NEW DEVELOPMENTS IN THE MAGNETOSTRICTIVE READOUT SYSTEM AT SLAC*

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Abstract

The present paper describes the work done at SLAC for the magnetostrictive wire spark chambers of SPEAR, LASS and the two-meter streamer chamber. All three are CAMAC systems based on the use of a time digitizer module with different interfacing techniques into three different computers (Sigma 5, PDP-9, PDP-11). Of particular interest is a display controller module that permits wide selection of the data to be displayed.

I. Introduction

A CAMAC magnetostrictive readout modular system using fast TTL memories was designed originally to be used with the spark chamber in the magnetic detector of the Stanford Positron-Electron Asymmetric Ring (SPEAR) at SLAC.[1] Subsequently, the great versatility of the time digitizer module made it possible to adapt the system to be used by the two-meter streamer chamber group (Experimental Group D) and to replace the previous system[2] used with the Large Aperture Solenoid Spectrometer (LASS).

II. The Time Digitizer

The time digitizer (ANNA) module (Fig. 1) is the basic module used by all three systems. This unit is a CAMAC four-channel single width module, with bridging clock, start and test inputs and four data inputs. The data inputs are pulses from magnetostrictive wands which have been passed through a zero-crossing circuit to develop a standard TTL logic pulse. Each channel is capable of recording 15 sparks with a resolution of 16 bits. An external clock is used to synchronize the input signals (start, data, test) and as a time base, when counted into the synchronous counter.

A start signal opens the clock gate enabling inputs and memories and allows a 16-bit synchronous counter to start counting (time base). When a spark is detected in a wand, a Write (synchronous) signal transfers the contents of the counter into a 16 × 16-bit fast memory.

At the end of the cycle (synchronous counter overflow) an all-zeroes-word (last word) is written in the memories as a control for the Q response during readout. The clock gate is then closed and the inputs inhibited until the next start pulse. A four-bit counter is used to address the memory locations and is incremented after each data input to accommodate many sparks. If overflow occurs (15 spark/wand) the corresponding input is gated off.

