SANDERS Information Display Systems





New concepts in man/machine communications





Information Displays For
The Applications
Spectrum...From
America's Space Program
To Its Business Offices...
SANDERS ASSOCIATES.INC.

Information display systems give men the ability to communicate directly with computers and command data complexes with great speed, efficiency, effectiveness, accuracy, and convenience.

They provide important new capabilities for:

- Presenting information in formats most suited to human understanding, decision making, and action...
- Controlling data processing, data collection, and data retrieval operations...
- ☐ Storing and manipulating data . . .
- Communicating information between data systems, and between nearby and remote operations centers.

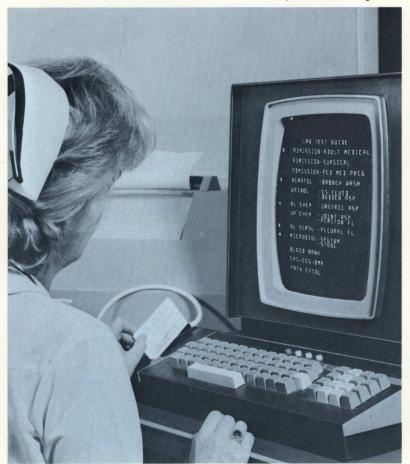
Because of these benefits, information displays have become vital man/machine communications links in defense, space and other government programs . . . and in modern business data processing systems.

To meet the widely different requirements of such applications, Sanders Associates, Inc. has developed an extensive set of advanced display capabilities and a series of display systems specifically configured for different uses.

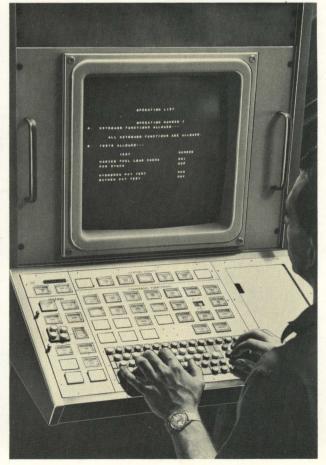
This series includes powerful, sophisticated displays for advanced missions manufactured under contracts from the Army, Navy, Air Force, and NASA. It also includes a line of business display systems which are economical yet offer a variety of unique performance features.

This book details the complete range of Sanders display capabilities.

Sanders CLINI-CALL* system provides faster, more efficient hospital data management



Sanders advanced displays for automatic checkout of NASA's Saturn V launch vehicle



Displays for Advanced Missions

	Avionics Displays
	Automatic Checkout
	Command and Contro
	Computer Simulation
	Graphic Presentations
	Intelligence Analysis
	Air Traffic Control
	Message Handling
	Program Control
П	Weather Reporting

Sanders display systems may be used to communicate with and control many different information sources... nearby or miles away. They present information for analysis and action by their operators in real time to permit effective control over the elements in a fast moving, dynamic situation.

Such display systems may selectively call up and show vital units of computer stored information, and they can process and display information from radar, sonar, communications, checkout, navigation, and other sensor inputs.

The advanced mission systems in our display family feature many powerful new performance capabilities including:

- Bright display of as many as 6000 alphanumerics, and symbols...up to 10,000 inches of vectors on a CRT as large as 22 inches, at refresh rates up to 60 cps.
- Projection of several thousand alphanumerics and line vectors on large area screens with real time updating capabilities (developmental).
- Mixing of video (TV and slide reference) information with digital (alphanumeric/graphic) information in real time.
- Modular software allowing program changes and system adaption to new, expanded usage with minimum effort and expense.
- Software, logic, and controls which allow programming of system computers directly from the information display consoles.
- Interconsole communication arrangements permitting all displays in a system to freely share and exchange information without interrupting central processor operations.
- Compatible peripheral equipment for producing continuous tone hard copies of displayed information; display and routing of multiple closed circuit TV channels (525 and 945 line); and selection of fixed reference (background) information from banks of photographic slides.

- Self-test features permitting any display console in a system to go off-line and thoroughly test its operational readiness.
- Powerful editing and control capabilities limited only by the software and the performance specifications of cooperating computers; operators can erase, insert, copy, flag, and transfer information with ease using photopen, 4-directional cursor buttons, trackball, slewstick, and other edit control methods.
- Display of finely formed, stroke generated characters in multiple sizes with multiple brightness levels for marking important data.
- Proprietary techniques for writing characters and vectors at high speeds directly through CRT deflection yokes to eliminate much of the circuitry, complexity, and various reliability problems associated with conventional writing techniques.
- Precision, high speed deflection techniques and advanced CRT/ phosphor types pioneered by Sanders for production of bright character displays in high light ambient conditions with freedom from flicker, jump, jitter, half page shift, and veiling phenomena.
- Function interlocks which fix the display operations allowable to different using personnel and adapt display systems to the "chain of command".

These important capabilities and many others are available in Sanders information display systems for advanced missions.

SATURN V Operational Display System

Developed by Sanders for the National Aeronautics and Space Administration, this advanced display system is to be used for monitoring and control of automatic prelaunch checkout on the Saturn V vehicle.

Sanders provided seven full systems under this contract, each including...a general purpose computer; 2 to 15 display consoles; central logic/memory equipment; and peripherals for hard copies, slide references, and closed circuit television. In all, 58 display consoles have been delivered.

