SCIENTIFIC DATA SYSTEMS

SDS 900 Series Computer Systems

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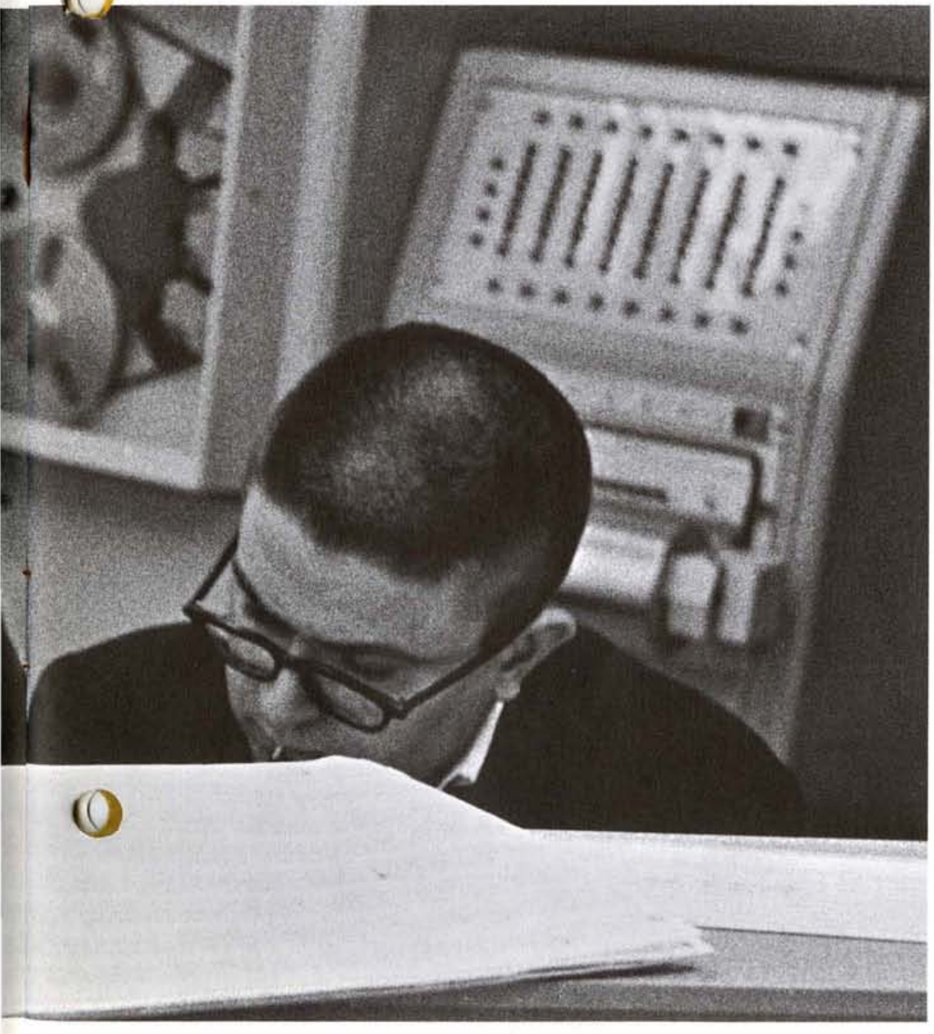

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INTRODUCTION

Every activity at SDS ultimately focuses on the company's effort to fulfill needs for versatile, efficient, total computing systems. Virtually every SDS product, from logic modules and analog/digital conversion devices to general-purpose computers and peripheral equipment, is involved in a systems project. Every service provided by SDS—engineering, programming, maintenance, and training—is directed at supporting the systems effort. As a result, more SDS computers are operating today in real-time engineering and scientific systems than those of any other computer manufacturer.

The key element in this total systems capability is a "building-block" philosophy that SDS applies to the design of all its products—both hardware and software. The resulting compatibility and modularity of equipment and programs enable SDS to design and construct complex systems from standard off-the-shelf products. The customary charges for systems engineering and check-out programming are completely eliminated when 80 percent of the system cost is represented by SDS products.

Over 200 SDS 900 Series computers are now operating in a wide range of systems applications. Of these, 125 were system-engineered by SDS. Typical applications include real-time industrial control, telemetry data acquisition and reduction, nuclear pulse-height analysis, missile check-out, and seismic data reduction.

SDS 900 Series computer-controlled systems reflect the broad range of central processor and peripheral equipment configurations made possible by the SDS modular, standardized approach to design of real-time data acquisition, data processing, and control systems.

SDS Data Systems

Over-all SDS systems capabilities are enhanced by SDS Data Systems (formerly Consolidated Systems Corporation of Pomona, California), an SDS subsidiary. Data Systems is a leading producer of digital data acquisition systems, computer-controlled electro-optical systems, and industrial control systems. In February 1955, it became the first company to deliver a large-scale, high-

Illustrated throughout the text are the following representative examples of operating SDS 900 Series computer systems:

System 1—Space Network Communications

System 2—Meteorological Data Processing

System 3—Aircraft Data Acquisition

System 4—Automobile Production Control

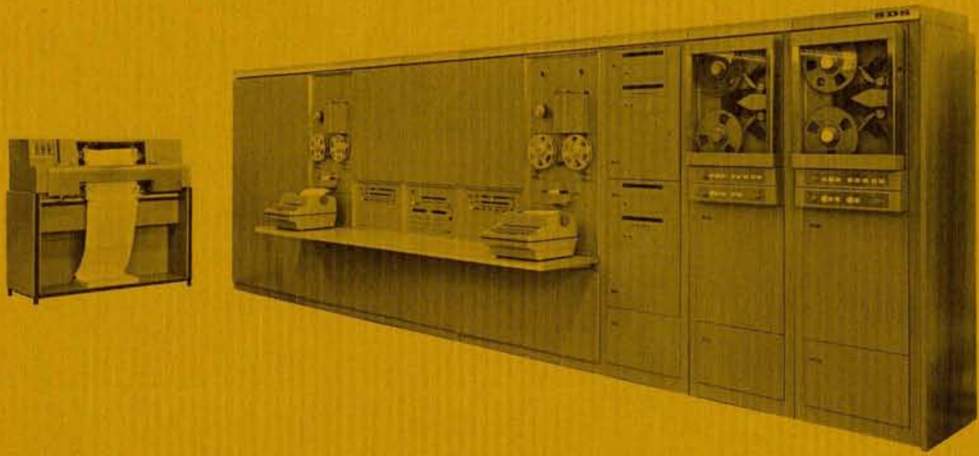
System 5—Hybrid Simulation

System 6—Instrumentation Data Test

System 7—Telemetry Data Reduction

System 8—Multiparameter Analysis

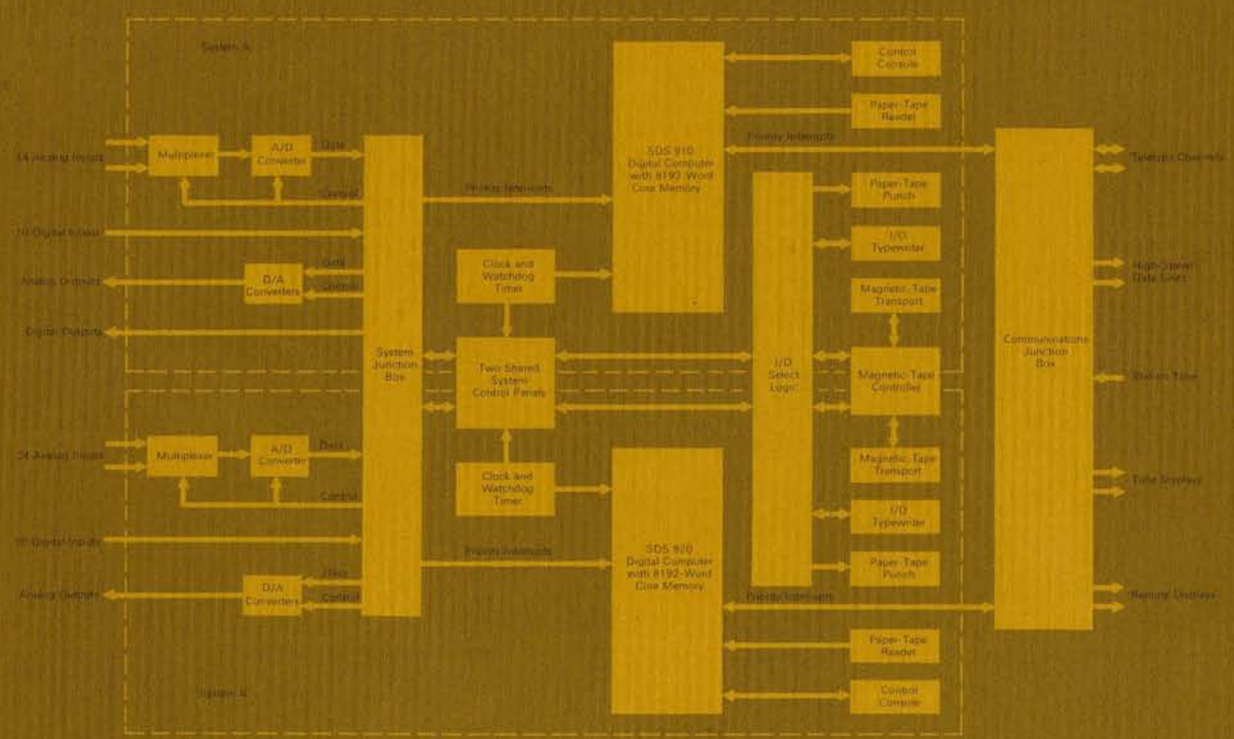
SYSTEM 1



INSTRUMENTATION SYSTEM FOR DEEP SPACE NETWORK

Eleven SDS computer-controlled systems are used for station instrumentation and data communications in the National Aeronautics and Space Administration's Deep Space Network tracking stations around the world. The SDS systems, located at each of six Deep Space Instrumentation Facility stations, receive, interpret, process, abstract, and record telemetry data from interplanetary spacecraft. Selected data is transmitted from the tracking sites to Jet Propulsion Laboratory in Pasadena, California, via the teletypewriter communications subsystem.