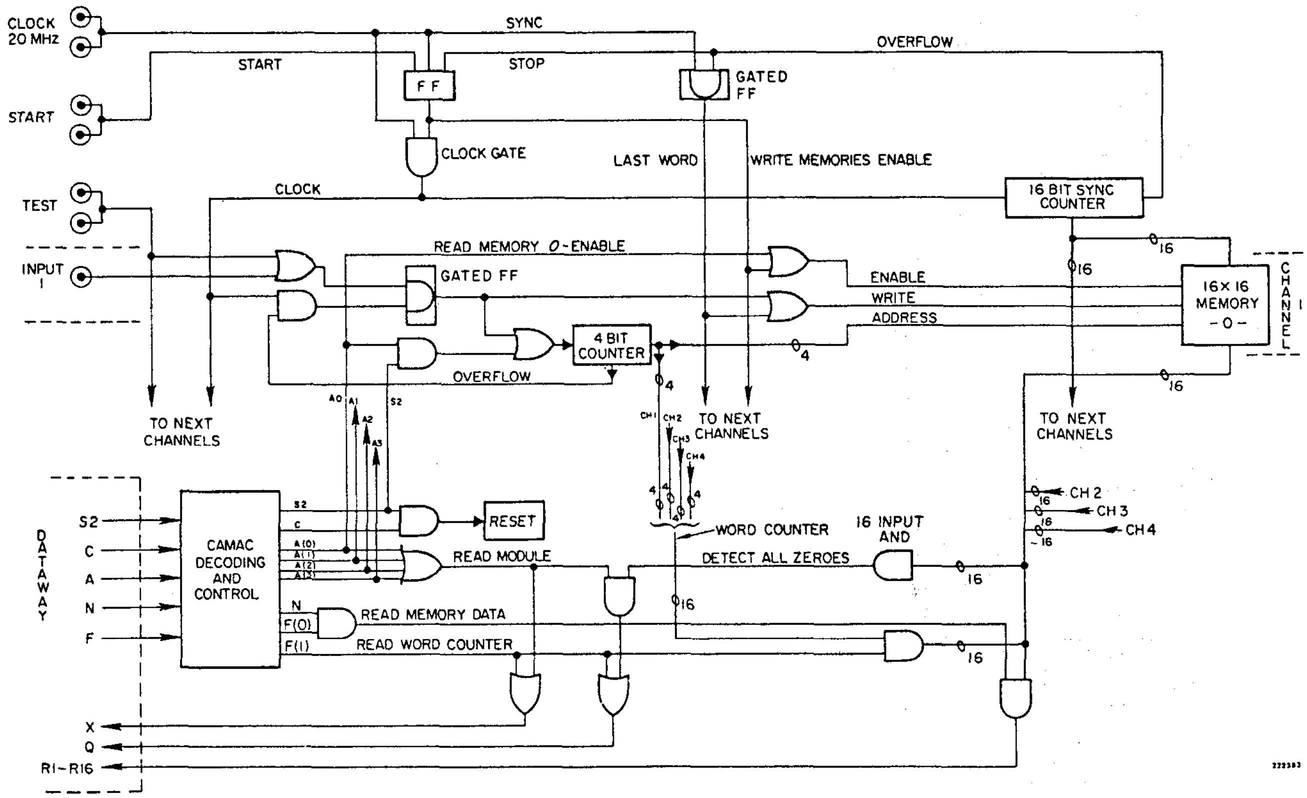

FIG. 1--Timing digitizer (ANNA).

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The digitizer furnishes also an X-line output that will be used by the processor to detect the presence of a module in the various bin locations during readout.

An important characteristic of this module is the fact that no buffer memory has been used between the synchronous counter and the memories; this reduces the hardware and simplifies the control system and, in conjunction with the high speed TTL memories used, data can be recorded at full clock speed. With a clock rate of 20 MHz, this system can resolve a spark pair 0.50 mm apart for a wand velocity of 5 mm/μsec.

III. The SPEAR System

The SPEAR system (Fig. 2) uses 41 ANNA modules (for a total of 164 wands), two crate controllers and a processor, besides wand amplifiers and zero crossing detectors.

When an event triggers the spark chamber, a start signal is generated enabling the modules to accept data. Two fiducial sparks on each wand, in addition to sparks due to particle tracks, are provided for time reference (zero time) and are registered into the memories as the first and last data word.

The original processor interfaces the branch highway to a Sigma 5 computer I/O and contains processing logic to generate one wire address in a 32-bit computer word and a D/A converter for oscilloscope display. Now a new microprocessor centered controller is being developed to preprocess and format all the CAMAC data in SPEAR, so that the original dedicated processor will no longer be necessary. The ANNA system has operated successfully for the past two years.

IV. The LASS System

The LASS system (Fig. 3), similar to the SPEAR system, has more versatility due to the fact that the original dedicated processor has been replaced by three new modules: a fixed time generator, a DMA branch driver and a scope controller.

A. The Fixed Time Generator

The fixed time generator has the function of setting the appropriate time signals for the system after receiving a start pulse from the fast trigger logic. Subsequently, it stops the scope display, starts the ANNA modules and (after 3.5 msec minimum) acknowledges the DMA branch driver that data are ready for transfer.

