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 initially 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 Specta 70 line as competition to IBM's System/360.

Later, 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 eight from the family to leave the current lineup of eight models. Of the current System 4004 family, Siemens is still selling Models 35, 45-III, 127, 135-II, 150, and 151; Models 16 and 26 are also available but are not being actively marketed.

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 and the December 1970 introduction of the 4004/151. The 4004/46 is no longer in production.

With eight current models offering a range of memory sizes from 32K bytes to 2 million bytes, Siemens' System 4004 family provides a strong small-to-medium scale alternative to competitive third-generation data processing systems. One of the Siemens models features virtual storage operation.

CHARACTERISTICS

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MODELS: 4004/16, 4004/26, 4004/35, 4004/45-III, 4004/127, 4004/135-II, 4004/150, and 4004/151.

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 "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.

Two Model 45-III Processors are shown here, along with three card readers, six disc drives, and twelve magnetic tape units.

REFERENCE EDITION. This is a mature product line, and no significant further developments are anticipated. Because of its importance, coverage is being continued, but no future update is planned.

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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.

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 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, and Eastern Europe. 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, 1977, Siemens reported gross sales of US $10.9 million, up 32% from the year before. The company has approximately 319,000 employees worldwide, about 12,000 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.

The Model 45-I 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

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.

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 4004/151 Processor 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 microprogram for the 4004/151.

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

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 4004/151 Processors to program as

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CHARACTERISTICS OF THE CURRENT SYSTEM 4004 PROCESSORS

	4004/16	4004/26	4004/35	4004/45-III	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
Virtual memory	No	No	No	No	No	No	No	Yes
Principal operating systems	DOS/16-26	DOS/16-26	DOS, BS1000	DOS, BS1000	DOS, BS1000	DOS, BS1000	DOS, BS1000	VMOS, BS2000
Processor price range, monthly rental (1) DM	2,000 to 2,800	3,000 to 7,000	9,000 to 10,000	21,500 to 48,000	8,500 to 17,000	15,500 to 31,000	38,000 to 100,000	45,500 to 101,000
Date of announcement	Feb. 1968	Feb. 1968	Sept. 1965	Oct. 1972	Oct. 1972	Oct. 1972	Dec. 1970	Dec. 1970
Date of first delivery	Feb. 1970	Jan. 1970	May 1967	Mar. 1973	Apr. 1973	Apr. 1973	Mar. 1972	Apr. 1972
Relative CPU power (4004/16 = 1.00)	1.00	1.00	0.95	2.20	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	0.765	0.765
Bytes accessed per cycle	1	1	2	2	2	2	4	4
Minimum capacity, bytes	8,192	16,384	32,768	65,536	65,536	65,536	131,072	262,144
Maximum capacity, bytes	16,384	65,536	65,536	524,288	524,288	524,288	2,097,152	2,097,152
Main storage type	Core	Core	Core	Core	Core	Core	Core	Core
Interleaving	None	None	None	None	None	None	None	None
Storage protection	None	None	Optional	Optional	Optional	Optional	Standard	Standard
CENTRAL PROCESSOR								
No. of hardware instructions	27	33	144	145	145	145	153	154
Registers, total/general-purpose	None	None	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 and 256	3072	3072
ROM word length, bits	None	None	54	56	56	56	72	72
ROM cycle time, microseconds/word	None	None	480	480	480	480	255	255
Max. virtual memory size, bytes	None	None	None	None	None	None	None	8,388,608
No. of interrupts	None	None	32	32	32	32	32	32
Floating-point hardware	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Decimal instructions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Divide hardware	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Indirect addressing	1 level	1 level	3 levels	3 levels	3 levels	3 levels	3 levels	3 levels (2)
Processor states	2	2	4	4	4	4	4	4
INSTRUCTION TIMES (decimal, in microseconds):								
Add, unsigned, unpacked (5 digits)	129.36	129.36	162.72	83.98	93.58	83.98	48.19	48.09
Add, signed, packed (5 digits)	32.56	32.56	19	5.04	12.24	5.04	2.04	2.04
Multiply, unsigned, unpacked (5 digits)	19,600 (3)	345.40	377.46	176.18	171.38	176.18	71.34	71.30
Multiply, signed, packed (5 digits)	19,600 (3)	243.32	244.50	106.64	95.00	106.64	27.05	27.03
Divide, unsigned, unpacked (5 digits)	24,200 (3)	280.72	261.12	143.15	149.75	143.15	59.38	58.58
Divide, signed, packed (5 digits)	24,200 (3)	185.68	152.64	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	2,080,000	5,240,000	5,000,000
No. of selector channels	1	8	1, 2	2, 3, 4	2	2	2, 4 ,6	2, 4, 6
Trunks per selector channel	6	1	2	2	2	2	3	3
Max. selector channel data rate, bytes/second	568,000	284,000	694,000	1,040,000	694,000	1,040,000	900,000	900,000
No. of multiplexer channels	None (4)	None	1	1	1	1	1	1
Trunks per multiplexer channel	None	None	8	9	9	9	16	16
Max. devices on multiplexer	None	None	192	256	256	256	248	248
Max. multiplexer channel data rate, bytes/second	None	None	36,000	77,000	72,000	77,000	216,000	216,000

