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Siemens System 4004

MANAGEMENT SUMMARY

The Siemens System 4004 family was introduced in January 1965 with announcement of the 4004/15, 25, 45-I, and 55. These four systems corresponded identically with the like-numbered RCA Spectra 70 (now UNIVAC Series 70) computer systems unveiled the previous month for the U.S., Canadian, and Mexican data processing marketplaces. Under a license agreement with RCA, Siemens initially marketed the full range of RCA's third-generation Spectra 70 line as competition to IBM's System/360.

Since then, nine additional Spectra-type processors (including the reworked "RCA Series") were added and four were dropped from the line by RCA. Of these, Siemens agreed to market four as they were, produced eight new versions of existing processors, and selectively dropped (or neglected) seven from the family to leave the current lineup of nine models. Of the current System 4004 family, Siemens is actively selling Models 35, 45-III, 46, 127, 135-II, 150, and 151; Models 16 and 26 are also available but are not being actively marketed.

Despite these nine processors, dozens of peripheral devices, and a wide array of software facilities, the System 4004 does not span nearly as broad a range of processing capabilities as the System/360 or 370. For example, the top-of-the line 4004/150 and 151 are slower than the System/360 Model 65—not to mention IBM's still faster 155-II, 158, 165-II, 168, and 195. At the other end of the size range, Siemens has shown little interest in serving the small-scale user; the small System 4004/16 and 26 Processors are sold almost exclusively for use in conjunction with larger computers.

With nine current processor models offering a range of memory sizes from 4K bytes to 2 million bytes, Siemens' System/360-compatible System 4004 family provides a strong small-to-medium scale alternative to competitive third-generation data processing systems. Two of the Siemens models feature virtual storage operation.

CHARACTERISTICS

MANUFACTURER: Siemens Aktiengesellschaft (AG), Data Processing Division, D-8000, Munich 70, Hofmannstrasse 51, Postfach 700078, West Germany; telephone (0811) 722-1. U.S. office: Siemens Corporation, 186 Wood Avenue South, Iselin, New Jersey 08830; telephone (201) 494-1000.

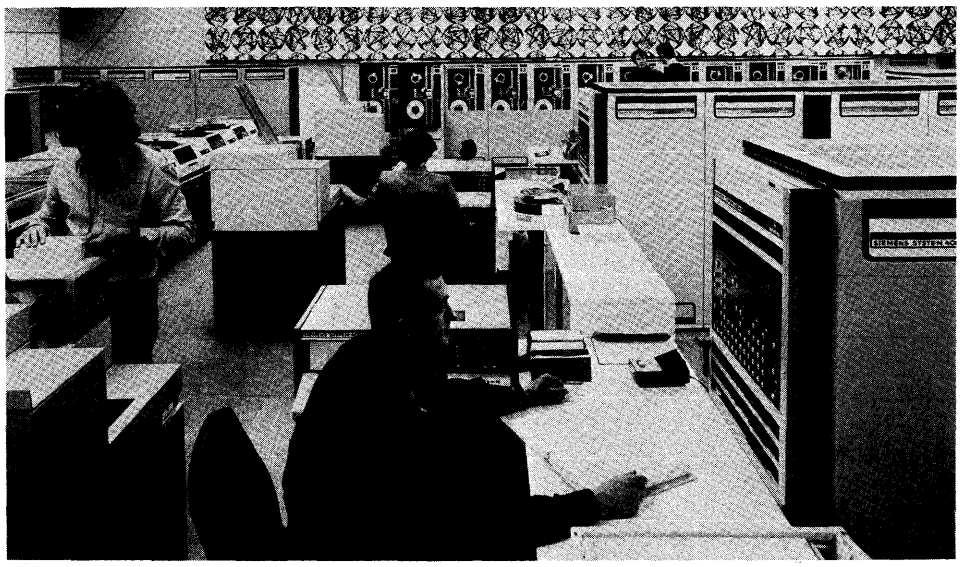
MODELS: 4004/16, 4004/26, 4004/35, 4004/45-III, 4004/46 4004/127, 4004/135-II, 4004/150, and 4004/151. (Note that these processors are based upon the UNIVAC Series 70, formerly the RCA Spectra 70; refer to Management Summary and table for specific model correlations.)

DATA FORMATS

BASIC UNIT: 8-bit byte. Each byte can represent 1 alphanumeric character, 2 BCD digits, or 8 binary bits. Two consecutive bytes form a "halfword" of 16 bits, while four consecutive bytes form a 32-bit "word."

FIXED-POINT OPERANDS: Can range from 1 to 16 bytes (1 to 31 digits plus sign) in decimal mode; 1 halfword (16 bits) or 1 word (32 bits) in binary mode.

FLOATING-POINT OPERANDS: 1 word, consisting of 24-bit fraction and 7-bit hexadecimal exponent, in



Siemens' medium-scale System 4004/45-III is based upon the RCA Spectra 70/45 (now the UNIVAC Series 70/45). Two Model 45-III Processors are shown here, along with three card readers, six disc drives, and twelve magnetic tape units.

Siemens System 4004

Siemens' strength is in the medium-scale area, where the general-purpose System 4004 processors are well suited to handle a broad range of business and scientific applications. For medium-scale installations that require data communications or time-sharing, Siemens displays an even stronger hand. The System 4004 line includes a versatile array of communications controllers, terminals, and software, and the company has been placing a strong emphasis on time-sharing since the April 1969 introduction of the 4004/46.

Most System 4004 users seem fairly well satisfied with the Siemens hardware, software, and support. Yet, from the all-important marketing standpoint, the System 4004 has been only moderately successful, and has contributed less than Siemens had originally hoped for toward increasing the firm's market penetration in West Germany, although Siemens' position has increased comfortably. That overall penetration has risen from about 5% of the installed German base in 1965 to about 16% in 1972. IBM remains the largest West German (as well as world-wide) vendor, though its share of the West German market has decreased from about 72% in 1965 to about 60% in 1972. Curiously enough, the size of IBM's market-share decrease since introduction of the third computer generation corresponds closely to the magnitude of Siemens' increase. On the other hand, Siemens' position is considerably stronger in West Germany than elsewhere in the world due to strong nationalistic buying influence.

Thus, the unavoidable conclusion seems to be that IBM's position in the marketplace is so strong that most users who want IBM-style equipment will elect to buy it from IBM rather than an alternate supplier—even when the other supplier is a home-based and internationally known manufacturer whose product line offers (in many cases) significant performance advantages.

As a matter of growing interest, Siemens' recent multinational agreement with CII of France and Philips of the Netherlands, with full company and government support on all sides, will expose the System 4004 to a much wider sphere of favorable nationalistic buying influence. Under this agreement, Siemens will provide the medium-scale computer systems marketed by all three firms in their own strongest market areas. This move can hardly do other than increase the 4004's overall European market penetration. This penetration is currently less than 5% of the total installed European computer base—but it should be noted that the installed base is predominantly second-generation gear, with the Siemens 4004 installed in about one-third of the third-generation accounts in Europe.

As a matter of interest, UNIVAC—which acquired the RCA Computer customer base and the rights to market Spectra-type systems to that base—is limited to trading

"short" format; or 2 words, consisting of 56-bit fraction and 7-bit hexadecimal exponent, in "long" format.

INSTRUCTIONS: 2, 4, or 6 bytes in length, specifying 0, 1, or 2 memory addresses, respectively.

INTERNAL CODE: EBCDIC (Extended Binary-Coded Decimal Interchange Code). The System 4004 processors can alternatively use 8-bit ASCII, but little software support is provided for this code.

MAIN STORAGE

STORAGE TYPE: Magnetic core.

CAPACITY: See table.

CYCLE TIME: See Table.

CHECKING: Parity bit with each byte is generated during writing and checked during reading.

