

# symbolics INC.

## LM-2 SPECIFICATIONS

### OVERVIEW

A standard LM-2 computer system consists of a CPU, disk, B&W graphics display, keyboard, "mouse", local network interface and systems software. Current options include additional main memory, additional disks, UNIBUS (TM Digital Equipment Corp.) compatible interface, back-up mag tape drives, network interfaces and color graphics.

### LM-2 CPU

The LM-2 is a Microprogrammed stack-oriented CPU with 32-bit data paths throughout. Its writable control store consists of 12K 48-bit words, with 16K optional. The CPU includes a 1K by 32-bit stack buffer, a 1K by 32-bit scratchpad memory, a 4K by 17-bit "dispatch memory", a multiplier/quotient register, and 32x32 "barrel shifter/masker".

The microcontroller has a 32 deep subroutine stack and a three-address microinstruction format. The microcycle time is 180 nsec.

The virtual memory map translates 24-bit virtual word addresses into 22-bit real word addresses. The 4.25K byte hardware translation buffer handles most translations in 180 nsec. The linear virtual memory consists of 65,536 pages of 256 32-bit words.

All CPU memories are parity-checked. The hardware debugging interface contains a microprocessor which can be connected to a telephone modem for remote access.

The 32-bit X-bus handles high speed devices such as main memory, disk interface and graphics display bitmap memory.

The 16-bit I/O-bus handles medium speed devices such as the Chaosnet interface, the keyboard, and the mouse. This bus is compatible with many commercially available printers, plotters and tape drives.

The CPU consists of a rack, X-bus and I/O-bus card cages and backplanes, 6 multiwire CPU boards, and power supplies for all but the disk and display monitor. The LM-2 draws a maximum of 15 amps at 110 VAC. The CPU uses Schottky TTL throughout, except for high performance MOS memories.

## GRAPHICS DISPLAY

The LM-2 high resolution graphics display consists of the BMI-1 bitmap and the BWD-1 high resolution monitor.

The BMI-1 bitmap is 128K bytes of MOS RAM accessed by the CPU as normal 32-bit memory. The CPU may change up to 32 pixels on the graphics screen on every memory cycle.

The CPU with its "barrel shifter/masker" is a powerful microprogrammed graphics engine. The shifter/masker allows packed grayscale/color pixels to be quickly aligned and displayed. Many graphic operations, such as line drawing and character generation, are microprogrammed.

The programmable BMI-1 can drive a large variety of interlaced and non-interlaced TV monitors. High resolution images using one bit per pixel or standard resolution images using 4 bits per pixel are supported.

The BWD-1 high resolution monitor is a non-interlaced, flicker-free monitor with a true white phosphor. Under normal LM-2 operation, it displays 896 rows of 768 dots at a 67 Hz frame rate.

The CD-1 is a standard resolution (454 rows of 576 dots) RGB color monitor and a separate color map. The dynamically writable color map converts a 4-bit color code into 8 bits of intensity for each of the 3 colors.

## MOUSE

The MO-2 mouse is a free-standing, hand-held device which transmits any change in its X or Y coordinate position to the LM-2.

## KEYBOARD

The KB-2 Keyboard is a high quality 96-key keyboard with several "mode" keys used extensively by the Lisp software. It includes an on-board microprocessor for encoding and buffering.

In addition to low level services, the network implements the remote file system, which allows an LM-2 to deal with a file at another node on the Chaosnet. The file system at the other node can be a time-shared mainframe, or an LM-2 operating as a file computer.

ZWEI is an "intelligent" text and program editor like the EMACS editor developed at MIT. ZWEI can handle multiple fonts, do justification and allows the programming of custom "macros". ZWEI contains several hundred sophisticated commands.

With the symbolic debugger, one can localize the position of an error to the particular sub-expression of Lisp code, and can inspect variables by pointing with the mouse. Pointing the mouse at a function immediately displays its source text. No octal or hex arithmetic is required.

The microcode assembler allows the easy development of user microcode for the LM-2.

Software is available which allows one LM-2 to debug another LM-2 through an EIA serial line or through the Chaosnet.