(1) These prices have been estimated by Datapro based upon publicly available information and have not been approved by Siemens. The prices include maintenance. The lower price is for a processor with minimum memory, the higher price for a processor with maximum memory.
(2) One additional level of indirect addressing is provided for the virtual memory backing store.
(3) Operations performed by subroutine.
(4) The special selector channel in Model 16 can be used to multiplex I/O devices up to the maximum aggregate data rate.

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, was designed to handle local batch processing, **if they had 8.4 million bytes 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 4004/151 uses an 8-register associative memory to translate virtual addresses used by the programmer into effective main memory addresses.**

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.

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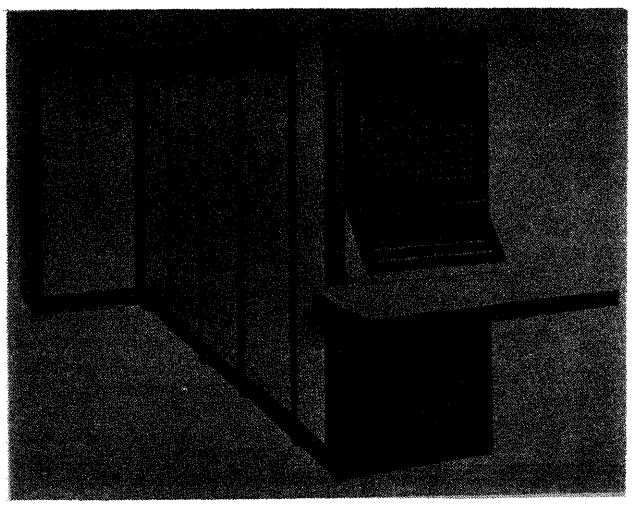

The System 4004/150 offers up to 2 million bytes of core storage.

remote batch processing, interactive time-sharing, and intercommunication among the remote terminals. It could service up to 48 remote users while concurrently processing up to 14 independent batch-mode jobs. The 4004/46 Processor was an upgraded version of the 4004/45-I. It included built-in logic that facilitated program segmentation and paging. The 262K main memory was divided into pages of 2048 or 4096 bytes each. Dynamic address translation facilities enabled each user to program as if he had a 2-million-byte virtual memory at his disposal. A magnetic drum permitted rapid swapping of program segments into and out of core memory. The 4004/46 stressed a good balance between interactive and batch-mode processing capabilities in a medium-scale system that was 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 had to the 4004/45. Despite its three-fold speed advantage over the 4004/46, the 4004/151 is still not a really large-scale computer.

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

The System 4004/35 through 151 Processors 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)

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.

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 87.5 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.

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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.

The System 4004 processors have four sets of general registers—one for each of four processor states. As a result, the Siemens processors can service interrupt conditions efficiently. 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. The two current operating systems—BS1000 for real-memory operations and BS2000 for virtual-memory operations—are also used on the new System 7.000 series and provide forward compatibility for 4004 users.