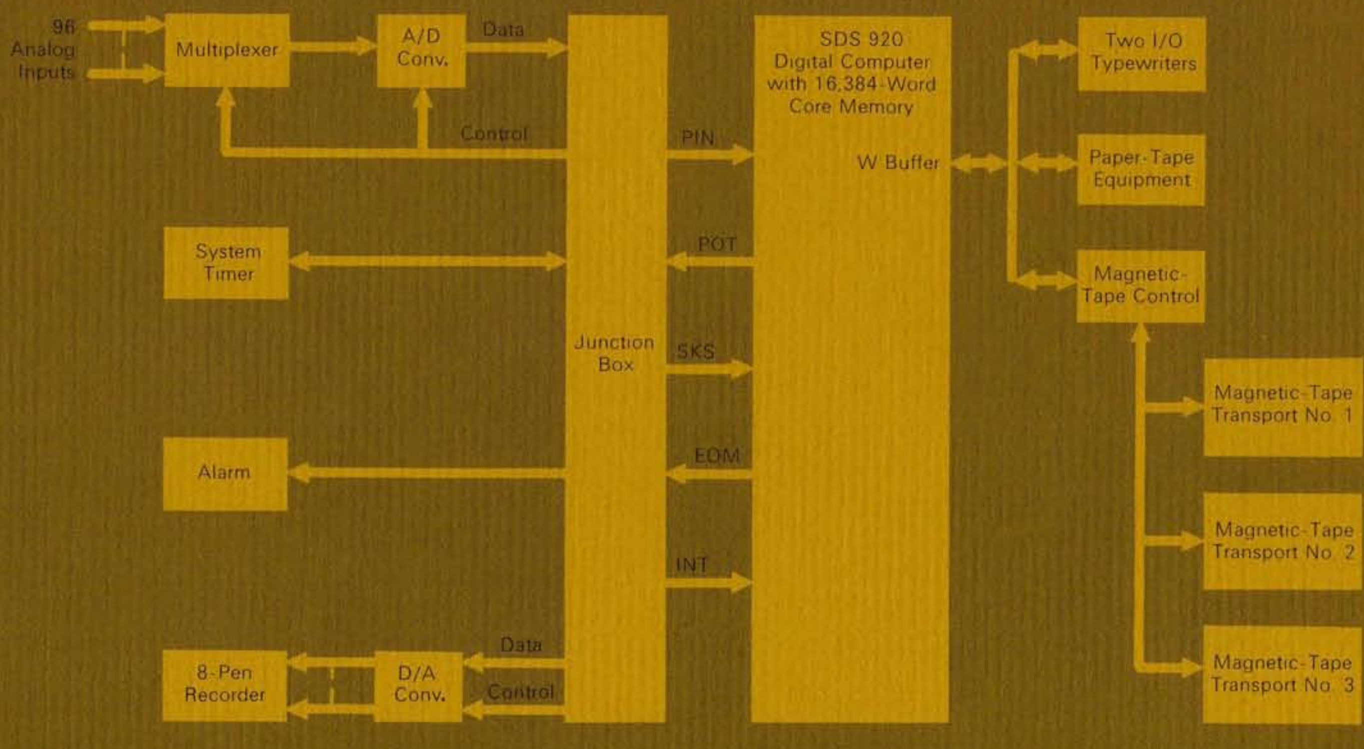
Each system configuration includes two computers, an SDS 910 and an SDS 920. Under computer control are two independent analog subsystems, two digital subsystems, communications systems, two independent magnetic tape systems, and other peripheral equipment.



SYSTEM 2

MOBILE METEOROLOGICAL DATA PROCESSING SYSTEM

SDS 920 Computer system, housed in a mobile van, is used by the Air Force Cambridge (Massachusetts) Research Laboratory to process and analyze real-time meteorological data such as wind direction and speed, air temperature and air-temperature difference, dew point, and net radiation. The computer controls high-speed data acquisition, sampling, editing, and visual output of data in meteorological units for quantitative analysis. After data has been processed, it is recorded continuously on industry-compatible magnetic tape. The system incorporates a special photoelectric paper tape reader that reads printed, rather than punched, binary information. Since the central component is a general-purpose digital computer, the system is used for varied data reduction, correlation, and computational tasks in addition to its primary functions.



speed, digital data acquisition system. Since then, Data Systems has produced more than 500 digital systems to perform such tasks as telemetry data processing, acquisition of data from test facilities, and seismic data recording.

Benefits of Computer Control

SDS 900 Series computers and other SDS system elements are designed on a completely modular basis and use a common interface logic. Thus the user can choose from the members of a logically and electrically compatible family of products to achieve the precise combination of performance characteristics needed for his application. Five stored-program, general-purpose digital computers—the SDS 910, 920, 925, 930, and 940—are available as the central computing element.

Modularity extends to the size of the magnetic core memory, the speed and type of peripheral input/output units, and the analog and digital modules and instruments that interface the computer to real-time equipment and the external environment. This modularity and compatibility feature enables the user to fully capitalize on the benefits of a computer-centered data system. These benefits include:

- **Flexibility.** A special-purpose system (i.e., one not using a computer) can perform only those functions built into it during the design phase. Any change in system function usually necessitates redesign and additional hardware. More important, such a change often means the device or system is not available for use while it is being modified. By contrast, a computer-based system has built-in flexibility. Simple or complex changes in function can generally be made merely by revising the computer program. Since hardware is not affected, down time is minimized.

- **Reliability.** Computer-based systems usually are much more reliable than their special-purpose counterparts, primarily because the central controlling element is standardized. Hardware is already debugged, well understood, and fully documented.

- **Reduced Solution Time.** Most special-purpose data acquisition systems provide neither analysis nor reduction capability. They usually record data on magnetic tape and then send it to a large digital computer for analysis and reduction. Because the large computer is most often situated at a remote site, a delay is imposed between the time data is available and meaningful answers are obtained. As a result, many applications require a costly "quick-look" system in addition to the basic system. The computer-based approach obviates this problem by providing data analysis and reduction capability *at the test site* as an inherent part of the basic data system.

- **Improved Understanding.** The computer-based approach tends to integrate instrumentation, reduction, and analytic efforts into a unified effort based on common aims and objectives. Improved understanding and communication, as well as a more efficient total system, result from this approach. In systems that do not use a computer, three separate groups generally participate in a data system project: instrumentation, data reduction, and engineering. Each group sees the project from the viewpoint of its own discipline; consequently, perspective may be lost.

- **Lower Initial Cost.** A major cost factor in special-purpose systems is the over-all controlling and sequencing logic, which must be uniquely designed and fabricated for each application. The computer-based approach minimizes such costs and the need for associated special hardware by using a common central element—the computer—that is produced in quantity rather than on a one-of-a-kind basis.

- **Lower Operating Cost.** The computer-centered system also decreases operating costs. Manual intervention is reduced because the computer, through its stored program, can perform more functions than the equivalent special-purpose system. The set-up procedure often consists of simply entering a program into the computer, thereby eliminating costly manual wiring and plugging procedures.

- **General-Purpose Use.** A computer-based system makes available to the user a powerful general-purpose machine for off-line use. Scientific problem solution or other general-purpose work can be performed in idle hours. All SDS computers are supplied with a full library of programming aids (e.g., mathematical subroutines, assemblers, FORTRAN, etc.) to enable the user to perform these off-line tasks.

THE COMPUTER-ORIENTED APPROACH

A computer-controlled system must be designed and implemented so that diverse system elements perform as a single entity. The manner in which these elements intercommunicate is particularly important in achieving this goal.

The computer-oriented approach eliminates many of the interface problems common to fixed-purpose systems. Use of a standard method of attaching hardware elements allows devices to intercommunicate *through* the computer, which serves as a communications focal point.

