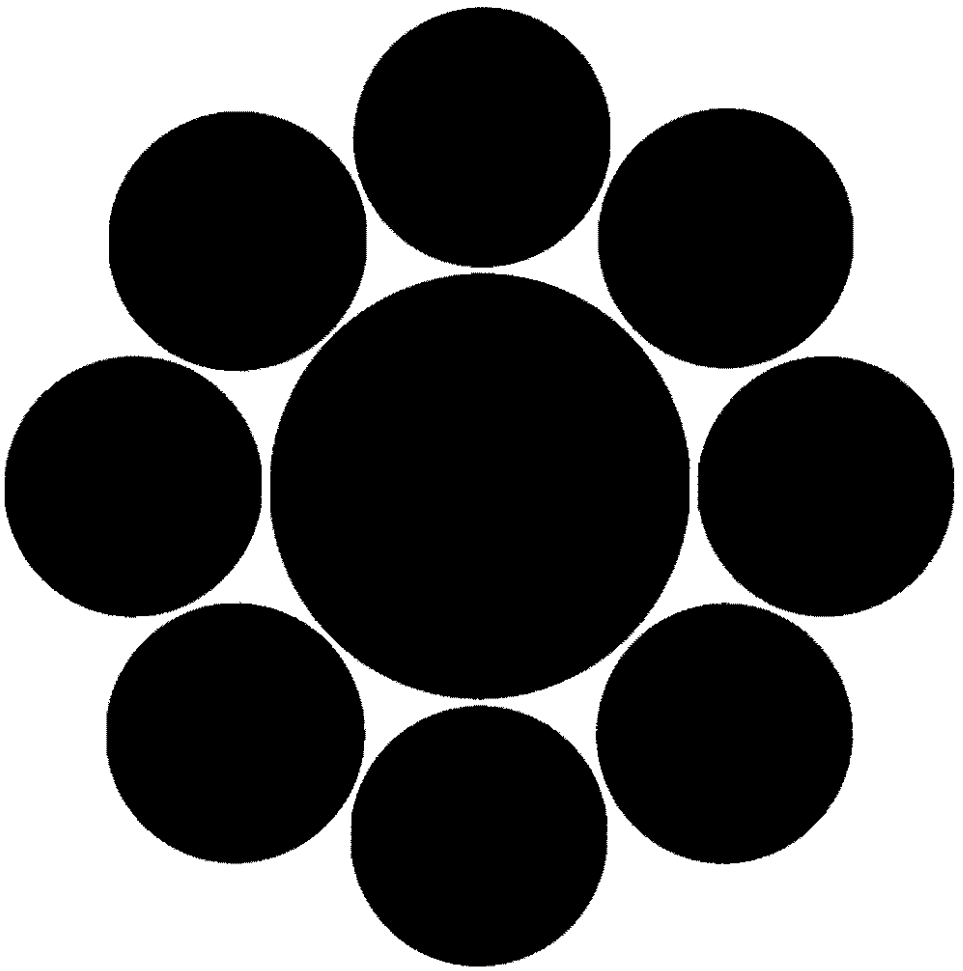
IBM

See your way to total control:
1800 Data Acquisition and Control System

NEGATIVES



Solving problems with speed, accuracy and flexibility

Holding a sensitive finger to the pulse of a process or manufacturing plant is not nearly so difficult as it used to be.

Now you can monitor operations all around the clock—and consistently apply optimum procedures...

You can keep the plant running smoothly—despite inevitable fluctuations and disturbances...

You can change more than one variable at a time—and achieve better control than was possible when you changed one plant setting and then waited to see what effect it had...

You can do all this—and more—with an IBM 1800 Data Acquisition and Control System. The 1800 System collects and analyzes a wide variety of data and distributes the output on a real-time basis. It accepts analog and digital electrical signals from devices like thermocouples, pressure and temperature transducers, flow meters, analytical instruments, and contacts. It can also provide electrical on/off and analog control signals for regulating and controlling processes using those devices.

The 1800 collects data at analog rates up to 24,000 conversions per second per analog-to-digital converter and at digital rates up to 100,000 samples per second. It can acquire telemetry data in bursts at rates up to 8,000,000 bits per second. It provides flexible scanning rates and patterns through random or sequential multiplexer addressing during a test or experiment.

