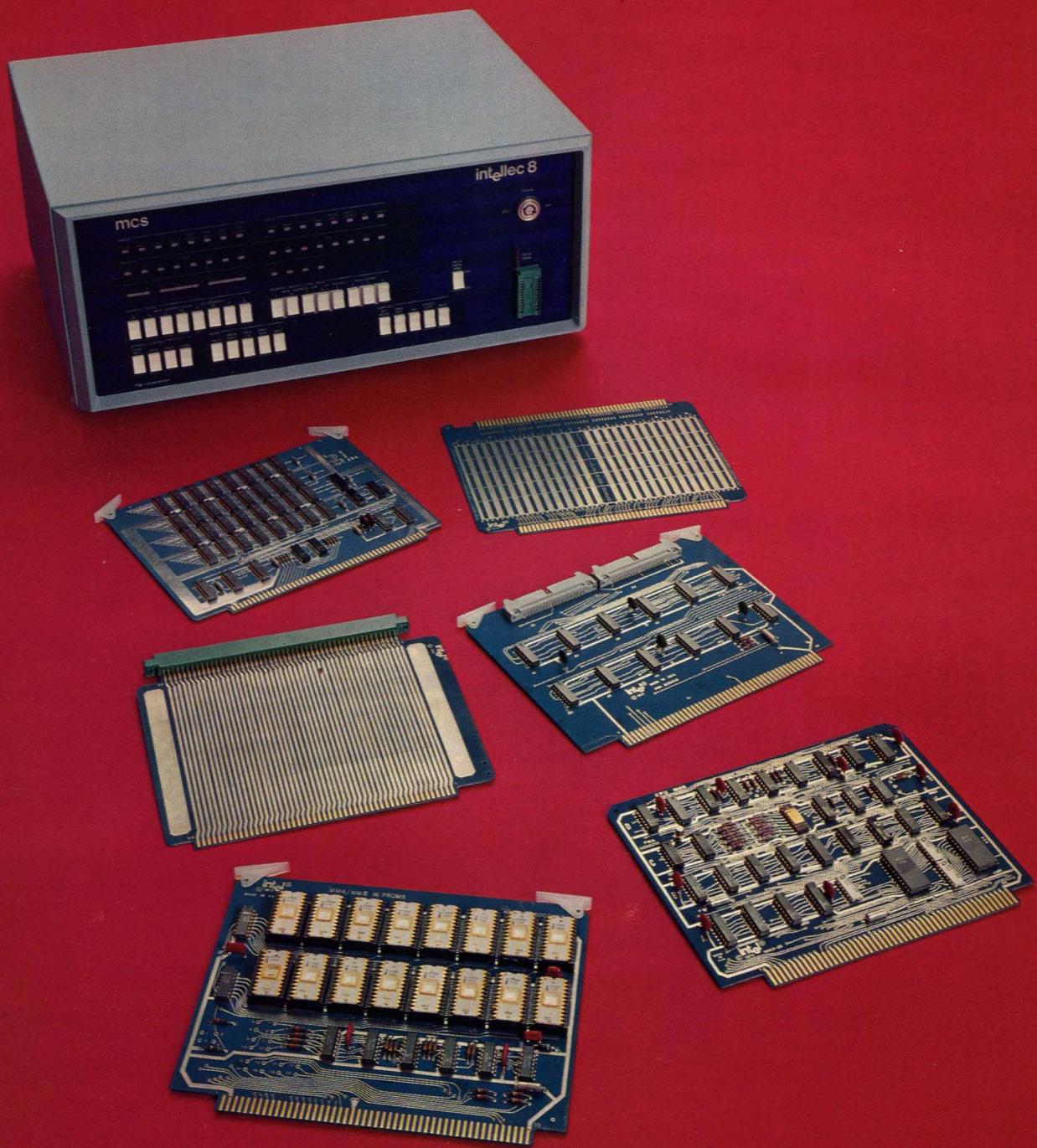


**intellec™**

A NEW, EASY, AND INEXPENSIVE WAY  
TO DEVELOP MICROCOMPUTER SYSTEMS



**intel®**

The Leader in Microcomputers

The widespread usage of low-cost microcomputer systems is made possible by Intel's development and volume production of the MCS-4 and MCS-8 microcomputer sets. To make it easier to use these sets, Intel now offers complete 4-bit and 8-bit modular microcomputer development systems called Intellec 4 and Intellec 8.