The environment in which a control computer operates is more often analog than digital in nature. A typical example is a temperature measurement converted to a voltage by a thermocouple. This voltage, a continuously varying value, is proportional to the temperature.

Before a computer can process such an analog measurement, the analog voltage must be converted to the digital representation required by the computer. This conversion is performed by signal-conditioning networks, analog multiplexers (high- and low-level), and analog-to-digital converters. Similarly, in many applications, the digital computer must provide analog (e.g., voltage) outputs through digital-to-analog converters.

Some types of systems data, however, are essentially digital: data from real-time clocks, decimal and other encoded display units, and remote, character-oriented teletypewriter devices. Peripheral units such as keyboard/printers, magnetic tapes, and card readers are also basically digital in nature.

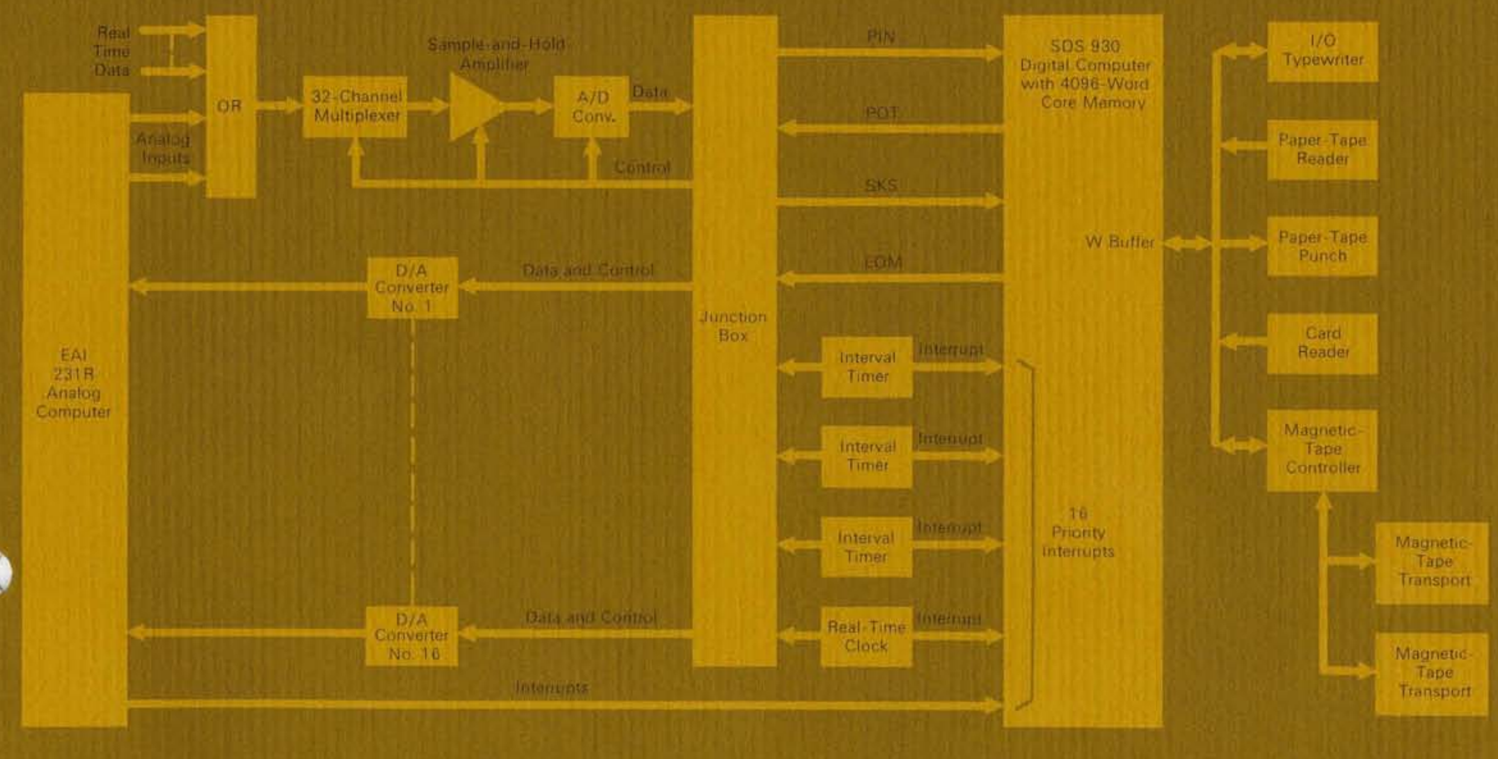
To implement a data collection system in which analog signals are sampled, digitized, and written onto digital magnetic tape, only three functional elements are required: the conversion subsystem, the computer, and the magnetic tape subsystem. Typically, the computer processes any or all of the following types of information in a computer-controlled system:

- Analog-to-digital data
- Digital-to-analog data
- Control information
- Status sensing
- Direct digital input
- Direct digital output
- Program interruption

SYSTEM 3

HIGH-PERFORMANCE AIRCRAFT DATA ACQUISITION AND ANALYSIS SYSTEM

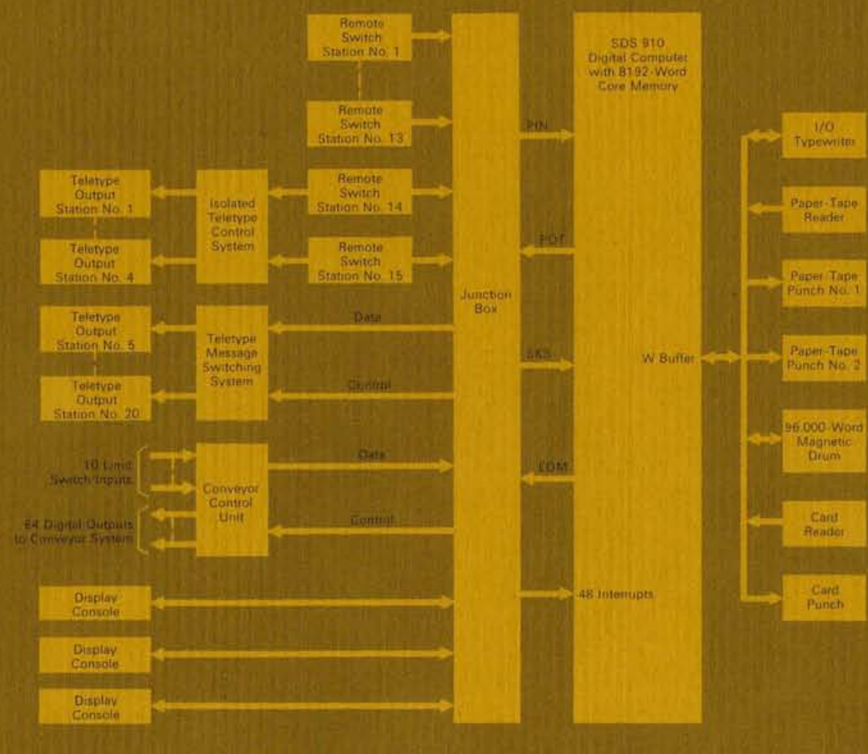
SDS 930 Computer system at the NASA Flight Research Center, Edwards Air Force Base, California, gathers telemetered data from hypersonic vehicles, such as the X-15, and records it on magnetic tape in real time. Subsequently, the recorded data is re-entered into the computer for detailed analysis. The system also performs hybrid simulation and computation tasks in support of X-15 research projects.



SYSTEM 4

CONTROL SYSTEM FOR AUTOMOBILE PRODUCTION

SDS 910 Computer system performs real-time control and reporting functions for Nissan, one of the largest automobile manufacturers in Japan. The system incorporates many remote teletypewriter output and manual input consoles, connected through standard SDS data communications equipment. Major system functions are (1) scheduling of painting operations and production flow, (2) real-time and nonreal-time quality control, and (3) process control, in which the system schedules and documents the work of the paint department. The system also compares scheduled production with actual production for continuous control.



System status and control information is used in two major ways. First, the digital computer must control the other system elements. It could, for example, select various multiplexer inputs to an analog-to-digital converter. Second, the computer must perform discrete tests for such conditions as the on-off status of a contact so that it can monitor its environment completely. The single-bit input and output used in these discrete tests can also be used to turn devices that are essentially bistable to either an "on" or "off" condition. Examples of discrete output are relay control, indicating lamps, etc. This single-bit input can be used for such other purposes as testing the status of peripheral units attached to the control computer. Up to 16,384 discrete input/outputs can be monitored. Included in this status-sensing category are such functions as testing a magnetic tape unit for the "load point" or "end-of-tape" conditions.