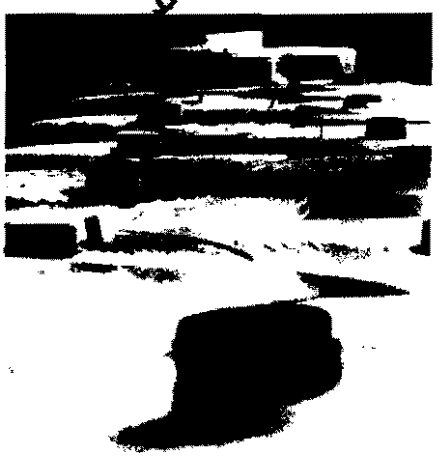
Meeting specific requirements

Each 1800 System consists of modular units which are easily integrated to meet specific system requirements. A comprehensive array of real-time process input/output (I/O) devices includes analog input, analog output, digital input and digital output. There are also data processing I/O units, including magnetic tape, disk storage, line printer, graph plotter, and card and paper tape devices. You can receive and transmit data on either a high-speed cycle-stealing basis or under program control, depending on the data rate of the I/O device.

System operations range from recording data on magnetic tape or disk storage with a minimum of editing and checking, to operations including data reduction and real-time display.

The processor-controller of the 1800 System contains a binary stored-program central processing unit which provides arithmetic, logic, and control functions. The processor-controller can be used for editing, supervisory control, direct digital control, or data analysis. A control and data path provides for attachment of an IBM System/360 or /370 either locally or remotely should a multisystem configuration be desired. System/360 or /370, for example, may be used to integrate the commercial aspects of an application while the controlling operations are handled by the 1800. This multiprocessor capability permits handling even large and complex real-time applications. Where real-time processing, remote from the central controller is required, IBM's System/7 may be attached to the 1800 by a communication link.

DP-1302



Configurations for industrial processing are readily expandable to keep pace with application growth. Uses for such systems are in petroleum refining, laboratory automation, chemical processing, electrical and mechanical component assembly and test, electric utility dispatching, primary metals production, and many other areas.

The 1800 System handles processing applications involving real-time computing abilities. Inputs may include signals from digital sources only or from both digital and analog sources. You can also display analyzed results in analog or digital form, or use those results to direct functions in many applications. For example:

- Research instrumentation and testing
- Traffic control
- Engine testing
- Components manufacturing control
- Automatic assembly and control
- Component inspection and sorting
- Automatic quality control

With the IBM 1800 System, you can exercise a complete range of process control, from off-line operator guidance to direct digital control. Your 1800 System, for example, can handle all these functions:

- High-speed data acquisition
- Data collection and analysis
- Data evaluation and operator guidance
- Process study
- Process optimization
- Supervisory control
- Direct digital control

System units and features

Processor-Controller. You can use either the 1801 or 1802 Processor-Controller in the IBM 1800 System. The 1802 includes circuitry and control for connection and operation of the IBM 2401 Magnetic Tape Unit.

Each processor-controller is available in two models. One has a core storage cycle of four microseconds, and the other a core storage cycle of two microseconds. Both are available with five core storage capacities: 4K (4,096 words), 8K (8,192 words), 16K (16,384 words), 24K (24,576 words), or 32K (32,768 words). In addition, the two-microsecond model has extended core storage capacity to 65,536 sixteen-bit words in increments of 8,192 words.

Standard features on all processor-controllers

Data Channels. High-speed input-output channels permit asynchronous I/O unit operations. Up to 15 cycle-stealing data channels are available.

Index Registers. Three index registers provide a means of saving program steps, core storage, and computer processing time.

Indirect Addressing. Indirect addressing alters normal effective address generation by using the value stored in the core storage location as the effective address.

Interval Timers. Three interval timers are provided to supply elapsed time and cyclic information to the program. Software is provided to expand the number of timers to 32 for use where periodic and timed executions are key.

Operation Monitor. Provides a means of sounding an alarm or setting an indicator if not reset by the program at periodic intervals.