STORAGE PROTECTION: Full Store and Fetch Protection, which protects against unauthorized reading as well as writing, is standard on the 4004/150 and 4004/151. Optional Memory Protect feature guards against inadvertent overwriting of data in specified 2048-byte blocks of storage for the 4004/35, 4004/127, and 4004/135-II (not available for 4004/16 or 4004/26). Optional Store and Fetch (read/write) Protection is also available for the 4004/45-III and 4004/46 Processors.

CENTRAL PROCESSORS

INDEX REGISTERS: None in 4004/16 or 4004/26 Processors. In the larger models, the programmer has access to sixteen 32-bit general registers, used for indexing, base addressing, and as accumulators, plus four 64-bit floating-point registers. (There are four sets of registers in all—one for each processor state—but only one set is normally accessible to the programmer.)

INDIRECT ADDRESSING: Up to three levels for the "real" memory systems, with a fourth level provided for virtual systems to address into the "backing store."

INSTRUCTION REPERTOIRE: See table. Each 4004/35 or larger processor has from 144 to 154 standard instructions, including add, subtract, multiply, and divide in four different modes: fixed-point binary, variable-length decimal, and "short" and "long" floating-point. Other instructions handle loading, storing, comparing, shifting, branching, radix conversion, code translation, editing, packing, unpacking, logical operations, etc. In addition, the time-sharing 4004/46 and 4004/151 Processors can include up to 128 microprogrammed special functions.

The 4004/16 and 4004/26 have limited repertoires of 27 and 33 instructions, respectively, including decimal and binary addition and subtraction, but no multiply, divide, or floating-point facilities.

INSTRUCTION TIMES: See table; the times shown are for 1-address binary addition of 32-bit fields and for 2-address decimal addition of signed 5-digit (3-byte) fields. Note that the instruction timings can be improved through changes in the microprograms for the 4004/46 or 4004/151.

OPTIONAL FEATURES: The following features are available for Models 4004/35 and above.

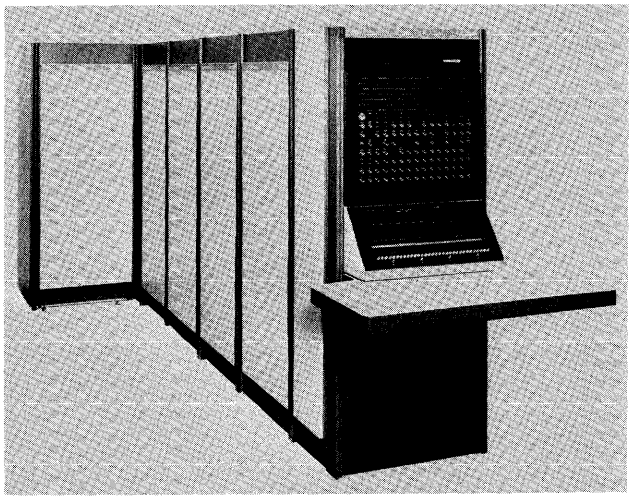
Siemens System 4004

CHARACTERISTICS OF THE CURRENT SYSTEM 4004 PROCESSORS

	4004/16	4004/26	4004/35	4004/45-III	4004/46	4004/127	4004/135-II	4004/150	4004/151
SYSTEM CHARACTERISTICS									
Maximum no. of central processors supported by standard software	1	1	1	1	1	1	1	1	1
Virtual memory	No	No	No	No	Yes	No	No	No	Yes
Principal operating systems	DOS/16-26	DOS/16-26	DOS, TDOS	DOS, TDOS	VMOS	DOS, TDOS	DOS, TDOS	DOS, TDOS	VMOS
Typical system monthly rental (1)	$6,300	$10,000	$15,000	$29,000	$45,000	$11,000	$20,000	$38,000	$53,000
Date of announcement	Feb. 1968	Feb. 1968	Sept. 1965	Oct. 1972	Apr. 1969	Oct. 1972	Oct. 1972	Dec. 1970	Dec. 1970
Date of first delivery	Feb. 1970	Jan. 1970	May 1967	Mar. 1973	Jan. 1970	Apr. 1973	Apr. 1973	Mar. 1972	Apr. 1972
Approx. number installed (as of 1/1/73)	98	82	204	365 (3)	16	None	93 (4)	60	10
RCA (now Univac) version	70/15 (2)	70/25 (2)	70/35	70/45-II (2)	70/46	None (2)	None (2)	70/6	70/7
Relative CPU power (4004/16 = 1.00)	1.00	1.00	0.95	2.20	1.45	1.33	2.20	4.75	4.32
MAIN STORAGE									
Cycle time, microseconds	0.88	0.88	1.44	1.44	1.44	1.44	1.44	0.765	0.765
Bytes accessed per cycle	1	1	2	2	2	2	2	4	4
Minimum capacity, bytes	8,192	16,384	32,768	65,536	262,144	98,304	65,536	131,072	393,216
Maximum capacity, bytes	16,384	65,536	65,536	524,288	262,144	196,608	262,144	2,097,152	2,097,152
Main storage type	Core	Core	Core	Core	Core	Core	Core	Core	Core
Interleaving	None	None	None	None	None	None	None	None	None
Storage protection	None	None	Optional	Optional	Optional	Optional	Optional	Standard	Standard
CENTRAL PROCESSOR									
No of hardware instructions	27	33	144	145	145	145	144	153	154
Registers, total/general-purpose	None	None	124/43	124/43	124/43	124/43	124/43	124/43	124/43
Read-only memory (ROM) size, words	Hard-wired	Hard-wired	1024	2048 and 256	2048	2048	2048 and 256	3072	3072
ROM word length, bits	None	None	54	56	54	56	56	72	72
ROM cycle time, microseconds/word	None	None	480	480	480	480	480	255	255
Max. virtual memory size, bytes	None	None	None	None	2,097,152	None	None	None	8,388,608
No. of interrupts	None	None	32	32	32	32	32	32	32
Floating-point hardware	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Decimal instructions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Divide hardware	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Indirect addressing	1 level	1 level	3 levels	3 levels	3 levels (5)	3 levels	3 levels	3 levels	3 levels (5)
Processor states	2	2	4	4	4	4	4	4	4
INSTRUCTION TIMES (decimal, in microseconds):									
Add, unsigned, unpacked (5 digits)	129.36	129.36	162.72	83.98	92.12	93.58	83.98	48.19	48.09
Add, signed, packed (5 digits)	32.56	32.56	50.40	23.82	24.30	26.22	23.82	11.22	11.22
Multiply, unsigned, unpacked (5 digits)	19,600 (7)	345.40	377.46	176.18	184.44	171.38	176.18	71.34	71.30
Multiply, signed, packed (5 digits)	19,600 (7)	243.32	244.50	106.64	107.12	95.00	106.64	27.05	27.03
Divide, unsigned, unpacked (5 digits)	24,200 (7)	280.72	261.12	143.15	150.81	149.75	143.15	59.38	58.58
Divide, signed, packed (5 digits)	24,200 (7)	185.68	152.64	83.95	83.95	83.35	83.95	23.26	22.47
I/O CONTROL									
Maximum aggregate I/O data rate, bytes/second	568,000	568,000	694,000	2,080,000	1,388,000	1,388,000	2,080,000	5,240,000	5,000,000
No. of selector channels	1	8	0, 2	0, 2, 4	0, 2, 4	0, 2	0,2	2, 4, 6	2, 4, 6
Trunks per selector channel	6	1	2	2	2	2	2	3	3
Max. selector channel data rate, bytes/second	568,000	284,000	694,000	1,040,000	694,000	694,000	1,040,000	900,000	900,000
No. of multiplexer channels	None (b)	None	1	1	1	1	1	1	1
Trunks per multiplexer channel	None	None	8	9	9	9	9	16	16
Max. devices on multiplexer	None	None	192	256	256	256	256	248	248
Max. multiplexer channel data rate, bytes/second	None	None	36,000	77,000	72,000	72,000	77,000	216,000	216,000
EMULATOR OPTIONS									
IBM 1401/1440/1460	No	No	Yes	Yes	No	No	No	Yes	No
IBM 1410/7010	No	No	No	Yes	No	No	No	Yes	No
RCA 301 (and Bull Gamma 30)	No	No	Yes	Yes	No	No	No	No	No