The complex internal architecture of the 4004 line makes programming at the assembly-language level difficult and error-prone. For this reason, coupled with the advantages of high-level langauges, most 4004 users do the bulk of their programming in COBOL, FORTRAN, RPG, or PL/1.

USER REACTION

Earlier this year, Datapro conducted a survey of Siemens computer users. We received responses from 13 System 4004 users who had a total of 14 systems installed. Our sampling included nine Model 151 systems and one of each of the following models: 45, 46, 127, 135, and 150.

The 13 respondents supplied the following ratings for their systems:

	Excellent	Good	Fair	Poor	WA*
Ease of operation	0	9	3	1	2.6
Reliability of mainframe	2	8	3	0	2.9
Reliability of peripherals	1	8	3	0	2.8
Maintenance service:					
Responsiveness	5	6	2	0	3.2
Effectiveness	1	5	6	1	2.5
Technical support	1	7	4	0	2.8
Manufacturer's software:					
Operating system	1	6	5	1	2.5
Compilers and assemblers	0	6	5	2	2.3
Applications programs	0	4	7	2	2.2
Ease of programming	1	8	3	1	2.7
Ease of conversion	0	6	6	1	2.4
Overall satisfaction	0	9	3	1	2.6

*Weighted Average on a scale of 4.0 for Excellent.

The majority of systems in our survey were being used primarily for scientific and engineering applications with

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 10.3 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 72.5 milliseconds, average 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 Multi-Channel 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 Disk 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 Multi-Channel Switch are optional.

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about a third also used for some business data processing. Our population included a number of universities, research institutes, and government agencies. Eight of the systems were owned by their users and six were rented from Siemens. Installed user experience ranged from 1.5 years to almost 9 years and averaged 5.3 years.

As could be expected of a computer system entering its second decade, the System 4004 is showing signs of its age. While many users were very pleased with the systems' technical reliability and hardware design, the respondents' primary dissatisfaction seemed to be summed up in one user's comment that the System 4004 is "limping behind with respect to the development and state of software."

On the positive side, representative comments included "good output at low cost," "good abilities for time-sharing use," "flexible for various tasks," and "good interactive, multi-user system."

With over two thirds of the survey population consisting of virtual memory Model 151 systems (and one Model 46 which has virtual memory but is no longer marketed), some distinction should be made among virtual and non-virtual system users. Generally, the Model 151 users rated their systems slightly higher in the categories of ease of operation, manufacturer's software, ease of programming, ease of conversion, and overall satisfaction. The non-virtual group reported slightly higher hardware reliability, maintenance service, and technical support.

Currently, the System 4004 is primarily of interest to 4004 users who want to expand or upgrade their installations. Although Siemens now is concentrating its marketing energies on the new Siemens 7.000 series, the company will continue to supply and support 4004's as long as there is sufficient user interest in the product line.□

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 Multi-Channel 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 ½-inch tape in IBM-compatible formats. Characteristics of the 9-track versions are as follows:

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 ½-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 ½-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 are 130 seconds for the 451 and 85 seconds for the 453.

450 & 4453 MAGNETIC TAPE UNITS: Provide 800-bpi NRZI or 1600-bpi phase-encoded recording on standard ½-inch magnetic tape drive 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 70 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.

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.

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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.

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 accessibility by the sprocket mechanisms separating the two forms.

