Systems Engineering Laboratories

SEL 810B
General Purpose Computer

Introduction

The SEL 810B is a 16-bit parallel digital computer with a full memory cycle time of 750 nanoseconds. Like all SEL 800 Series computers, the SEL 810B utilizes highly reliable silicon monolithic integrated circuits and modular construction throughout.

The SEL 810B Computer is fully program compatible with the SEL 810A and therefore is offered with the most complete, powerful, field proven software package available for any computer in its size or price class. SEL 810B programming is simplified by a powerful repertoire of direct address and augmented instructions. The SEL 810B is also completely compatible with the full line of field proven SEL 810A peripheral devices.

A high degree of flexibility designed into the SEL 810B Computer and its peripheral devices make it the first choice of a rapidly growing list of customers with requirements running the full gamut of industrial and scientific real-time applications.

Why the SEL 810B?

- ☐ 750 Nanosecond Full Cycle Time
- ☐ All Silicon Monolithic Integrated Circuits
- ☐ Two Hardware Index Registers
- ☐ Up to 32,768 Words of Memory
- ☐ High-Speed Hardware Multiply and Divide
- ☐ Real-Time Input/Output Structure
- ☐ 16-Bit Binary Word Length Plus Parity Bit
- ☐ Multi-Level Indirect Addressing
- ☐ Post-Indexing and Pre-Indexing
- ☐ Up to 98 Levels of Priority Interrupts
- ☐ 64 Direct Information Channels for Word-Parallel Transfers Direct to/from Memory
- ☐ Up to 8 Block Transfer Control Units for Cycle Stealing Transfers Direct to/from Memory
- ☐ Complete Program Compatibility with SEL 810A Computer
- ☐ Real-Time Executive with Foreground/Background Capability
- ☐ Disc and Magnetic Tape Operating Systems
- ☐ Macro-Assembler features Nesting, String Concatenation and Internal (Set Symbol), Fixed and User Supplied Element Types
- ☐ FORTRAN IV (USASI Standard) with a Comprehensive Sub-routine Library and which also Permits In-line Assembly Language Coding
- ☐ Desectorizing Loader accepts Relocatable Modules produced by both the FORTRAN IV Compiler and the Macro-Assembler
- ☐ Extensive and Versatile Instruction List
- ☐ Complete Line of Peripheral Devices including Data Acquisition and Control Subsystems

Revised 9/1/68

Computer Organization

The SEL 810B features a core memory full cycle time of 750 nanoseconds, making it the fastest speed machine in its price class. Plug-in 8192 word core memory modules permit easy expansion from the basic 8192 word core memory capacity up to the maximum of 32,768 words.

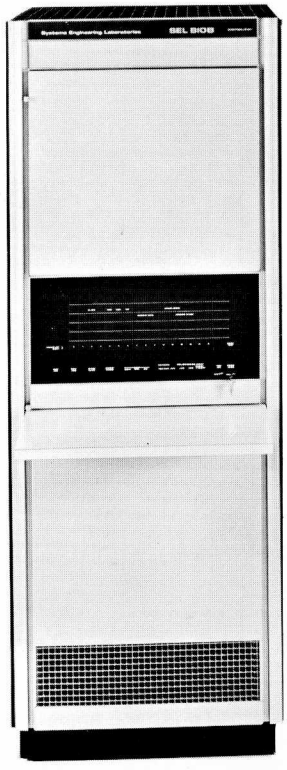
Designed to excel as a stand-alone scientific problem solver as well as the nucleus of a wide variety of data acquisition and control systems, the basic SEL 810B also includes the following outstanding features seldom found in comparably priced machines: hardware multiply and divide, hardware program counter, double precision accumulator, two priority interrupt levels, switch addressable program halt, sixteen sense switches, memory parity, hardware index register, real-time input/output system, power fail-safe protection, an ASR-33 input /output typewriter, indexing and multi-level indirect addressing. Indexing operations require no additional execution time and both pre-indexing and post-indexing operations may be performed.