Interrupt. The 24-level priority interrupt facility provides an automatic branch in the normal program sequence based upon internal and external conditions.

Programmed Interrupt. A special form of the priority interrupt system provides efficient multiprogramming capability.

Parity and Storage Protect. The core storage array provides 18 bits per word, including one parity and one storage protect bit.

DP-795

Process Interrupts. A contact closing, or a voltage level changing from a "0" to a "1" state, initiates process interrupts. These features provide termination and sensing of 16 contacts per group, or 16 voltage levels per group, with 24 groups maximum. Process conditions may interrupt the processor-controller on a multilevel priority basis.

Analog Input. The collection of analog data and its conversion for presentation to the digital processor-controller is the function of the analog input feature.

A physical phenomenon is first sensed and converted to an analog electrical signal by sensors or transducers, such as thermocouples or strain gages.

Conversion of analog signals from a voltage level to digital values is accomplished by an analog-to-digital converter (ADC). The converter is fast enough to handle multiple sources of analog signals. The switching of analog signals is accomplished by a multiplexer. The analog input units and features consisting of modular packaged equipment convert voltage or current signals into digital values. Other features used to accomplish the conversions include multiplexers, amplifiers, and signal conditioning elements.

Digital Input. The processor-controller can accept real-time digital information in any format brought into the system in 16-bit groups.

The format may be in any form. For example, unrelated bits from contact or voltage levels, or related bits such as binary-coded decimal digits. The system can handle any mixture of digital formats, and you can quickly implement conversion from one base to another by programming.

Digital and Analog Output. The digital and analog output features (DAO) of the 1800 provide versatile control capability. They permit exercising computer control over many types of control system auxiliary devices. Equipment that can be controlled includes set point positioners, actuators, displays, and telemetry systems. These control outputs are available with the DAO features:

- Pulse output
- Electronic contact operate
- High-speed digital register output
- High-speed analog voltage output

Communications Adapter. Permits use of regular telephone lines for binary synchronous communications between the 1800 and an IBM System/360 or /370, between two 1800s, between the 1800 and an IBM 1130 Computing System, and between the 1800 and an IBM 2780 Data Transmission Terminal.

Data Communication System. The 2790 adapter allows the 1800 to be used as a controller in a two-wire in-plant communications system. Shop floor terminals are provided for efficient data collection, and monitoring and controlling various plant floor functions.

Additional expansion with System/7

The 1800 can be expanded beyond its own broad system capability by communication link to the IBM System/7 with its high-speed real-time response to external interrupts. Programming support in teleprocessing mode is provided by the 1800 Distributed System Program (1800 DSP) and the 1800 Multiprogramming Executive Operating System (MPX). Outstanding System/7 capabilities include isolated digital I/O, an auto-ranging analog-to-digital converter, and the ability to set the range of the ADC under program control. System/7 is particularly suited to collecting on-line data from remote locations, performing device control and preliminary data reduction.

Your programs can be prepared in the 1800 and loaded into System/7 via the communication link. The 1800, acting as host, can analyze and produce reports, store data, and update control parameters stored within one or more interconnected System/7s. The 1800 and System/7 can be integrated to function as a single system of greater power and flexibility than the two systems individually.

IBM data processing units available for attachment to the 1800 System

IBM 1816 Printer-Keyboard provides printed output at a maximum rate of 14.8 characters per second and provides for data entry into the processor-controller via a keyboard.

IBM 1443 Printer operates on a data channel to provide on-line printing with a minimum amount of processor-controller time and attention. Two models are available.

Model 1 prints 120 to 430 lines per minute and Model 2 prints 200 to 600 lines per minute.

IBM 2401 Magnetic Tape Unit utilizes a nine-track read/write head and has a single density of 800 bits per inch.

Model 1 operates at a data rate of 30,000 eight-bit bytes per second, Model 2 at 60,000 and Model 3 at 90,000.

IBM 1053 Printer (Model 3) provides printed output at a maximum rate of 14.8 characters per second. When multiple 1053s are installed, they can simultaneously print independent messages from the processor-controller.