The Intellec modular microcomputers provide a flexible, inexpensive, and simplified method for developing OEM systems. They are self-contained, expandable systems complete with central processor, memory, I/O, crystal clock, power supplies, standard software, and a control and display console.

The major benefit of the Intellec modular microcomputers is that random access memories (RAMS) may be used instead of read-only memories (ROMS) for program storage. By using RAMS, program loading and modification is made much easier. In addition, the Intellec front panel control and display console makes it easier to monitor and debug programs. What this means is faster turn-around time during development, enabling you to arrive at that finished system sooner.

**The Intellec 8 Eight-Bit Microcomputer Development System** The Intellec 8 is a microcomputer development system designed for applications which require 8-bit bytes of data to perform either binary arithmetic manipulations or logical operations. The Intellec 8 comes complete with power supplies, display and control panel, and finished cabinet. It can directly address up to 16K 8-bit bytes of memory which can be any mix of ROMS, PROMS, or RAMS. The Intellec 8 is designed around the Intel 8008 central processor chip. There are 48 instructions including conditional branching, binary arithmetic, logical, register-to-register, and memory reference operations. I/O channels provide eight 8-bit input ports and twenty-four 8-bit output ports—all completely TTL compatible. The unit has interrupt capability and a two-phase crystal clock that operates at 800 kHz providing an instruction cycle time of about 12.5  $\mu$ s.

The Bare Bones 8 has the same capability as the Intellec 8 only it does not include the power supplies, front panel, or finished cabinet. It is designed as a rack-mountable version.

The Intellec 8 system comes with a standard software package which includes a system monitor, resident assembler, and text editor. The programmer can prepare his program in mnemonic form, load it into the

Intellec 8, edit and modify it, then assemble it and use the monitor to load the assembled program.

Other development tools for the Intellec 8 include a PL/M compiler, cross assembler, and simulator designed to operate on general-purpose computers. PL/M, a new high-level language, has been developed as an assembly language replacement. A PL/M program can be written in less than 10% of the time it takes to write that same program in assembly language without loss of machine efficiency.

**The Intellec 4 Four-Bit Microcomputer Development System** The Intellec 4 is a 4-bit microcomputer development system for both prototype and production applications. It contains 5K bytes of program memory, data storage, I/O, TTY interface, standard software, control panel, and power supplies—all in a small, compact cabinet. The Intellec 4 is designed around the Intel 4004 four-bit parallel central processor chip. It has a repertoire of 45 instructions, 16 working registers, a four-level address stack, and the capability of directly addressing over 43K bits of memory. The unit has a two-phase crystal clock that operates at 750 kHz providing an instruction cycle time of about 10.8  $\mu$ s.

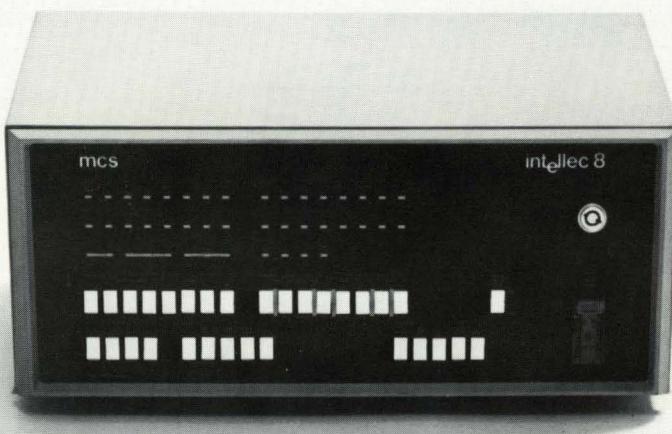
Bare Bones 4 has the same capability as the Intellec 4 only it does not include the power supplies, front panel, or finished cabinet. It is designed as a rack-mountable version.

Standard software for the Intellec 4 includes a System Monitor and Resident Assembler. Additional developmental assembler and simulator software packages written in FORTRAN IV and designed to operate on general purpose computers are also available.

