# ATTACHE' USER'S MANUAL


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CHANGE RECORD

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| A | 4/78 | Initial Release |

NOTE

Throughout this manual, a distinctive type style will be used to indicate characters to be typed on the keyboard, or a message that is seen on the video monitor. In this distinctive type, the number "ZERO" is Ø, and the letter "O" is O.

# 1 INTRODUCTION

## 1-1 WHAT IS THE ATTACHE'

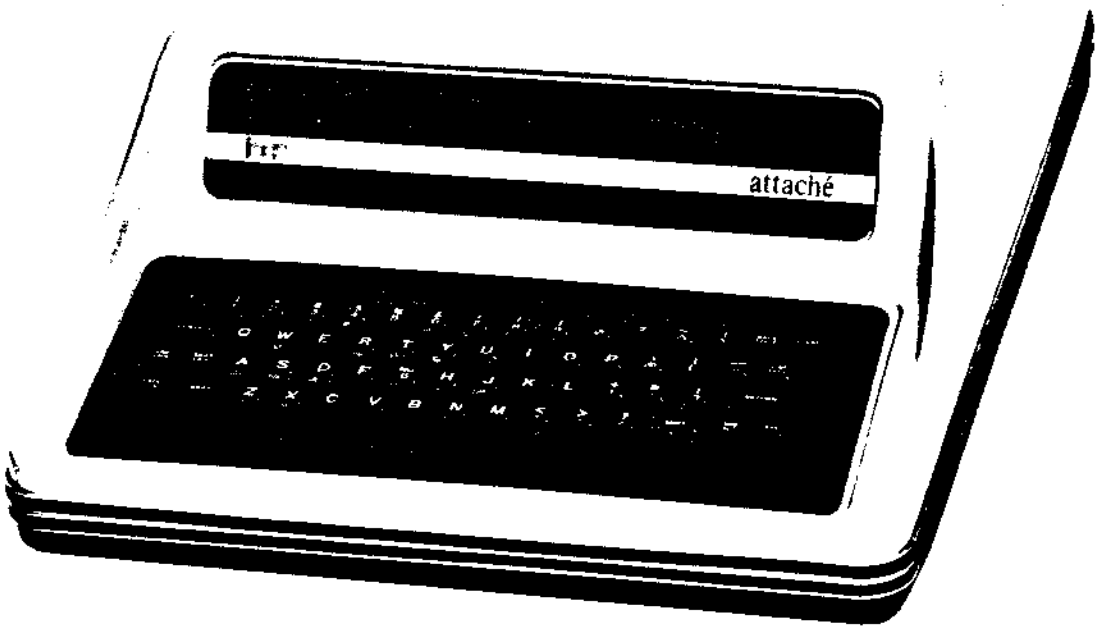
The ATTACHE' is a unique small computer. Its modular architecture makes it an ideal home computer for the hobbyist or for small business uses. The ATTACHE'can be expanded to become a complete small computer system.

The ATTACHE' Computer (see the facing page) is the basis for a comprehensive computer system providing 8K or Extended BASIC (on cassette tape), BASIC in a Read Only Memory (ROM BASIC), Disk Extended BASIC (called DEBBI - Disk Extended Basic By iCOM), or a Floppy Disk Operating System (FDOS-III) with Assembler and associated utility programs.

The ATTACHE' Computer System employs a field-proven iCOM computer, firmware, peripherals and software development packages to provide optimum performance and reliability in any processing environment.

Personal computing is given new emphasis with iCOM's software development packages. These packages, consisting of several of the most powerful dialects of BASIC available for small computer systems, provide the user with many useful features. iCOM's Floppy Disk Operating System (FDOS-III) allows the hobbyist to create and implement software programs through a powerful Assembler package that includes a Linking Loader and Symbolic Debugger, along with editing functions. Numerous PROMs are availabe for automatic loading and execution of stored programs.

The ATTACHE' is unique in the personalized small systems market in that its flexibility permits hardware and software capabilities to grow along with processing requirements. This potential, along with the high performance and dependability of the system, is possible through the use of the high-speed microprocessor CPU. System expansion may include such items as additional memory (up to 64K), PROMs, I/O ports, and an audio cassette interface.




The ATTACHE' Computer

# 1 INTRODUCTION

## 1-2 OVERVIEW OF THE ATTACHE'

The ATTACHE', from conception to production, was created as a personalized, individualized processing system. The computer's hardware, firmware, and software are modularly designed to allow for system expansion as the owner's experience and sophistication with computers progresses. Because of this design philosophy, the ATTACHE's processing power may increase along with the owner's knowledge of programming techniques and computer hardware.

### HARDWARE COMPONENTS

The minimum ATTACHE' configuration includes a motherboard, a keyboard, a central processing unit, a turnkey board (including 1K RAM and provisions for 1K PROM), a video board (for monitor hook-up), and a power supply. Additional memory and I/O ports can be optionally added, along with various peripheral controllers.

### SOFTWARE PACKAGES

Development software, including a Floppy Disk Operating System (FDOS-III) with Assembler, Linking Loader and Symbolic Debugger, Source Text Editor, and various utility programs, may be purchased from iCOM. Additionally, the ATTACHE' is capable of running BASIC, a powerful but simple computer language that the user may add in order to design and program custom software. Three versions of BASIC are available with the system: a standard 8K BASIC, an extended BASIC which may be supplied on either cassette, disk or ROM board, and a full disk BASIC (DEBBI - Disk Extended Basic By iCOM) capable of performing all disk functions. The development software (BASIC and/or FDOS-III) permits the user to produce custom programs for various chores and processing applications.

All the programming packages contain a complete set of prompts and other tutorial messages that allow an inexperienced operator to make full use of the system with minimum instructions and supervision.

The ATTACHE' is a powerful, advanced, and complete personalized computer. Whether used as a simple computer (i.e., standard configuration with a monitor and/or cassette for I/O) or expanded to a full computer system (with the addition of up to 64K of memory and a line printer and disk system), the ATTACHE' can meet the processing/computing needs of the hobbyist and small businessman today, tomorrow, and in the future.