Program interruption is among the most important of the computer characteristics required for real-time systems operation. The processes to which real-time computers are interfaced are most frequently asynchronous; that is, no predictable time relationships exist between the external environment and the computer. Frequently, the computer must receive input data, evaluate a control algorithm, and output results on a "demand" basis. This "on-demand" philosophy of computer operation permits the computer to perform calculations in synchronism with the external system. Program interruption provides this capability by enabling the computer to respond to external stimuli. The computer's sequence is automatically and instantaneously diverted to accommodate or otherwise process the particular stimulus.

SDS SYSTEM ELEMENTS

The major elements comprising an SDS computer-controlled system are (1) the general-purpose digital computer, (2) peripheral equipment, (3) digital modules and analog instruments, and (4) junction boxes.

SDS Computers

The five SDS 900 Series general-purpose digital computers are designed with unusually fast and flexible

input/output capabilities, facilitating their integration into real-time systems. Need for special hardware and programming is thus minimized. SDS computers are built to meet rugged mechanical standards, and they incorporate worst-case electronic design techniques. The combined effect of using silicon semiconductors exclusively and keeping component counts to a minimum gives these computers a Mean Time Between Failures at least three times that of any comparable equipment. Table 1 summarizes basic characteristics of SDS 900 Series computers.

Peripheral Equipment

A complete line of peripheral units is available for use with SDS 900 Series computers. These devices can be selected and arranged to give the computer any desired level of capability in such areas as operator and programmer communication; storage via magnetic tape and disc files, including the new SDS rapid-access disc (RAD) file; line printer output; and paper tape and punched card input and output.

The standard SDS peripheral units use recording media that are fully compatible not only with other SDS units but also with virtually all modern computers without intervention or conversion. Table 2 summarizes the principal characteristics of standard SDS peripheral units.

Digital Modules and Analog Instruments

SDS offers a complete line of digital modules and analog instruments that serve as basic building blocks in special systems hardware. These link the computer and its peripheral equipment to the physical world. All modules and instruments meet the same rigid standards of noise rejection, compatibility, and reliability that characterize other SDS equipment. Silicon semiconductors, film resistors, and silver-mica capacitors are used, insuring maximum reliability over a wide temperature range. As a result, "hot spots" no longer pose design or environmental restraints. In addition, the new SDS digital-to-analog and analog-to-digital converters use monolithic silicon integrated circuits. Field tests indicate that even the most complex of these modules have a Mean Time Between Failures exceeding 250,000 hours—the equivalent of at least 10 years' normal use.

Table 1. SDS 900 Series Computer Characteristics

Feature	SDS 910	SDS 920	SDS 925	SDS 930*
Word Size (bits)	24 plus parity	24 plus parity	24 plus parity	24 plus parity
Cycle Time	8 μsec	8 μsec	1.75 μsec	1.75 μsec
Memory Size (words)	2048-16,384	4096-16,384	4096-16,384	4096-32,768
Index Registers	1	1	1	1
Extra Time for Indexing	no	no	no	no
Multilevel Indirect Addressing	yes	yes	yes	yes
Add Time	16 μsec	16 μsec	3.5 μsec	3.5 μsec
Multiply Time	248 μsec	32 μsec	54.25 μsec	7.0 μsec
Hardware Multiply/Divide	no	yes	no	yes
Standard I/O Channel	W Buffer	W Buffer	TMCC-W	TMCC-W
Single-Bit Control (standard)	up to 16,384	up to 16,384	up to 16,384	up to 16,384
Single-Bit Sense (standard)	up to 16,384	up to 16,384	up to 16,384	up to 16,384
Parallel Digital Input (standard)	24 bits	24 bits	24 bits	24 bits
Parallel Digital Output (standard)	24 bits	24 bits	24 bits	24 bits
Real-Time Clock	optional	optional	optional	optional
Memory Protect	no	no	no	optional
Optional I/O Channels	Y Buffer	Y Buffer	Y, C, D channels; E, F, G, H channels; data multiplexing system	Y, C, D channels; E, F, G, H channels; data multiplexing system
Priority Interrupt	up to 1024 levels	up to 1024 levels	up to 1024 levels	up to 1024 levels

*Characteristics of the SDS 930 and 940 Computers are virtually identical except that the memory size of the latter machine is expandable to 65,536 words.

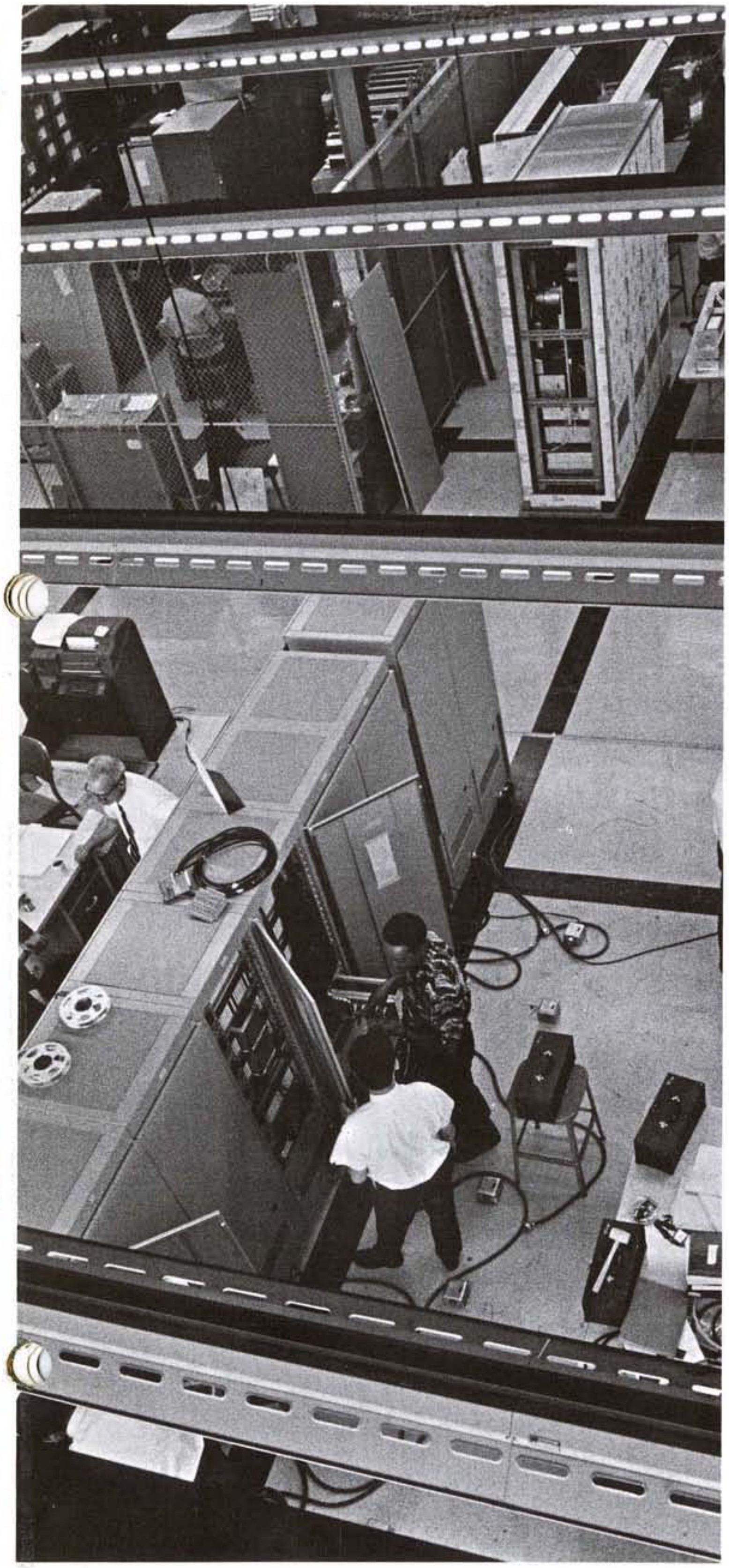


Table 2. Standard SDS Peripheral Units	
Device	Characteristics
Keyboard/Printers	Teletype Models 35 KSR and 35 ASR Keyboard/Printers and 15-inch, 15-character/second Selectric typewriters.
Paper Tape Readers	10 and 300 characters/second (5-, 6-, and 7-level formats).
Paper Tape Punches	10 and 60 characters/second (5-, 6-, and 7-level formats).
Card Readers	Photoelectric reading of standard 80-column cards at 400 and 800 cards/minute.
Card Punches	Standard 80-column cards punched at 100 and 300 cards/minute.
Magnetic Tape Units	IBM-compatible format. Basic transport speeds of 75 and 120 inches/second. Systems are available with recording densities of 200, 200/556, or 200/556/800 bits/inch. Transfer rates from 15,000 to 96,000 characters/second. SDS MAGPAK is a compact, low-cost magnetic tape system with storage capacity of 6 million characters and transfer rate of 1500 characters/second. Two independently driven tape cartridges, each containing 600 feet of dual-channel Mylar-base tape, provide four information channels.
Disc Files	Capacities from 524,288 to 67,000,000 characters. Transfer rates range from 60,000 to 480,000 characters/second. Average access times are as low as 17 msec. Some files have access times as low as 500 μsec where used to move large amounts of data between disc and computer memory.
Line Printers	Strip printer outputs 2400 lines/minute. Full 120- and 132-column units print at 140, 600, and 1000 lines/minute.
Graph Plotters	Continuous-form incremental plotters operate at 300 steps/second. X-Y and strip records available upon request.
CRT Display Equipment	A complete set of plug-in modular elements allows the use of regular laboratory scopes or use of an SDS 21-inch CRT display. Provides for vector and character generator options and optional light gun for man-machine interaction.
Data Communications Equipment	Full line of interface equipment for all common carrier and private line communications media.

