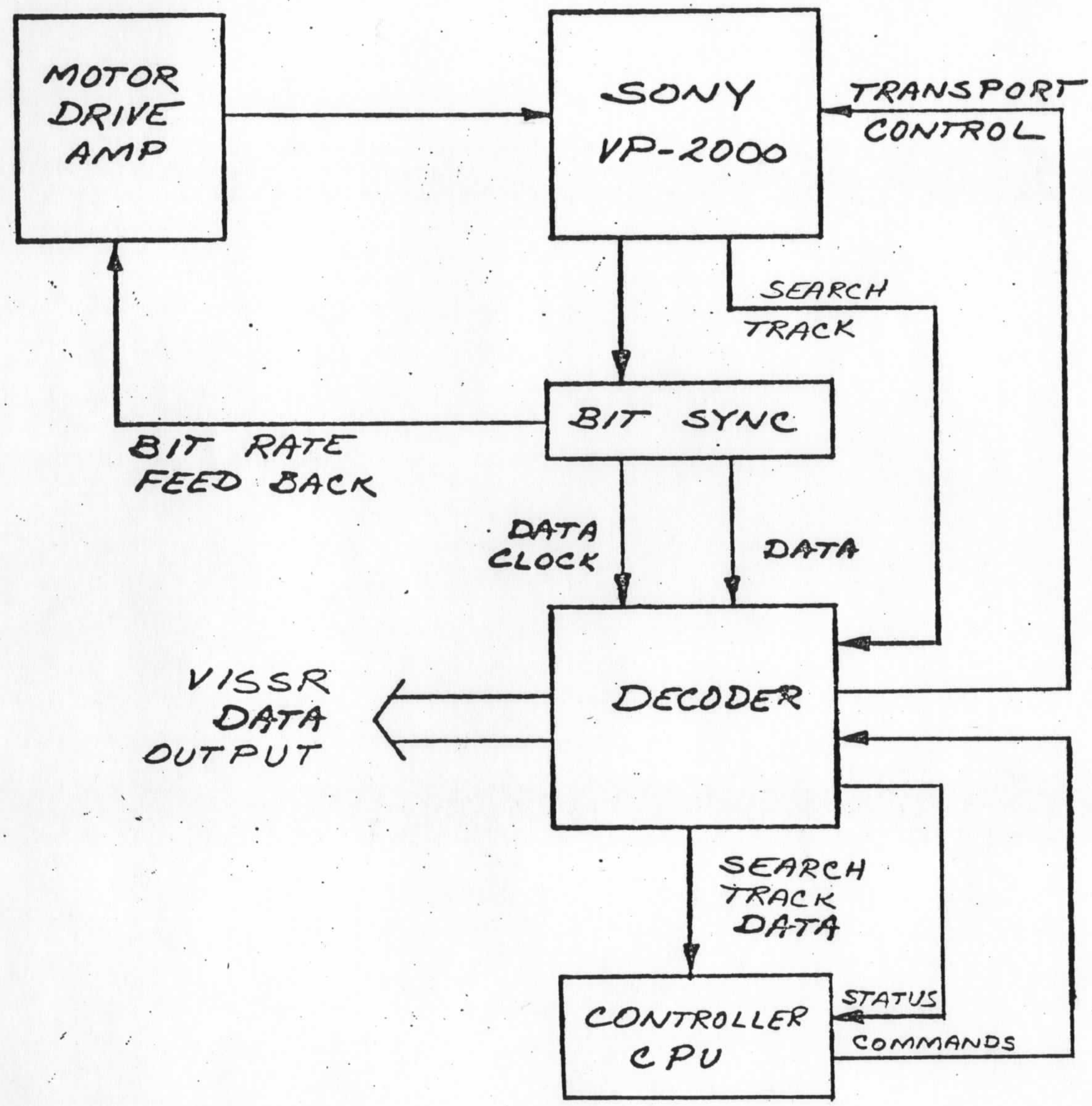
SYNC	(1)	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)	5	6

1 SATELLITE IDENTIFIER
2 SCAN COUNT
3 YEAR
4 DAY
5 HOUR
6 MINUTES

} SEARCH TRACK ACCESS PARAMETERS



ARCHIVE RECORDER
HARDWARE CONFIGURATION
FIGURE 4



ARCHIVE PLAYER
HARDWARE CONFIGURATION
FIGURE 5