Four complete systems are located at the Kennedy Space Center, Florida for final checkout of fully assembled vehicles at Launch Complex 39. Interfaced with NASA checkout computers, the Sanders displays serve as links between system test personnel and

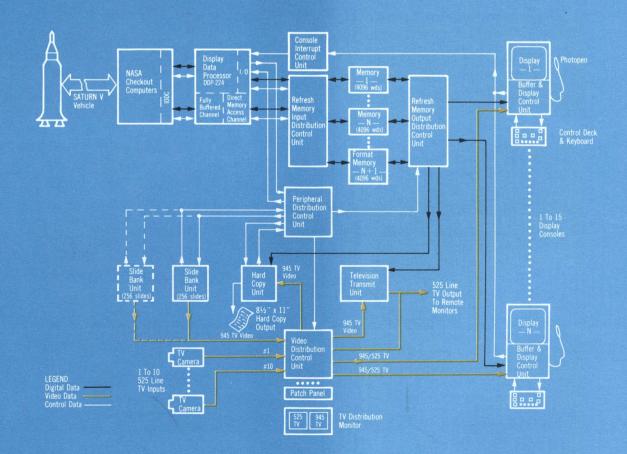
the vehicle under test, providing realtime monitoring, command, and emergency control capabilities.

Three additional systems are installed at the Marshall Space Flight Center in Huntsville, Alabama for laboratory testing, simulation, and stage checkout purposes. Sanders has also produced a display system of similar design for the government of Canada.

The sophisticated, extremely versatile nature of Sanders Saturn V Operational Display System is apparent from its specifications and block diagram on these pages. Operators at any console in the system can:

- Monitor the presentations on all other consoles.
- Reassign memories to different consoles by simple keyboard command.
- Call background information from banks holding up to 512 photographic slides.

- Receive real-time digital data multiplexed with video data from the slide banks.
- Request continuous tone hard copies of the video and/or digital data on the screen.
- Perform a complete console selftest.
- Type commands in a scratch pad area for computer/system execution.
- Use appropriately coded card keys to access the data and operations permitted by system software.
- Receive inputs from any of ten 525line closed circuit TV channels.
- Generate data formats and place them in storage for later recall from that console or any other console.



Specifications

Viewing Area: 13" x 13"; normal display is 12" x 12"

Display Capabilities: tabular and random plot modes may be used separately or mixed within a frame; maximum capabilities are (1) 2003 tabular alphanumerics, (2) 666 random alphanumerics, (3) 1000 connected vectors, (4) 500 unconnected vectors, or (5) 945-line TV slide display mixed with 330 tabular or 165 random alphanumerics or vectors generated digitally.

Frame Refresh Rate: 48.8 CPS

Repertoire: 64 alphanumerics including 4 blanks

Alphanumeric Generation Method: 16stroke cursive generator Alphanumeric Size: selectable large or small sizes either 0.2" x 0.15" or 0.4" x 0.3"; sizes can be intermixed within a frame

Alphanumeric Generation Time: 3.5 μ sec to position; 6.5 μ sec to write (tabular)

Vector Generation Method: constant time generator

Vector Generation Time: 20 μ sec per vector (connected); 20 μ sec to position, 20 μ sec to write (unconnected)

Vector Length Ratio: 20:1; 0.1 to 2 inches

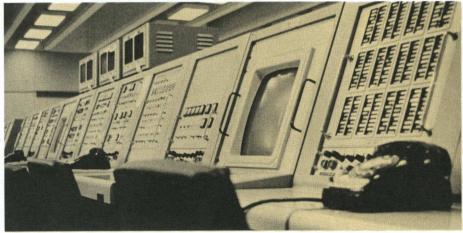
Vector Writing Speed: 10,000 to 200,-000 inches per second

Brightness: 20 foot-Lamberts TV and 25 foot-Lamberts alphanumerics

and vectors with 3:1 contrast in 50 foot-candle ambient

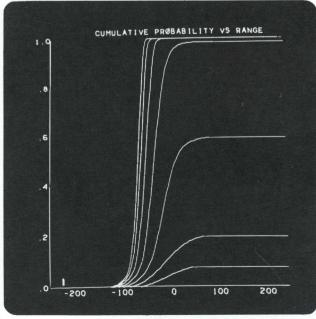
Refresh Memory: 4096 words x 12 bits magnetic core type

Special Features: (1) 525-line standard EIA TV, (2) 945 line TV (modified to 1:1 aspect ratio), (3) slide display and digital data superposition, (4) full editing capabilities including Photopen®, (5) internal storage bank for several formats, (6) self-test, (7) card key function interlock, (8) complete interconsole communications, (9) storage for two full data pages, (10) qualified to MIL-I-6181D RFI specifications (11) designed to meet 10 minute mean-time-to-repair requirements

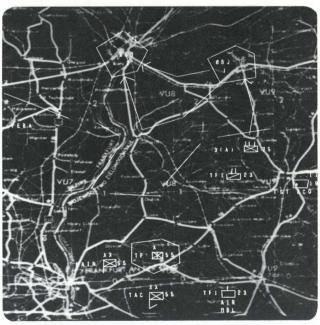








Typical Saturn V system presentation of digitally generated alphanumeric/graphic information.



Typical display of video information from photographic slide mixed with digitally generated alphanumerics and vectors.

960 Series High Data Density Display Systems

Sanders 960 Display Series is designed for very high speed alphanumeric/graphic communication with a host of modern computer systems. Displays in this series can present over 6000 alphanumerics and symbols ... up to 10,000 inches of vectors ... on large area CRT screens at a refresh rate of 50 CPS.

This display series also features a very versatile word format, allowing detailed application-oriented interfacing with computers and data systems having almost any logic structure.

Maximum operational and functional flexibilities are obtained by use of a completely modular design concept. Each 960 display is configured

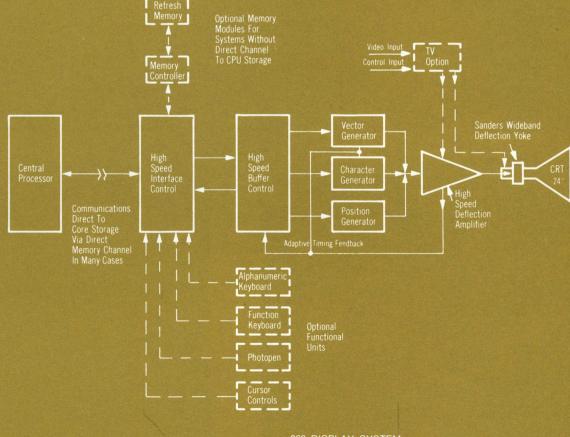
to exact customer requirements . . . provided with the specific interfacing, editing, presentation, and communications capabilities an application requires.