A full line of hardware and accessories, also available from SDS, includes rack mounting cases for up to 45 modules, power supplies, and a module tester with factory-approved test specifications.

The SDS line of analog instruments includes:

- **Solid state analog-to-digital converters,** which convert analog voltages into equivalent digital numbers. These units provide the basic means of communication from a wide variety of analog devices to digital equipment and feature conversion rates to 54,000 per second (12 bits), resolution to one part in 2^{15}, and full-specification performance between 0° and 60°C.
- **High-speed multiplexers,** which select and switch many analog inputs to a single output. Each multiplexer system is composed of a control section and several analog switches installed in standard SDS 25-module mounting cases. These, in turn, can be installed in standard 19-inch relay racks. This modular packaging concept facilitates system construction and expansion.
- **Digital-to-analog converters,** which convert digital numbers into equivalent analog voltages. These solid-state units serve as the basic means for translating communication from digital equipment into signals understandable to a wide variety of analog devices. Monolithic integrated circuitry is used extensively.
- **Analog amplifiers,** which are used as components in SDS multiplexers, analog-to-digital converters, digital-to-analog converters, sample-and-hold circuits, and in other applications. These amplifiers are constructed on standard SDS etched-circuit, plug-in modules. Features include fast settling time, no choppers, high loop gain, and adjustments for gain and offset.

Table 3 briefly summarizes the kinds of digital and analog building blocks available from SDS. These modules cover an operating frequency range from dc to 8 megacycles.

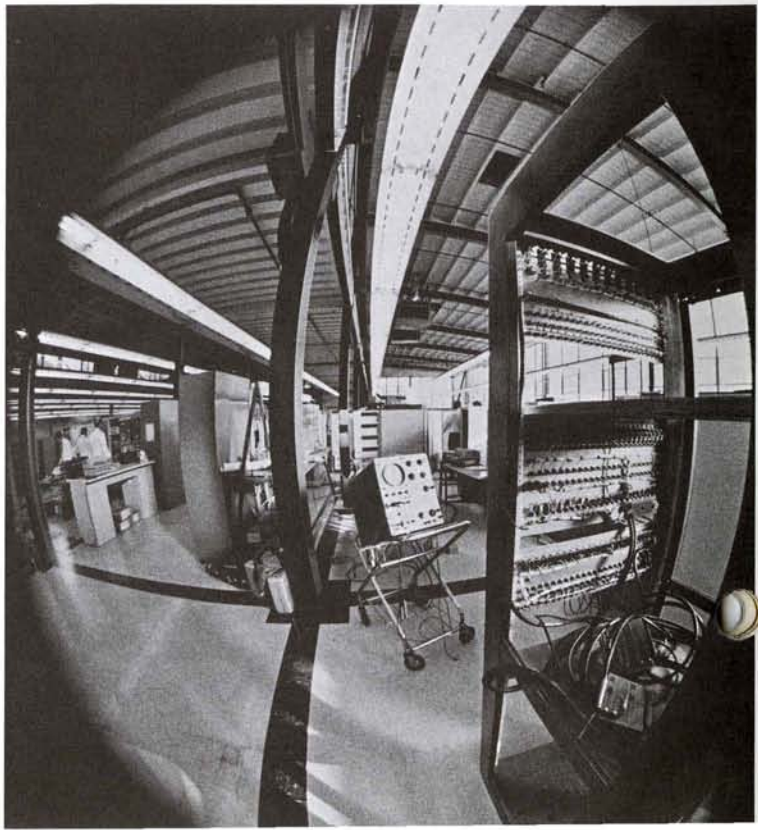
Junction Boxes

The SDS EJ20, EJ25, and EJ30 Electronic Junction Units ("J Boxes") provide a standard means of attaching analog instruments to the SDS computer's parallel input/output bus. These units simplify the assembling of SDS computer-controlled systems and eliminate the one-time engineering charge that might ordinarily be made to design and produce a special-purpose unit. The EJ20 is used primarily with SDS 910 and 920 Computers; the EJ25 and EJ30 are used with the entire 900 Series.

Table 3. SDS Digital and Analog Instruments

Basic Circuit Type	No. of Different Module Types
Amplifiers, Inverters, Line Drivers	18
Clocks and Oscillators	6
Flip-Flops	13
Gating Circuits, Inverters	23
Special-Purpose (Shift Register, Schmitt Trigger, One-Shots, etc.)	5
Interface and Control (Delays, Transformer Coupler, Display Drivers, etc.)	17
Analog Amplifiers	7
Regulators	3
Digital-to-Analog Converters	7
Analog-to-Digital Converters	6
Multiplexers and Sample/Hold	Note 1

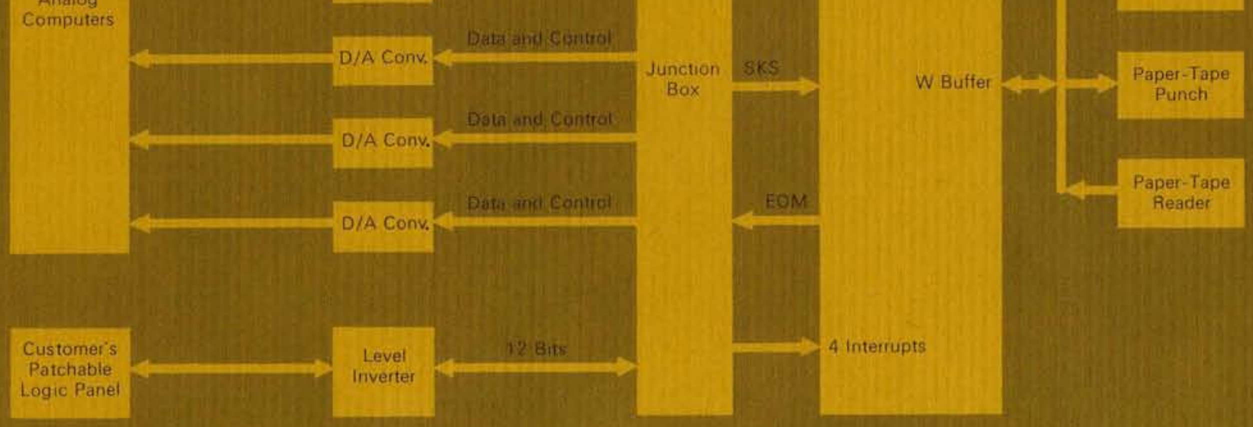
NOTE 1: Many complete assemblies ranging in size from 16 to 256 channels in both single-ended and differential input configurations.