**Standard Microcomputer Modules** Microcomputer Modules, standard cards that can be purchased individually so that the designer can develop his system with as little or as much as he needs, are also available. For example, the 4-bit Central Processor Module is a complete microcomputer system in itself. It contains the 4004 CPU, program storage, data storage and I/O, all on a single module. The 4-bit OEM Systems Module is the ultimate in volume/cost effectiveness. It contains the 4004 CPU, crystal clock and mask-programmed (4001) ROMS for program storage and RAMS (4002) for data storage.

Additional CPU, PROM Memory, Input/Output, PROM Programmer, Data Storage, Instruction Storage, Control, Universal Prototype, and other standard modules provide developmental support and systems expansion capability.

# intellec™ 8



## Features

- Ideal for developing MCS 8 Systems.
- The Intellec 8 microcomputer system has 5K bytes of memory (expandable to 16K), I/O, TTY interface, standard software, control panel, power supplies, and a compact finished cabinet (less than 0.8 ft<sup>3</sup>). Bare Bones 8 is a rack-mountable unit and comes without the power supplies, front panel and finished cabinet accessories.
- The heart of the Intellec 8 is Intel's eight-bit "computer-on-a-chip," the 8008. This is an 8-bit parallel CPU with a repertoire of 48 instructions, seven working registers, an eight level address stack, interrupt capability, and it directly addresses 16K bytes of memory.
- DMA channel is standard.
- Standard software provided with the Intellec 8 includes a system monitor (loader, hex memory dump, instruction editor), a resident assembler, and a text editor.
- With this system, all program development may be done in RAM memory.
- A complete PROM programmer is provided as an option. After the program is firm, it may be committed to non-volatile storage in Intel's 1702A programmable and erasable Read-Only-Memory.
- Complete system control and hardware debugging aids are provided via the control panel.
- Crystal clocks are used for system stability.
- System is expandable to 16 microcomputer modules in a single chassis.

## Specifications

Word Size:	Data: 8 bits Instruction: 8, 16, or 24 bits	
Memory Size:	5K bytes expandable to 16K bytes	
Instruction Set:	48, including: conditional branching, binary arithmetic, logical, register-to-register and memory reference operations	
Machine Cycle Time:	12.5 $\mu$ s	
System Clock:	Crystal controlled	
I/O Channels:	4 expandable to 8 input ports 4 expandable to 24 output ports	
Interrupt:	Single Level	
Direct Memory Access:	DMA Standard	
Memory Cycle Time:	900 nanoseconds	
Operating Temperature:	0°C to 55°C	
Power Supplies:	+5v ± 5%	-9v ± 5%
	12 amps*	1.8 amps*
Physical Size:	Intellec 8: 7" x 17½" x 12¼" (table top only) Bare Bones 8: 6¾" x 17" x 12" (suitable for mounting in standard RETMA 7" x 19" panel space)	
Weight:	30 lb.	
Standard Software:	System Monitor Resident Assembler Text Editor	
Support Software:	PL/M Compiler Cross Assembler FOR-Simulator	written in FORTRAN IV

## **Standard Systems and Optional Modules**

**INTELLEC 8** (imm8-80) Standard System includes the following Modules and Accessories:

Central Processor Module

Input/Output Module

PROM Memory Module

RAM Memory Module

Chassis with Mother Board

Power Supplies

Control and Display Panel

Finished Cabinet

Standard Software

System Monitor

Resident Assembler

Text Editor

**BARE BONES 8** (imm8-81) Standard System includes the following Modules:

Central Processor Module

Input/Output Module

PROM Memory Module

RAM Memory Module

Chassis (rack mountable with Mother Board)

Standard Software

System Monitor

Resident Assembler

Text Editor

**OPTIONAL MODULES** available for the Intellec 8 and Bare Bones 8:

PROM Programmer Module with Control Software

Additional I/O or Output Modules

Additional RAM Memory Modules

Universal Prototype Module

Module Extender

Drawer Slides and extenders for Rack Mounting

## **Software**

**Standard** All peripheral interface to Intellec 8 standard software is via TTY, model ASR33. The standard software includes a System Monitor, Resident Assembler and Text Editor.