B. The DMA Branch Driver

The DMA branch driver (Fig. 4) interfaces the ANNA modules via CAMAC to a PDP-11 computer in a 16-bit word format through the computer Unibus in direct memory access (DMA) mode, in which the data transfers are controlled by Q and X responses. The DMA contains an address decoder which allows the program to load a memory address register (location of the first data word to be transfered) and the word counter register (maximum number of words to be

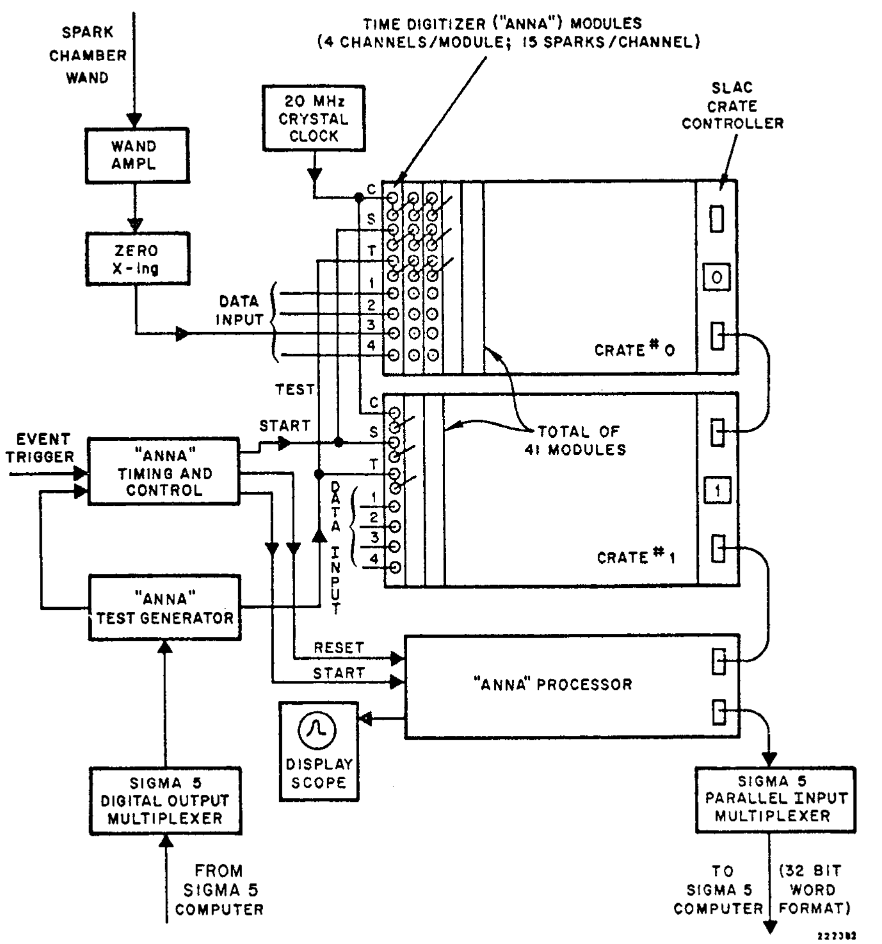

FIG. 2--SPEAR system.