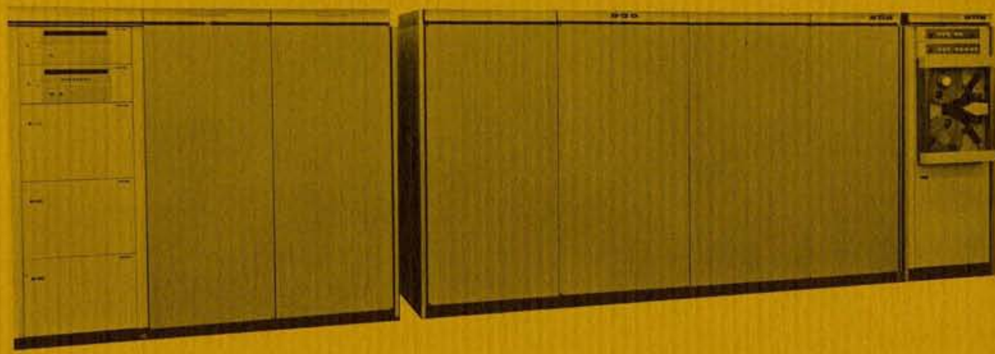


SYSTEM 5

HYBRID SIMULATION SYSTEM

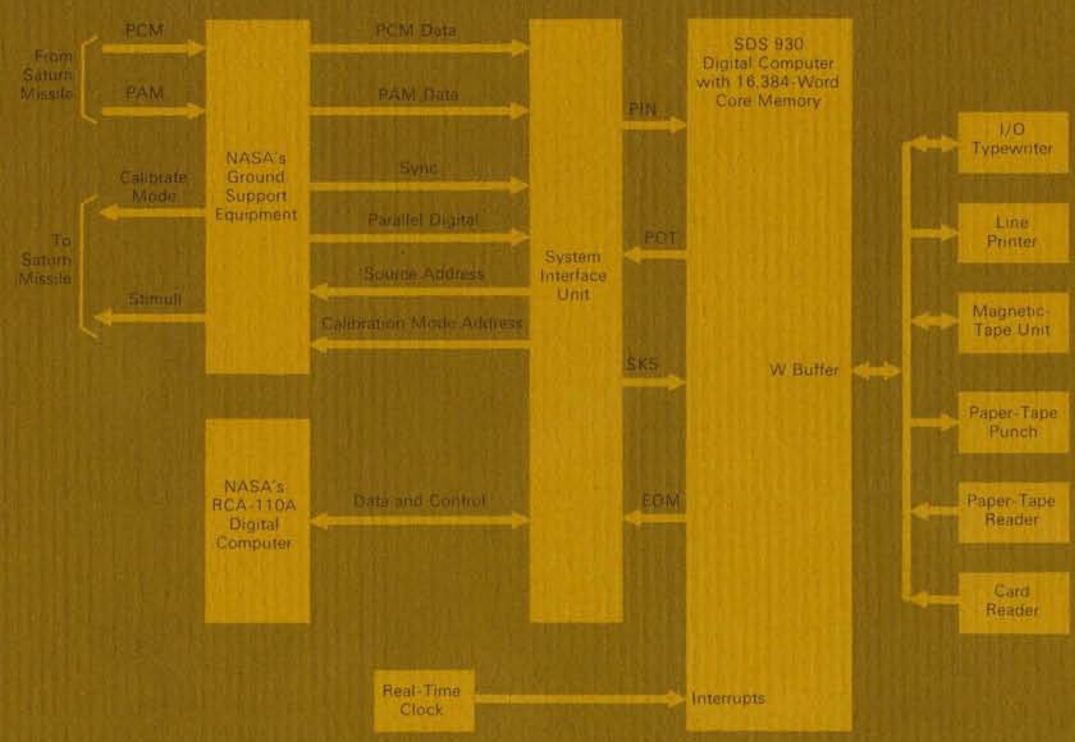
SDS 930 Computer system in the Data Systems Simulation Laboratory of North American Aviation's Autonetics Division, Anaheim, California, is used in hybrid simulation for development of space vehicles, aircraft, and guidance systems. Computer system accepts 20 analog inputs, converts them to digital values at rates up to 10,000 samples per second, and provides four analog outputs from the digital computer. The SDS 930 Computer and interface system can be used with several analog computers or can accept inputs from an analog magnetic tape system. System functions include on-line error analysis of simulated flight lines, generation of two- and three-dimensional terrain, and simulation of on-board digital control equipment.





INSTRUMENTATION DATA TEST STATION

Instrumentation Data Test Station (IDTS), developed by Dynatronics, Inc., and centered around an SDS 930 high-speed digital computer, processes data associated with the Saturn booster test program at NASA's Marshall Space Flight Center, Huntsville, Alabama. IDTS performs functions of a control computer, a data processing station, and a slave data processing facility. In the control computer function, IDTS conditions itself and its peripheral hardware preparatory to a data processing run. Digital time-division multiplex data is received for processing from any or all of three telemetry ground facilities: the Digital Data Acquisition Station, the Telemetry Data Station, and the Pulse Code Modulation (PCM) facility.

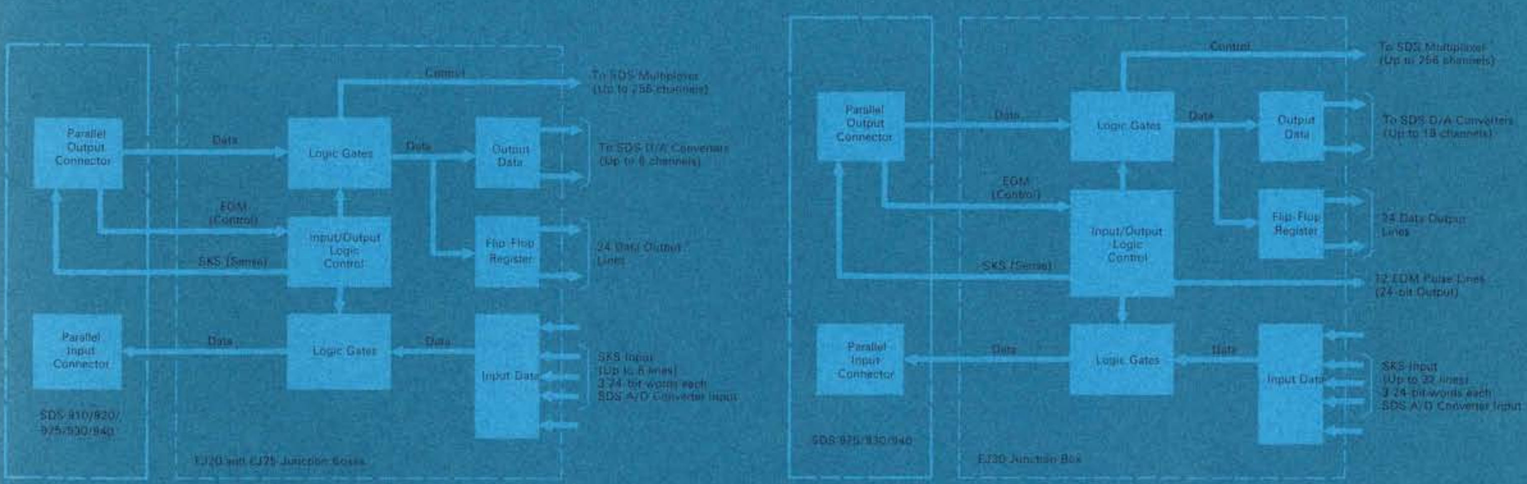


The EJ20 and EJ25 enable the computer to perform the following input/output operations under program control:

- Read, in parallel, any one of three groups of 24-bit words, using EOM and PIN instructions.
- Output, in parallel, one 24-bit word to a flip-flop holding register by the use of EOM and POT instructions.
- Test eight lines by use of Skip on External Signal instructions.
- Address and control an SDS analog multiplexer. The EJ20 and EJ25 have circuits that select the multiplexer with an EOM and set the address with a POT; two EOMs are used to step or reset the multiplexer.
- Read one SDS analog-to-digital converter. The computer selects the converter with an EOM and reads it with a PIN.
- Set up to six SDS digital-to-analog converters. The computer selects a particular converter with an EOM and sets it with a POT.
- Receive signals to the two Y Buffer interrupts when the Y Buffer is not used.

The EJ30 provides these capabilities:

- Read, in parallel, any one of three groups of 24-bit words, using EOM and PIN instructions.
- Output, in parallel, one 24-bit word to a flip-flop holding register by the use of EOM and POT instructions.
- Output a single pulse on any one of 12 lines with EOM instructions.
- Test 32 lines by use of Skip on External Signal instructions.
- Address and control an SDS analog multiplexer. The EJ30 has circuits that select the multiplexer with an EOM and set the address with a POT. Two EOMs are used to step or reset the multiplexer.



Block Diagrams Showing Internal Elements and Input/Output Connections for EJ20, EJ25, and EJ30 Junction Boxes

- Control up to 18 digital-to-analog converter channels. An EOM selects the desired channel, and a POT transfers the value.
- Read one SDS analog-to-digital converter. The computer selects the converter with an EOM and inputs the digital value with a PIN. The converter can be tested for completion with an SKS instruction.