(1) Includes maintenance. Prices have been converted to U.S. dollars at the rate of 3.0 DM per dollar. Purchase prices for these typical systems can be derived through application of an overall purchase-to-lease ratio of about 50 to 1.
(2) Models 16 and 26 are based upon integrated-circuit versions of the 70/15 and 70/25, respectively. Model 45-III is based upon Siemens' own improvement of the 45-II rather than upon RCA's improved version, the 70/2. Models 127 and 135-II were developed by Siemens, using the fundamental 70/45-II architecture.
(3) This installation figure includes Models 45-I and 45-II, announced in Jan. 1965 and Sept. 1970 and delivered in Jan. 1967 and April 1971, respectively.
(4) This installation figure includes Model 135-I, announced in Dec. 1970 and delivered in April 1971.
(5) One additional level of indirect addressing is provided for the virtual memory backing store.
(6) The special selector channel in Model 16 can be used to multiplex I/O devices up to the maximum aggregate data rate.
(7) Operations performed by subroutine.

Siemens System 4004



The System 4004/150, Siemens' own adaptation of the former RCA 6 Processor, offers up to 2 million bytes of core storage.

with existing RCA customers in the U.S., Canada, and Mexico as of December 1971. Siemens, while free to sell the System 4004 worldwide, has devoted its primary marketing emphasis to West Germany, Austria, Switzerland, Italy, France, Spain, the Benelux countries, Sweden, Denmark, Brazil, and South Africa. Thus, the two vendors will not ordinarily be facing each other in the same marketplace with the same gear.

For the fiscal year ended September 30, 1972, Siemens reported total earnings of $127.5 million, up to 73% from $73.8 million in the year before. The company has approximately 234,000 employees worldwide, about 15,000 of whom are directly involved with the manufacture, sales, and support of data processing equipment. Siemens activities range from telephone and data communications equipment–for which it is the largest European vendor–to semiconductor devices, air conditioning, power cables and insulated wires, power generation and distribution, railway signaling gear, a wide variety of medical/dental electronic equipment, etc.

PROCESSOR MODELS

The characteristics and orientation of the current System 4004 processor models and the systems built around them are summarized in the following paragraphs and in the accompanying table.

The System 4004/35, 45-III, 127, 135-II, and 150 Processors constitute the heart of Siemens' third-generation computer line. All five are general-purpose computers suitable for a wide range of applications, and all five are fully compatible at the hardware level. With respect to their internal speeds and prices, these processors generally fall into the gaps between the IBM

Elapsed Time Clock provides a program-controlled timer which is counted down at a constant rate and generates an interrupt when the count reaches zero.

Direct Control permits control and synchronizing information to be transferred between up to six central processors and/or special external devices located up to 500 feet from one another. The feature consists of two special instructions and six external-signal lines.

The 97 Operator Console and Typewriter provides system control facilities by means of switches and an I/O typewriter.

VIRTUAL MEMORY: Dynamic address translation facilities enable users of the 4004/46 and 4004/151 Processors to program as if they had 2.1 million and 8.4 million bytes, respectively, of main memory at their disposal. The drum-type 567 Virtual Memory Storage Systems hold 2048-byte or 4096-byte "pages" of data, permitting rapid swapping of program segments into or out of main memory. The 4004/46 uses a translation memory, consisting of an integrated-circuit array of 512 two-byte words with a 90-nanosecond access time, to translate virtual addresses used by the programmer into effective main memory addresses. The 4004/151 uses an 8-register associative memory to perform the translation functions.

INTERRUPT SYSTEM: None in the 4004/16 and 4004/26. The 4004/35 and larger processors have 32 levels of priority interrupts, individually maskable in each processor state. Each of the four processor states has an independent set of operating registers.

EMULATORS: The 4004/35, 45-III, and 150 Processors can be equipped with extra-cost "emulators" that enable them to execute programs written for earlier IBM or RCA computers. See the table for specific emulation capabilities of each processor. Each emulator consists of an Emulator Control Program in core storage and an emulator Microprogram that resides in the processor's read-only memory. In general, emulation requires a System 4004 processor with I/O devices equivalent to those of the system to be emulated, and with more core storage capacity and processor power. Only the more common peripheral devices (such as magnetic tape units, card readers, punches, and printers) can be emulated. Internal speeds of the System 4004 processors in emulation mode range from about 0.9 to 4.2 times as fast as the original computers, depending upon the pair of machines involved.

INPUT/OUTPUT CONTROL

I/O CHANNELS: One multiplexer channel, which can accommodate a number of simultaneous low-speed I/O operations, is standard in Models 4004/35 and above. Selector channels, which can handle one I/O operation at a time, can be used with any System 4004 model. The 4004/16 has a single data channel with 6 trunks. The 4004/26 has 8 selector channels with one trunk per channel. See the table for details of the I/O channel possibilities.

CONFIGURATION RULES: Most System 4004 peripheral devices can be connected to either a multiplexer or selector channel of any System 4004 processor. Each channel on the 4004/26 or larger has a number of trunks, and each trunk can accommodate one peripheral device or control unit. See the table for details.

Siemens System 4004

System/360 processors where their model numbers might lead one to expect them to fall. (For example, the System 4004/45-III is faster and slightly more expensive than the System/360 Model 40, but slower and less costly than the Model 50.)

The Model 45-1 was a member of the original System 4004 line, announced in January 1965. The great majority of currently installed System 4004 processors are Model 45's. The 35, a slowed-down version of the 45 at a substantially lower price, was introduced eight months later. The 150 was announced as a top-of-the-line general-purpose processor in December 1970, with deliveries beginning in March 1972. The 135-I was announced in December 1970 to remove the memory limitations and serve as an upgrade system for Model 35 users. An improved 135-II was announced in October 1972 with about 50 percent higher throughput, an increased upper limit on main memory, expanded read-only memory (ROM), and greater I/O handling capability. The 127, announced at the same time as the 135-II in October 1972, is designed to fill the gap created by the 135-II's strong price/performance improvements over the smaller Model 35. The 45-III is an upgraded version of the original Model 45 that is identical with the 135-II except for the 45-III's emulator availabilities, larger memory range, and greater I/O channel configurability. The Model 150 is based upon an enhanced version of the Model 60 plus an enlarged memory range and several minor additional processor changes.

The 4004/46 Time-Sharing System, announced in April 1969, is designed to handle local batch processing, remote batch processing, interactive time-sharing, and intercommunication among the remote terminals. It can service up to 48 remote users while concurrently processing up to 14 independent batch-mode jobs. The 4004/46 Processor is an upgraded version of the 4004/45-I. It includes built-in logic that facilitates program segmentation and paging. The 262K main memory is divided into pages of 2048 or 4096 bytes each. Dynamic address translation facilties enable each user to program as if he had a 2-million-byte virtual memory at his disposal. A magnetic drum permits rapid swapping of program segments into and out of core memory. The 4004/46 stresses a good balance between interactive and batch-mode processing capabilities in a medium-scale system that is fast and flexible enough to satisfy all the computing needs of many organizations.

The 4004/151, announced in December 1970, provides all the facilities of the Model 46 plus about three times its processing power, and bears the same relationship to the general-purpose Model 150 processor as the 4004/46 bears to the 4004/45. Despite its three-fold speed advantage over the 4004/46, the 4004/151 is still not a

Switching devices are available to connect a standard I/O trunk on each of two to four processors to one I/O device, or to connect two to four devices to one trunk.