ATTACHE' specifications are given on the facing page.

| | |
|---|---|
| Physical Characteristics: | |
| Dimensions | 6.825" high (17.3 cm) X 21" deep (53.3 cm) X 16" wide (40.6 cm) |
| Weight | 25 pounds |
| Power Requirements | 100, 115, or 130 VAC, 60 Hz, or 200, 230, or 260 VAC, 50 Hz; 100 W (nom) |
| Environmental Requirements: | |
| Temperature: | |
| Operating | 15.6° to 38°C (60° to 100.4°F) |
| Humidity: | |
| Operating | 5% to 80% non-condensing |
| Operational | |
| CPU | 8080A at 2 MHz clock rate |
| Interfacing | TTL, RS 232, Teletype |
| Memory (capacity) | 64K (combination ROM, PROM, RAM) |
| System Protection | Input power fuse |
| Program Development Software: | |
| BASIC | 8K, Extended, and Disk (DEBBI) versions |
| Disk Operating System (FDOS-III) | Assembler<br>Editor<br>Linking Loader<br>Debugger |
| Miscellaneous | Utility Programs<br>PROM Loaders |

ATTACHE' Specifications

# 2 GENERAL DESCRIPTION

## 2-1 FUNCTIONAL BLOCK DIAGRAM

The ATTACHE' may be considered as being composed of five main functional areas for general description purposes; these functional areas are:

MOTHERBOARD
POWER SUPPLY
CPU
I/O
VIDEO BOARD & KEYBOARD

A functional block diagram of the ATTACHE' computer is shown on the facing page. The block diagram shows how all components of the ATTACHE' interconnect through the motherboard.

The MOTHERBOARD contains the system bus lines and slot provisions for connecting up to ten ATTACHE' logic boards (three standard and seven optional boards). All boards use the S-100 bus for system flexibility. Motherboard bus lines provide signal paths to and from all logic boards. All bus lines on the motherboard are in parallel; thus, all bus lines are available to every logic board plugged into the motherboard slots. ATTACHE' system expansion may be accomplished simply by plugging in additional logic boards.

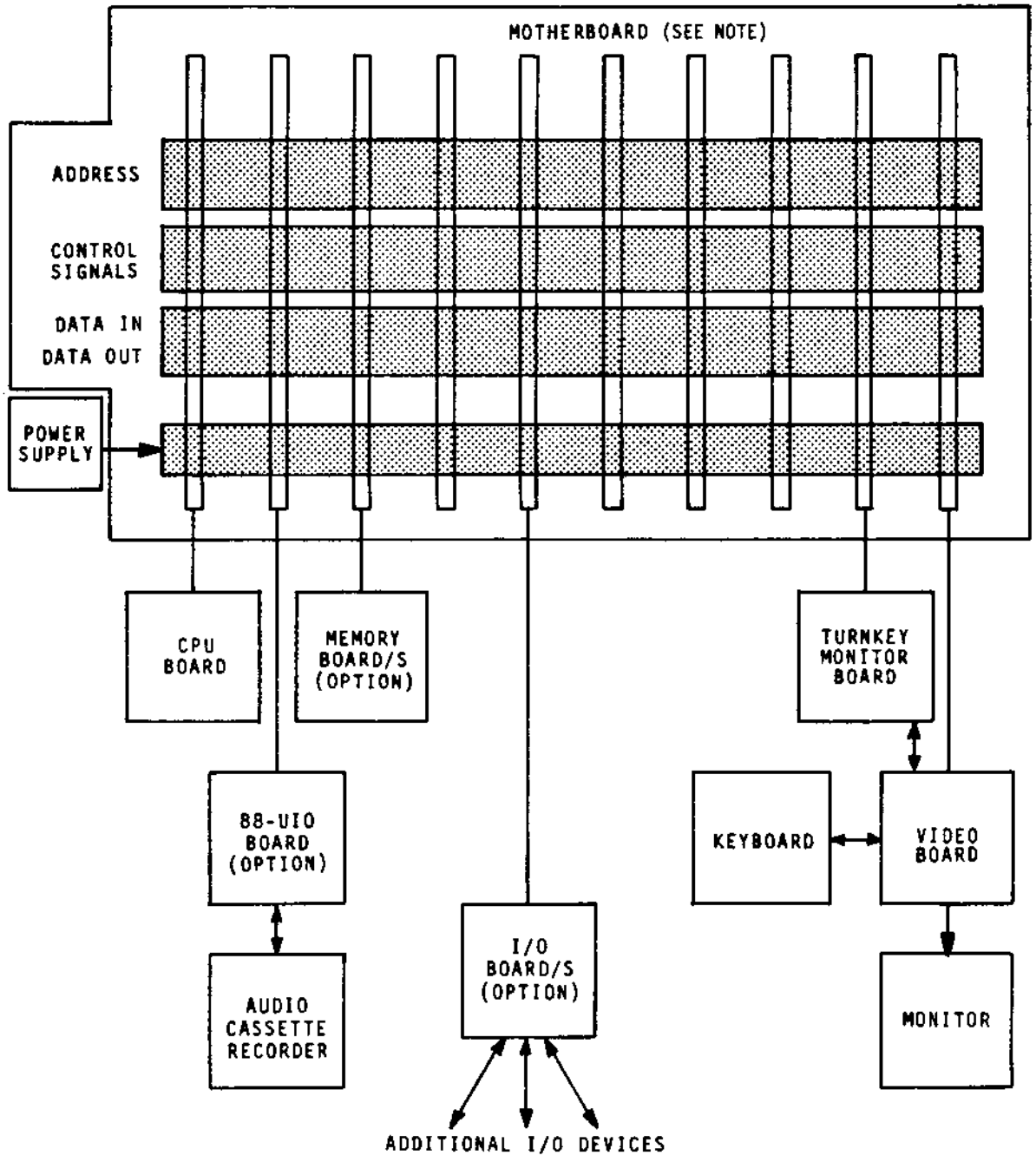
The POWER SUPPLY supplies D.C. power to the motherboard for distribution. The voltages provided to the motherboard are +8 volts, +18 volts, and -18 volts.

The CPU (Central Processing Unit) is an eight-bit microprocessor which, together with its associated circuitry, provides all functional, computational, and timing requirements for the ATTACHE' computer system. The CPU also controls all ATTACHE' I/O communications via its I/O and interrupt capabilities.

I/O (Input/Output) interfacing is controlled via the CPU and a port (channel) arrangement. Controllers for each type of peripheral unit are plugged into the motherboard, up to a maximum of seven controllers (one in each of the optional slot positions).

A system keyboard and video driver are provided for operator control of the computer. The keyboard is an integral part of the computer and eliminates the necessity of using a separate terminal for system control. Video display capability may be added to the system simply by connecting a monitor.

The following subsections describe the system components.




NOTE: THIS IS A FUNCTIONAL LAYOUT OF THE MOTHERBOARD ONLY, IT DOES NOT SHOW THE ACTUAL BUS LAYOUT.