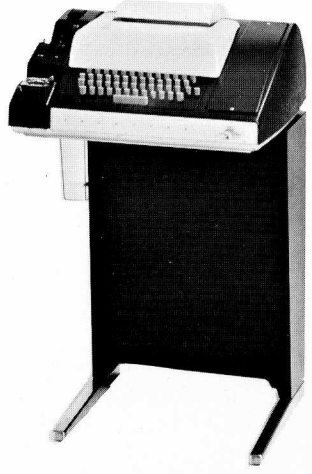
Standard options include an additional hardware index register, groups of individually armable hardware priority interrupts, input/output parity generator/checker, up to eight automatic Block Transfer Control Units and time sharing options including program protect, instruction trap, variable base register and stall alarm.

The program protect feature permits core memory protection in 512 word maps. This protect arrangement has evolved in the design of 16-bit computers as the most efficient approach to flexible memory protection making the SEL 810B a superior computer in real-time, time-shared, multi-programming applications.

The variable base register option permits dynamic relocation of the base (first 512 words) memory map. The stall alarm option triggers an interrupt in the event the contents of the program counter are not changed for a period of 32 machine cycles. Additional standard options include auto start which restarts program execution when power is reapplied after a power failure, table top operator console, 60 Hz real-time clock and radio frequency interference treatment for the computer cabinet.

The basic input/output system of the SEL 810B permits program controlled single word transfers to and from any peripheral device and memory or the A-Accumulator. Optional automatic Block Transfer Control units permit automatic transfers of up to 32,767 16-bit words to and from peripheral devices at combined rates up to 1,333,000 words per second. Up to eight automatic Block Transfer Control units can be active at once.