SIMULTANEOUS I/O OPERATIONS: Concurrently with computing, a System 4004 can control a maximum of one high-speed I/O operation per selector channel and one low-speed I/O operation per multiplexer trunk. Alternatively, the multiplexer channel can operate in the "burst" mode and handle a single higher-speed operation.

I/O INTERFERENCE: Selector channel operations impose only modest demands upon the System 4004 processors. The control of multiplexer channel operations, however, can impose substantial demands upon the processors.

MASS STORAGE

564 DISC STORAGE UNIT: Provides interchangeable disc-pack storage of modest capacity. Each disc pack contains six 14-inch discs, weighs 10 pounds, holds up to 7.25 million bytes of data, and is compatible with the IBM 1316 Disk Pack used in IBM 2311 Disk Storage Drives. One read/write head serves each of the 10 recording surfaces. Up to 36,250 bytes (10 tracks) can be read or written at each position of the comb-type access mechanism. Average head movement time is 75 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 156,000 bytes/sec. Record lengths are variable. Up to eight 564 units can be connected to a 551 Random Access Controller on a Model 4004/35 or larger. Up to four 564 units can be connected to a 4551 controller for attachment to a 4004/16 or 4004/26 Processor. The 5513 Dual-Channel Switch, 5512 Record Overflow, and 5511 File Scan features are optional.

567-8 DRUM MEMORY UNIT: Provides fast random-access storage and retrieval for program segments, file directories, tables, etc. Storage is provided for up to 4.13 million bytes on 800 tracks with a maximum data capacity of 5161 bytes per track. Record lengths are variable. Average access time is 8.6 milliseconds, and data transfer rate is 277,000 bytes per second. One 567-8 unit can be connected to a 551 Random Access Controller. The 5513 Dual-Channel Switch, 5512 Record Overflow, and 5511 File Scan features are optional. The 567-8 unit can be connected through a 551 Controller to any System 4004 processor.

567-16 DRUM MEMORY UNIT: Similar to the 567-8 unit described above except that the storage capacity is 8.26 million bytes on 1600 tracks. One 567-16 unit can be connected through a 551 Controller to any System 4004 processor.

594 DIRECT ACCESS STORAGE UNIT: Provides fairly high-speed, medium-to-large-capacity random-access storage on interchangeable 11-disc packs that are compatible with the IBM 2316 packs used in the IBM 2314 Direct Access Storage Facility. Each disc pack drive is capable of storing up to 29.17 million bytes. From 1 to 16 active drives and 2 spare drives can be connected to a 592 Controller. A spare drive is provided with each group of eight units. Total on-line storage capacity of the 16-active-drive subsystem is 466.8 million bytes. Each drive has a comb-type access mechanism that can read or write up to 145,880 bytes (20 tracks) at each of its 200 positions. Average head movement time is 60 milliseconds, average

Siemens System 4004

really large-scale computer; its internal speeds are substantially lower than those of the System/360 Model 65, for example.

The 4004/16 and 26 processors are very similar to one another in processing power, and differ primarily in their memory ranges and selector channel capabilities. Each is based upon improved, integrated-circuit versions of the RCA Spectra 70/15 and 25, respectively.

HARDWARE FEATURES

Designed to provide compatibility with the IBM System/360, the System 4004/35 through 151 Processors naturally have many hardware characteristics in common with the System/360. They have a large, complex instruction repertoire that enables them to perform four different types of arithmetic: fixed-point arithmetic in either fixed-length binary or variable-length decimal mode, and floating-point arithmetic on either one-word or two-word operands. In addition, they can perform radix conversions, code translations, and conversions between the packed (2 decimal digits per byte) and unpacked (1 digit per byte) data formats. They enable the programmer to make use of sixteen 32-bit general registers that can serve as accumulators, index registers, or base address registers. They use a base-plus-displacement addressing scheme that permits direct addressing of up to 16 million bytes of core storage. And finally, they have a comprehensive interrupt system that enables them to respond to a variety of special conditions, both internal and external.

There are, however, at least two significant hardware differences between the System 4004 and System/360 processors. First, although the machine instructions used by applications programmers are the same in both lines, the "privileged" instructions–which are normally reserved for operating system use–are quite different. Second, whereas the System/360 processors have one set of general registers, the System 4004 processors have four sets–one for each of four processor states. As a result, the Siemens processors can service interrupt conditions more efficiently than the IBM processors, in which it is necessary to save and restore the contents of multiple registers each time an interrupt is processed. The general registers are located in an extension of core storage in the 4004/35 and in a high-speed "scratchpad" memory unit in all the larger System 4004 processors.

SOFTWARE

Siemens furnishes a broad array of supporting software for the System 4004 line. There are four distinct general-purpose operating systems, and extensions of two of these are available to support communications-oriented installations. In addition, specially tailored software is available for users of the small-scale Models 16

rotational delay is 12.5 milliseconds, and data transfer rate is 312,000 bytes/sec. Record lengths are variable.

An optional 5521 Multi-Channel Switch allows the 594 System to be shared by two selector channels on the same or different processors. The first eight 594 drives are connected to the 592 Controller with a 4501 or 4502 Disk Adapter for single- or dual-channel access. A second Disk Adapter for the 592 Controller is required for more than 8 active drives plus a spare. The 592 Controller attaches to a standard interface trunk on the selector channel of a 4004/35 or larger. The 5511 File Scan feature is optional.

4578 DIRECT ACCESS STORAGE SUBSYSTEM: Provides high-speed, medium-to-large-capacity random-access storage on interchangeable 11-disc packs that are compatible with the IBM 2316 packs used in the IBM 2314 Direct Access Storage Facility and the Siemens 594 Disk Drive. Consists of a controller plus two 4579 Disc Drives. Up to six more active drives and a spare can be added to the subsystem. The operational characteristics of the 4578 are the same as those of the 594 subsystem, above, except that the average head movement time is 35 milliseconds and the average rotational delay is 12.5 milliseconds. The 5511 File Scan feature and 5513 Multichannel Switch are optional. The 4578 can be attached to a System 4004/35 or larger processor.

4580 DIRECT ACCESS STORAGE SUBSYSTEM: Provides high-speed, large-capacity random-access storage on interchangeable 11-disc packs that are physically (but not logically) compatible with the IBM 2316 packs used in the IBM 2319 Direct Access Storage Facility and the Siemens 594 and 4579 Disk Drives. Consists of a controller plus two 4581 Disc Drives. Up to six more active drives and a spare can be added to the subsystem. The operational characteristics of the 4580 are the same as those of the 4578 Subsystem, except that 400 cylinders are available on each pack, each containing 20 tracks (19 of which are usable for data storage) for a capacity of 54.82 million bytes per 4581 spindle. The maximum on-line capacity of the 4580 subsystem is 438.56 million bytes. The 4580 is available for attachment to the 4004/35, 45-III, 127, 135-II, and 150. The 5511 File Scan feature and 5513 Multichannel Switch are optional.

580 DIRECT ACCESS STORAGE UNIT: Provides high-speed, large-capacity random-access storage on interchangeable, 12-high, iron-oxide-coated packs that are physically (but not logically) compatible with the IBM 3336 packs used in the IBM 3330 Disk Storage. Consists of a controller and one 581 Disc Drive. Up to seven more drives can be added to the subsystem. Each disc pack can store up to 100.02 million bytes of data on 404 cylinders, with 19 tracks (247,570 bytes) per cylinder. Average head movement time is 30 milliseconds, average rotational delay is 8.4 milliseconds, and data transfer rate is 806,000 bytes per second. The 580 subsystem can be used with the 4004/150 only, and the 5511 File Scan and 5513 Multichannel Switch features are optional.