ATTACHE' Functional Block Diagram

# 2 GENERAL DESCRIPTION

## 2-2 ATTACHE' COMPUTER SYSTEM COMPONENTS

The standard configuration of the ATTACHE' contains the following elements: Motherboard, Power Supply, CPU board with 8080A microprocessor, Turnkey board, Video board, and Keyboard.

The motherboard provides space for up to ten S-100 bus compatible boards. The ATTACHE' is shipped with only three slots filled (CPU, Turnkey, and Video boards) in the standard configuration. These boards are shown on the facing page. The ten positions are slot independent, meaning that any board may be placed in any open slot (since the video board is a piggyback board, it is normally placed in the last slot so it only takes up one slot position).

The S-100 bus carries all power, data, status, address, and control signals and is fully parallel, allowing all signals to be available to all boards plugged into the motherboard.

The power supply provides all required power for the ATTACHE'. The supply has the output capacity to power up to seven additional (optional) boards in an expanded system configuration. A block diagram of the power supply is shown on the facing page. The input power is filtered before reaching the power supply board. The supply provides DC voltages of +8 and ±18 volts to the motherboard.

The basis of the ATTACHE' computer is the central processing unit (CPU board) which includes the 8080A microprocessor and its associated circuitry. The microprocessor performs all the arithmetic and logic functions for the system. It supplies the control, status, timing, and synchronization functions required for all system components. The CPU board also controls I/O operations through port selection and interrupt sequencing.

The Turnkey board contains a PROM with the Monitor program, minimal system memory and any bootstrap loading routines ordered with the system, a serial I/O interface, and the Auto Start Control.

Minimal system memory is comprised of 1K of random access memory (RAM), with a provision for 1K of programmable read-only memory (PROM). Additional RAM and/or PROM boards may be added to expand the system memory capacity.

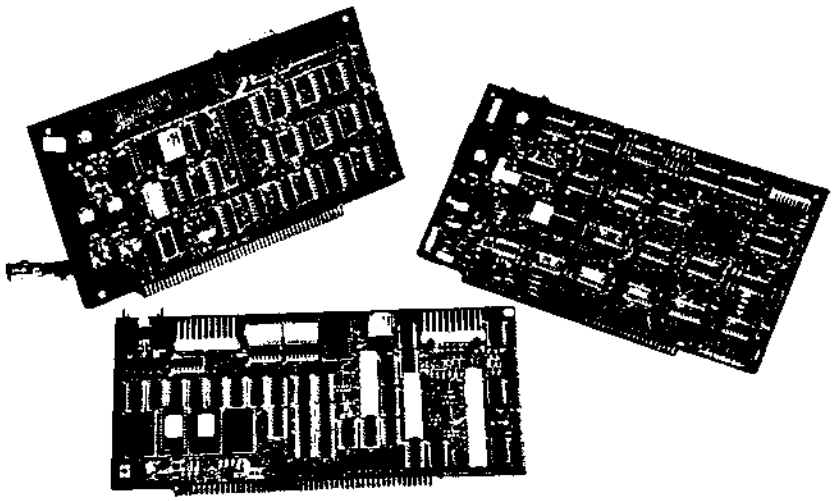
The Turnkey board is addressed to channels 20 and 21 and is used to supply TTL serial data to the video board. This serial data is usually sent to the video board at a 9600 baud rate, but this may be changed by the user.

The Auto Start Control forces the CPU to fetch an instruction from a specified memory address when the RESET switch is activated. The memory address specified is switch-selectable. The ATTACHE' then begins program execution from the selected address.

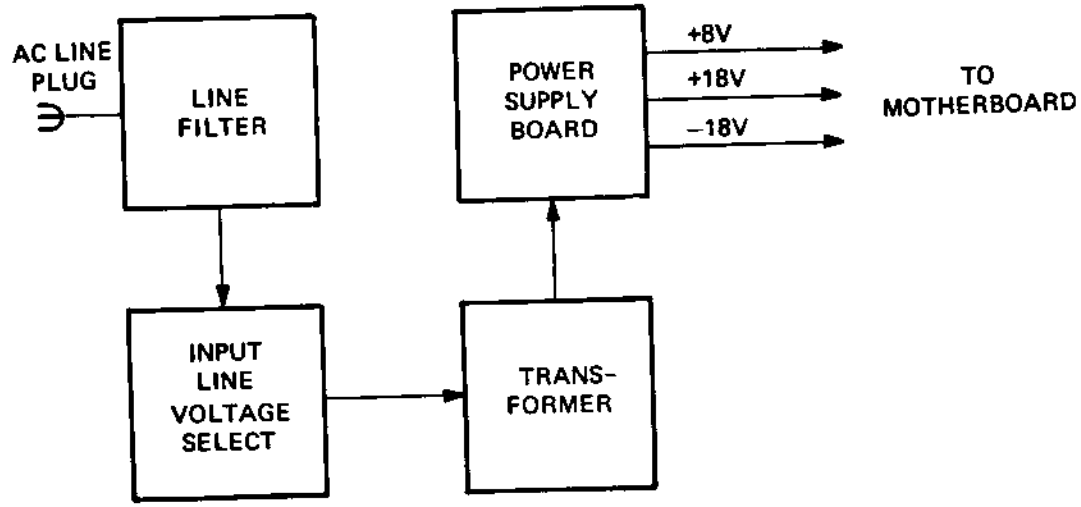
The Video board, in conjunction with the Turnkey board, supplies display signals and data to a monitor. Video output signals provide for a 16 line X 64 character display. Characters may be displayed in upper and lower case.

The video board is a piggyback type board, and is usually installed in the last slot on the motherboard so that only one slot position is used. It may be placed in any motherboard slot; the use of the last slot is a physical consideration only.

The Keyboard and Video board provide for complete system control and interfacing without requiring a separate terminal. The operator can control system functions via the keyboard, which is similar to a typewriter keyboard with added terminal functions. The keyboard also includes five light emitting diodes (LEDs) for monitoring system power and status conditions.



ATTACHE' Circuit Boards




Power Supply Block Diagram

## 2-3 ATTACHE' COMPUTER OPTIONAL SYSTEM COMPONENTS

Many options may be added to the standard system configuration to increase processing power and/or memory storage capacity, and to customize the ATTACHE' to perform specific tasks or operations.

Memory may be expanded by the addition of 4K or 16K memory boards. These boards, when plugged into any open slots on the motherboard, are instantly integrated into the system. Optional memory boards with the following characteristics are available for the ATTACHE' computer.