For example, some 960 displays are refreshed via a direct memory access channel to associated computers when maximum display/computer intimacy is desired and computer capacity permits. In other cases, a separate refresh memory module is included in the display itself so that various data handling operations can be performed "off-line".

Many other options are available with Sanders 960 Series Display Systems including:

 Edit modules . . . allow delete, copy, transfer, erase, enter, format, update, retrieve, interrogate, and other operations on displayed or stored data.

- Processor module . . . allows "offline" data processing when desired.
- Photopen . . . a high speed solid state unit with finder beam permits rapid, accurate, fatigue-free selection of data on the CRT.
- Character/function keyboards . . .
 permit selection of ASCII characters, greek, mathematical, electronic, and target symbols . . . selection of edit, command and control functions.
- Joystick... enables rate plotting of vectors and cursor.
- Trackball . . . enables plotting of vectors and cursor.
- Transparent sketchpad . . . allows drawing of curves, sketches, and tracing of graphics.
- Programmable function keyboard
 ... used with Photopen to make an electronic keyboard on a portion of CRT face.



Specifications

Viewing Area: 20" diameter circle (24" CRT); normal data display in 14" x 14" inscribed square with remaining area for status and operational use; data display in circumscribed square also possible with proportional increase in positioning time

Display Capabilities: at 50 CPS frame rate can present over 6000 alphanumerics . . . from 8,000 to 10,000 inches of vectors; tabular and random positioning modes may be employed either separately or mixed within a frame; vectors may have any length up to full screen diagonal

Frame Refresh Rate: 50 CPS nominal

Timing: employs Sanders developed adaptive timing structure to display maximum of data at high frame rates; only as much time is used for an operation as is actually required; internal circuitry senses completion of an operation (alphanumeric generation, vector generation, or random deflection) and immediately begins operations on next data

Character Repertoire: 128 characters maximum; may be ASCII alphanu-

merics, greek, mathematical, electronic, and target symbols

Alphanumeric Generation Method: 22stroke cursive generator

Alphanumeric Size: four character sizes may be selected and intermixed within a frame; 0.125", 0.156", 0.25", 0.5" high upper case characters standard; others available between 0.125" minimum and 0.5" maximum

Alphanumeric Generation Time: variable, 3.75 μ sec maximum for 0.125" nominal character size

Tabular Positioning Time: variable, proportional to distance; 7 μsec maximum within inscribed square; 10 μsec maximum within circumscribed square; 1 μsec minimum

Vector Generation Method: constant velocity generator

Vector Generation Time: variable, proportional to length; 42.0 μ sec maximum (full 20" diagonal); 2.0 μ sec minimum

Vector Writing Speed: 500,000 inches per second nominal

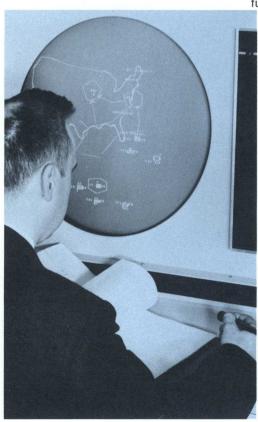
Positioning Accuracy: ±1 percent of full scale absolute

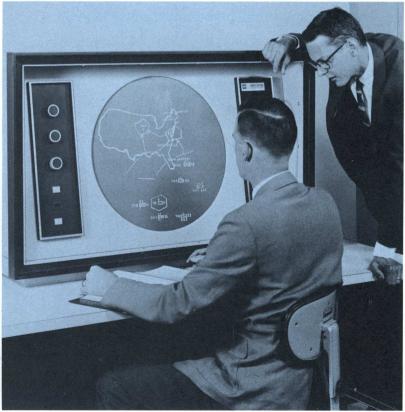
Positioning Repeatability: ±.0.1 percent of full scale within specified positioning time

Jitter: less than 0.02" peak-to-peak

Brightness: 25 foot-Lamberts with 4:1 contrast in a 40 foot-candle ambient; data may be written with up to 8 different brightness levels, intermixed within a frame, under program control

Special Features: (1) positioning and writing accomplished through single magnetic deflection yoke, (2) adaptive timing, (3) large area screen, (4) versatile word format, broad interfacing flexibility, (5) vectors may be solid (----), dashed (----), dot/dashed (-----), or dotted (· · · · ·) under program control, (6) selected characters, groups of characters and vectors can be caused to blink under program control, (7) sub or superscripts may be used, (8) full alphanumeric/ function keyboards, editing capabilities, Photopen and other cursor controls, 525, 729, and 945 line TV features also available





Advanced Avionics Display Systems

Sanders is also developing advanced display, data processor, and data communications configurations for integration of the full avionics system complements on supersonic aircraft.

Integration of sensors (radar, low light TV, IR, ECM, navigational and others) with onboard computers and complete weapon/cockpit displays is involved in these efforts of study, simulation, design and development.

Heads-up displays . . . vertical and horizontal situation displays . . . attitude director indicator displays . . . tactical and threat evaluation displays . . . navigational displays . . . and multisensor displays operating in various mixed modes (combined radar/symbolic, combined TV/symbolic, etc.) are typical of those being developed and evaluated.

These activities have led to the concepts embodied in Sanders' new Airborne Data Display System (ADDS*).

ADDS is a total avionics display system. It is a completely modular, ex-

ceptionally flexible system for use in flight simulation, dynamics, command/ control, checkout, and test applications requiring real time presentation and control of graphical, textual, and video information.