INPUT/OUTPUT UNITS

432 & 442 MAGNETIC TAPE UNITS: Available in 9-track and 7-track versions, both of which record on standard 1/2-inch tape in IBM-compatible formats. Characteristics of the 9-track versions are as follows:

Siemens System 4004

and 26 and of the time-sharing 4004/46 and 151 Processors. At each software level, Siemens furnishes appropriate supervisory programs, language translators, service programs, and utility routines.

Of the software operating systems provided by Siemens, the Disk Operating System for Models 16 and 26 (DOS 16/26) and the general-purpose Disk Operating System for the other processors (DOS) were written by Siemens. Other software is the same as or a modified version of that developed by RCA. Future software developments by UNIVAC and Siemens, although essentially for the same basic processors, will be independent.

Much of the Siemens software, quite naturally, is patterned after the corresponding IBM facilities. Siemens has made a point of maintaining the highest practical degree of source-language compatibility with the IBM Assembler, COBOL, FORTRAN, and RPG languages.

The complex internal architecture of the 4004 line, like that of the System/360, makes programming at the assembly-language level unusually difficult and error-prone. For this reason, coupled with the other increasingly evident advantages of high-level languages, most 4004 users are doing the bulk of their programming in COBOL, FORTRAN, or RPG.

COMPATIBILITY

The Siemens System 4004 compatibility picture has three important dimensions:

- Compatibility within the System 4004 family.
- Compatibility with the IBM System/360 or 370.
- Compatibility with older Siemens (RCA) and IBM computers.

Among the 4004/35 through 4004/151 Processors, Siemens has achieved a high degree of data and program compatibility at the hardware level. Any two of the general-purpose models equipped with equivalent storage, features, and peripheral devices can execute the same programs and produce the same results (provided only that the programs are valid ones and do not depend on any fixed relationships between internal processing and input/output times). The time-sharing 4004/46 and 151 Processors can directly execute object programs written for the general-purpose models, though the converse is not necessarily true. Source-language programs can be freely interchanged between the time-sharing and general-purpose models. The 4004/16 and 26, with their severely restricted instruction sets, however, have only a limited degree of program compatibility with the larger processors.

432 Unit: 800 bpi; 30,000 bytes/sec. at 37.5 inches/second.

442 Unit: 800 bpi; 60,000 bytes/sec. at 75 inches/second.

The 7-track versions have the same tape speeds and offer a choice of three recording densities: 200, 556, or 800 bpi. The 432 and 442 are dual-drive models (two tape drives per unit), and can read in both the forward and reverse directions. No pinch rollers are used. Controllers capable of handling up to 8 or 16 tape drives and either 1 or 2 I/O channels are available to connect the 432 and 442 to any System 4004 processor. Rewind times are 292 and 195 seconds for the 432 and 442 Units, respectively.

4420 MAGNETIC TAPE SUBSYSTEM: This 1600-bpi, 9-track unit records on standard 1/2-inch tape in IBM-compatible format. Data transfer rates of 30,000 and 60,000 bytes/second are available with tape speeds of 18.75 and 37.5 inches/second, respectively. The basic 4420 Subsystem consists of a controller and two 4421 Tape Units, and can be expanded to a total of six units. Rewind time is 100 seconds. The 4420 Subsystem can be connected to any System 4004 processor.

451 & 453 MAGNETIC TAPE UNITS: These models record on standard 1/2-inch magnetic tape at 1600 bpi in the IBM-compatible phase-encoded mode. Each unit contains two tape drives. Peak data rates are 60,000 bytes/sec for the 451 and 120,000 bytes/sec for the 453. Optional "Bi-Modal" versions of each unit can operate at 800 as well as 1600 bpi. Both models can read in both the forward and reverse directions, and no pinch rollers are used. Controllers capable of handling up to 8 or 16 tape drives and either 1 or 2 I/O channels are available. Rewind times for both models are 130 seconds.

450 & 4453 MAGNETIC TAPE UNITS: Provide 800-bpi NRZI or 1600-bpi phase-encoded recording on standard 1/2-inch magnetic tape in IBM-compatible formats. These single-drive units have data transfer rates of 120,000 and 240,000 bytes/second for the 800 and 1600 bpi recording densities on the 450, and 60,000 and 120,000 bytes/second for the 800 and 1600 bpi recording densities on the 4453. Tape speed is 150 inches/second for the 450 and 75 inches/second for the 4453. Rewind times for the 450 and 4453 are 60 and 130 seconds, respectively. Either unit can be attached to a selector channel on any System 4004 processor through single or dual-channel controllers.

237 CARD READER: Reads 80-column cards serially, on demand, at up to 1435 cpm. EBCDIC is the standard code, and column binary is optional. A 2000-card input hopper and two stackers can be loaded and unloaded while the reader is operating. Optional features permit reading of pencil-marked data and 51-column stub cards.

4235 CARD READER: Reads 80-column cards at up to 600 cpm. Includes controller for attachment to multiplexer channel.

4239 CARD READER: Reads 80-column cards at up to 1000 cpm. Two output stackers with a combined capacity of 3000 cards are standard. Optional features include column binary, perforated ticket stub handling, mark reader, and 96-column IBM System/3 card capability. Includes controller.

Siemens System 4004

Compatibility with the System/360 or 370 lines is achieved through similar hardware and compatible source languages. The System 4004 Assembler, COBOL, FORTRAN, and RPG languages are all essentially the same as their System/360 or 370 counterparts. As a result, most System/360 or 370 source programs can be assembled or compiled and executed on a System 4004 processor (4004/35 or above) with little or no need for program changes. System/360 or 370 object programs, however, cannot be executed directly on a System 4004 because of the differences in the "privileged" instructions; reassembly or recompilation is always necessary.

To facilitate conversions from older Siemens (RCA) and IBM computers to the System 4004 line, Siemens has again followed IBM's lead by offering a series of emulators. These extra-cost features use a combination of microprograms in read-only memory and specialized software to enable a 4004/35, 45, or 150 to execute programs written for the second-generation RCA 301, 501, or IBM 1400 Series computers. Thus, Siemens has made available a third-generation System/360 alternative that makes it as easy as possible for System/360 users to "leave the fold" and switch to Siemens. But many of these IBM users have been unwilling to switch suppliers and undergo a conversion even to save a few thousand dollars a month—notwithstanding Siemens' excellent worldwide reputation.

The IBM System/370 offers impressive price/performance ratios plus technology that is truly new and exciting. The presence of the System/370 Models 125 through 145, plus the prospect of smaller System/370 processors yet to come, has unquestionably reduced Siemens' chances of convincing great numbers of IBM users to displace their System/360's in favor of Siemens equipment rather than IBM's new line.

In summary, Siemens offers proven, dependable 360-like systems at prices that deserve serious consideration by second-generation computer users who are considering upgrading, or by users of competitive small-to-medium-scale third-generation equipment who are considering a switch in vendors. □

236 CARD PUNCH: Punches and read-checks 80-column cards at up to 300 cpm. Contains a full-card buffer. EBCDIC is the standard code, and column binary is optional. A 1000-card input hopper and two 850-card stackers can be loaded and unloaded while the punch is operating.

4238 CARD PUNCH: Punches and read-checks 80-column cards at up to 293 cpm for punching in positions 1-10 only, and up to 103 cpm for full-card punching. Contains a full-card buffer and includes controller. Up to 1200 cards can be accommodated in the input hopper, and up to 600 in both output stackers combined.

234 CARD PUNCH: Punches and read-checks 80-column cards at 100 cpm. Contains a full-card buffer. EBCDIC is the standard code, and column binary is optional.

4223 HIGH-SPEED PAPER TAPE READER: Reads 5-, 6-, 7-, or 8-level punched tape at up to 1200 characters/second. Tape widths of 17.4, 20.5, 22.2, or 25.4 mm can be handled. Connects to any System 4004 Processor except Models 46 and 151 via a 4220 or 4222 Controller.