A 4K Static RAM board, with a highly dependable 4096 word by 8-bit memory array, is available to increase system memory capacity. It is fully static (i.e., does not require refreshing of stored data) and therefore requires no wait states, and the memory chips require only minimum support circuitry. Address selection is switch selectable, in 4K increments. Typical memory access time is 300 ns. All memory chips are socketed.

The 16K Static RAM board is a larger edition of the above providing a 16,384 word by 8 bit memory array. This board features low power consumption, fast access time (215 ns) and reliable operation. Addressing is switch selectable, in 16K increments. All memory chips are socketed.

A4K Synchronous RAM board that relies on timing signals from the CPU, instead of on-board single-shot circuitry, is an excellent choice to increase system memory capacity without refiguring timing parameters. Because the memory chips are synchronous, they require few support circuits, thus increasing reliability. Typical access time is 200-300 ns.

A larger version of the above is the 16K synchronous RAM board. It contains all the features of the 4K synchronous RAM with additional memory capacity (16,384 words of 8-bits) and low power dissipation. The 16K RAM board has a memory access time of 350 ns.

For applications requiring additional read-only memory, a 2K electrically programmable PROM may be added to the system memory. The PROM provides 2,048 bytes of permanent storage for automatic start-up routines, bootstrap loaders, or dedicated control programs. The PROM board offers the option of power down circuitry in order to reduce current drain when the PROM is not being used. For programs requiring yet more storage, an 8K PROM board is available.

Input/Output capabilities of the ATTACHE' can be increased with the addition of two-port serial, four-port parallel, or TTL serial interface boards. The two-port serial interface may be used to "talk" to two serial I/O devices (e.g., video monitor and teletype) simultaneously. Control and handshake operations may be programmed to meet individual requirements. Interfacing

is RS 232, 20 MA current loop, or TTL compatible. Seven- or eight-bit operation, with one or two stop bits and odd or even parity can be selected. Baud rates of 37.5 through 9600 may be chosen.

(e.g., video monitor and teletype) simultaneously. Control and handshake operations may be programmed to meet individual requirements. Interfacing is RS 232, 20 MA current loop, or TTL compatible. Seven- or eight-bit operation, with one or two stop bits and odd or even parity can be selected. Baud rates of 37.5 through 9600 may be chosen.

The four-port parallel interface allows communications with up to four parallel I/O devices simultaneously. Each port contains 16 data lines. All lines are TTL compatible, and data-in, data-out, and interrupt processing are software controlled.

ATTACHE' processing power can be enhanced by use of additional S-100 bus compatible devices. A Process Control Interface (PCI) board, with a software controlled interrupt structure and handshake configuration included, may be installed in the system to control operation of an electrical or mechanical unit. The PCI board can be used with appropriate sensors to monitor heat, humidity, light, or other changing conditions in a home or office. It may be used as a control device for controlling automatic sorting or grading operations, or to respond to changes in pressure.

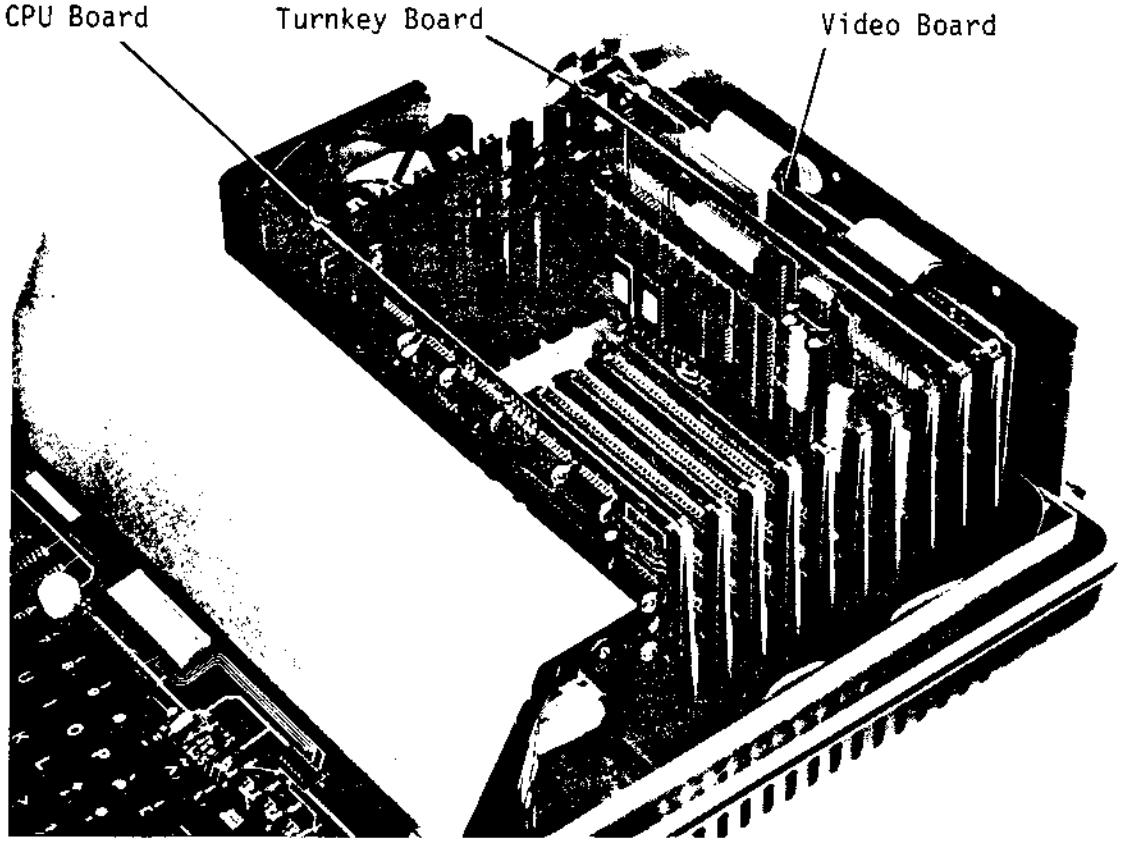
An Analog-to-Digital Converter (ADC) can be installed in the ATTACHE' to convert analog signals into 8-bit or 12-bit digital signals for processing in the system. A multiplexer board can be added in conjunction with the ADC to expand the analog input capacity up to 14 channels. (Up to four multiplexer boards may be used, providing a total of 96 channels.) Analog-to-digital conversion can be used in a variety of scientific monitoring applications or in the home in remote control devices, video games and computer graphics.