4245 HIGH-SPEED LINE PRINTER: This full-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.

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

4216 OPTICAL DOCUMENT/JOURNAL TAPE READER: Reads documents and/or journal tapes at up to 828 documents/minute.

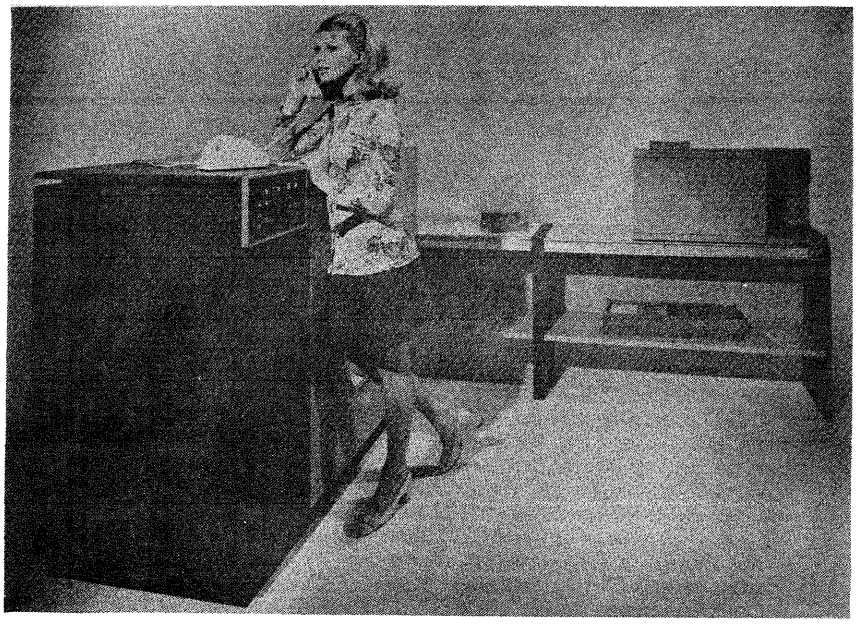
4262 OPTICAL PAGE READER: Reads at up to 420 documents/minute. The input hopper holds from 880 to 4200 documents, and each output stacker can contain about 400 to 1900 documents. Documents can be from 76.2 to 228 mm wide and from 156 to 356 mm long.

COMMUNICATION DEVICES

627 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.

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—MULTI-CHANNEL: Permits connection of multiple low-speed and



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.

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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) or BS1000. A Primary Operating System (POS) is available for the 4004/35 only.

Specialized software support is provided for the 4004/16, 26, and 151. The 4004/16 and 26 Programming System offers a modest set of disc-oriented (Disk Operating System 16/26) facilities for the smallest processor in the line. The Virtual Memory Operating System (VMOS) and BS2000 complement the time-sharing hardware facilities of the 151 Processors.

Of the above operating systems, BS1000 and BS2000 are the main current operating systems with full centralized Siemens support.

The facilities provided are summarized in the following paragraphs.

BS 1000: This operating system is a real-memory, batch, remote batch, and transaction-processing system control program that is supported on all 4004 models from the 4004/35 upward. BS 1000 was made available for use on the 7.000 series in April, 1975 as Version 1.3. BS 1000 had previously been available on the 4004 as early as November, 1973. Each of up to 14 independent programs may be loaded at any location in main memory for simultaneous execution. Each program must reside in a single block of contiguous memory, and each program is assigned a priority that can be changed during execution. Depending upon the user's requirements, a BS 1000 system can be generated with a minimum resident main memory requirement of 12K bytes.

The principal control system components of the BS 1000 include:

- Executive (EXEC)
- Job Management System
  - —Monitor (MONITR)
  - —SPOOL 1 System
  - —SPOOL 2 System
  - —Job Control System 1 (JCS1)
  - —Resource Management System (RMS)
  - —Job Control System 2 (JCS2)
  - —Data Set Catalog System (DACS)
  - —Job Accounting System (MESACNT)
- File Control Processor (FCP)
- Telecommunications System (TCS)
- Real Time Control Programs (ASMUS, DIACUP)
- Voice Output System

The main functions of the EXEC are to manage main memory, analyze and service interrupts, schedule I/O, and communicate with the operator through the system console(s). EXEC occupies 12K bytes of main memory as a minimum. An optional System Overlay feature of the EXEC permits system disk overlays to be made resident in main memory in an area that can be 4K to 50K bytes in size.

The Job Management System (JMS) comprises the systems for automatic job execution.

In order to reduce the workload on the operator, the MONITR allows a "job" consisting of several programs to be processed in a job stream. MONITR is always overlaid by the next program to be started so that it does not occupy any memory space during program processing.