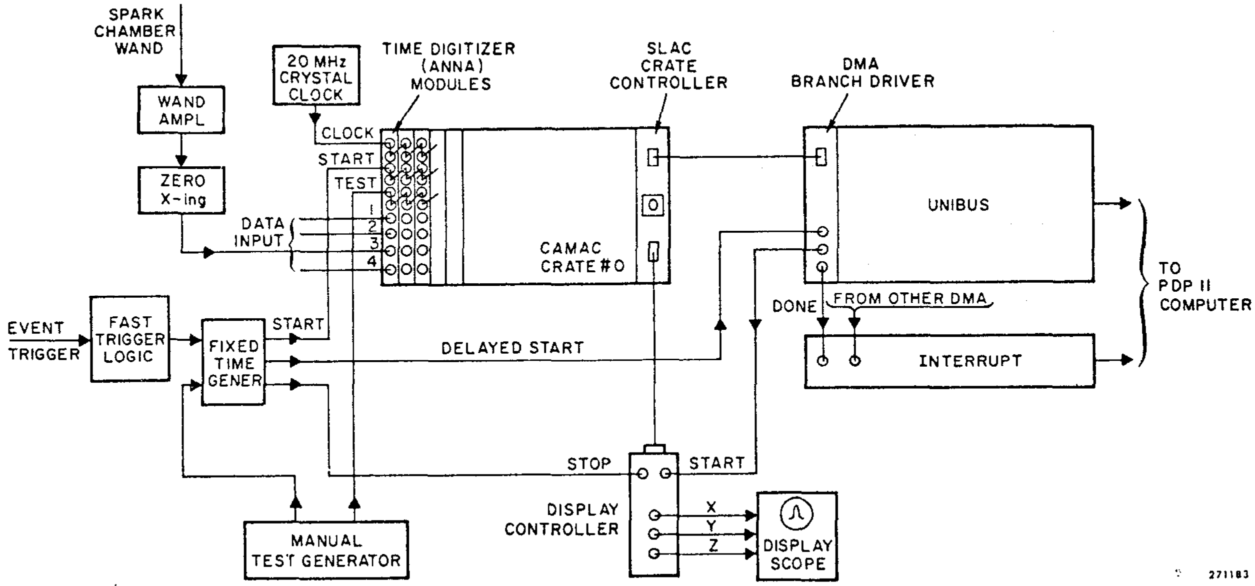

FIG. 3--LASS system.

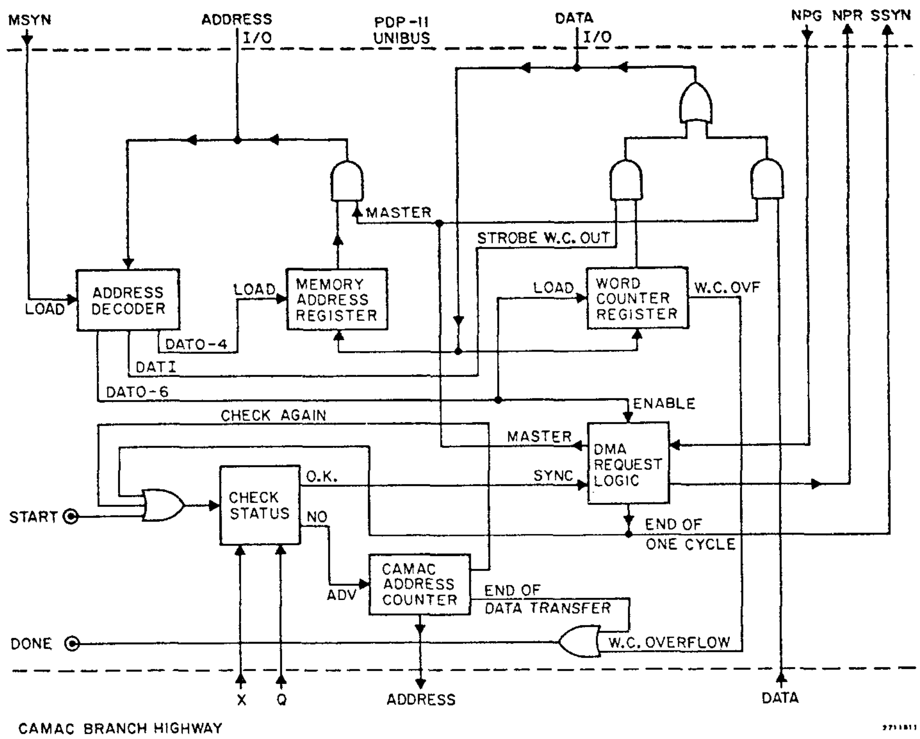

FIG. 4--DMA branch driver.

transferred). At the end of the ANNA write cycle the DMA sends an NPR (nonprocess request) signal requesting the control of the Unibus; the computer replies with a NPG (grant) signal and the data transfer starts. The transfer is accomplished in two subsequent steps: in the first all the word counters of the ANNA modules are transferred. This gives the computer an indication of the total number of sparks recorded. In the second all the data (fiducials and sparks) are transferred.

During readout the DMA makes a selection in the data to be transferred by detecting the presence of an ANNA module in a crate and skipping over empty locations (using the X line) and controlling the exact number of sparks per wand to be transferred (using the Q line). At the end of the transfer the DMA sets a DONE signal, which ANDed with all other DMA sources generates a computer interrupt, and starts the scope display.