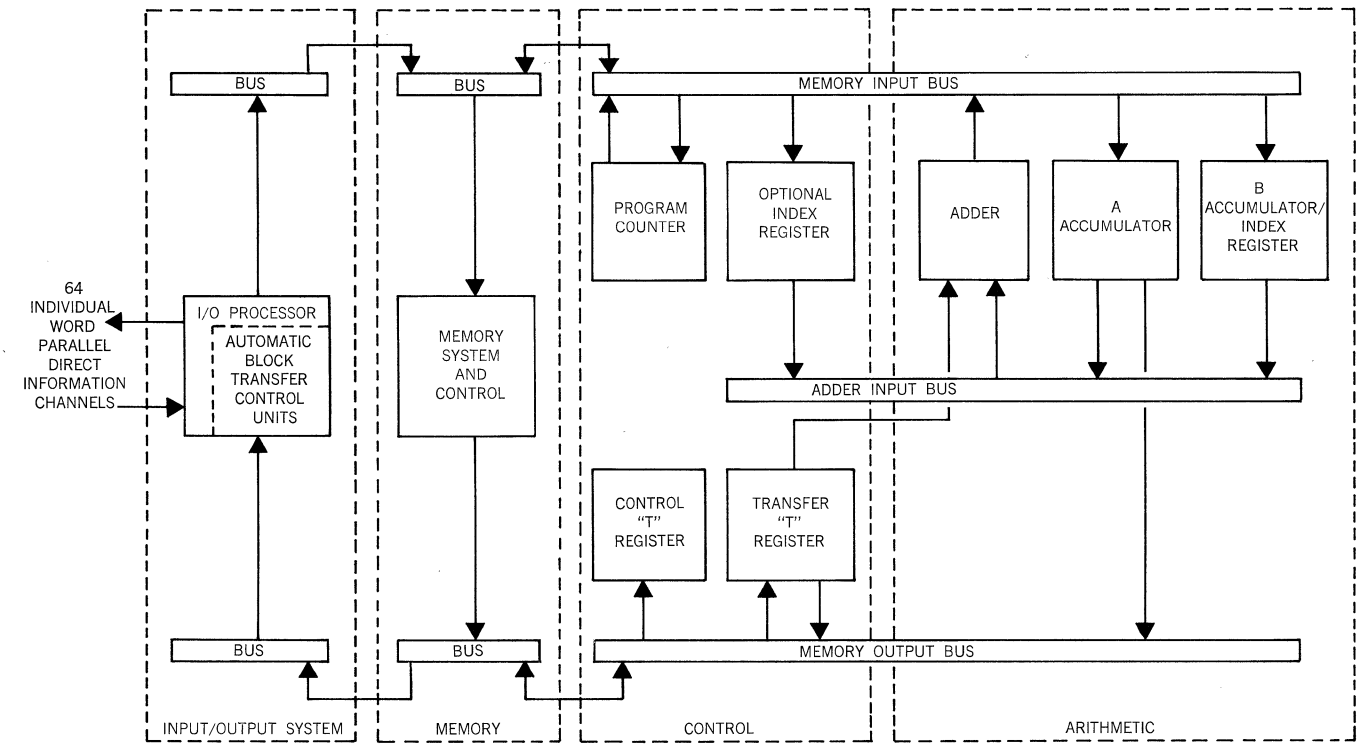


Physical Description

The SEL 810B Computer cabinet opens from the rear to provide access for servicing. Circuit modules are mounted on "pages" which swing out for service access. Each circuit module on the swing out pages has test points to simplify trouble-shooting. Wire wrap techniques are used exclusively to assure highest reliability.

Functional Description

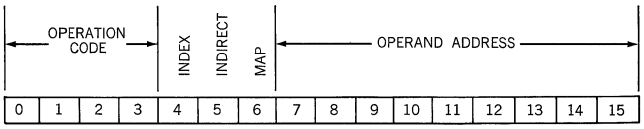
The input/output system of the SEL 810B contains the input/output processor and optional automatic Block Transfer Control units. Word transfers can occur between memory and external devices without disturbing the contents of the arithmetic section. The control section of the central processing unit includes a 15-bit program counter, a control register, an optional hardware index register and a transfer register. Transfer of data words between the arithmetic section and memory are routed through the "T" register. The arithmetic section of the central processing unit contains the upper arithmetic register (A-Accumulator), lower arithmetic/index register (B-Accumulator) and a 16-bit parallel adder.



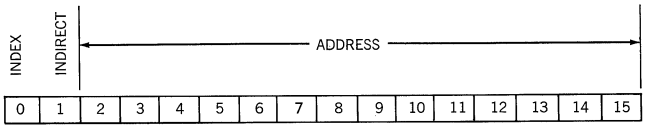
Basic SEL 810B Word Formats

Four basic SEL 810B word formats are outlined in the following diagram:

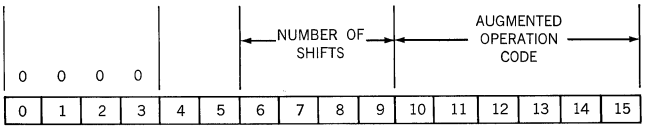
INSTRUCTION FORMAT



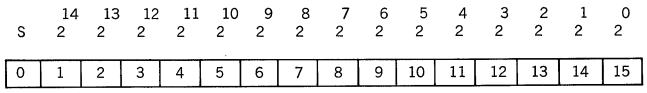
INDIRECT ADDRESS FORMAT



AUGMENTED INSTRUCTION FORMAT



DATA FORMAT



Basic Computer Instruction List

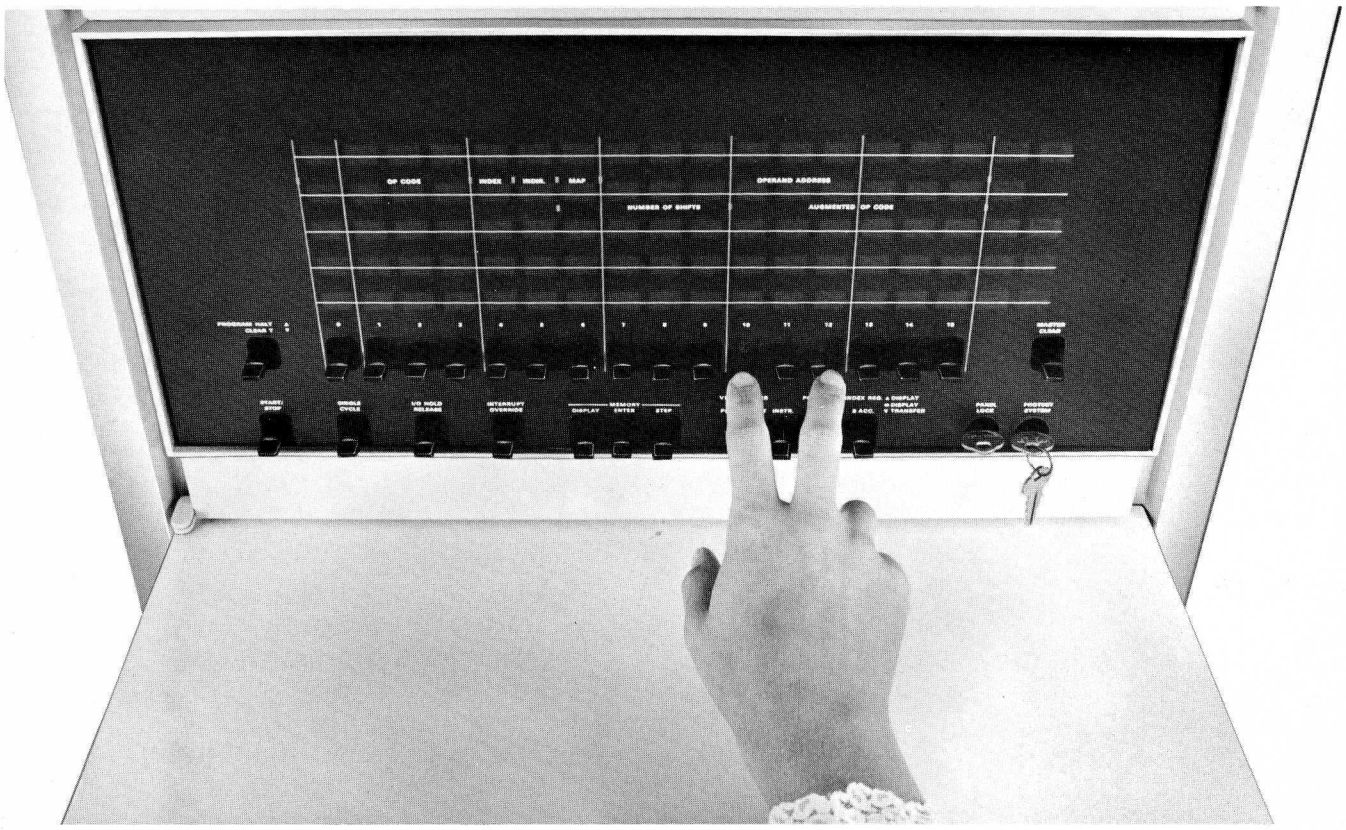
The SEL 810B is equipped with a powerful repertoire of direct address and augmented instructions. This repertoire, including two 3-way branch/skip instructions is coupled with hardware indexing and indirect address chaining, resulting in maximum program speed and flexibility. Indexing requires no additional instruction time. Indirect operations require an additional 750 nanoseconds per indirect level.

CLASS	CODE MNEMONIC	TIME (Microseconds)	FUNCTION
ARITHMETIC	AMA	1.5	Add Memory to A
	AMB	1.5	Add Memory to B
	SMA	1.5	Subtract Memory from A
	MPY	4.5	Multiply B times Memory
	DIV	8.25	Divide A and B by Memory
	RNA′	.75	Round A by MSB in B
	OVS′	.75	Overflow Set
LOAD/STORE	LAA	1.5	Load A from Memory
	LBA	1.5	Load B from Memory
	STA	1.5	Store Memory from A
	STB	1.5	Store Memory from B
	LCS′	.75	Load Control Switches in A
	*LIX′	1.5	Load Index
	*STX′	1.5	Store Index
BRANCH/SKIP	BRU	.75	Unconditional Branch
	SPB	1.5	Store Place and Branch
	SNS′	.75	Skip if Sense Switch Not Set
	IMS	2.25	Increment Memory and Skip
	CMA	2.25	Compare Memory and A (3 way) n+1 (A<M), n+2 (A=M), n+3 (A>M)
	IBS′	.75	Increment B (Index) and Skip
	SAZ′	.75	Skip if A is Zero
	SAP	.75	Skip if A is Positive
	SAN′	.75	Skip if A is Negative
	SOF′	.75	Skip no Overflow
	SAS′	.75	Skip on A. Sign (3 way) n+1(—), n+2(0), n+3(+)
	SNO′	.75	Skip if A is Normalized
	LOB′	1.5	Long Branch
	*SXB′	.75	Skip on Index set to Pointer B
	*IXS′	.75	Increment Index by (n) and Skip if (+) o < n < 16
LOGICAL	ABA′	.75	AND A and B
	OBA′	.75	OR A and B
	NEG′	.75	Negate A
	ASC′	.75	Complement A sign
	CNS′	.75	Convert Number System