### A. System Monitor

1. Contained in four 1702A PROMs located on the PROM memory module.
2. Program assigned to upper 1K of memory.
3. Lower 15K of memory may then be used for either program or data storage.
4. Intellec 8 modular computer systems have a control program called a Resident Monitor in PROM so that no "bootstrap" operation need ever be performed. The monitor functions are

as follows:

- a. Load RAM memory from paper tape, either in BNPF format or hexadecimal format.
- b. Display the contents of RAM memory on a printer.
- c. Modify individual bytes of RAM memory, move blocks of RAM memory, fill blocks of RAM memory with constant data.
- d. Write contents of RAM memory to paper tape in either BNPF or hexadecimal format.

### B. Resident Assembler

1. Translates mnemonic code to binary machine code.
2. Loaded into system RAM memory via paper tape.
3. 4K of memory storage is required for both the resident assembler and the symbol table.
4. This two pass assembler generates a program tape which is reloaded via the monitor.

### C. Text Editor

1. Loaded to system via paper tape.
2. Edits the source program during program development.

**Development Support: PL/M Compiler, Assembler and Simulator** In addition to the standard software available with the Intellec 8, Intel offers a PL/M compiler, cross assembler, and simulator written in FORTRAN IV and designed to run on any large scale computer. These routines may be procured directly from Intel, or alternatively, designers may contact three nation-wide computer time-sharing services: AL/COM, G.E., and Tymshare, for access to the programs.

**PL/M Compiler** PL/M is a high level procedure-oriented systems language for programming the Intel MCS-8 microcomputer. The language retains many of the features of a high-level language, without sacrificing the efficiencies of assembly language.

A significant advantage of this language is that PL/M programs can be compiled for either the Intel 8008 or future Intel 8-bit processors without altering the original program.

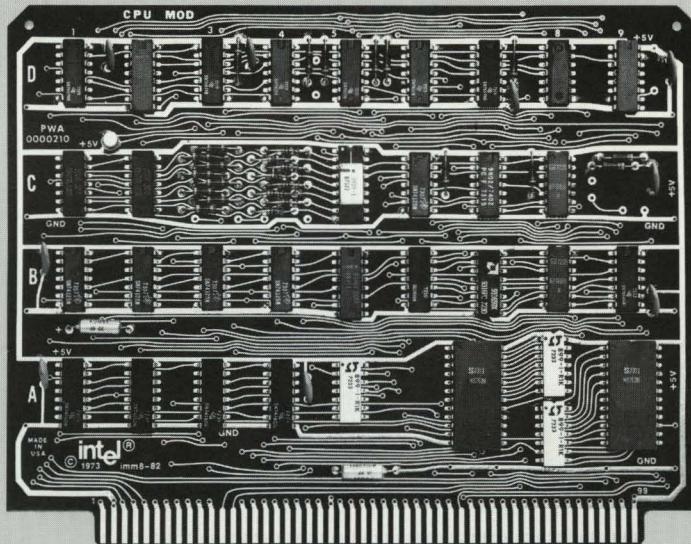
**Assembler** The MCS-8 Assembler generates object codes from symbolic assembly language instructions.

It is designed to operate from a time shared terminal with input by paper tape or directly from the terminal keyboard.

**Simulator** The MCS-8 Simulator, called INTERP/8, provides a software simulation of the Intel 8008 CPU, along with execution monitoring commands to aid program development for the MCS-8.

# intellec 8

## MODULE DESCRIPTIONS



Modules may be ordered individually. All modules are 8" wide, 6.28" high and use standard 100-pin connectors.

### imm8-82 Central Processor Module

- Intel's 8008-1 eight-bit parallel single chip CPU—p-channel silicon gate MOS.
- Accumulator and six 8-bit working registers.
- Subroutine nesting up to seven levels.
- Interface to 16K 8-bit bytes of PROM, ROM, or RAM via the PROM Memory Module and RAM Memory Module.
- Interface for expansion to eight 8-bit input ports and twenty-four 8-bit output ports, via the I/O and Output Modules.
- Interrupt capability.
- Two phase crystal clock.
- All module interfaces are TTL compatible.

### imm6-26 PROM Memory Module

- Provides sockets for up to sixteen 1702A electrically programmable and erasable PROMs for a system's fixed program memory (maximum 4K bytes/module).
- For volume requirements, Intel mask programmed 1302 ROMS may be substituted in the same module.

### imm6-28 RAM Memory Module

- A 4K x 8 n-channel MOS memory system using Intel's 1024 bit static RAM (2102).
- Address latching, data latching, and module select decoding are provided on the card.
- Provides both program storage and data storage.