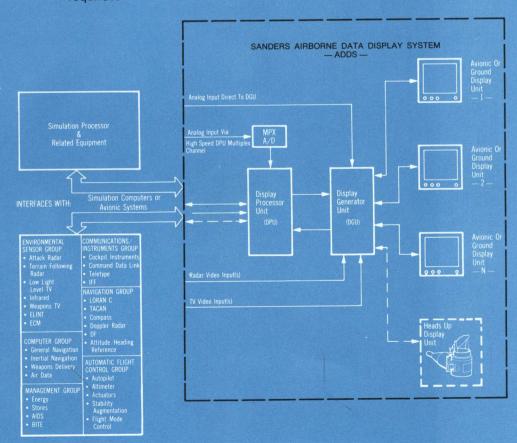
ADDS equipment is packaged to airborne environmental specifications, therefore, it is useful in both ground and flight operations without modification.

Depending on the mission, an ADDS system contains:

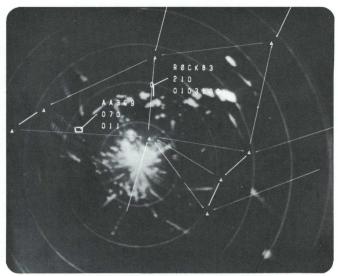
• Display Processor Unit (DPU) . . . microelectronic, stored program, general purpose digital processor capable of handling a wide variety of sensor and other inputs under program control . . . refreshing several displays via direct-to-memory channels . . . preprocessing raw sensor data received via digital and/or analog input channels . . . arranging and formatting data for optimum display presentation . . . handling all normal arithmetic, I/O, and logical functions . . . contains basic 4096 word x 24-bit memory expandable to 32K words as required.

- Display Generation Unit (DGU)...
 contains all necessary circuitry for
 alphanumeric, symbol, and vector
 generation...interfacing displays
 and processors...timing and control...selection of video display
 modes.
- Avionic Display Units (ADU) and Ground Display Units (GDU) . . . with CRT sizes from 5" to 19" and brightness levels from 400 to 2000 foot-Lamberts depending on requirements.
- Portable Support Equipment (PSE)

 for checkout, testing, debugging, and "forced" data entry directly to processor core storage.
- Options . . . many special features and peripherals may be used with a basic ADDS system including . . . radar sweep (PPI, sector PPI, etc.) paper tape punches/readers . . . TV sweep (525 line, 729 line, 945 line) . . . teletypewriters . . . light pen and cursor editing functions . . . video hard copy devices . . . magnetic tape recorders . . . and others.



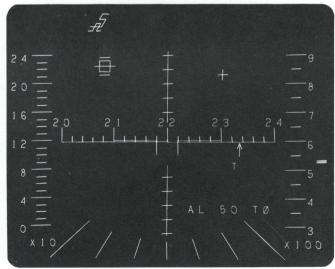
Typical ADDS Displays



Multisensor Display (scan converted radar/navigation data)



Low Light TV/Attitude Director Indicator Display



Vertical Situation Display

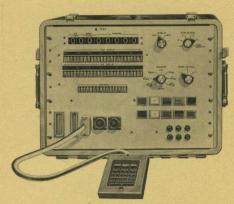
Typical ADDS Equipment



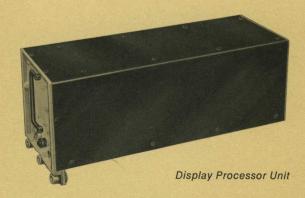
Avionic Display Unit



Heads Up Display Unit



Portable Support Equipment



Desk-Top Information Displays

Automatic Testing/Checkout
Banking Systems
Commercial Credit Systems
Computer Input/Output Control (DATA-PHONE and Local)
Computer Programming
Educational Systems
Engineering Reports/Data
Financial Quotations/ Information
Inventory Control
Invoicing/Billing
Key Punch Replacement
Library Systems
Low-Cost Management Information Systems
Man/Computer Conversational Operations
Medical Records/Diagnostic Systems
Message Handling/ Dispatching
Newspaper/Publishing Operations
Order Processing
Process Control
Program Monitoring/Control
Record Retrieval/ Maintenance
Travel Reservations Handling

Sanders family of information displays includes compact desk-top systems particularly designed for use in business data processing, communications, and information retrieval operations.

Designated the 720 DATA DIS-PLAYS, these systems give instant visual access to computer-stored business records. Such records can be freely called up, entered, and updated from the desks and locations where availability of up-to-the-minute information is essential to customer service, decision making, and more efficient inter-facility data communications.

The 720 Data Display Systems employ standard ASCII coding and can communicate with any modern computer either directly or via DATA-PHONE equipment. They can be used to link many offices, warehouses, and plants into a complete network of instantaneous communications.

Furthermore, Sanders can supply a complete display package for data entry and retrieval operations with the IBM System/360. Sanders has the display hardware . . . buffering/interface hardware . . . and an application program called AUTOGRAPH*, designed expressly for a broad range of file maintenance applications.

The AUTOGRAPH program employs simple program modules for routine data entry, storage, retrieval, and update operations with system entry and exit points that permit the user to introduce his own processing procedures. Sanders interface and buffering unit for the IBM System/360 is described more fully on page 16.

Sanders 720 Data Display Systems have many benefits for modern business including improved management effectiveness, cost controls, customer service, inventory control, and record accuracy. They are economical yet they contain a number of exclusive, advanced capabilities.