CLASS	CODE MNEMONIC	TIME (Microseconds)	FUNCTION
REGISTER CHANGE	CLA′	.75	Clear A
	TAB′	.75	Transfer A to B
	IAB′	.75	Interchange A and B
	CSB′	.75	Transfer B Sign to Carry and Clear B Sign to Positive
	TBA′	.75	Transfer B to A
	*TAX′	.75	Transfer A to Index
	*TXA′	.75	Transfer Index to A
	*TAP′	.75	Transfer A to Protect Reg.
	*TPA′	.75	Transfer Protect Reg. to A
	*TBV′	.75	Transfer B to VBR
	*TVB′	.75	Transfer VBR to B
	*XPX′	.75	Set Index Pointer to X
	*XPB′	.75	Set Index Pointer to B
SHIFT	RSA′	Time for shifts varies as follows: Shifts 1-5 Time 1.5; 6-10 2.25; 11-15 3.19	Right Shift A
	LSA′		Left Shift A
	FRA′		Right Shift A and B
	FLA′		Left Shift A and B
	RSL′		Right Logical Shift A
	FRL′		Logical Rotate A and B
	LSL′		Left Logical Shift A
	FLL′		Left Logical Shift A and B
CONTROL	HLT′	.75	Halt
	NOP′	.75	No Operation
	TOI′	.75	Turn off Interrupt
	PIE′	1.5	Priority Interrupt Enable
	PID′	1.5	Priority Interrupt Disable
INPUT/ OUTPUT	AIP	3.0 + WAIT	Accumulator Input
	AOP	3.0 + WAIT	Accumulator Output
	MIP	3.0 + WAIT	Memory Input
	MOP	3.0 + WAIT	Memory Output
	CEU	3.0 + WAIT	Command External Unit
	TEU	3.0 + WAIT	Test External Unit

* Optional
′ Augmented

Operator Control Panel



The SEL 810B has the most complete and functional control panel of any computer in its class. The entire control panel is designed for maximum operator/machine communication. Control panel functions include:

- ☐ Manual data entry from 16 data switches into T-Register
- ☐ Manual transfer of T-Register contents to the B-Accumulator/Index Register, A-Accumulator, Instruction Register and Program Counter
- ☐ Manual program Start/Stop
- ☐ Master Clear of all registers.
- ☐ Sixteen Sense Switches
- ☐ Single Cycle control switch for manual program advance
- ☐ Manual Load and Display of memory locations.
- ☐ Manual Input/Output Hold/Release.
- ☐ Manual inhibit control of priority interrupt.
- ☐ Switch selectable display of optional index register.
- ☐ Switch Addressable Program Halt.
- ☐ Optional key lock inhibit of all control switches.
- ☐ Optional key lock switch for program protect and instruction trap mode.

SEL 810B

Programming Support

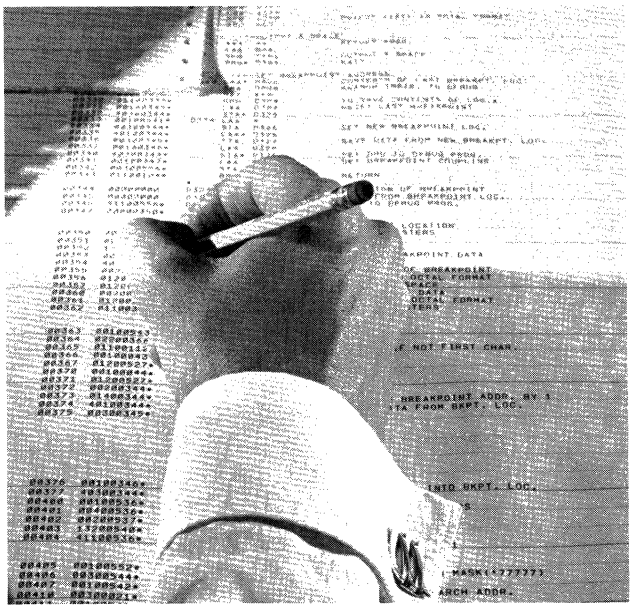
Standard and custom SEL 810B software packages can be delivered for a wide range of custom applications. Standard software packages include a Real-Time Executive, FORTRAN IV Compiler, Disc and Magnetic Tape Operating Systems, Macro-Assembler, Sub-routine Library, Utility Routines, Diagnostic Programs, and Applications Programming.