SPOOL 1 is used for small-to-medium configurations and supports systems with available main memory of at least 64K bytes. SPOOL 2 is for large configurations and supports systems with available main memory of 128K bytes or larger. Both spoolers support input of jobs and files from local peripherals and intermediate storage and output of print and punch files via local peripherals. In addition, SPOOL 2 also accepts input from remote terminals, supports intermediate storage and output to remote terminals, and reads/writes temporary files via a virtual magnetic tape interface.

SPOOL 2 also offers an extensive function catalog and can support dual systems with the multi-channel switch and two-channel disk controller.

JCS 1 is an integral part of SPOOL 1 and supports FIFO automatic job execution under a 64-class job classification system that assigns any of 3 priorities to an individual job. JCS 2 is intended for use with SPOOL 2 and runs as an internal process that does not require its own time slot. JCS 2 supports up to 10 priority levels.

DACS catalogs and manages data sets by generation dates, assigns proper data sets to user programs, and initializes storage space for disk output, as well as permitting temporary or permanent storage of job variables for interchange between programs.

FCP controls I/O data communications between the CPU and the peripherals.

TCS is analogous to FCP except that it controls communication between the CPU and remote terminals connected to a communications controller as well as the interconnection of 2 or more CPU's via a data exchange controller. TCS runs in conjunction with SPOOL 2.

Two TCS access methods are available under BS 1000:

- TCS for non-programmable communications controllers (3630).
- TCS-NEA for programmable communication controllers (TRANSDATA 960) and communications front-end processors. TCS-NEA supports communication network configurations.

TCS and TCS-NEA consist of a communication control program and up to 8 user programs.

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ASMUS, a real-time control program that runs under BS 1000, supports overlapped (re-entrant) operation of several interactive data terminals and/or remote batch peripherals. ASMUS supports overlapped execution of several active programs by providing segment-reentrant control. User programs with ASMUS can be written in Assembler or COBOL.

DIACUP is an interactive program that supports the writing of up to 137 communication user programs that can be run as subroutines in the same program slot as DIACUP. DIACUP requires a minimum of 4096 bytes of main memory.

The minimum configuration required to run the BS 1000 operating system consists of a System 4004 CPU with at least 64K bytes of main memory, 1 console, 1 disk storage device connected via a selector channel, 1 card reader, and 1 printer.

BS 2000: This a virtual memory operating system that provides significant functional enhancements over BS 1000. BS 2000 was introduced for the 7.000 as Version 1 in December, 1973. BS 2000 can be run on any medium-to-large scale System 7.000 from the model 7.730 up; as well as the System 4004/151. The essential features of BS 2000 include dynamic memory management for a virtual address space of up to 8 million bytes; concurrent support of local or remote batch processing, multiprogramming of up to 120 tasks, and interactive processing (time-sharing) for more than 100 users under control of a batch-oriented task management system; and real-time operation. BS 2000 treats all programs as either Class I (memory resident) or Class II (pageable). A Class II program can be up to 5 million bytes in length. Users are classified as system administrators, operators, or user/programmers.

There are two main types of programs under BS 2000: privileged and non-privileged routines. The Control System is privileged and consists of the Executive, the Data Management System, the Teleprocessing System, and System Services. Non-privileged routines consist of language processors, utility routines, and user programs.

The Executive performs the following functions:

- Handling console I/O
- Processing user command language
- System accounting, spooling
- Interrupt handling.

The Data Management System handles I/O operations except for data terminals and the console(s), including file management and the shareability of files. Access methods supported by the Data Management System include SAM (Sequential Access Method), ISAM (Indexed Sequential Access Method), PAM (Primary Access Method), and BTAM (Basic Tape Access Method). PAM can only access 2048-byte pages.

The Teleprocessing System supports remote access to the computer system including facilities for resource management, logon/logoff, support of logical or virtual terminals, data transfer, and error handling.