Their advantages include:

 Complete editing features which give operators total control over displayed data (and format when desired); operators can correct, delete, add, and move data at will; new numbers, words, even sentences and paragraphs can be in-

- serted into the middle of displayed messages and the text automatically opens up to make room.
- More usable data capacity (up to 50% more data per message) than competing systems with equivalent character memory capacities because the Sanders 720 system does not count blank spaces as characters.
- Complete format flexibility allowing rows, columns, tables, headings, paragraphs, and forms to be set up, changed, and controlled by both keyboard and computer operations; a format "lockout" feature permits "supervisory" display consoles to create formats which can be filled in, but cannot be accidentally changed, by "line" display consoles.
- Fully modular design which lets businesses buy just the capabilities they need ... 256, 512, or 1024 character systems . . . partial or full editing . . . vertical (page appearance) or horizontal (TV appearance) screen orientations . . . and accommodate future expansion as the need requires.
- Minimum interruption of computer operations because display memories buffer data from the computer at all times except during transmission and reception of complete messages; unique display logic "compresses" all messages into the most compact form before communication with computer.
- Reliable, silent, low power operation because only solid state, microcircuit electronics are employed.
- Clear, bright, high definition characters formed from continuous strokes.
- Simple operation using keyboard controls very similar to those on typewriters and adding machines; secretaries can master operation with a minimum of training time.

These features of Sanders 720 Data Display systems permit businesses to capitalize on the high speed search, sorting, sequencing, comparison, and calculation powers of their computer facilities with simplicity and ease.





720 System Specifications

Viewing Area: 7½" x 9½" vertically or horizontally oriented

Characters Per Display: 1024, 512, or 256 are available

Characters Per Line: 52 in vertical displays; 64 in horizontal displays

Lines Per Page: 40 in vertical displays; 32 in horizontal displays Character Repertoire: 64 ASCII alphanumerics

Character/Function Code: ASCII standard

Frame Refresh Rate: 46.5 CPS

Alphanumeric Generation Method: 16stroke cursive generator

Alphanumeric Size: 0.13" high, nominal; 0.08" wide, nominal

Character To Character Spacing: 0.05" nominal

Line To Line Spacing: 0.08" nominal

Alphanumeric Write Time: 21 μ sec

Deflection Method: magnetic

Spot Size: 0.015" maximum

Brightness: 30 foot-Lamberts minimum (with 6" x 8" raster)

CRT Filter: gray, 49% light transmission minimum

Phosphor: P4, type W modified

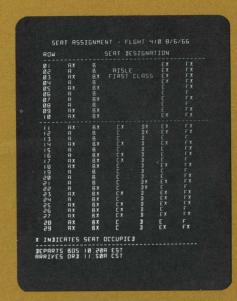
Refresh Memory: 1024 characters maximum capacity; magnetostrictive delay line type

Communications: up to 1000 cable feet from control unit to display terminal; up to 10 cable feet from keyboard to display terminal

Maximum Parallel I/O Rate: 47.5 thousand characters per second

Parity: inserted in I/O logic before transmission

Input Power: 115 VAC $\pm 10\%$, 60 CPS @ approx. 200 watts for display terminals; 115 VAC $\pm 10\%$, 60 CPS @ approx. 150 watts for control unit.



PHONE BRIDESS 491-3954 625-2988 961 33 120GROOM 262-3056 536-8446 17WASHAVE 666-3378 ANB-7304 BELLEMERE GEO INCHELSER BELLEVUE H I 32PRSPCT BELLI STANLEY 4BRATTLE 165 55 566 81 691-7458 319 09 238 00 BELLIND GUY H 90GLENHI HRE-6392 200 44 BELLOWS M S 3046L HL BELLOWS GED F 105ROWELL 566 67 NP ICH

INVENTORY RECORD - PRPER, BOND 92

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STOCK NRHE:
SUBLE BOND HH B.SXII

SUPPLIER:
R. B. PRPER INC.

MIN (RECORDER PT):
BURN ON CONSMET:
BURN ON HRMD:
R-19 CTMS

RVG. COST:
BURN ON ORDER:
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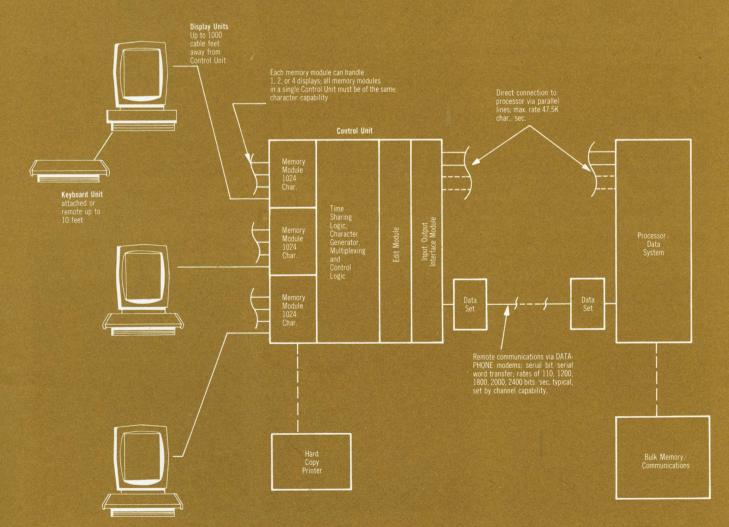
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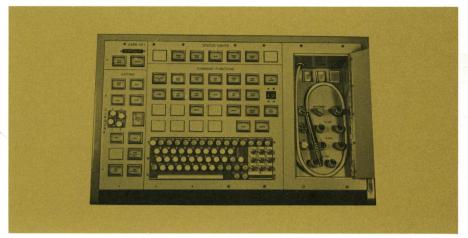
Over 1000 characters can be written anywhere on a screen having more than 2000 locations, thus the Sanders 720 system can display more information over larger screen areas.

As shown here, the 720 system can display the entire seating capacity of the largest commercial airliner. The 720 system does not store all the blank spaces between columns, rows, etc. Its full memory capacity is used to store displayable characters and a few format control characters. Thus, the 720 system can display far more information in most formats than competing systems with similar memory capacities.

This customer account record is an example.

Formats, headings, spaces between data, etc. can be generated by "supervisory" display operators and be permanently "fixed". Operators of other displays can manipulate data only in blank "answer" spaces (shown by open, uncolored blocks on this inventory record).





Typical modular keyboard unit includes ... Photopen and 4-directional cursor controls ... complete alphanumeric keyset ... sophisticated editing capabilities ... controls for communications, peripherals, self-testing ... many other features.