All software packages are completely modular, permitting the addition of more powerful software elements as the basic configuration and size of the computer expands.

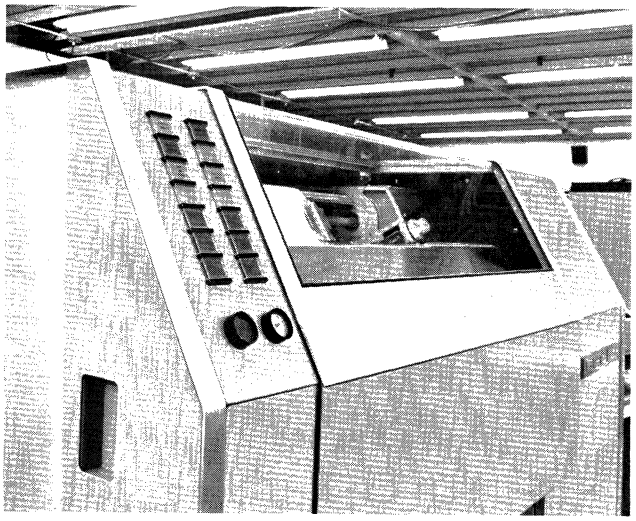
REAL-TIME EXECUTIVE — The Real-Time Executive provides the optimum in software capability for operating on-line, real-time SEL 810B Computer system programs under a combined hardware and software priority structure and precise time of day or time interval assignments. Inherent Foreground/Background capability permits protected priority execution in the Foreground core area of both core resident and disc resident programs concurrent with the loading, assembling, compiling and execution of programs in the Background core area. Maximum utilization of the nanosecond processing speeds of the SEL 810B is readily achievable by virtue of the Real-Time Executive Task Scheduler which also provides dynamic core allocation for the priority execution of disc resident programs in the Foreground core area.

COMPILER — The SEL 810B FORTRAN IV Compiler meets all USASI[1] standards. Convenience features include no reserved identifiers, optional in-line assembly language coding, tracing, mapping and chaining.

DISC AND MAGNETIC TAPE OPERATING SYSTEMS — The Disc and Magnetic Tape Operating Systems are complete program preparation and execution systems, including a FORTRAN IV Compiler and the Macro-Assembler, which provide the programmer with a choice of writing programs in the language most suited to the problem. A Resident Executive is provided which enables efficient usage to be made of machine time. The Resident Executive routine processes control statements and executes a variety of control functions. The capability exists for searching and loading specified programs from magnetic tape or disc, writing and editing tapes, initiating and controlling processing, including batching of assemblies and compilations. In addition, the operating systems contain a number of utility and debugging routines which can be executed under executive control.



1 United States of America Standards Institute, Committee X3 Computers and Information Processing.



MACRO - ASSEMBLER — The SEL 810B Macro-Assembler generates in-line coding according to the respective prototype and parameter list assigned to a given Macro call name. The elements within the Macro may either be internal (set symbols), fixed, or user supplied parameters. Nested Macros to any depth are permitted as well as character string concatenation capabilities.

SUB-ROUTINE LIBRARY — Callable by both the FORTRAN IV Compiler and the Assembler, sub-routines in the package include Single and Double Precision Floating Point, Complex Floating Point, Integer, Input/Output and control functions as well as data conversion routines.

UTILITY ROUTINES — A large number of available Utility Routines include an efficient tape editor, on-line debug, dumps, trace, listing, conversion programs and input/output handlers.

DIAGNOSTIC PROGRAMS — Diagnostic Programs for the central processor, memory and all peripheral equipment are provided. The central processor diagnostics execute the entire instruction repertoire in a wide variety of sequences while monitoring for errors. Programs for input/output channels and associated peripheral equipment test the ability of selected input/output units to generate or receive all acceptable data patterns in random and worst-case sequences.

APPLICATIONS PROGRAMMING — Systems Engineering Laboratories can provide applications programing support for the SEL 810B in fields such as data aquisition, recording and logging, process control, data display, data analysis, complex systems checkout and scientific computation. The resident programming staff is availible to perform any programming tasks requested by the customer.

Customer Services

FIELD MAINTENANCE — A skilled staff of customer engineers specializing in computer hardware operation, repair and programming is located at district offices in many major cities throughout the United States and Canada. These representatives offer 810B customers immediate computer service and programming assistance. On call or resident service contracts are available.