### imm8-60 Input/Output Module

- Four 8-bit input ports (32 lines).
- Four 8-bit data latching output ports (32 lines).
- Asynchronous transmitter/receiver is associated with one pair of ports for TTY communication.
- All input and output ports are TTL compatible.

### imm8-62 Output Module

- Eight 8-bit data latching output ports (64 lines).
- All output ports are TTL compatible.

### imm8-74 Control and Display Panel

- Provides complete operator control for Intellec 8 and displays system status.
- Address and Data Entry switches.
- Status, instruction code, data and address displays.
- Complete program development tool.
- ADDRESS, PROGRAM SEQUENCE, and MODE CONTROL switches permit easy alteration and examination of the program during the debugging phase of program development.
- Control and socket for 1702A PROM programming is also provided.

### imm6-70 Universal Prototype Module

- Accommodates 14, 16, 24, or 40 pin wire wrap sockets (maximum of 52 16-pin sockets).
- Provides breadboard capability for developing custom and specialized interface circuits.

### imm6-72 Module Extender

- Extends Intellec modules out of card chassis for ease in test and system debugging.

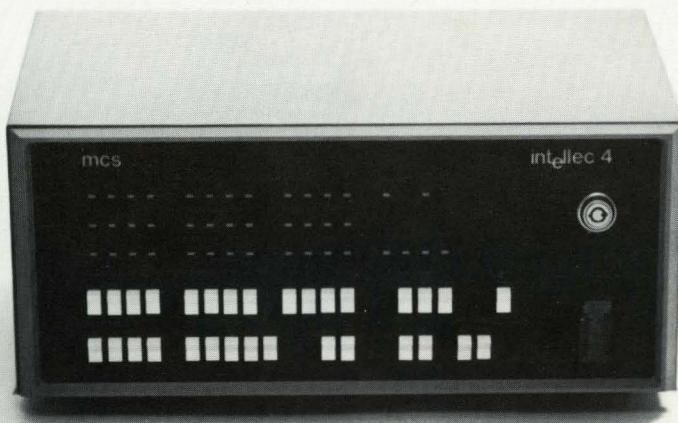
### imm8-76 PROM Programmer Module

- Provides all timing and level shifting circuitry for programming Intel's electrically programmable and erasable 1702A PROMs.
- This programmer is controlled by special system software that is supplied with the module.

### Chassis Module (Used in the Intellec 8 and Bare Bones 8)

- Capacity for up to sixteen microcomputer modules. (16 sockets with standard system.)
- PC Mother Board eliminates back plane wiring—all cards plug into common bus.
- Standard 100 pin connectors (125 Mil centers) are used for all boards in system.
- Space is provided for additional memory and I/O modules and unique customer developed system interface modules.
- A fan is provided.

# intellec™ 4



## Features

- Ideal for prototyping MCS 4 Systems.
- The Intellec 4 is a complete microcomputer system with 5K bytes of program memory, data storage, I/O, TTY interface, standard software, control panel, power supplies, and a compact finished cabinet (less than 0.8 ft.<sup>3</sup>). Bare Bones 4 is a rack-mountable unit and comes without the power supplies, front panel and finished cabinet accessories.
- The heart of the Intellec system is Intel's four-bit "computer on a chip," the 4004. This is a 4-bit parallel CPU with a repertoire of 45 instructions, sixteen working registers, a four level address stack, and capability of directly addressing over 43K bits of memory.
- DMA Channel is standard.
- Standard software provided with the Intellec 4 includes a system monitor which provides a loader, hex memory dump, and instruction editing, and an assembler which is loaded to RAM program memory.
- With this system, all program development may be done in RAM memory.
- A complete PROM programmer is provided as an option. After the program is firm, it may be committed to non-volatile storage in Intel's 1702A programmable and erasable Read-Only-Memory.
- Complete system control and hardware debugging aids are provided via the control panel.
- Crystal clocks are provided for system stability.
- System is expandable to 12 microcomputer modules in a single chassis.