Sanders bright, clear, high contrast characters formed from continuous strokes produce minimum operator fatigue and error rate. Important data elements may be highlighted by larger or brighter characters (two sizes shown).

How Sanders Displays Are Matched to Your Application

The systems in our display family achieve great flexibility through use of modular "building block" components. They can be configured to meet exact customer requirements by selecting and integrating functional modules appropriate to the task.

The modular nature of Sanders displays means even completely new system configurations can employ tested, proven hardware and techniques. And, such new systems can be created more rapidly and economically from modular components. They can be easily expanded to meet new requirements in the future.

The following paragraphs describe our capabilities with each of the functional elements which go into advanced information displays.

Keyboards and Control Logic

... compose and control communications between man and display and between man and computer.

Sanders keyboard/logic techniques are based on human factors research. They are flexible and can be configured to meet the exact operator/performance criteria of varied display missions.

They can employ . . . large repertoires of alphanumerics, symbols, and line vectors . . . all types of editing features and edit data selectors including Photopen®, miniature slewstick, trackball, 4-directional cursor controls, and others . . . audio alarms . . . facilities for direct control of computers, communications and peripherals.

Sanders' displays provide the capability for implementing "software" keyboards which employ subroutines in a display's central logic or computer to match functions with different key modes. The keyboard is not "hard wired" into the system. Simple programming allows keyboard/system capabilities to be changed and expanded as future situations demand.

®Sanders Associates Registered Trademark

Symbol and Vector Generators

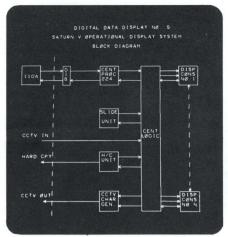
... produce the letters, numbers, symbols, and line vectors which are presented on the display screen.

Sanders has investigated, evaluated, and employed nearly every known technique for producing symbols and vectors in information display systems. Our capabilities have advanced from dot, raster, monoscope, and shaped beam ideas to a variety of modern stroke generation techniques.

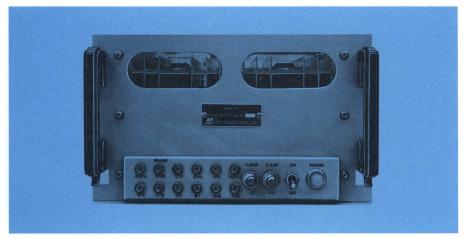
In fact, our present proprietary stroke generator capabilities allow writing of finely defined characters directly through CRT deflection yokes in time periods as short as 2.5 microseconds.

Using these techniques we can create a nearly unlimited variety of symbols and alphanumerics in as many sizes and brightnesses as required by any application.

Furthermore, Sanders has performed considerable research on the human factors of symbol and vector appearance including character aspect ratios, brightness levels, contrast ratios, line weights, and others. Thus, we are able to display data in the forms most easily read, and with the exact characteristics required for minimum operator fatigue and error rate.



Characters and vectors on Sanders displays are in sharp focus across the full screen area. They are also very stable. Sanders display presentations are particularly free of flicker, jump, jitter, half page shift, and veiling.



Modular core memory unit specifically created for use in high speed, high reliability information display systems.

Positioning and Presentation Modules

... write data at desired points on the display screen with the qualities required for fast, accurate assimilation by display operators.

Sanders has developed advanced techniques for positioning and writing displayed information. Some of these are . . . proprietary deflection yoke allowing full screen positioning on CRTs over 22" in diameter in less than 6 microseconds . . . dynamic focus and astigmatism techniques allowing data display on flat face CRTs with no loss of sharpness or quality even near edges . . . high speed techniques for random and tabular character positioning, production of freely oriented and connected line vectors.

Furthermore, Sanders has done considerable research on CRT characteristics, particularly on the best phosphor qualities for presentation of information under different conditions of ambient lighting. Working with CRT manufacturers, we have developed special capabilities for selection of the CRTs most exactly suited to different display missions.

In addition, the company has developed significant capabilities for reducing detrimental phenomena of flicker, jump, jitter, half page shift, and veiling. We can present information with the brightness, resolution, and contrast required by nearly any display application.

Memories

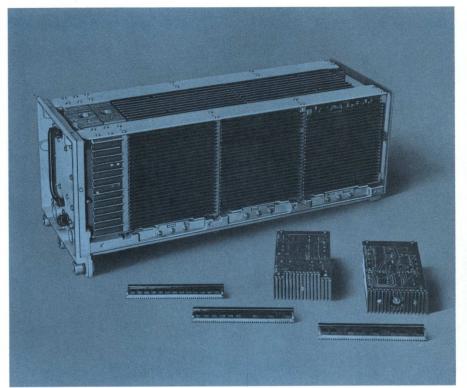
... store inputs from display keyboards and computers while repeatedly presenting such stored information to the display screen.

Sanders employs memory modules of several kinds and capacities in advanced displays. Our in-depth experience covers virtually every type and size of memory system including exceptionally compact (less than 1 cubic foot), rugged, and fast core memories with greater than 100,000-bit storage capacities developed for use in airborne equipment.

Memory modules in our Saturn V system are magnetic core units with capacity to store two full frames of information (4096 12-bit words); memory modules in low cost displays are delay line units with basic capacities for 1024 7-bit words.

Different memory types and sizes are selected for different display applications. Large-capacity memories can be employed when many thousands of characters and complex positioning schemes are required, for example. Or, such memories can be used to store several "pages" of information for instant operator recall.

Memories and associated logic can also be used to store recallable formats and background. Disc files and other bulk storage media can be employed to retain many data pages, formats, and computer subroutines as required.



Compact general purpose digital computer designed by Sanders. Contains two plug-in core memory modules each with storage capacity for nearly 100,000 bits.



... match the input/output characteristics of information displays with those of their cooperating computers, both electrically and logically.