IBM 1442 Card Read Punch operates on a data channel and provides for serial reading and punching of cards. Two models are available. Model 6 reads 300 cards per minute and punches 80 columns per second. Model 7 reads 400 cards per minute and punches 160 columns per second.

IBM 1810 Disk Storage is a device with both random and sequential access capabilities. Its storage medium, an oxide-coated disk in an interchangeable cartridge, has a capacity of 512,000 sixteen-bit words. Each 1810 drive operates on a separate data channel with a maximum reading/writing rate of 36,000 words per second. One 1810 (containing up to three disk storage drives) can be attached to an 1800 System.

IBM 2311 Disk Storage Drive provides up to 3.125 million 16-bit words of random access storage per drive. Up to eight drives are attachable. A two-channel switching option permits sharing a 2311 between two 1800s or between an 1800 and a System/360 or System/370.

IBM 1055 Paper Tape Punch (Model 2) punches one-inch eight-track paper tape at a maximum rate of 14.8 characters per second. Data characters are punched as an image of the data in core storage.

IBM 1054 Paper Tape Reader (Model 2) reads one-inch eight-track paper tape at a maximum rate of 14.8 characters per second. Data is read into the processor-controller core storage.

IBM 1627 Plotter is an incremental plotter for recording digital information in graphic form. The plotter operates up to a maximum rate of 200 or 300 steps per second, depending upon the model selected.

IBM 2791 or 2793 Area Stations provide two-way communication between the shop floor and the computer. Shop personnel key in job status information and receive instructions on the terminal's display. Instructions to the workmen are in the user's own terminology to minimize training.

IBM 2795 or 2796 Data Entry Units can be used by one or two workers at individual work locations. They provide one-way transmission for production information from the shop floor to the 1800. Both Area Stations and Data Entry Units read cards and badges.

1816 Printer-Keyboard

7999

493

1053 Printer

7705

1055 Paper Tape Punch

6958

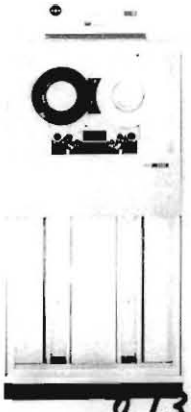
1443 Printer

1184

1442 Card Read Punch

1504

2791 Area Station



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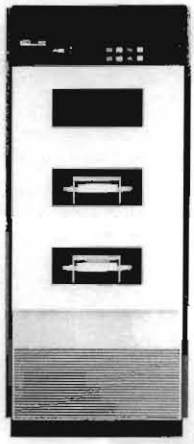
2401 Magnetic Tape Unit



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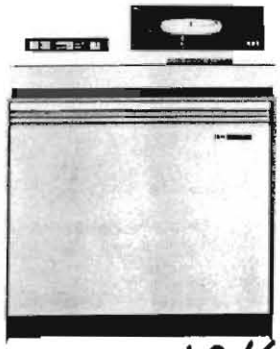
1810 Disk Storage



1014

2311 Disk Storage Drive

1501

2795 Data Entry Unit

7753

1627 Plotter

7896

1054 Paper Tape Reader

The IBM 1800 Multiprogramming Executive Operating System (MPX)

This is a real-time multiprogramming operating system capable of maximizing the efficiency and throughput of the IBM 1800.

MPX is designed for asynchronous control of independent processes while performing batch processing functions. The increased throughput provided by MPX is accomplished through sophisticated input/output handling techniques which make the central processing unit available during input/output and interval timer operations.

MPX control programs are modular to provide extended flexibility in covering real-time applications and to minimize the need for user modifications due to unique application requirements.

Multiprogramming is achieved through the programmed interrupt feature, which eliminates time-consuming list searching.

The MPX Executive Director directs handling of process and data processing input/output interrupts in whatever priority you select. The system provides timer control over the process, supervises the execution of real-time core loads or subroutines dictated by the process, and makes the system available to the Batch Processing Monitor.

The MPX Input/Output Control Routines (IOCR) provide complete input/output overlap capabilities within the system and for the user. Overlap provides maximum availability of the central processing unit during input/output operations and timed intervals. The techniques employed within the Input/Output Control program assure maximum I/O device throughput. The system automatically resolves all conflicting requests for a device from the random sources.