## Specifications

Word Size:	Data: 4 bits Instruction: 8 or 16 bits
Memory Size:	Instruction Memory: 1K Bytes (8 bits) in PROM switchable to 4K bytes (8 bits) RAM Data Storage: 320 words (4 bit), expandable to 2560 words
Instruction Set:	45, including conditional branching, binary and decimal, arithmetic, register-to-register and I/O
System Clock:	Crystal Controlled
Machine Cycle Time:	10.8 $\mu$ s
Direct Memory Access:	DMA Standard
Memory Cycle Time:	900 nanoseconds
I/O Channels:	4 input ports, 8 output ports, expandable to 16 input ports, 48 output ports
Operating Temperature:	0°C to 55°C
Power Supplies:	+5v $\pm$ 5%      -10v $\pm$ 5% 8 amps*      1.8 amps*
Physical Size:	<small>*required for maximum system</small> Intellec 4: 7" x 17 $\frac{1}{8}$ " x 12 $\frac{1}{4}$ " (table top only) Bare Bones 4: 6 $\frac{3}{4}$ " x 17" x 12" suitable for mounting in standard RETMA 7" x 19" panel space
Weight:	30 lb.
Standard Software:	System Monitor Resident Assembler
Support Software:	Cross Assembler      FORTRAN IV Simulator      written in

## Standard Systems and Optional Modules

**INTELLEC 4** (imm4-40) Standard System includes the following Modules and Accessories:

- Central Processor Module
- Control Module
- RAM Memory Module
- Chassis with Mother Board
- Power Supplies
- Control and Display Panel
- Finished Cabinet
- Standard Software
- System Monitor
- Resident Assembler

**BARE BONES 4** (imm4-41) Standard System includes the following Modules:

- Central Processor Module
- Control Module
- RAM Memory Module
- Chassis (rack mountable with Mother Board)
- Standard Software
- System Monitor
- Resident Assembler

**OPTIONAL MODULES** available for the Intellec 4 and Bare Bones 4:

- PROM Programmer Module with Control Software
- Instruction/Data Storage Module
- Input/Output Module
- Data Storage Module
- ROM Memory Module
- Universal Prototype Module
- Module Extender
- Drawer Slides and extenders for Rack Mounting

## Software

**Standard** All peripheral interface to Intellec 4 standard software is via TTY, model ASR33. All control after system start-up is provided through the TTY.

### A. System Monitor

1. Contained in four 1702A PROMs located on the Central Processor Module.
  2. Intellec 4 modular microcomputer systems have a control program called a Resident Monitor in PROM so that no "bootstrap" operation need ever be performed.
- The monitor functions are as follows:
- a. Load RAM memory from paper tape, either in BNPF format or hexadecimal format.
  - b. Display the contents of RAM memory on a printer.
  - c. Modify individual bytes of RAM memory, move blocks of RAM memory, fill blocks of RAM memory with constant data.
  - d. Write contents of RAM memory to paper tape in either BNPF or hexadecimal format.

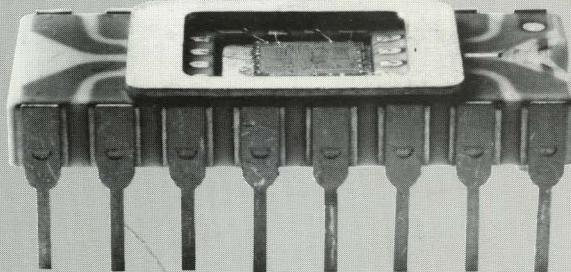
### B. Resident Assembler

1. Translates mnemonic code to binary machine code.
2. Loaded into system RAM Memory via paper tape.
3. Data storage devices (4002 RAM) store label and symbols (eight/RAM).
4. This two pass assembler generates a program tape which is reloaded via the monitor.

**Developmental Support: Cross Assembler and Simulator** In addition to the standard software provided with the Intellec 4, Intel offers a cross assembler and simulator written in general FORTRAN IV and designed to operate on general purpose computers. The package consists of a simulating routine, which enables the computer to simulate the operation of an MCS-4 microcomputer set and an assembly routine used primarily as an aid to programming the simulated microcomputer.

The routines may be procured directly from Intel, or alternatively, designers may contact three nationwide computer time-sharing services—AL/COM, G.E., and Tymshare—for access to the programs.

*The 4004 Central Processor Chip is the heart of each Intellec 4 System.*



# intellec™ 4

## MODULE DESCRIPTIONS

Modules may be ordered individually. All modules are 8" wide, 6.28" high and use standard 100-pin connectors.