System Services include an Interactive Debugging Aid, a Desk Calculator function, a Dynamic Linking Loader, and an Audit Mode for generation of branch address tables.

For execution, tasks are classified as either interactive or background (batch). Interactive tasks are initiated via the keyboard of a data terminal. Batch tasks can be assigned any of 9 priorities.

Operating system components (except the Executive), user programs and application programs are stored in virtual memory and relocated into real memory during execution. Virtual memory space is reallocated to the programs during loading. Virtual memory is divided into consecutive 64K-byte segments each containing 16 pages of 4K bytes each.

Real memory under BS 2000 is divided into two sections: one is reserved for the Executive and the real-memory resident programs, and the other is divided into 4K page frames. All paging is done on demand only.

Virtual memory is subdivided into 6 classes. Classes 1-4 are reserved for the system, while Classes 5 and 6 are available to the user. Class 6 memory is available for user-written programs and begins at the low-order end of the available memory area. Class 5 memory comprises the high-order 64K and is used for tables and buffer areas that have to be set up for user tasks.

The speed of virtual address translations is considerably increased by a Content Addressable Memory (CAM) that holds information about the last eight pages accessed, thus reducing the number of references that must be made to the Block, Segment, and Page tables.

LANGUAGE PROCESSORS

A variety of language processors are supported under the BS 1000 and BS 2000 operating systems:

Language	BS 1000 (Memory Requirement)	BS 2000
Assembler	yes (34K)	no
Assembler	yes (70K)	yes**
RPG 2	yes (Min. 26K)	no
ALGOL 60	yes (66K)	yes
ANS COBOL	yes (24 or 46K)	yes
FORTRAN IV	yes (56 or 92K)	yes
PL/I	yes (86K)	yes
BASIC	no	yes**
BASICL*	no	yes**

* Double-precision version.
**Shareable.

Two versions of the ANS COBOL compiler are available under BS 1000: a basic version that requires 24K of resident main memory; and an enhanced version that requires 46K bytes.

The PL/1 compiler offers capabilities that are midway between the IBM D-level and the ECMA level. The Assembler contains an extensive macro capability.

All language processors available under BS 2000 are pageable. All but BASIC and BASICL produce pageable object modules.

UTILITY ROUTINES

A full set of utilities is available for BS 1000 and BS 2000, including a Sort/Merge program, library maintenance routines, a linkage editor, system service routines, diagnostic routines, debugging aids, test data generators, and peripheral/media conversion routines.

UNIVERSAL DATA BASE MANAGEMENT SYSTEM (UDS): UDS, a separately priced product, is available for the System 7.000 and System 4004 computers. Minimum requirements are a 128K main memory, a card reader, a printer, and two disk drives. For smaller systems, Siemens offers UDS Version 1 Variant A, which requires a minimum of 46K of real memory. UDS runs under BS 1000, with BS 2000 support scheduled to become available in the second quarter of 1978. UDS interacts with ASMUS for real-time operations when used in conjunction with TCS. User programs supported under UDS Version 1 must be written in COBOL. UDS follows the recommendations of the April 1971 Report of the CODASYL DBTG, the CODASYL COBOL Data Base Facility Proposal of March 1973, and

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the COBOL JOD for 1975. UDS is functionally upward compatible with Siemens other data base systems: SESAM and PRISMA.

The major components of UDS are:

- Data Definition Language (DDL)
- Storage Structure Language (SSL)
- Data Base Handler (DBH)
- Data Manipulation Language (DML)
- Interactive Query Language (IQL)
- Service Programs.

GOLEM INFORMATION RETRIEVAL SYSTEM: This system provides access under BS 2000 to the central processor from remote data communications terminals. GOLEM uses a flexible, interactive, conversational language for data access that includes features for browsing, specification of descriptor ranges, etc. GOLEM also supports simultaneous terminal operations for multiple application programs, and can handle stored data in variable formats, contents, and lengths. Documents are logically divided into segments, and 5-level access codes are used to ensure data access security. Under BS 2000, GOLEM is a pageable program. GOLEM is a separately priced program product.

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 processor 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.■