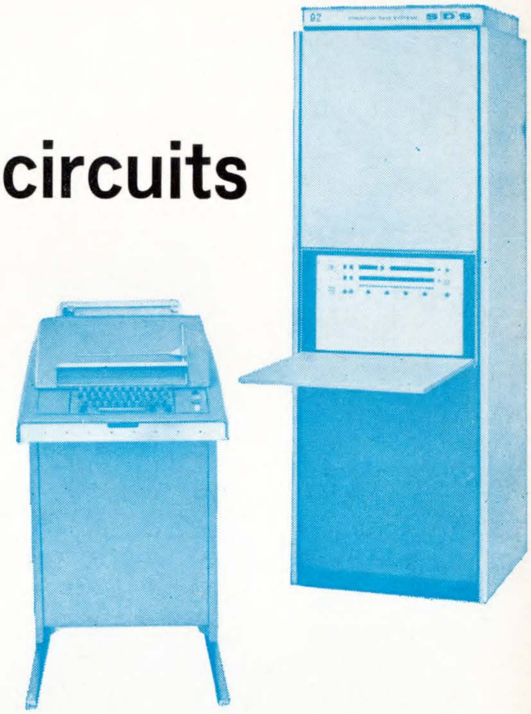
DDC

System uses integrated circuits



Scientific Data Systems, Inc., rejects NAND logic in favor of the more-reliable, less-expensive AND/OR approach

By its novelty, DDC is future-looking. The computer with perhaps the most futuristic design is the SDS-92, made by Scientfic Data Systems, Inc. It's the first industrial process-control system to use off-the-shelf integrated circuits (cover).

Edmond Pelta, director of circuit design, says Scientific Data used integrated circuits in its analog-to-digital and digital-to-analog converters for greater packing density, speed, accuracy, economy and reliability. The company is also convinced that integrated circuits will play an increasingly important role in computers of the future, and it wants to get started with them as soon as possible.

In designing the SDS-92, Scientific Data altered several company policies of long standing. One was a rule that every SDS system must be interchangeable with every other. Another was the use of AND/OR logic instead of the more widely used—but more costly and less reliable—NAND approach.

Its 1.75-microsecond memory cycle makes the SDS-92 the second-fastest computer covered in this report. Add time is 3.5 microseconds. The magnetic ferrite-core memory, with silicon driver circuitry, is offered in 2,000, 4,000 or 8,000 words of storage space, with possible expansion to 32,000. Word length is 12 bits plus a parity, or checking, bit.

The manufacturer hopes the 92's speed will suffice well into the future. "We wanted a computer so fast that it wouldn't need to be modified for at least three years, no matter what the process application," explains William Kamsler, manager of advanced systems design.

To hold the cost down, Scientific Data hit on the 12-bit word that company studies had shown to be adequate for the calculating accuracy needed for DDC. To cut costs further, the company used a memory from the SDS-9300, one of its scientific machines. The basic price of the SDS-92, with 2,000 words of memory, is $29,000. This includes a cabinet-mounted programer's console and an input-output teletype printer.

For small process plants a 4,000-word memory is considered enough. For medium-size plants, or for processes that mix different types of control such as conventional plus feed-forward or cascade, or for customers that want at least a simple type of process optimization, 8,000 words is considered the minimum necessary memory.

The choice of AND/OR logic circuits was made for reasons of reliability and economy. Diodes cost less than transistors and required simple circuitry.

Integrated-circuit pigeon-holes

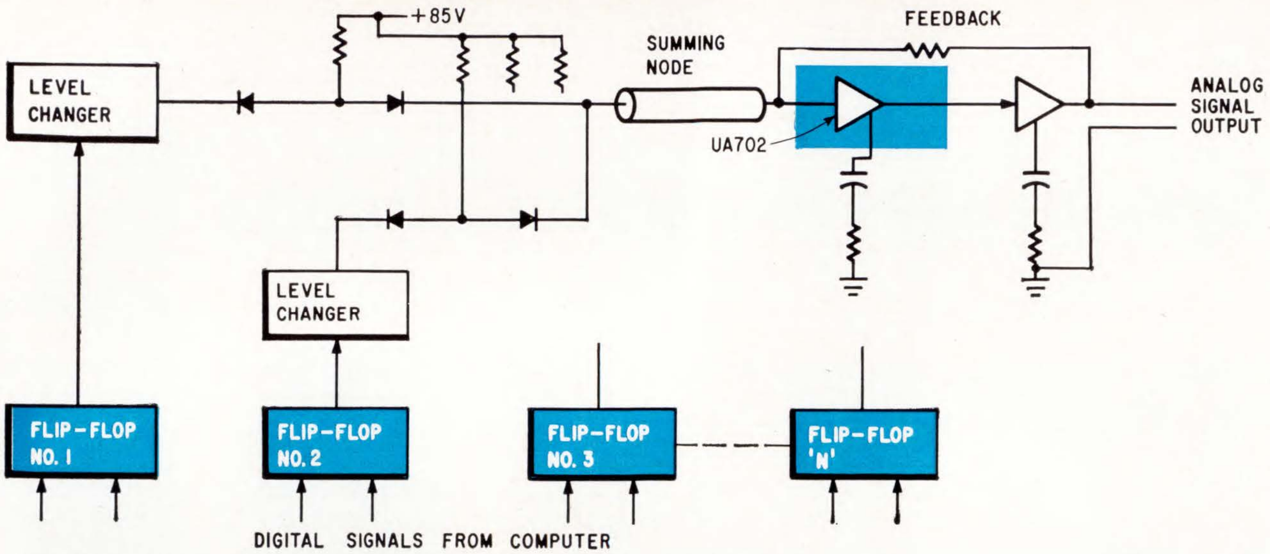
The input signal and output signal subsystems use integrated circuits as the storage registers, or pigeon-holes, for incoming or outgoing data in the analog-to-digital and digital-to-analog converters. A DDC system for an oil company in the Midwest that SDS has bid on will serve as a good system's example.