The MPX Batch Processing Monitor (BPM). This monitor allows development of real-time applications through the use of FORTRAN or the Macro Assembler while the system remains on-line. In a real-time environment, BPM functions are automatically executed whenever real-time executions are inactive.

Macro Assembler. Permits development of special-purpose application-oriented languages through macro capability, resulting in reduced installation programming time.

New system residence capability. The MPX System not only supports the 2311 disk as a storage device, but can now reside on the 2311 as well as the 1810 disk.

The 1800 Time-Sharing Executive System (TSX)

TSX provides foreground/background capability by making it possible for background jobs to be processed when the real-time foreground task relinquishes control of the processor-controller.

Through time sharing, idle computer time is minimized or eliminated. Programs may be written in FORTRAN and/or symbolic assembler language.

Time-Sharing Executive System components may be considered in three separate groups—control programs, service programs and processing programs.

Control programs prepare the system for and control the processing programs.

Service programs include a group of loaders and builders which serve as system generation aids, and a comprehensive IBM library subroutine package designed to aid in the efficient use of the machine system.

Processing programs include the assembler which translates programs written in symbolic language into machine language, and the FORTRAN compiler which translates programs written in FORTRAN language into executable machine language. The compiler also provides for calling the necessary arithmetic, functional, conversion, and input/output subroutines from the TSX subroutine library.

The 1800 Card/Paper Tape Programming System

This is a non-disk-oriented system of four components: assembler, FORTRAN compiler, subroutine library, and utility routines. Programs are available for either card-oriented or paper-tape-oriented 1800 Systems. This system is intended for smaller 4K or 8K 1800 Systems where special-purpose real-time problems do not require a general-purpose operating system.

In addition to the many 1800 programs available in the IBM Type II and Type III libraries, a variety of Program Products designed to meet the application requirements of a large number of users, are available under license agreements.

1800 Chromatograph Monitoring provides advanced data acquisition and fused peak analysis techniques for the simultaneous monitoring of multiple chromatographs in real time. This program is particularly well-suited to the quality control laboratory environment.

PROSPRO II (TSX/1800) is a unique programming approach to industrial control computer applications which are mostly continuous operations. It offers simple, fill-in-the-blanks tabular programming. PROSPRO II substantially reduces the programming effort associated with system installation. User coding is only necessary for special instruments, special logs, and special messages to operators.

Clinical Laboratory Data Acquisition System (CLDAS) provides a basic framework for satisfying the data acquisition and processing requirements of hospital clinical laboratories. CLDAS automatically acquires data from continuous-flow-type single or multiple channel automatic analyzers, continuously monitors instrument operation and provides operator messages for detected instrument malfunctions. CLDAS performs the data reduction and analysis required to convert raw instrument readings into final determinations, and provides a report for each instrument run which lists the final determinations for each channel active during that run.

Clinical Laboratory Management System (CLMS) utilizes a unique file approach to meet the rapidly changing requirements of a modern hospital clinical laboratory. CLMS directs and controls the flow of information from receipt of the initial requisition for a test until the final result has been developed and is ready for reporting.

1800 Report Program Generator (RPG) significantly enhances the commercial capability of the 1800 by providing an easy-to-learn language that is specially oriented to commercial applications such as accounts receivable, payroll, inventory accounting and sales analysis. A file conversion utility enables RPG to be used for generating operating reports from sensor-based disk data files created by FORTRAN-coded on-line programs.

Additional support

Experienced IBM specialists located in Sensor-Based Systems Centers and Field Systems Centers in strategic locations throughout the country provide expert planning and installation guidance. Operating systems are available in these centers for testing purposes.

Through IBM educational courses, your programmers, systems analysts and instrumentation specialists can obtain conceptual and hands-on training to help design, install, operate and manage 1800 and System/7 installations.

IBM Systems Engineers with sensor-based training and experience in a wide variety of industry applications are available to help insure successful installation.

In new application areas where more extensive support may be required, IBM Custom Contract Services are available for the performance of a broad range of tasks including systems design and analysis, application and program development, and systems installation and evaluation.