An Interrupt/Real Time Clock (RTC) board is available for sophisticated applications where several levels of interrupts are required. The board permits interruption of running programs by eight levels of priority interrupts. The RTC can operate in either 60 Hz or 2 MHz (system clock) mode and allows for interval selection of interrupts or repetition of a specified operation.

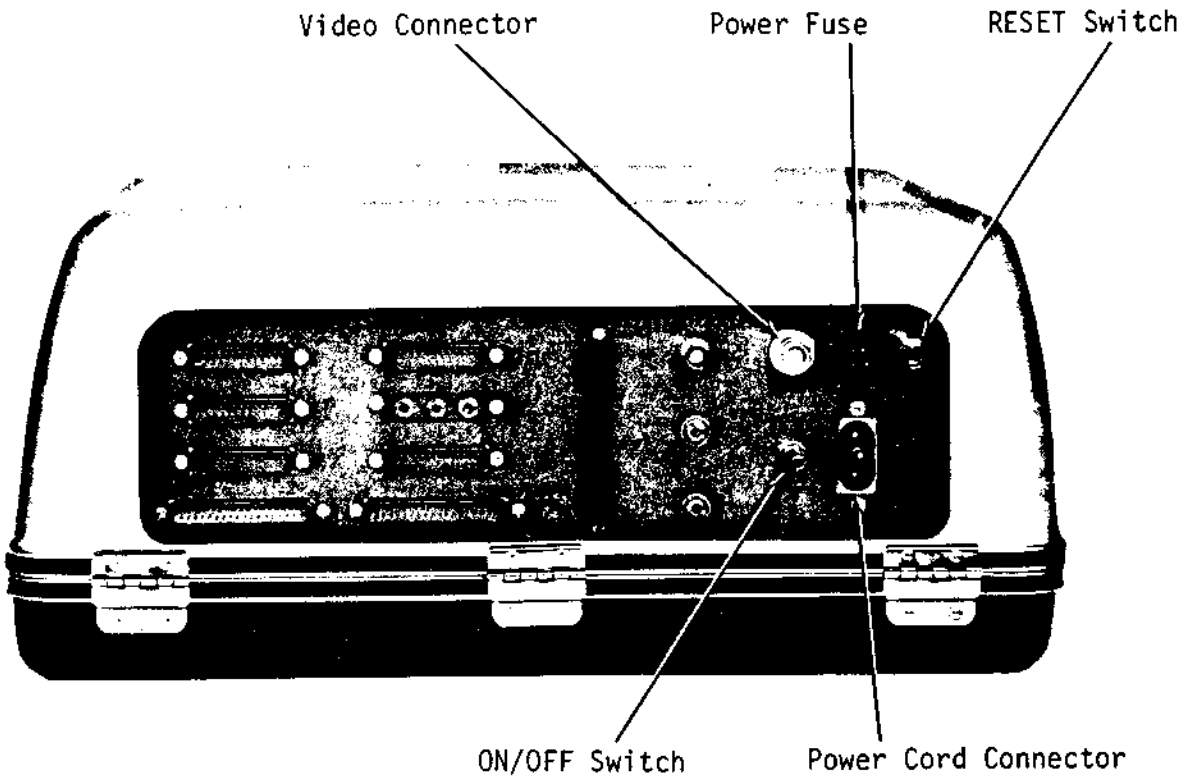
## 2-4 STANDARD CONFIGURATION LAYOUT

The standard configuration of the ATTACHE' includes the following boards: CPU board, Turnkey board and Video board.

The photograph on this page shows the board placement for the standard configuration. Any additional boards would be inserted into any other motherboard slots.




Standard Configuration Layout




ATTACHE' Rear Panel

# 3 OPERATING THE ATTACHE' COMPUTER SYSTEM

## 3-2 THE KEYBOARD

The keyboard provides for operator input to the ATTACHE' and gives the operator an indication of system status.

The keyboard, shown on the facing page, provides the operator with a readout of status conditions and a means of interfacing with the system.

Five light emitting diodes (LEDs) are provided to indicate system status conditions, as follows:

- POWER - lights when power is on
- I/O - lights when an input or output data transfer is taking place.
- INTE - lights when interrupts are enabled.
- INT - lights when an interrupt is being processed
- HALT - lights when processing is stopped due to the CPU having executed a HALT instruction ($166_8$)

The keyboard is operated in the same manner as a typewriter. A normal typewriter arrangement is used for key positions, with extra keys for terminal and control functions.

The CAPS LOCK key is a dual position key. In the down position, all alphabetic characters input to the ATTACHE' are upper case, all others are lower case. If the key is in the up position, all inputs to the ATTACHE' are lower case characters.

The SHIFT keys function in the same manner as those on a typewriter. Holding down a SHIFT key while typing a character key causes the character on the upper part of the key to be input to the ATTACHE'.

The CONTROL key enables the user to input special control characters to the system. To input a control character, hold down the CONTROL key and type a character key. Each control character has special meaning to the ATTACHE'.

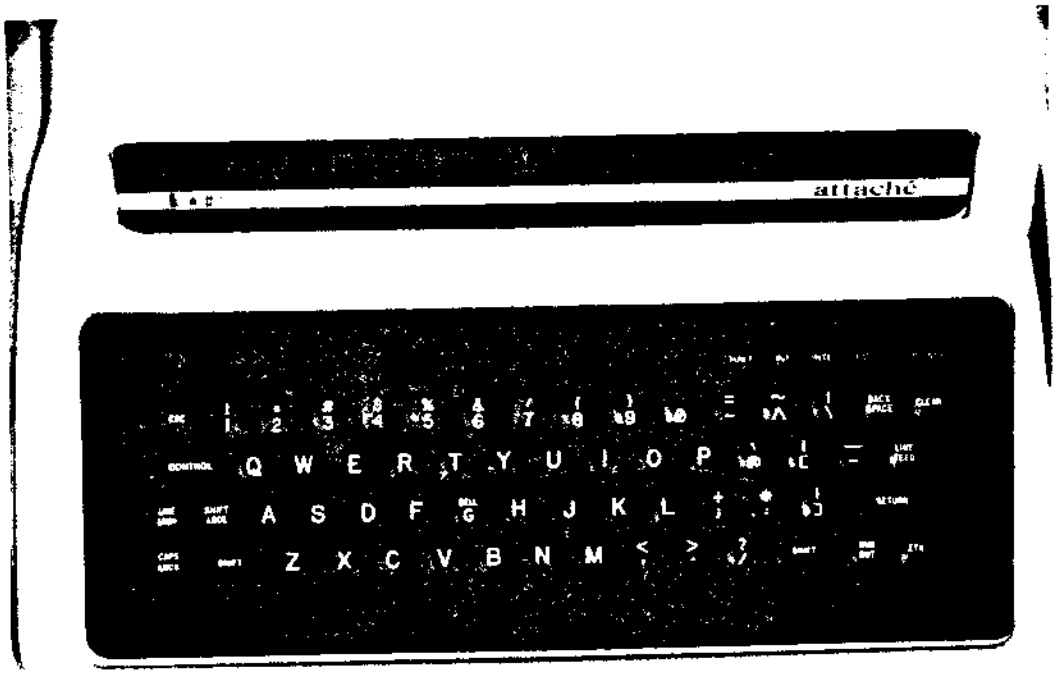
The ETX (escape) key is a special key usually used for ending a command or ending execution of a currently running program. It performs the same function as the CONTROL C (CONTROL and C keys simultaneously pressed), and is used to interrupt the program.