4226 PAPER TAPE READER: Reads 5-, 6-, 7-, or 8-level punched tape at up to 400 characters/second.

4229 VERY HIGH-SPEED PAPER TAPE READER: Reads 5-, 6-, 7-, or 8-level punched tape at up to 1500 characters/second. Setztechnik (TTS) code and Olivetti-compatible versions are available. Paper tape widths can be 17.4, 20.5, 22.2, or 25.4 mm. Can be attached to any System 4004 processor except the 46 and 151 through a 4220 or 4222 Controller.

4225 PAPER TAPE PUNCH: Punches 5-, 6-, 7-, or 8-level paper tape at up to 100 characters/second. A Setztechnik (TTS) code version is available.

4228 PAPER TAPE PUNCH: Punches 5-, 6-, 7-, or 8-level paper tape at up to 150 characters/second. A Setztechnik (TTS) code version is available. Paper tape widths can be 17.4, 22.2, or 25.4 mm.

4280 PAPER STUB READER: Reads 8-level paper stubs at up to 120 characters/second. Stub dimensions are 50 mm in width and from 24 to 50 characters in length. The input hopper and output stacker each hold 600 paper stubs.

243 HIGH-SPEED PRINTER: Prints up to 1250 lpm using the standard 64-character print drum, or up to 833 lpm when equipped with an extended character set of 96 graphics (including lower-case letters). Available with either 132 or 160 print positions. Skipping speed is 75 inches per second. Contains a full-line buffer.

4241 LINE PRINTER: Prints at up to 908 lpm using the standard 64-character print chain. Print trains of any composition with up to 120 different characters are available. Provides 136 print positions.

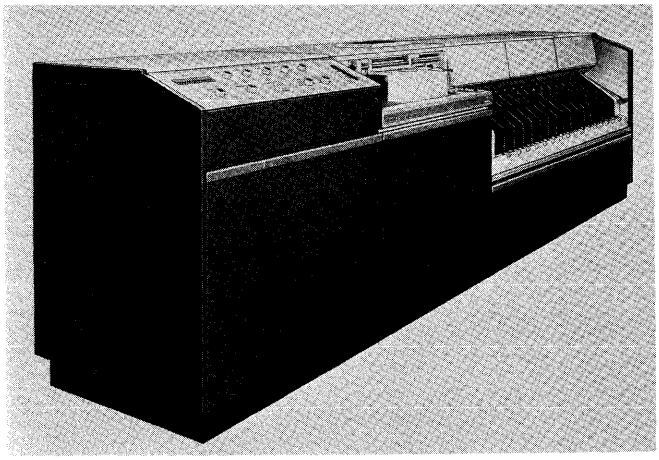
4242 LINE PRINTER: Similar to the 4241 except that a 160-print-position line and split platens are available. Each platen can operate independently, and each can feed its own special forms under separate carriage control. About 20 of the print positions are removed from accessability by the sprocket mechanisms separating the two forms.

4245 HIGH-SPEED LINE PRINTER: This fully-buffered drum printer provides 4 "zones" of 34 print positions each across a 136-position line. Depending upon the number of zones printed, the 4245 can operate at up to 1600 lpm with the standard 64-character drum.

4247 HIGH-SPEED LINE PRINTER: Provides printing of numerics only across a 132-position line at up to 1500 lpm; with a 64-character alphanumeric drum, maximum print speed is about 750 lpm.

97 I/O CONSOLE: Provides a 10-character/second printer for Models 4004/35 and above.

Siemens System 4004



The 4250 Optical Document Reader/Sorter has 16 pockets, can be used either on-line or off-line, and reads characters printed in various fonts, including OCR A, OCR B, and IBM 407.

4217 INTERROGATING TYPEWRITER: Provides a 20-character/second I/O console printer for the 4004/16 or 4004/26 Processor.

4250 OPTICAL DOCUMENT READER/SORTER: Allows on-line or off-line operation at up to 1533 documents/minute. Can hold 2500 to 3500 documents in the input hopper. Has 16 sort pockets, each capable of holding 800 to 1100 documents. Various fonts are available, including OCR A, OCR B, and IBM 407.

4251 OPTICAL DOCUMENT READER: Operates at up to 1533 documents/minute. Has 3 output stackers for documents. Other operational characteristics are identical with those of the 4250, above.

4252 OPTICAL DOCUMENT READER: Connects to any 4004 except the Model 46 or 151 through the 4263 Adapter. Reads the OCR-A font, handwritten numbers, and pencil marks at up to 750 documents/minute.

4261 OPTICAL DOCUMENT/JOURNAL TAPE READER: Reads documents and/or journal tapes at up to 828 documents/minute.

4262 OPTICAL PAGE READER: Reads at up to 420 documents/minute. The input hopper holds from 880 to 4200 documents, and each output stacker can contain about 400 to 1900 documents. Documents can be from 76.2 to 228 mm wide and from 156 to 356 mm long.

COMMUNICATION DEVICES

625 DATA EXCHANGE CONTROL: Connects two of the same model System 4004 processors, up to 200 feet apart, permitting direct memory-to-memory data interchange via a selector or multiplexer trunk on each of the two processors. Either processor can originate transmission or request data.

4627 DATA EXCHANGE CONTROL: Similar to the 627 except that the 4627 connects a 4004/26 to any other model System 4004 processor except the 46 or 151. The data transfer rate depends on the speeds of the processors.

656 COMMUNICATION CONTROLLER–SINGLE CHANNEL: Permits remote communication, in ASCII synchronous transmission mode, with any of the following equipment: another suitably equipped System 4004 computer, an IBM System/360 or 370 with a 2701 or 2703 controller, or Siemens (RCA) standard synchronous devices. Operates via either dialed public networks or private lines, at half-duplex transmission rates of 1200, 2400, 4800, 9600, 11,200, or 19,200 bits/second. Connects to a System 4004 selector or multiplexer channel.

668 COMMUNICATION CONTROLLER–MULTICHANNEL: Permits connection of multiple low-speed and medium-speed remote terminals to the multiplexer channel of any System 4004 processor except the Model 16 or 26. Can be equipped, via appropriate buffers, to handle a broad range of communication services, speeds, and codes. Transmission speeds can range from 50 to 4800 bits/second. Three models are available, with capacities for 16, 32, or 48 buffers. Each buffer handles one half-duplex line; a full-duplex line requires a pair of buffers. One 668 CCM can service to a mixture of up to 16 different types of buffers with a maximum total data rate of 76,800 bits/second.

4666 COMMUNICATION CONTROLLER–MULTICHANNEL: Similar to the 668 CCM except that the 4666 allows the remote connection of up to 30 low- and medium-speed remote terminals to a System 4004 processor and can handle a maximum total data rate of 204,800 bits/second.

Numerous Siemens telephone devices, video data terminals, and other remote terminals are available that operate at speeds from 100 to 4800 bits/second. Included among these are the TRANSDATA systems, consisting of paper tape and punched card I/O and printer devices capable of operating at speeds up to 2400 bits per second. These terminals and other communications devices are produced by Siemens' Teleprocessing Division, the leading European supplier of communications equipment.

SOFTWARE

OPERATING SYSTEMS: Software support for the System 4004 line is furnished at a number of distinct levels. Users of the general-purpose System 4004/35, 45-III, 127, 135-II, and 150 Processors can choose the Disc Operating System (DOS), Tape Operating System (TOS), or Tape/Disc Operating System (TDOS). A Primary Operating System (POS) is available for the 4004/35 only.

Specialized software support is provided for the 4004/16, 26, 46, and 151. The 4004/16 and 26 Programming System offers a modest set of card/tape (Basic Operating System) and disc-oriented (Disk Operating System 16/26) facilities for the smallest processor in the line. The Virtual Memory Operating System (VMOS) complements the time-sharing hardware facilities of the 4004/46 and 151 Processors.