You'll want the full story

Your IBM representative welcomes the opportunity to tell you more about the 1800 Data Acquisition and Control System. Ask him to outline for you the many advantages that this high-performance system can bring to your specific applications. And let him show you how this powerful tool can be most effectively used in meeting your real-time data acquisition, analysis, and control demands.

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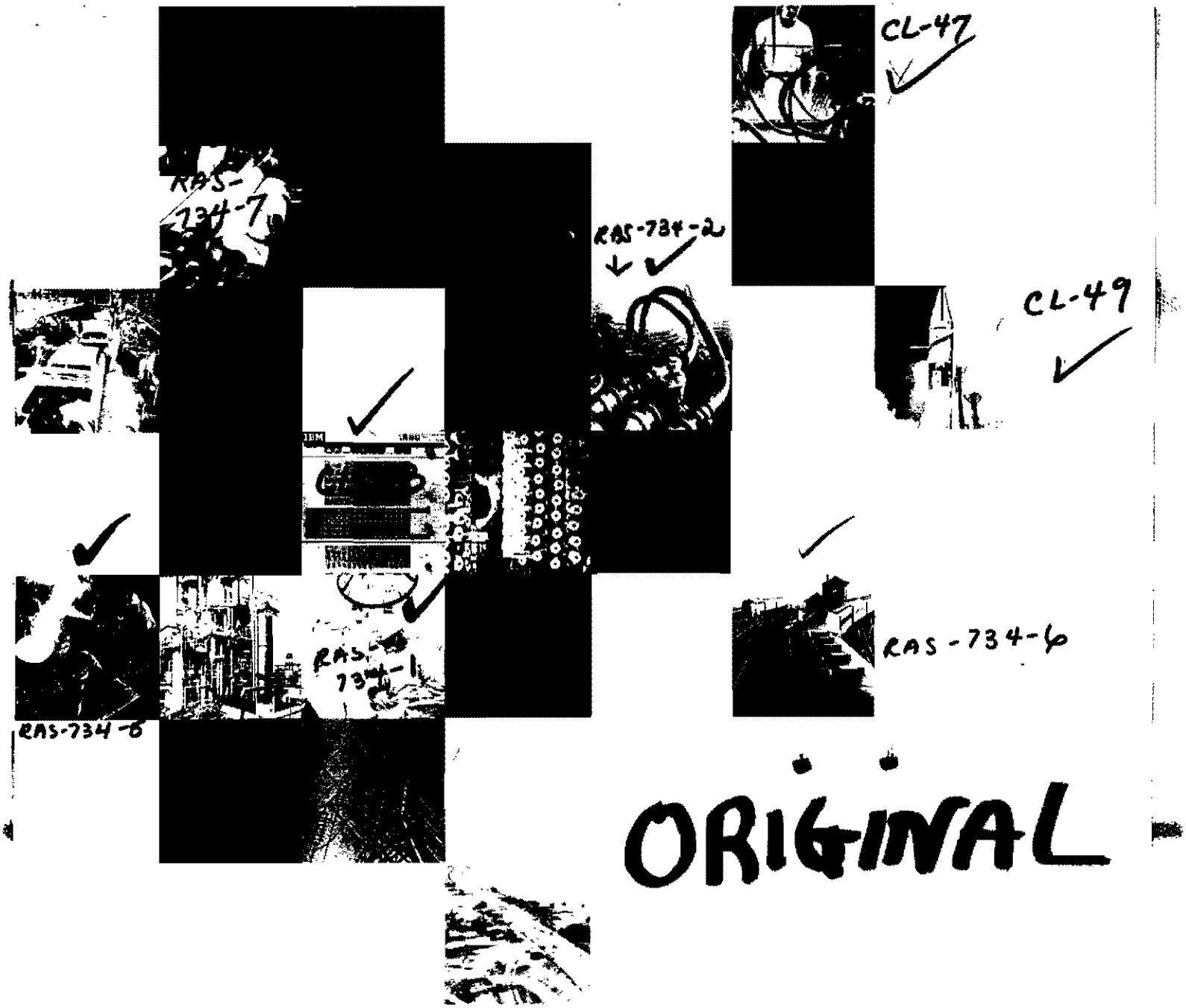


ORIGINAL

IBM

New growth features let you do more

IBM 1800 Data Acquisition
and Control System

Five new features plus enhancements to MPX (the Multiprogramming Executive Operating System) make the IBM 1800 more useful than ever.