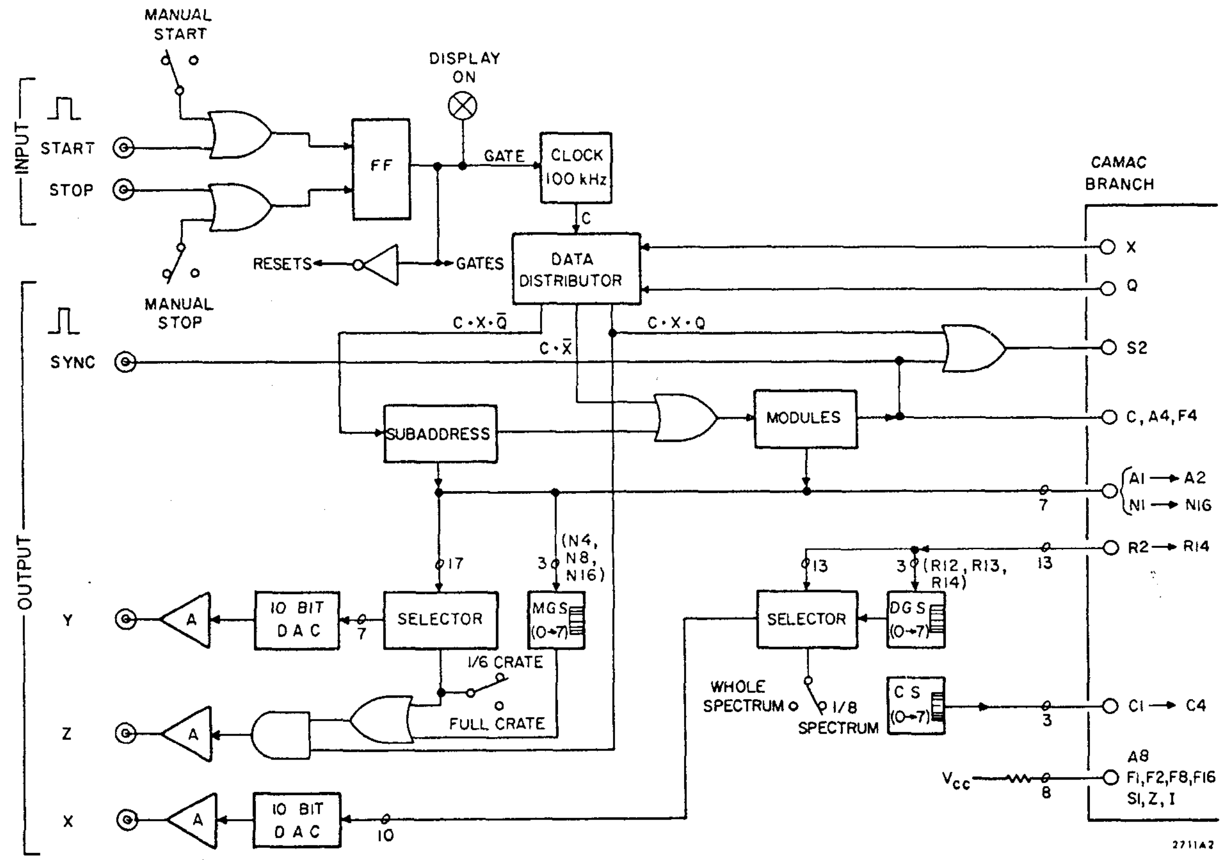

FIG. 5--Scope controller.

C. The Scope Controller

The scope controller (Fig. 5) is a CAMAC double width module serving as a branch driver and can be used with any CAMAC system, provided that the data to be displayed are stored in memories. A DONE signal at the end of the data transfer from the DMA starts the operation. The scope controller then takes command of the branch highway and displays the data on an oscilloscope until the next event.