Of the above operating systems, DOS and VMOS are the main current operating systems with full centralized Siemens support. POS, TOS, TDOS, and BOS for the 16/26 are furnished on an "as-is" basis only, with no maintenance.

The facilities provided at each of these support levels are summarized in the following paragraphs.

Siemens System 4004

4004/16 AND 26 PROGRAMMING MONITORS: A modest Basic Operating System is furnished on an as-is basis for these small-scale System 4004 models, in addition to a more advanced, disc-based DOS 16/26. Both monitor systems offer conventional single-stream operation only.

The Basic Operating System consists of a set of interrelated software facilities that are appropriate for the small computers' usual function as auxiliary or I/O processors used in conjunction with larger computers. The basic facilities include an Assembly System, an Input/Output Control System (IOCS), a Report Program Generator (RPG), a Sort/Merge Generator, and a group of about 10 loaders, diagnostics, and data transcription routines. Any two data transcription functions (such as card to tape and tape to printer) can be performed concurrently.

Except for the Sort/Merge Generator, all of the 4004/16 and 26 basic routines are designed to operate on a configuration consisting of 8K processor, card reader, punch, and printer. As a result, their capabilities are quite modest. The Sort/Merge requires at least three magnetic tape drives. The other routines can take advantage of magnetic tape and increased storage capacity, when available, for improved performance.

The 16/26 Disc Operating System offers full disc residence for ISAM structured data sets, a COBOL processor, and more than three dozen utility routines. This DOS 16/26 system has current Siemens support and is the preferred System 4004/16 and 26 monitor.

PRIMARY OPERATING SYSTEM (POS or GBS): POS is a tape-resident operating system primarily for System 4004/35 installations with at least the following equipment: 16K processor, card reader, punch, printer, and four magnetic tape drives (at least one of which must be a 9-track model). A program library can be maintained on either punched cards or magnetic tape.

The POS Control System, consisting of a Supervisor, Job Control, and Program Loader routines, controls and coordinates the execution of all programs. The Supervisor and other resident routines and buffer areas occupy approximately 4800 to 6800 bytes of core storage. The Supervisor handles interrupt analysis and processing, I/O scheduling, error recovery, operator communication, program loading, and end-of-job processing. The Job Control routine, which the Supervisor normally calls into core storage between jobs, handles job-to-job transitions and I/O device assignments.

The POS File Control Processor (FCP) is a generalized I/O control system. In conjunction with the Supervisor, the FCP controls I/O operations at both the logical and physical levels. Logical control is provided by file definition and I/O control macros included within the POS Assembly System. Physical control of the actual data transfers between memory and I/O devices is handled by the Supervisor. An assembly-language programmer can choose to work at either the logical record level or at the physical level; in the latter case, he must specifically provide for all blocking, buffering, and I/O device functions.

The language translators available under POS are an Assembly System, a COBOL compiler, and a Report Program Generator (RPG). The Assembler and COBOL compiler require at least 32K bytes of core storage. Other POS facilities include a tape Sort/Merge routine and a useful complement of library maintenance, diagnostic, and utility routines. The Peripheral Control Program (PCP) permits concurrent operation of up to three data transcription routines under POS.

DISC OPERATING SYSTEM (DOS or PBS): DOS is a disc-resident operating system that provides multiprogramming control of up to 14 concurrent jobs. Minimum configuration requirements are a 32K processor, one disc drive, card reader, printer, and console typewriter. DOS consists of four groups of components: a Control System, which monitors and controls the processing environment; a Language System, which provides a choice of four programming language translators; a Data Communications System; and a Utility System, which simplifies testing and production operations.

The DOS Control System consists of a Supervisor, a Monitor, a Job Accounting System, and a Spooling capability. The minimum systems residence is 8K bytes for limited multiprogramming, with 10K bytes required for full 14-job multiprogramming. Data Communications requires an additional 6K to 10K, and Job Accounting and Spooling each require about 8K bytes additional. The full-blown DOS main memory requirement is about 35K bytes with all options included.

The DOS Supervisor handles interrupt control, I/O scheduling, error recovery, program loading and termination, memory allocation, and console control. The Supervisor permits concurrent execution of up to 14 independent programs, provided that sufficient memory space and peripheral devices are available. A separate generalized I/O system that works in conjunction with the DOS Control System to control I/O at both the logical and physical levels is provided. The generated I/O system occupies approximately 4K bytes and can handle both sequential and random processing. The Monitor is a non-resident routine that controls stacked-job processing of successive programs, without operator intervention, on the basis of control statements in an input job stream. Up to 14 such job streams can be handled concurrently if the necessary hardware facilities are available.

The DOS Data Communications System (DUS) is a modular software system designed to operate under control of the DOS Executive and facilitate the implementation of a data communications system. It consists of two major components: Communications Systems Program (CSP) and Communications User Program (CUP). The CSP routines perform the functions of interrupt analysis, line servicing, message acknowledgement, buffering, queuing, error handling, code translation, and logging. The CUP is a user-written application program that interfaces with the Siemens software by means of macros.

DOS is the main real-memory operating system for the System/4004.

TAPE OPERATING SYSTEM (TOS or BBS): TOS is a magnetic tape-resident operating system that can control the concurrent operation of up to six independent programs. TOS, however, provides no support for random access or data communications. Minimum configuration requirements are a 64K processor, five tape drives, card reader, and console typewriter. TOS consists of a Control System, a Language System, and a Utility System.

Siemens System 4004

The TOS Control System consists of an Executive, a File Control Processor, and a Monitor. The Executive requires 16,000 bytes of core storage and handles interrupt control, I/O scheduling, error recovery, program loading and termination, memory allocation, and console control. It can also supervise the concurrent execution, under a priority system, of up to six programs, provided that sufficient memory space and peripheral devices are available. The File Control Processor (FCP) is a generalized I/O system that requires approximately 4000 bytes and handles the processing of sequential files at both the physical and logical I/O levels. The Monitor controls all program preparation runs, including assembly, compilation, linkage edits, and/or library maintenance. Activated by an operator type-in, the Monitor operates under control of the Executive and initiates the operations specified by control cards in an input job stream. The Monitor can also be used to control the execution of production programs.

The language translators available under TOS are an Assembly System, COBOL and FORTRAN compilers, and a Report Program Generator.

The TOS Utility System includes a tape Sort/Merge program, an Automatic Integrated Debugging System (AIDS) that facilitates program testing, and routines to perform data transcription, diagnostic, and library maintenance functions.

TAPE/DISC OPERATING SYSTEM (TDOS or BPBS): TDOS is an extended and considerably more powerful version of the Tape Operating System described above. Minimum configuration requirements are a 64K processor, one disc drive, three magnetic tape drives, card reader, printer, and console typewriter.