SDS COMPUTER INTERFACE CHARACTERISTICS

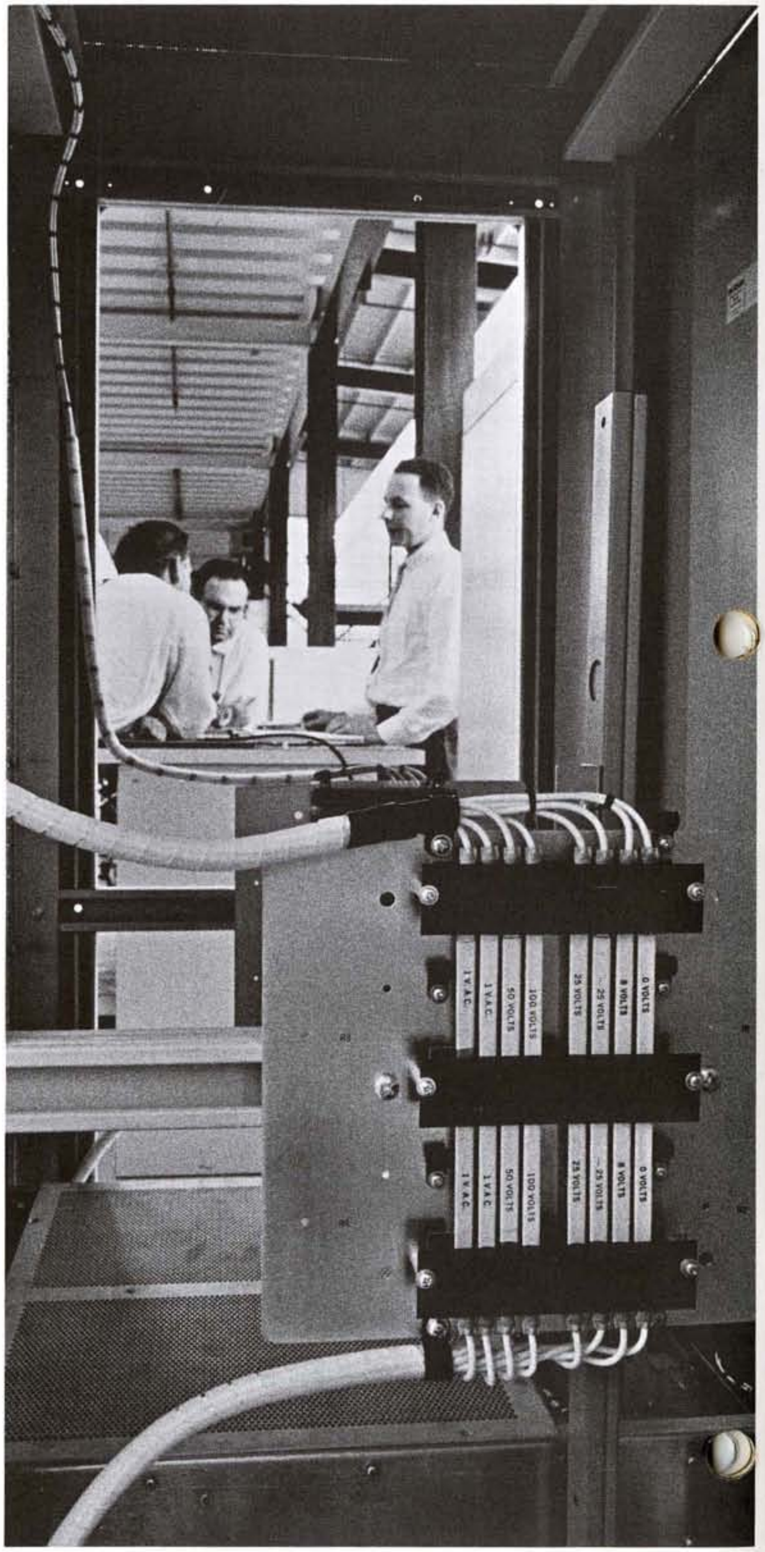
SDS computers are basically system-oriented machines with unusually fast and flexible input/output capabilities that greatly facilitate system design and construction.

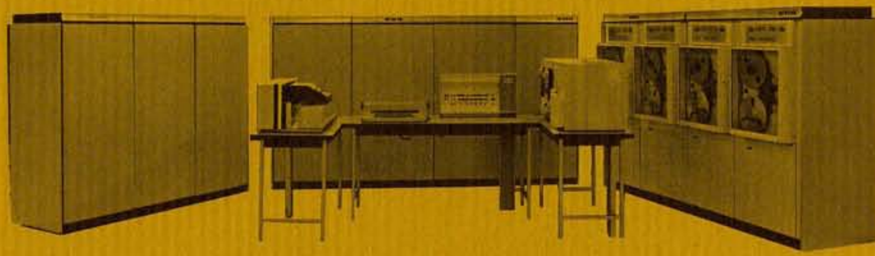
All SDS 900 Series computers use three input/output systems: the word-parallel I/O system (also known as POT/PIN), single-bit sense and control, and a priority interrupt system. In addition, the SDS 925 and 930 use up to four direct-access communication channels to transmit data to memory over a path separate from that used by the central processor. A data multiplexing system, using this second path to memory, permits connecting an unlimited number of data multiplex channels to the computer.

A memory interlace feature, available with all SDS 900 Series computers, permits the input/output of large blocks of data without interrupting the main program.

These I/O systems provide completely generalized methods of communicating between an SDS computer and a real-time system. Both methods are compatible with either standard SDS linkage units or special-purpose devices. Further, the flexibility of these I/O systems simplifies the design and attachment of customer-furnished linkage equipment to any SDS computer.

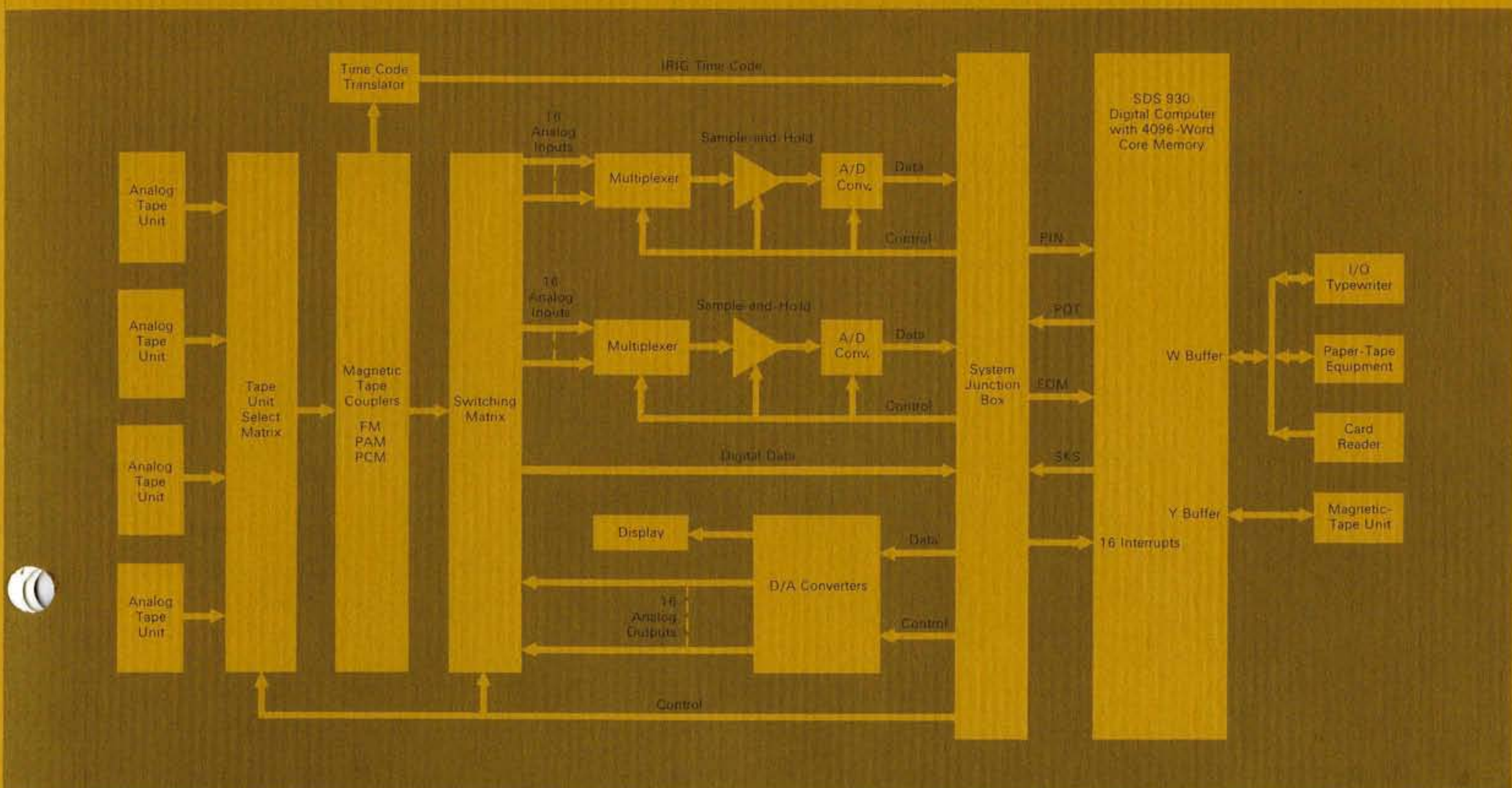
Linkage equipment is interchangeable among all SDS computers since the interface characteristics of these computers are identical except for signal duration, which varies among the SDS central processing units. Wherever pulse shape is important, however, interface units themselves incorporate all necessary timing compensation circuitry.