### imm4-42 Central Processor Module

- This is a complete microcomputer system with the processor, program storage, data storage, and I/O in a single module.
- The heart of this module is Intel's 4004 single chip four-bit parallel processor—p-channel silicon gate MOS.
- Accumulator and sixteen working registers (4 bit).
- Subroutine nesting up to 3 levels.
- For development work, the CPU interfaces to standard semiconductor memory elements (provided by Intel's standard memory and I/O interface set 4008/4009).
- Sockets for 1K bytes of PROM (Intel 1702A PROM) are provided.
- 320 words (4-bit) of data storage (Intel 4002) are provided.
- Four 4-bit input ports and eight 4-bit output ports (includes TTY interface).
- Bus-oriented expansion of memory and I/O.
- Two phase crystal clock.

### imm4-22 Instruction/Data Storage Module

- This microcomputer module has memory capacity identical to the Central Processor Module and is used for expanding memory and I/O.
- Sockets for 1K bytes of PROM program storage are provided.
- 320 words (4-bit) of data storage are provided.
- Four 4-bit input ports and eight 4-bit output ports.

### imm4-24 Data Storage Module

- This microcomputer module has capacity for sixteen Intel 4002 RAMS—1280 words (4-bit) of data storage.
- 320 words (4-bit) of data storage are provided.
- A maximum Intellec 4 system may contain up to 2560 words of storage—decoding for this expansion is provided.
- A 4-bit output port is associated with each RAM on this microcomputer module providing sixteen 4-bit output ports on each module.
- All output ports are TTL compatible.

### imm4-60 Input/Output Module

- This module provides input and output port expansion without additional memory.
- Eight 4-bit input ports and eight 4-bit output ports are provided.
- Ports on this module are TTL compatible.

### imm4-72 Control Module

- Contains circuitry required to interface the Central Processor to instruction storage on the RAM Memory Module.
- This module also contains debouncing and timing circuitry for RESET and TEST control lines to the CPU.

### imm6-26 PROM Memory Module

- Provides sockets for up to sixteen 1702A electrically programmable and erasable PROMs for a system's fixed program memory (maximum 4K bytes/module).

- For volume requirements, Intel 2048-bit mask programmed MOS ROMs (1302) may be substituted in the same module.

### imm6-28 RAM Memory Module

- A 4K x 8 n-channel MOS memory system using Intel's 1024-bit Static RAM (2102).
- Address latching, data latching, and module select decoding are provided on the card.
- Provides program storage for up to 4K instructions.

### imm4-44 OEM System Module

- For final volume production systems where cost and card count must be minimized.
- Contains 4004 CPU, crystal clock, 320 words of data storage, and provision for a combination of up to sixteen 256 x 8 masked program ROMs (4001) for program storage and 80 x 4 data storage devices (4002 RAMs).
- Instruction and data storage is expandable using the Data Storage Module.

### imm6-70 Universal Prototype Module

- Accommodates 14, 16, 24, or 40 pin wire wrap sockets (maximum of 52 16-pin sockets).
- Provides breadboard capability for developing custom and specialized interface circuits.

### imm6-72 Module Extender

- Extends Intellec modules out of card chassis for ease in test and system debugging.

### imm4-74 Control and Display Panel

- Provides complete operator control for Intellec 4 and displays system status.
  - Address and Data Entry switches.
  - Status, instruction code, data and address displays.
- Complete program development tool.
  - ADDRESS, PROGRAM SEQUENCE, and MODE CONTROL switches permit easy examination of the program during the debugging phase of program development.
- Control and socket for 1702A PROM programming is also provided.

### imm4-76 PROM Programmer Module

- Provides all timing and level shifting circuitry for programming Intel's programmable and erasable 1702A PROMs.
- This programmer is controlled by special system software supplied with module.

### Chassis Module (used on the Intellec 4 and Bare Bones 4)

- Capacity for up to twelve microcomputer modules.
- PC Mother Board eliminates back plane wiring—all cards plug into common bus.
- Standard 100-pin connectors (125 mil centers) are used for all boards in the system.
- Space is provided for additional Memory, I/O modules and unique customer-developed systems interface modules.
- A fan is provided.

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