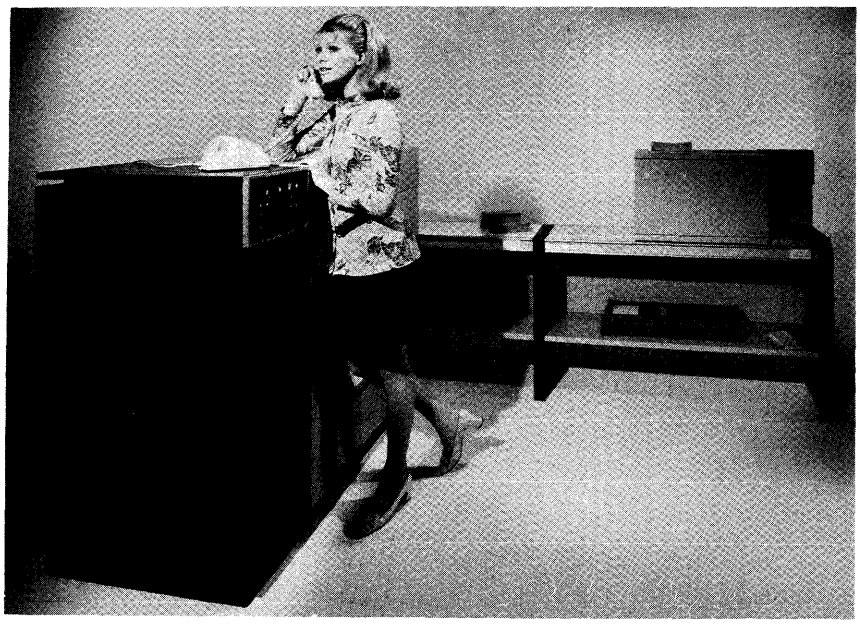
TDOS provides all the facilities and functions of TOS, and a TOS user can move up to TDOS without reprogramming or recompiling. In addition, TDOS provides: (1) support for mass storage devices; and (2) more efficient operation, particularly in a multiprogramming environment, through the use of discs as library storage media.

VIRTUAL MEMORY OPERATING SYSTEM (VMOS or BSV): VMOS is the primary operating system for the System 4004/46 and 151 Virtual Memory Computers. Designed to control concurrent local and remote processing in the batch, interactive, and communications modes, VMOS is an outgrowth of the earlier Time-Sharing Operating System (TSOS) that features a data management system, better RPG, COBOL and FORTRAN compilers, additional utility routines, "Spooled" remote input and redirectable output capabilities, and a text processing routine called Autoform.

VMOS controls the overall processing environment by allocating the system's resources, controlling the scheduling and execution of all tasks, servicing all interrupts, managing virtual memory by controlling the "swapping" of pages between main and drum memory, and initiating error recovery procedures. Spooling of card input and printer output on disc or tape drives improves hardware utilization; additional spooling facilities permit input from remote terminals to be spooled and processed in batch mode and give a high degree of control to the operator for redirection of "spoolout" files as well as flexible forms control commands. A Command Language is used for communication between VMOS and the system's users, operator, and administrator.

The VMOS data management system features improved catalog management techniques for faster access, improved channel utilization through queuing of requests for seek operations on random-access devices, use of the same physical block size in all random-access devices, handling of errors on an exception basis, and the ability to pass files from program to program.

A priority task scheduler designed to allow multiple levels of prioritization is included in VMOS. A basic central processor time-slice is given to each batch task in the



The TRANSDATA 8418 Remote Batch Terminal is one of the numerous data communications terminals produced by Siemens' Teleprocessing Division, which is Europe's leading supplier of communications equipment.

Siemens System 4004

input queue, and a special longer time-slice is given to the highest-priority task, in addition to putting that task at the head of the queue. A percentage-of-core parameter or a relative-frequency parameter can be used to divide the basic system resources between batch and interactive jobs and establish relative priorities between the batch and interactive workloads. Interactive jobs can be subjected to a fixed delay period specified at Sysgen time to limit CPU-bound interactive jobs from excessive use of the system resources.

Other noteworthy features of VMOS include: Dynamic Alternate Track Assignment, used in conjunction with the File Reconstruction System (FRS) and Error Recovery to recover from disc errors; a Random Access Volume Initializer (VOLIN); Tape Mark Positioning Control with non-standard and omitted label options; Catalog Display Program; dynamic step-down of dual-channel disc and tape controls for maintenance; and Remote Batch Processing features designed for error recovery, orderly terminal shut-down, and accounting statistics.

VMOS provides language processors for both batch and conversational use. The batch-mode Assembler and COBOL and FORTRAN compilers are themselves pageable and produce pageable object programs. The RPG and Sort/Merge programs operate in conventional batch (non-paged) mode. Also usable in the background batch processing mode are a number of applications modules, including PERT, scientific and mathematical subroutines, etc.

Conversational languages supported under VMOS include Extended BASIC and IFOR (an interpretive, compile-and-go FORTRAN IV processor). A COBOL Syntax Checker (COBSYN) permits rapid detection and correction of COBOL programming errors by users at remote terminals. An Interactive Debugging Aid (IDA), usable in either conversational or batch mode, facilitates testing and modification of programs written in Assembly Language, COBOL, or FORTRAN. Code II (COBOL Test File Generator) is used to create test files on public disc as part of the COBOL program development subsystem. Finally, for the larger 4004/151 computer only, Siemens offers two additional compilers: FAST FORTRAN, designed to provide rapid compilation and effective diagnostic facilities in a conversational environment; and Interactive COBOL, designed to enable terminal users to construct, check, test, and modify programs using the full ANSI COBOL language plus IBM extensions.

Extended VMOS communications capabilities, also available only for the larger 4004/151 computer, include: (1) dynamic message buffering; (2) bulk message storage and a store-and-forward capability; (3) an intercept facility that returns undelivered messages to the sender; (4) a tape logging capability that enables a record of all message traffic to be maintained; and (5) extended terminal support facilities.

COBOL: Siemens offers COBOL compilers under five of the 4004 operating systems: POS, DOS, TOS, TDOS, and VMOS. All except the POS version use essentially the same source language as IBM's OS/360 COBOL F, which includes many of the facilities of ANS COBOL but also has numerous incompatibilities and restrictions with respect to the standard language. POS COBOL uses a subset of the language elements supported in the larger compilers; among the features excluded from the POS version are the Sort, Report Writer, and Random Access modules.

FORTRAN: Siemens offers FORTRAN compilers for operation under DOS, TOS, TDOS, and VMOS. All use the FORTRAN IV source language and include all the facilities of ANS FORTRAN.

BASIC: A compiler for the BASIC language is offered only under VMOS.

REPORT PROGRAM GENERATORS: Siemens offers RPG's at nearly all of the 4004 software support levels: POS, DOS, TOS, TDOS, VMOS, and the 4004/16 and 26 Programming Monitors. Upward compatibility at the source-language level is preserved among all versions. The RPG's use data from user-prepared specification sheets to generate object programs which perform common business data processing functions. In addition to their basic report-writing functions, RPG programs can update files, perform various types of calculations, and accommodate user-coded routines to handle functions that cannot be programmed efficiently in the RPG language.

ASSEMBLERS: Assembly Language is the standard symbolic programming language used to write machine-oriented programs for all models of the 4004. Siemens therefore furnishes Assembly Systems at all support levels. The restricted instruction repertoire of the 4004/16 and 26 necessitates a specialized Assembly System that is not fully compatible with the ones for the larger processors. All of the other Assembly Systems use the same source language and include facilities for defining and using macro-instructions.

UTILITY ROUTINES: Sort/merge programs are offered at all System 4004 support levels. All are generalized programs which are controlled by user-supplied parameters, and all can accommodate either fixed or variable-length records in blocked or unblocked form. Magnetic tape and/or disc drives are used, depending upon the orientation of the particular operating system.

Each software level also includes an appropriate complement of data transcription, diagnostic, and other utility routines.

APPLICATION PROGRAMS: A complement of about 75 generalized business and scientific application programs is available for the System 4004 line. Many of these are rather simple subroutines, while others include major data management systems, manufacturing control programs, and engineering systems involving dozens of man-years of development expense.

PRICING

Siemens declined to provide any detailed price data on the System 4004 equipment. Note, however, that approximate mainframe and system prices are listed in the table on page 70C-754-01c. Siemens is currently marketing the System 4004 Series on a "bundled" basis.

CONTRACT TERMS: The standard Siemens equipment rental agreement allows use of the equipment (exclusive of the time required for remedial and preventive maintenance) for 182 hours per month. An extra-use charge is made only if additional maintenance is required because of excessive use. The standard agreement covers maintenance of the equipment between 8 a.m. and 5 p.m., Monday through Friday. Extended periods of maintenance are available at extra cost. ■