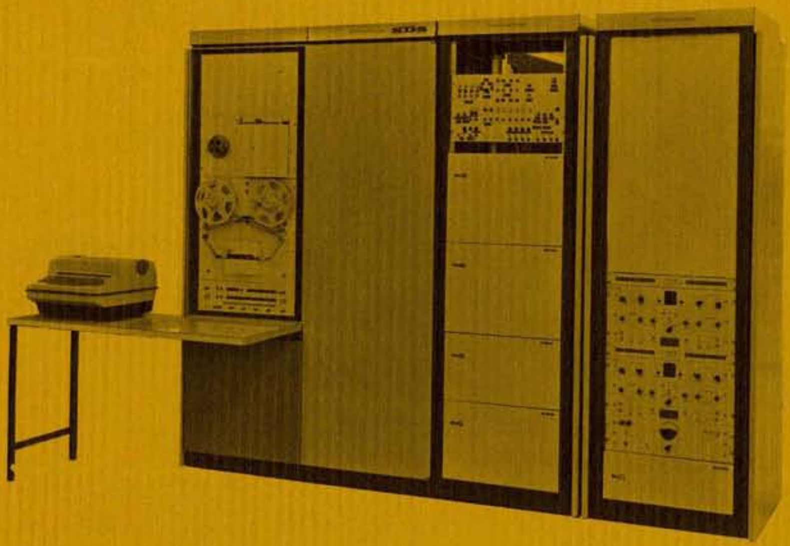


COMPUTER-CONTROLLED TELEMETRY DATA REDUCTION SYSTEM

An SDS 930 Computer system, used by NASA as a telemetry data reduction station at Slidell, Louisiana, demonstrates the ease with which an SDS computer can be integrated into a large-scale system. The system accepts analog and digital information from ground station equipment and converts, buffers, and records this data on industry-compatible magnetic tape. Input selection, validity checks, accuracy checks, scaling, autocalibration, and linearizing functions are also accomplished under program control.

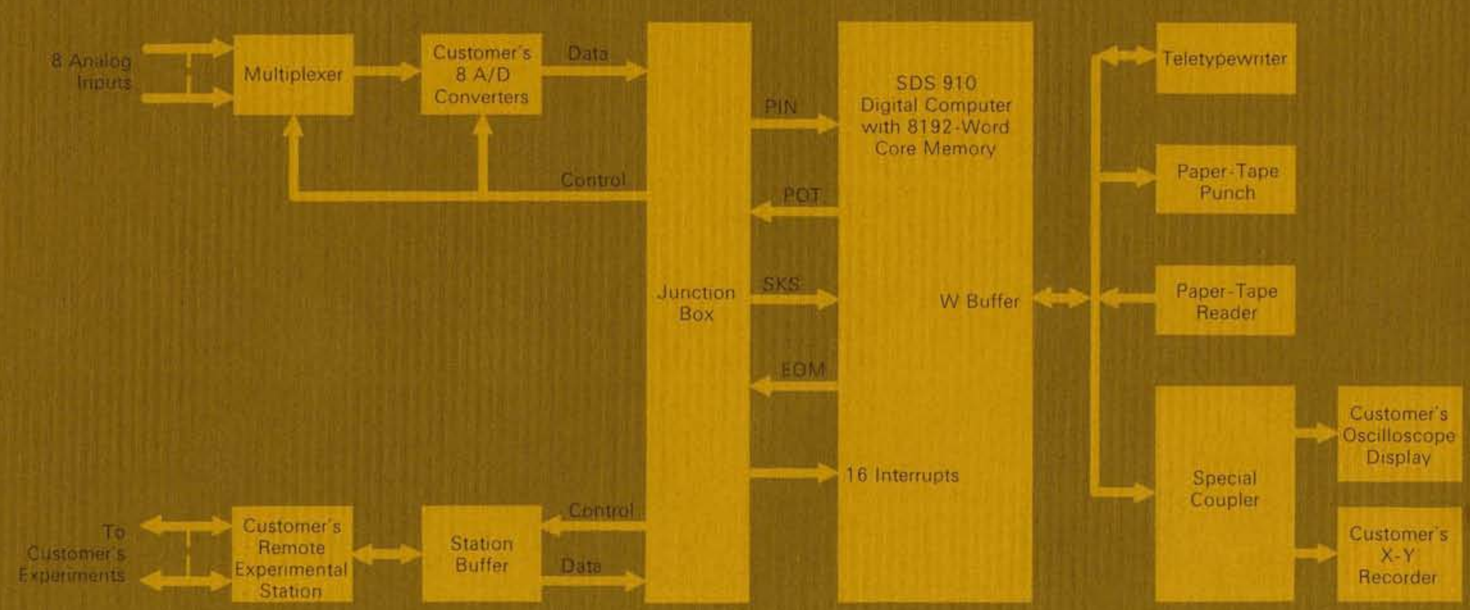


SYSTEM 8



MULTIPARAMETER ANALYZER AND DATA ACQUISITION SYSTEM

SDS 910 Computer system is used by Iowa State University's Physics Department at Ames, Iowa, as a nuclear pulse height analyzer. Data from external analog-to-digital converters is input to the computer either as parallel words or by means of a memory increment feature. Interface capability is also provided for (1) input from up to nine remote 24-bit registers, (2) output of analog signals by X-Y recorder or oscilloscope display, and (3) generating or sensing various control signals.



The most important of the SDS input/output systems, from the point of view of real-time system integration, are the word-parallel I/O system and the interrupt systems.

Word-Parallel Input/Output

The parallel input/output system in all SDS computers is basically a bus structure over which the following kinds of information are transmitted under program control:

- Control outputs ("select" or "external function" commands)
- External status sensing
- Data output
- Data input

This system transfers information from 24 input/output lines to a specified location in the computer's memory or transfers information from memory to the input/output lines without disturbing any operating registers. Data can be transferred as single words or large blocks of information, and instructions can be modified by indexing and/or indirect addressing.

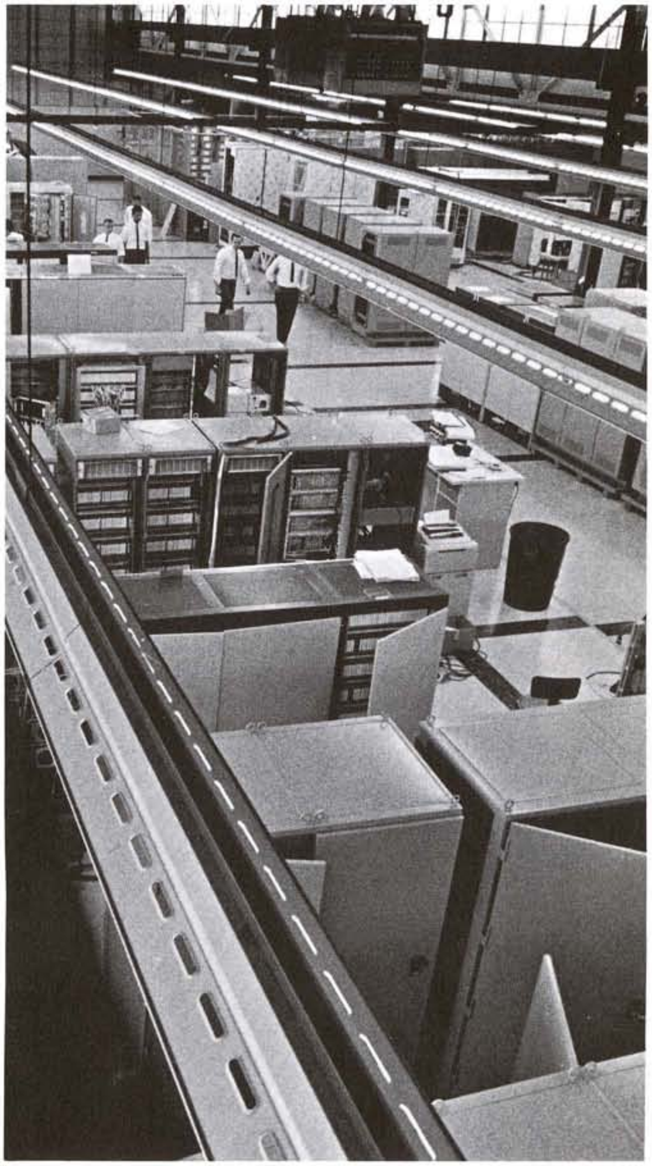
Interrupt Systems

Every SDS computer accommodates two interrupt systems: (1) a "standard" interrupt system and (2) a priority interrupt system.

The "standard" interrupt system is associated with the central processor and standard input/output channels. Some of these interrupts are standard SDS computer hardware, such as the two levels associated with each input/output channel. Others are optional and are supplied with various central processor features, such as the real-time clock and power fail-safe units.

The priority interrupt system is associated with special external system sources. Its basic function is to let the computer control, or be controlled by, an external, real-time environment having a high degree of complexity. Any SDS 900 Series computer can have up to 1024 levels of priority interrupt. Because the system assigns a unique memory location to each interrupt level, a unique programmed process can be assigned to every external interrupt. Valuable program space and time need not be wasted in determining the source of the interrupt. The program (or, more properly, the subroutine) associated with the interrupt is entered immediately after the interrupt signal is recognized.

This interrupt system is based on a set of ordered priorities. Higher-priority interrupts automatically interrupt lower-priority ones; and interrupts of lower priority are queued until their priorities are the highest ones outstanding. Both functions (interrupt of an interrupt with automatic return and lower-priority queuing) are features of hardware rather than software.



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