The RUB OUT key only functions when BASIC is being run. The RUB OUT key is used to delete characters from the line being entered. If the CAPS LOCK key is up, when the RUB OUT key is pressed, the character is printed after a backslash (/). Subsequent RUB OUT's will each delete a character. The first character then entered will be preceded by a second backslash. This has the effect of placing all deleted characters between backslashes. If the CAPS LOCK key is down, the character is deleted and an underscore is printed.

The CLEAR key clears the screen and positions the cursor at the home position (bottom left corner) of the screen.

The Line/Local (LINE LOC.) key controls the modes of the keyboard. In local mode (key locked down), the keyboard is connected directly to the monitor; in line mode (key up), the keyboard is linked to the monitor through the CPU.

A special feature of the ATTACHE' is the repeat function. Any key held pressed down will start to repeat after approximately 3/4 second and will continue repeating until released.




ATTACHE' keyboard

# 3 OPERATING THE ATTACHE' COMPUTER SYSTEM

## 3-3 POWERING UP AND INITIALIZING THE SYSTEM

To power up the ATTACHE', check all cable connections and turn power on in each of the system components. RESET the computer, and the system is operational.

Before powering up the ATTACHE', check to make sure that all system cables are securely connected and that the power cord is properly plugged in at the source and at the computer's rear panel. The power on and initialization procedure is as follows:

1. Locate the power switch for each of the system components. (The location of the ATTACHE' power switch is shown on the facing page.) Refer to the appropriate instruction manuals for other system equipment.) Turn each of the power switches to the ON position.

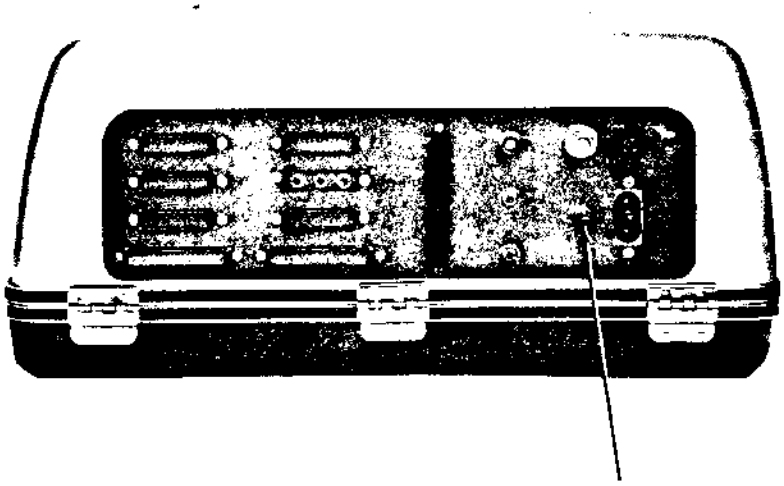
2. Check the POWER indicator on the ATTACHE' keyboard; it should be lighted. (If it is not lighted, refer to the troubleshooting section of this manual.) The ATTACHE' power indicator is shown on the facing page. Refer to the appropriate instruction manuals for indicator locations on other equipment.

3. Check each of the power ON indicators on all system components; they should all be lighted. If any of the indicators are not lighted, refer to the troubleshooting section of the appropriate manual.

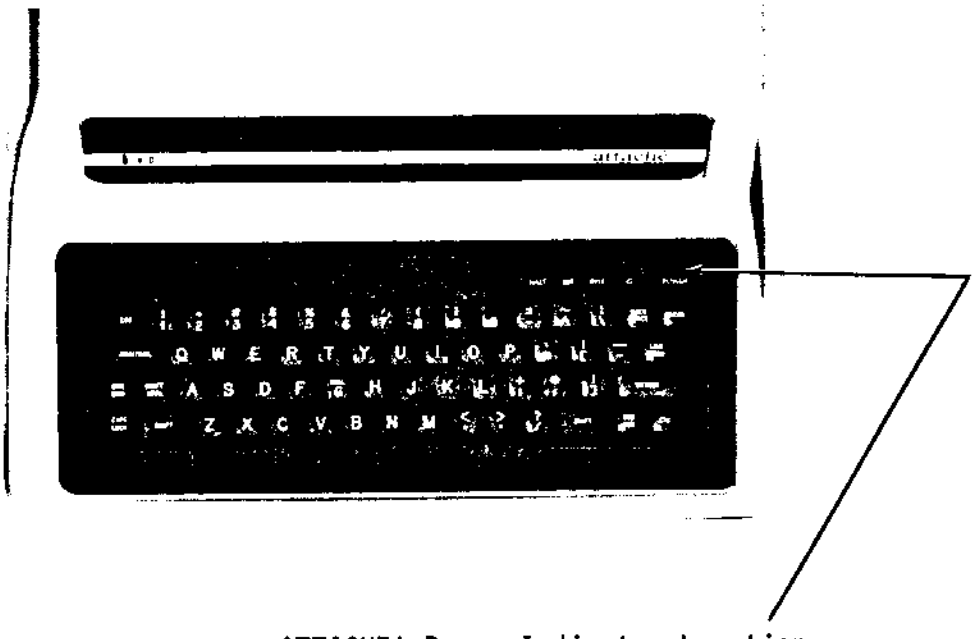
4. Press the RESET switch on the rear panel of the ATTACHE' to initialize the system.

5. Check the monitor to make sure the cursor is present (at the bottom left corner of the screen). If the cursor has not appeared on the screen, refer to the troubleshooting section of this manual.

6. If all power indicators are lighted, and the cursor has appeared on the monitor, a program may be loaded into the system memory from disk, audio cassette, or paper tape, as described in section 3-4.