DOCUMENTATION — Complete hardware and software documentation is available for the SEL 810B Computer. This includes computer and peripheral equipment maintenance manuals, program reference manuals, operation manuals and program maintenance manuals.

MAINTENANCE AND PROGRAMMING TRAINING — Maintenance and programming training courses are regularly scheduled at the Fort Lauderdale, Florida plant. Maintenance and programming training courses can also be conducted at the customer's facility.

Basic SEL 810B

Specifications

WORD SIZE
16-bits plus parity bit

INTERNAL MEMORY FULL CYCLE TIME
750 nanoseconds

CORE STORAGE
8192 words — expandable to 32,768 words

AUTOMATIC WORD TRANSFER RATE
1,333,000 words/second

COMPUTATION TIMES INCUDING ACCESS AND INDEXING

Load/Store	1.50 microseconds
Add	1.50 microseconds
Subtract	1.50 microseconds
Multiply	4.50 microseconds
Divide	8.25 microseconds

INPUT/OUTPUT TYPEWRITER
ASR 33 Typewriter with Paper Tape Punch and Reader
Punch — 10 characters/second
Reader — 20 characters/second

ENVIRONMENT
Temperature (Storage) 0°F to 150°F
(—17.6°C to 65°C)
Temperature (Operating) 32°F to 131°F
(0°C to 55°C)
Relative Humidity (Storage) 5 to 95%
Relative Humidity (Operating) 30 to 90%

POWER
Power — 1,200 watts
Voltage — 115 VAC (± 10%), 60 cps (± 1%) single phase

WEIGHT
450 pounds

SIZE
24 inches wide
62 inches high
30 inches deep (45 inches including table top)

Peripheral Equipment

CARD READERS/PUNCHES

81-440A Punch . . . . 100 cards/minute
81-471-01A Reader . . . 200 cards/minute
81-472-01A Reader . . . 600 cards/minute

PAPER TAPE READERS/PUNCHES

81-510A Reader . . 300 characters/second
81-520A Punch . . . 110 characters/second
81-525 Reader/Punch . 300/110 characters/second
80-530 Paper Tape Spooler

MAGNETIC TAPE UNITS

81-610-78A Magnetic Tape Control Unit (7 Track) handles up to eight Magnetic Tape Units — 200, 556, 800 bpi.
81-610-98A Magnetic Tape Control Unit (9 Track) handles up to eight Magnetic Tape Units — 800 bpi.
80-615-07A Magnetic Tape Unit (7 Track) 45 ips
80-615-11A Magnetic Tape Unit (7 Track) 120 ips
80-615-12A Magnetic Tape Unit (7 Track) 150 ips
80-615-14A Nine track option for 80-615-07A, 11A and 12A

LINE PRINTERS

81-732A . . . . 1,000 lpm, 120 columns
81-733A . . . . 300 lpm, 120 columns

X-Y PLOTTERS

81-810A Incremental plotter, 12 inch chart width, 300 steps/second.
81-812A Incremental plotter, 31 inch chart width, 200 steps/second.

GRAPHIC DISPLAY SYSTEM

80-816A 16-inch CRT display with vector generator

DISC FILE/CONTROL UNIT

81-653A . . . . . Moving Head Disc — 1,536,000 word capacity
81-654A . . . . . Fixed Head Disc — 113,664 to 909,312 word capacity

TYPEWRITERS

80-712A ASR-33, KSR-33, RO-33, ASR-35, KSR-35, RO-35 . . . . . 10 characters/second

ANALOG INPUT

61-4110 . . . . . Low Level MOS-FET
71-1201 . . . . . High Level MOS-FET
81-906 . . . . . Low Level Accurelay
71-1211 . . . . . Wide Range High Speed

ANALOG OUTPUT

80-981 Series . . . . Voltage and Current

DIGITAL INPUT/OUTPUT

80-960 Series	Contact Sense	Contact Closure
	Voltage	Electronic Switch
	Pulse	Relay
	Discrete Bit	

OTHERS

In addition to the full range of standard peripheral units, a large variety of data acquisition, interface and control components are built by Systems Engineering Laboratories for application in SEL 810B Computer systems.

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Systems Engineering Laboratories

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