The 1800, designed to collect and analyze a wide variety of analog and digital signals in a real-time environment, now offers upward growth to applications requiring increased system capacity and throughput.

Here's what's new:

- Up to twice as much core capacity
- Selector channel
- Communications adapter
- Up to 15 cycle-stealing channels
- New in-plant communication terminals

Descriptions follow . . .

CL-50

Twice as much core capacity. Now you can have up to 65,536 sixteen-bit words with the two micro-second model of the 1800. You can add core storage in increments of 8,192 words to reach this maximum.

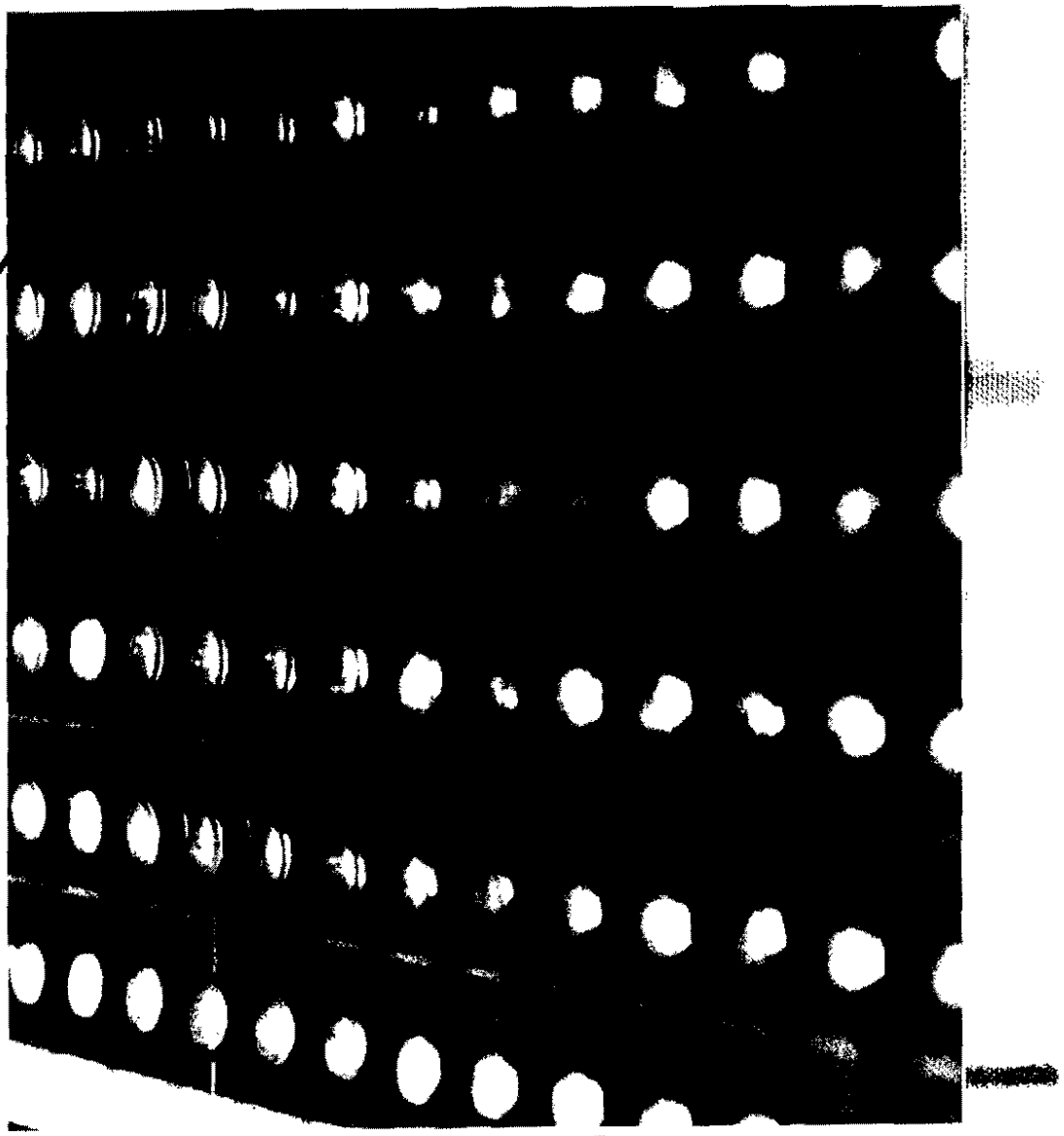
Selector Channel. Permits attachment of as many as eight IBM 2311 Disk Storage Drives. A two-channel switching option permits sharing a 2311 between two 1800s or between an 1800 and a System/360.