A low-level multiplexer, or time-shared switching device, is connected to five differential thermocouple transducers. The high-level multiplexer is connected to various conventional processes transducers.

The commutating, or switching, devices are Uni-Mod relays made by James Electronics, Inc. Each logic card has four input channels, or relays, along with their transistor drivers and control gates. The Uni-Mods are used for their low leakage, 6×10^{-4} picofarads. The system's common-mode noise rejection is 140 decibels.

The analog-to-digital converter receives the multiplexed signals and feeds them to a junction box. The junction box isolates the computer main frame (the logic, arithmetic and control sections) from the power and ground systems of the process plant. It also couples signals in and out of the main frame, to and from the process.

The digital-to-analog converters, one for each output control signal, use flat-packaged, 14-lead integrated circuits similar to the DTL-931 made by



Digital-to-analog converter uses integrated circuits in all input registers and in the input circuit to the operational amplifier. The registers are double-rank flip-flops.

Fairchild Semiconductor a division of the Fairchild Camera & Instrument Corp., as the input storage registers. A Fairchild UA-702 is the input to the operational amplifier shown in the diagram at the top of this page. Here's where real savings in over-all system costs are expected.

Why integrated circuits?

Pelta gives five main reasons for using integrated circuits.

- The analog-to-digital and digital-to-analog converters were due to be redesigned—a small but perfect place to start using integrated circuits.
- Because of a need for simultaneous output signaling to the final process controlled-valves, integrated circuits provided an inexpensive way to get simultaneous storage.
- Savings could be obtained. Four circuit cards were formerly needed to hold eight flip-flops, one digital-to-analog resistor network, eight inverters and an operational amplifier, when all used discrete components. Now the same design, using integrated circuits, requires only one printed-circuit card. This reduces card costs by 75%. It also reduces by 50% the computer cabinet space needed for each converter.
- The cost for discrete components for the two input storage registers, 4 transistors, 12 diodes, 16 resistors and 4 capacitors—plus the circuit cards is higher than for equivalent integrated circuits and their single circuit card.
- With integrated circuits, analog and digital subunits can now be mounted on the same size card, measuring 5 by 5.4 inches. This cuts circuit wiring cost 50%.

Here's how integrated circuits are used in a digital-to-analog converter.

The input storage registers, in the diagram above, are double-rank, or two-stag, flip-flops. When the clock, or the system time control, goes from 0 to +4 volts, a digital signal at the input terminal of an integrated-circuit register is transferred into the first stage. There is no output signal yet from the converter.

When the clock goes from +4 volts back to 0, the signal in the first rank transfers into the second rank; a voltage goes to the level changer and a conventional digital-to-analog signal conversion occurs. This happens simultaneously for all input registers.

Integrated circuits eliminate an extra storage register at each input, and probably increase the reliability of the converters.

Reliability for the integrated-circuit package is probably the same as that of just one transistor in the old design, Kamsler maintains.

This increase in reliability and reduction of manufacturing costs, added to the simpler design and higher reliability obtained by using AND/OR logic, account for the SDS-92's low price and high

Drawback: packaging of integrated circuits

While Scientific Data is sold on the performance capabilities of integrated circuits, it isn't completely happy with the packages available.

Edmond Pelta, director of circuit design, says: "We're using both flat-packs and TO-5 can types of integrated circuits. The packs have all the leads we need; but they're hard to handle, hard to test and hard to insert on the circuit cards. The leads are too close and bend too easily.

"There's only one reason integrated circuits are packaged this way: the military backed their development and order the largest quantities.

"The TO-5 cans are easier to handle, test and insert, but they don't have enough leads. You have to use more to do the job.

"What we'd like to see is a flat-pack embedded in a plastic cube, or similar design. The leads could be self-supporting and could come out of the cube in a design that made for easy insertion. We could really lower manufacturing, testing and handling costs with this type of packaging."

speed. Converters using integrated circuits will be recommended by Scientific Data for each direct-digital control system. Scientific Data also plans to use integrated circuits in the redesign of its multiplexers, and tentatively for a third-generation computer that is still in the idea stage. The first generation consisted of tube-using computers; the second, transistorized machines.

Software for control

The SDS-92, when used in a complete system, will be able to perform the two-mode and three-mode control algorithms, or conventional process control, plus feed-forward, cascade and adaptive, or optimizing control.

A complete array of peripheral devices, from magnetic tape to display oscilloscopes and auxiliary drum memories and disk files, is available, but at added cost.

Scientific Data, like other companies covered later in this report, prefers to sell its main frame plus input-output teleprinter to a systems builder. Several systems companies, such as Fischer & Porter Co., Leeds & Northrup Co. and possibly the Allis-Chalmers Mfg. Co. and Bunker-Ramo Corp. are reported discussing quantity prices for the 92.