The main feature of this module is its ability to expand a particular area of the display screen 48 times. Three eight-position thumbwheel switches are used to select one of the seven possible crates (CS switch) and to expand the part of the spectrum to be analyzed in more detail. The module group select switch (MGS) (associated with the y coordinate) selects any group of four consecutive modules (for 1/6 crate), while the data group select switch (DGS) (associated with the x coordinate) selects 1/8 of the horizontal (data) screen for a total amplification of 48 (Fig. 6).

Two 10-bit DAC are used to convert Data and Address into x and y coordinates.

During display operation the controller uses the X-line to detect the presence of an "ANNA" module in the crate and skips over empty locations, and the Q-line to check if a subaddress has been completely read before incrementing the next subaddress.

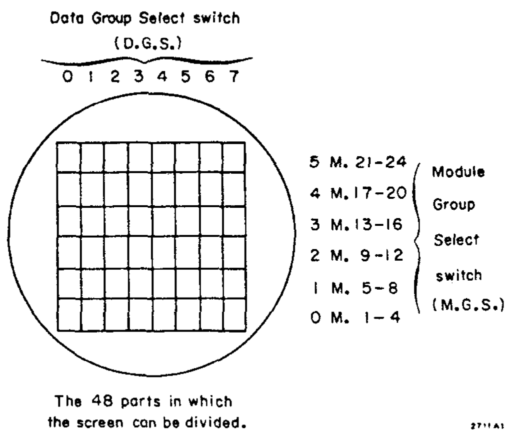

FIG. 6--Scope display.

V. The Two-Meter Streamer Chamber System

The system for the two-meter streamer chamber group (Fig. 7) is the least sophisticated due to the necessity of using pre-existing electronics.

A branch driver NIM module (called MRO) interfaces six time-digitizer (ANNA) modules (for a total of 24 wands) to the existing electronics from scintillation counters, hodoscopes, scalers, high voltage DVM, etc., whose outputs are daisy-chained to the interface to a DEC PDP-9 computer.