✓

RAS. 421-11

Communications Adapter. Lets you use regular telephone lines between the 1800 and an IBM System/360. Between two 1800s. Between the 1800 and an IBM 1130 Computing System. Between the 1800 and an IBM 2780 Data Transmission Terminal.

Up to 15 cycle-stealing data channels. Additional high speed channels for overlapped operation of system units or features help you get a significant increase in system throughput.



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CL-52

An in-plant communication system. The IBM 2790 Data Communication System when controlled by an 1800 adds a low-cost, two-wire terminal capability for data collection, monitoring and control of various plant floor functions.

The IBM 2791 or 2793 Area Stations (top) provide two-way communication between the shop floor and the computer. Shop personnel key in job status information and receive instructions on the terminal's display. Instructions to the workmen are in the user's own terminology to minimize training. The IBM 2795 or 2796 Data Entry Units can be used by one or two workers at individual work locations. They provide one-way transmission for production information from the shop floor to the 1800. Both Area Stations and Data Entry Units read cards and badges.

The photographs on this page show design models of the IBM 2790 Data Communication System.

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R 78 39

In addition to supporting the new 1800 features, the Multiprogramming Executive Operating System (MPX) has also been improved. Now this real-time operating system has:

Macro Assembler. Permits development of special purpose application-oriented languages through macro capability, resulting in reduced installation programming time.

New system residence capability. The MPX System not only supports the 2311 disk as a storage device, but can now reside on the 2311 or the 1810 disk.

Multiple SPAR *Coreloads.* SPAR (special area) type coreloads may now reside in any coreload area, providing new flexibility in dynamic, high response environments.

Multitasking capability. Lets you achieve concurrent operation of multiple sub-programs within a SPAR-type coreload and between partitions.

More software timers. You can select as many as 32 timers for use where periodic and timed executions are key.

Disk input to the FORTRAN *compiler.* Now the FORTRAN compiler accepts source input from either the 1810 or 2311. Source updating capability is also provided.

Keyboard input to Batch Processing Monitor. The Supervisor and Disk Management Programs are provided with a conversational mode of operation. This allows acceptance of an input stream from either of two 1816 Printer Keyboards or a 1442 Card Read/Punch.

All these enhancements have increased the value of the 1800 Data Acquisition and Control System for a broad range of applications.

Consider laboratory automation and scientific research systems. Here there is mounting demand for increased core capacity, disk storage, and throughput. The 1800 with its new features provides the answer.

As a manufacturing control system, the 1800 is used for production monitoring, machine control and product testing. It needs large-capacity storage, area and work terminals, and an interchange of data with a central system performing production scheduling and optimization. The new 1800 features meet all these needs.

A large-scale processing plant can use an 1800 for direct digital control, supervisory control and unit optimization. Now the 1800 can be connected to a central System/360 to provide over-all control strategy and operations scheduling.

Many utility companies have extensive requirements for monitoring generating plants and distribution stations. Through the 1800, they can now transfer all collected data quickly and easily to a central computer installation for load frequency control and economic dispatch calculations.

Traffic control systems for both automobile and railroad car traffic have exacting requirements for collection of data from many remote sensors. Here, too, the new 1800 features provide the capability for improved control of multiple high-density traffic situations.

The 1800 is a versatile system that can be readily adapted to specific needs. Have your IBM representative give you further details about how the expanded capabilities of the 1800 can contribute to your data acquisition and control system requirements.

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