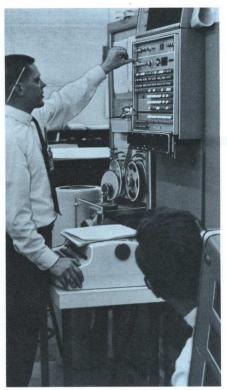
Information display systems are easily interfaced with computers specifically designed for time sharing operations. We provide suitable interface modules for matching our displays with these systems and with all other types of special and general purpose computers.

In fact, all systems in our display family can be interfaced with any computer, either military or commercial. That is, we can supply custom interface modules which convert display inputs/outputs to the logic levels, rates, codes, word lengths, and organizations required for efficient use of any computer system.

For example, Sanders new Model 731 Data Communications Buffer (DCB) provides direct interface between the Sanders 720 Data Display and either selector or multiplexor channels of the IBM System/360. The 731 DCB is modular and can be supplied in either of two configurations. For local direct applications, the parallel data transfer rate is 47,500 characters per second. For remote

applications, the 731 DCB will handle 2000 and 2400 bit per second synchronous data using standard ASCII code.

Sanders experience in developing various general and special purpose processors for specific missions provides the necessary capability and understanding of the detailed interface problems which often occur. One of these processors is a general purpose, stored program computer, packaged in a volume of only 8 cubic feet. It employs parallel, synchronous organization and has a core memory system with capacity for 8,192 24-bit words, and is fully qualified for airborne applications.



Sanders also designs the displayoriented software which assures that displays, computers, and other equipment in a complete system will function together with maximum speed and efficiency.

Software

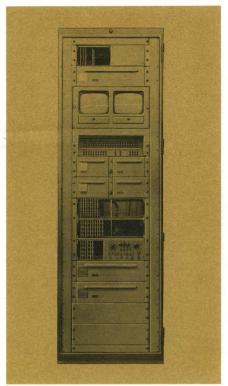
... the machine instructions which control display/computer communications plus processing and execution of display generated commands.

Sanders has full capabilities for design of software which integrates display consoles, computers, data links, and peripherals into a single, mission-oriented system.

For such purposes we have designed:

- Programs to control processor interrupt operations for time sharing communications between multiple display terminals and system peripherals.
- Special display-oriented executive routines for direction of all operations in entire system complexes.
- Simple problem-oriented languages and related programs which allow display operators to command the full capabilities of their computer and data networks with ease.

We have also designed software systems utilizing modular programming which permits simple, economical adaptation of system capabilities by alteration of short subroutines in machine storage. And, Sanders displays can allow reprogramming of system computers from the keyboard of any console in a display system.



TV Distribution Unit which monitors and routes 10 channels of 525-line TV and 945-line (modified) high resolution TV to one or a combination of information display consoles and remote TV monitors.

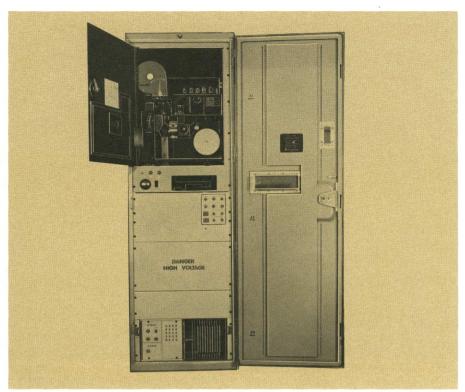
Communications Interfaces

. . . transfer information between display consoles and other equipment in a system and between operations centers at nearby or remote locations.

Systems in Sanders display family may use many types of communications links. They can communicate long distances, for example, via DATA-PHONE equipment and other types of communications modems,

Short range communications can include direct memory-to-memory techniques which permit many displays to freely transfer and share information without interrupting operations of central computers. Multiple channels of 525 and 945 line television information may also be used for interdisplay communications and to repeat the contents of information display screens on any number of remote television monitors.

Furthermore, Sanders capabilities include advanced, very reliable techniques for transfer switching and routing of information within large-scale display system and data collection/processing complexes.



Advanced Hard Copy Unit supplies continuous tone prints of alphanumeric, vector, and mixed video/digital information. First copy available 30 seconds after command; succeeding copies require 5 seconds each.

Peripheral Equipment

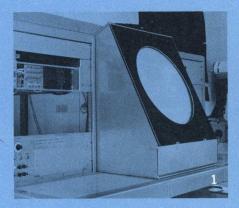
... expands and augments the primary capabilities of information display systems in different applications.

Systems in our display family can employ a variety of peripheral equipments including:

Hard copy units of various types; one Sanders hard copy peripheral produces 8½" x 11" continuous tone prints of either separate or mixed alphanumeric and video information in less than 30 seconds per copy. Another, the Model 706 Hard copy Adapter, interfaces between the 720 Data Display system and the Models 33 and 35 Teletypewriters. Local or remote operation may be selected, and a maximum

system capacity of 12 displays and 12 teletypewriters can be used with any one 720 System Control Unit. The Model 706 features up to three independent single or multiple mode display channels. In the multiple mode, data transmission for any one channel is time shared and there are no system interlocks . . . making possible uninterrupted operation of all display terminals not engaged in hard copy output.

- Standard input/output peripherals; we have extensive experience with all types of standard computer peripherals such as teletypes, electric typewriters, printers, magnetic and paper tape units, and others.
- Photographic slide units for selection and display of fixed reference (background) information; a typical slide reference peripheral developed for our Saturn V system allows 3.5-second (nominal) access to any of 256 slides in storage; for different applications, slide backgrounds can be converted to video and mixed with alphanumerics for display, or they can be projected through an optical window in the CRT if desirable for different missions and to obtain full-color presentations.







Sanders Qualifications

In addition to information displays, Sanders is prime contractor for advanced systems in the fields of: radar . . . communications . . . electronic warfare . . . ASW/oceanography . . . data storage and processing . . . ground support/checkout . . . electrooptics . . . and others. Competence in these technologies directly enhances Sanders ability to supply information displays matched to total system missions.