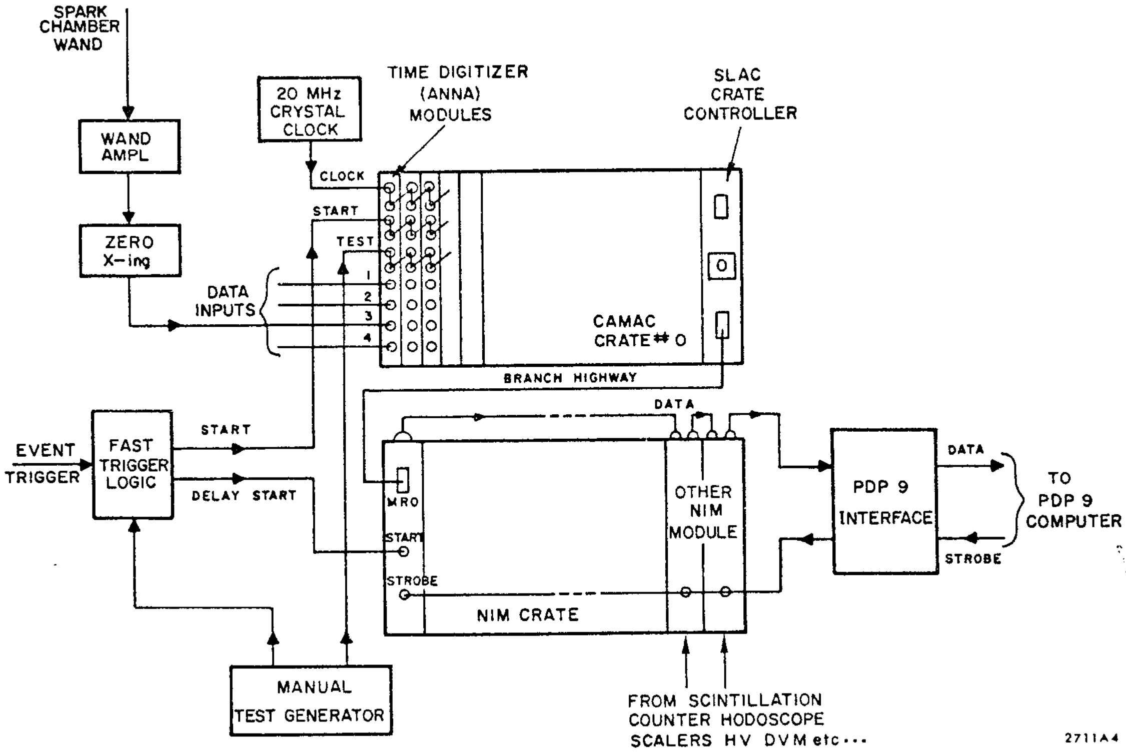

FIG. 7--Two-meter streamer chamber system.

The necessity of a processor to preselect the data has been overcome by using the computer itself to make all the decisions, so the MRO transfers the entire contents of the memories (16 words/wand) per event. The computer then makes a selection on the data. This is possible due to the small amount of data per event and to the fact that this computer is not used full time by the other sources.

VI. Conclusion

The following is a summary of the main features of the system:

a) Main characteristics of all these systems are: expandability, simple logic configuration, high recording speed and capacity of 15 sparks/wand with a word length of 16 bits per spark.

b) The modular configuration of the systems permits expansion of the number of channels, the only restriction being the seven-crate limitation of the particular crate controller used.[3]

c) An external clock is distributed to all the ANNA modules and each module has its own 16-bit

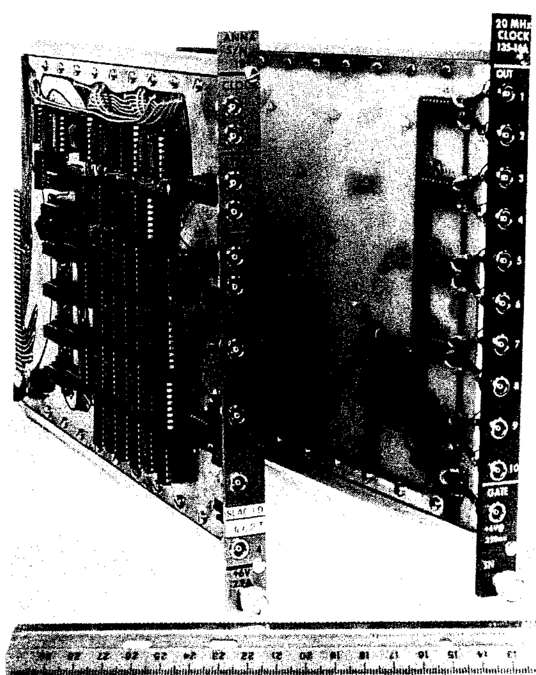

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FIG. 8--The time digitizer and 20-MHz clock modules.

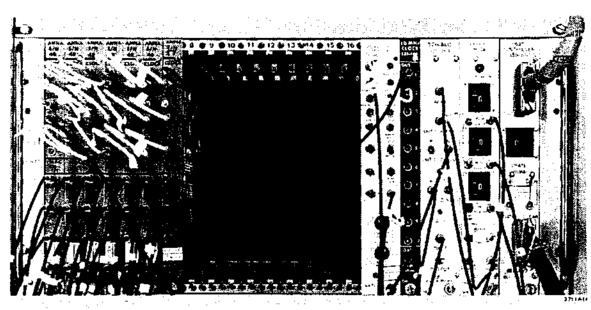

FIG. 9--The LASS system. #2711A14

synchronous counter, so no fast data signal transfer occurs between modules.

d) Each system is completed by a test generator which controls the correct functioning of the memories in the ANNA modules.

The array of modules described offers a versatile CAMAC solution to magnetostrictive readout systems.

Acknowledgments

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References

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