ATTACHE' Power Switch Location



ATTACHE' Power Indicator Location

# 3 OPERATING THE ATTACHE' COMPUTER SYSTEM

## 3-4 LOADING BASIC

> This section shows how to load BASIC from cassette tape, disk, or ROM. Refer to Section 4 of this manual for BASIC features and to the BASIC user's manual for specific programming instructions.

- In ATTACHE's equipped with the turnkey monitor PROM, proceed as follows:

LOADING FROM CASSETTE TAPE

Turn on the ATTACHE'. Make sure the LINE LOC key is up and the CAPS LOCK key is down. Press the RESET switch on the rear panel. The monitor should now display the turnkey monitor's prompt character and the cursor. Type in J177700 and start the tape*. As the tape's tone changes from a steady sound to a warble, enter one more zero. This will cause the program to jump to the Multi-Boot Loader (MBL) PROM and begin loading BASIC. At the end of the BASIC tape, the monitor should display:

MEMORY SIZE?

Initialize BASIC (consult BASIC user's manual for exact instructions). If keyboard control is lost, press the RESET switch and return to the monitor. Enter J000000, or J and the space bar. This will reset the CPU and BASIC should display:

OK

LOADING FROM DISK

Insert the diskette into the drive and allow the disk to time in. Turn on the ATTACHE'. Make sure the LINE LOC key is up and the CAPS LOCK key is down. Press the RESET switch on the ATTACHE' rear panel. The monitor should now display the turnkey monitor's prompt character and the cursor. On the keyboard enter J177400. The disk should start loading and the monitor should display:

MEMORY SIZE?

(Consult Disk BASIC user's manual for instructions.)

If keyboard control of BASIC is lost (console to non-existing terminal, etc.), press the RESET switch to return to the monitor. Enter J000000 or J and the space bar. BASIC should echo:

OK

LOADING FROM ROM

Turn on the ATTACHE'. Make sure LINE LOC is up and CAPS LOCK is down. Press the RESET switch. The monitor should display:

MEMORY SIZE?

With very few exceptions, ROM BASIC is the same as Extended BASIC. Consult the Extended BASIC manual for instructions.

- In ATTACHE's not using a monitor PROM, proceed as follows:

For all BASIC versions (i.e., cassette tape, disk, ROM), set the start address to jump to the Mini Disk Boot Loader (MDBL), Disk Loader (DL) or Multi-Boot Loader (MBL) PROM.

LOADING FROM CASSETTE TAPE

Connect a coaxial cable from your recorder to the "play in" jack of the 88-UIO ACR cable. Make sure the LINE LOC key is up and the CAPS LOCK key is down. Turn on the ATTACHE'. Start the recorder. As the tone changes from a steady sound to a warbling tone, press the RESET switch on the rear panel. At the end of the tape, the monitor should display:

MEMORY SIZE?

LOADING FROM DISK

The LINE LOC key must be up and the CAPS LOCK key should be down. Insert the diskette and turn on the drive. Allow it to time in. Turn on the ATTACHE' and press the RESET switch on the rear panel. The disk will begin loading BASIC, and the monitor will display:

MEMORY SIZE?

* The distinctive type face is used to indicate the characters to be typed on the keyboard, or the message that is seen on the video monitor.

# 4 ATTACHE' SOFTWARE

## 4-1 AVAILABLE SOFTWARE PACKAGES

iCOM provides a wide range of sophisticated software to support the ATTACHE' microcomputer system.

Software is an important component of any computer system. The key to applying the computer system to various business applications and the ease with which the computer system can be operated depends to a major extent on the software-hardware interrelationship that exists within the system. The software available with the ATTACHE' computer makes it the most advanced, sophisticated small computer on the market today. It is the only truly complete computer system in the personalized computer field.

The software packages currently available are:

Program development software

- BASIC - 8K version
- BASIC - Extended version
- BASIC - Disk Extended version (DEBBI)
- Floppy Disk Operating System (FDOS-III)

Utility software

- Disk Boot Loader PROM
- Multi-boot PROM

The program development software requires a minimum system configuration plus 8K of memory and either an audio cassette recorder or paper tape capability for the 8K BASIC version, or 16K of memory and either a ROM BASIC board or disk system for the Extended version of BASIC, or 24K of memory and a disk system for the Disk version of BASIC (DEBBI).

The Floppy Disk Operating System (FDOS-III) requires a minimum system configuration and a disk system plus associated PROMs.

# 4 ATTACHE' SOFTWARE

## 4-2 BASIC LANGUAGE

BASIC is a powerful, high level, simple-to-learn computer language. Because of its English-like instructions and commands, it is quickly learned, and an inexperienced programmer can begin programming in BASIC within a short time period.

The ATTACHE' BASIC is one of the most powerful dialects of the language available, with numerous features (e.g., editing, string processing, numerical computations) not usually found in a small business computer language.

The three versions of BASIC available with the ATTACHE' are all of the interpretive type (i.e., allow for instant feedback of program results and diagnostics.

8K BASIC is designed to utilize 8K of memory and is available on audio cassette or paper tape. (Use of paper tape requires a tape reader.) The cassette version includes provisions for loading or saving programs and numeric array data.

Extended BASIC requires a minimum system configuration plus 16K of memory and either an 88-UIO board with a cassette recorder or a disk system, or a ROM BASIC board (if ROM BASIC is used, Extended BASIC is run from the ROM BASIC board).

ROM BASIC may be used in conjunction with an audio cassette recorder for storing and loading of data only. ROM BASIC is the same as Extended BASIC.

Extended BASIC includes all features of the 8K BASIC, plus additional powerful elements which increase the system capabilities.

Disk Extended BASIC By iCOM (DEBBI) is a superset of the Extended BASIC. It contains all Extended BASIC features plus complete facilities for reading or writing data files and saving and loading program files. DEBBI includes provisions for file handling.

The special features of 8K BASIC, Extended BASIC, and DEBBI are described in Section 4-3.

## 4-3 SPECIAL FEATURES OF 8K BASIC, EXTENDED BASIC, AND DEBBI

Special features of 8K, Extended BASIC, and Disk BASIC are listed below.

### 8K BASIC

Boolean Operators - AND, OR, and NOT, for bit manipulation and complex decision-making.

Direct Control of Input and Output and Memory - I/O ports may be read or written directly through use of the INP and OUT instructions. This will allow the transfer of information between the outside world and BASIC. Any memory location may be inspected or changed via the PEEK and POKE verbs to allow transfer of byte-oriented data, and provide an interface with machine language subroutines.