The company employs over 9000 people, operates from 10 east coast plants with about 1.7 million square feet of floor space, and has an annual sales volume over \$135 million (fiscal '67).

Some of our resources with special significance in display efforts are listed at the right.

Comprehensive Display Test/Evaluation Facilities

Sanders simulates, evaluates, and proves (or disproves) new display concepts with unusual thoroughness using an elaborate display system test bed.

Breadboard hardware, software, and the human factor considerations of controls and CRT presentations can all be evaluated on this system.

Some of its capabilities include: communication with any of several inhouse computers . . . operation at refresh rates up to 60 CPS, line locked . . . operation at brightness levels over 100 foot-Lamberts . . . mixed video/digital data presentations . . . digital rotation and translation of displayed data . . . presentation of characters/vectors at extremely high rates.

The flexibility of this system allows Sanders to test nearly every element of advanced displays . . . I/O and interface designs . . . vector/character generators . . . deflection subsystems . . . and others. Newly developed ideas can be demonstrated in an operating display *before* they are used in a customer's system.

In-House Computer Systems

Sanders display efforts are also supported by a variety of companyused computer systems. These include: IBM System/360 Models 50, 40 (two), 30, and 20 plus Honeywell Models DDP-516 and DDP-116. We also use a GE-225 time sharing system via DATA-PHONE link.

Computer Design Programs

For these machines we have a growing library of programs which analyze and specify display system design parameters. General programs describe CRT characteristics, deflection amplifier power/bandwidth requirements, and other factors with consideration of variable display formats, refresh rates, etc. Some other programs include:

- Television Program . . . considers relationships between resolution, aspect ratio, retrace time, bandwidth, etc. . . . analyzes tradeoffs between TV dead time, and other parameters in pursuit of optimum mixed video/alphanumeric displays.
- Radar Program . . . considers relationships between radar dead time, range, PRF, and hits/target for specified detection probabilities, antenna scan rates, and other parameters.

- New concepts, hardware, and presentation formats can be evaluated on Sanders elaborate display system test bed (only console shown) before they are used in customer equipment.
- A number of computer systems at Sanders are used for study of display interfacing/communications design tradeoffs.
- 3 & 4. Sanders also has facilities for, and considerable experience with large quantity production of display systems to military, NASA, and commercial specifications.
- 5 & 6. The environmental laboratory at Sanders can perform tests meeting the requirements of nearly every military/NASA specification and standard
 - The company has two flight facilities and a variety of instrumented aircraft for operational testing of airborne equipment.

Computer #1 Program . . . describes

 Computer #2 Program . . . describes the amount of central processor

display system.

systems.

types.

the amount of central processor

time required to refresh a specified

time required to normalize, convert,

and scale a variety of input data streams associated with display

Computer #3 Program . . . considers

the extent of central processor in-

volvement in the handling of input

sensory data, i.e., digitized radar

data, multiplexed data, and other

Optimum display designs can be

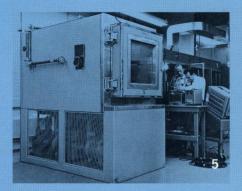
determined with speed and accuracy

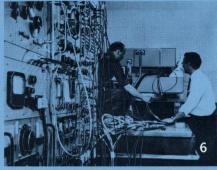
using these Sanders programs. Trade-

off possibilities can often be found

which might have been missed by

traditional analysis methods.







Large Quantity Production Capabilities

Sanders is fully able to supply even extremely sophisticated display systems in quantity.

We have, for example, produced 58 advanced display consoles plus extensive associated equipment to full NASA specifications. And, other displays are now being produced at rates exceeding 60 systems per month.

Detailed Reliability And Q. C. Programs

Reliability and Quality Control activities at Sanders have had intimate experience with the requirements of information display programs. Both are fully qualified to military and NASA standards.

Extensive Environmental Test Facilities

Sanders environmental laboratory can test to the requirements of nearly every military/NASA specification and standard. It can simulate altitudes up to 200 miles, temperatures from -157°F to +509°F, vibrations from 0 to 5000 CPS at force outputs to 12,500 pounds (sine) and 5,300 pounds (random), shock loads to 500 g's, It is also fully equipped for humidity, salt spray, cooling, sand and dust, acceleration, acoustic noise, fungus, RF power, and many other tests.

RFI Control Capabilities

The company has a complete activity for analysis, prediction, measurement, and suppression of radio frequency interference.

This group is equipped and qualified to perform work under all applicable military RFI specifications. It has many low RF ambient screen rooms, and measurement equipment covering the DC to 100 GHz spectrum.

Sanders Saturn V Operational Display System, for example, is qualified to MIL-I-6181D.

Flight Test Facilities

For evaluation of airborne equipment under actual operational conditions, Sanders has two flight test facilities. One is located at a company-owned, 127-acre airport just a few miles from corporate head-quarters. The second is adjacent to Sanders plant at Grenier Field in Manchester, New Hampshire.

Several types of aircraft, both jet and propeller driven, are on permanent bailment to Sanders for use as flight test platforms. Complete test instrumentation is installed in each aircraft and at appropriate ground sites.

INSTALLATION, SERVICE, SYSTEM CONSULTATION

Sanders Associates, Inc. supplies all display services including: (1) consultation and analysis for definition of system parameters and interface requirements, (2) design and fabrication of hardware, (3) development of appropriate software, (4) installation of equipment, and (5) complete maintenance support.

These integrated, mission-oriented display services apply to all areas of complete systems including display terminals, peripherals, computers, and communications links.

We offer not only a family of display capabilities, but a complete family of display services as well.



For further information contact: Corporate Division Development
Sanders Associates, Inc. Nashua, New Hampshire 03060 Area Code (603) 883-3321

Continuing product development may result in specification changes at any time.

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