Strings - Variables and constants can contain as many as 255 alphanumeric characters. Functions may take substrings from the left, right, or middle of long strings, or concatenate long strings from shorter strings. Conversion can be performed between numbers and their string representation.

Arrays - Numeric and string arrays may have as many dimensions as can be written on a program line and are limited in size only by available memory.

FOR Loop Nesting - Nesting of FOR loops is limited only by available memory.

Math Functions - Intrinsic math functions include: SIN, COS, TAN, LOG, EXP, SQR, ABS, INT, FRE, RND, POS.

User Defined Functions - These may be defined using a single argument and are limited to the size of a single line.

### EXTENDED BASIC

Integer variables are stored as double byte signed quantities with a range of -32768 to +32767. Variables stored in this manner occupy half as much space and are faster for arithmetic. Integers can be mixed with other variable types in an expression. Formulas containing mixed types of numeric variables are automatically converted to the dominant variable.

Extended BASIC provides a PRINT USING statement to control the format of numerical output or the placement of text. PRINT USING specifies output format in scientific notation, integer, $fill, right-hand +/- sign, etc., and the number of digits to be printed in a number. Strings may also be printed in specified width fields.

Automatic Line Numbering and Renumbering - Program lines can be numbered automatically as each program line is entered. Line numbers can also be renumbered automatically to reflect added or deleted lines.

Edit commands provide a vehicle for changing and/or deleting characters within lines or entire lines without affecting the rest of the program. The EDIT mode is entered automatically each time a syntax error is detected in a program line.

IF...THEN...ELSE statement allows IF statement nesting which is limited only by available memory.

The SWAP statement will exchange the values of two variables. This can speed up string sorts by a factor of two.

The ERASE statement eliminates arrays from a program, freeing that memory space for other uses.

Error messages explicitly describe user errors.

Error Trapping facilities allow the user to write error detection and handling routines for error recovery or to provide a more complete explanation of errors than a BASIC-supplied error message.

Trace is a valuable debugging aid. Each program line number is printed as the line is executed, to expose infinite loops and other programming pitfalls. Trace can be enabled or disabled as needed.

Extended BASIC allows for the defining of functions which are not a part of the intrinsic function list. These may be of any type and have any number of arguments.

DEBBI

Information is stored in sequential files and may be accessed by three modes: ASCII sequential input, ASCII sequential output, and record-oriented random.

A PIP (Peripheral Interchange Program) utility program provides facilities for formatting new disks, diskettes, or minidiskettes, in addition to initialization and directory printing.

DEBBI can support up to 16 floppy disks.

All functions of Extended BASIC are included in DEBBI.

## 4-4 COMPARISON OF BASIC VERSIONS

The following table summarizes the features and differences of the versions of BASIC that may be used on the ATTACHE'.

| FEATURES | BASIC VERSION | | |
|---|---|---|---|
| | 8K | EXTENDED | DEBBI |
| Minimum Memory Requirement | 8K | 16K | 20K |
| Numeric Types | | | |
| Single Precision | Y | Y | Y |
| Double Precision | N | Y | Y |
| Integer | N | Y | Y |
| Strings | Y | Y | Y |
| PEEK and POKE | Y | Y | Y |
| INP and OUT | Y | Y | Y |
| Arrays - any size or dimensionality | Y | Y | Y |
| IF...THEN...ELSE | N | Y | Y |
| PRINT USING for formatted output | N | Y | Y |
| EDIT command | N | Y | Y |
| Automatic line numbering | N | Y | Y |
| Error trapping | N | Y | Y |
| Trace | N | Y | Y |
| Disk files for programs and data | N | N | Y |
| Functions | | | |
| Intrinsic | 11 | 22 | 23 |
| User-defined | Y* | Y | Y |
| Machine language subroutines | Y | Y | Y |

*In 8K BASIC, functions must be defined on one line and may have only one argument.

## 4-5 FLOPPY DISK OPERATING SYSTEM

The Floppy Disk Operating System (FDOS-III) is a complete software package designed for assembling and editing ATTACHE' Assembly Language programs. It includes a System Monitor, Text Editor, Assembler with Linking Loader and Debugger, and assorted utility programs.

The primary control program for the system is the FDOS-III System Monitor. The monitor remains resident in memory and is used to load and execute both FDOS-III and user programs.

The FDOS-III Text Editor is used to create and maintain source program files. Lines may be added, deleted, or altered with editor commands. A paging command allows the sequential loading of memory, one page at a time, to minimize the use of memory space.

The FDOS-III Assembler converts an assembly language source program into a relocatable object file on disk. In a two-pass operation, the Assembler reads the assembly code and assigns addresses to all the symbols; it then converts mnemonics and symbolic addresses to their machine language equivalents.

The FDOS-III Assembler includes a set of pseudo-op instructions to reserve memory storage space, define contents of memory locations and control the parameters of the Assembler's operation.

The Assembler's Linking Loader will load and prevent the accidental overlay of relocatable object code modules produced by the Assembler. The Linking Loader defines the addresses assigned to external references and prints a list of any undefined addresses. The Linking Loader also performs disk file searches to resolve undefined references.

The Debug Module provides commands which permit the contents of memory locations, registers, and flags to be displayed and/or modified. It is designed to control program execution during debugging. Debug allows for inserting, displaying, and removing of breakpoints to initiate pauses during program execution.

## 4-6 DISK BOOT LOADER PROM; MULTI-BOOT PROM

The Disk Boot Loader and Multi-Boot Loader PROMs are designed to eliminate the use of bootstrap loaders to "call-in" system software.

The Disk Boot Loader (DBL) PROM is capable of automatically loading system software contained on a disk system into the computer. This eliminates the need for toggling in a bootstrap loader.

The Multi-Boot Loader (MBL) PROM performs the same function as the DBL PROM, but it is used to load cassette stored system software into the computer. The MBL PROM is addressed at $177000_8$. Either PROM may be installed on the Turnkey board, or on a PROM Memory Board.

## 4-7 ACCESSING THE PROM MONITOR

Accessing the PROM monitor program is easily accomplished at either power-on or while during operation.

To transfer to the monitor program, follow these steps:

1. The monitor PROM must be installed in PROM socket K1 on the Turnkey Module.
2. The AUTO-START address switches on the Turnkey Module must be set to 176400 octal and the PROM address switches to 176000 octal (RAM must be at $174000_8$).
3. Turn power on.
4. The PROM monitor outputs its prompt character, a period (.).
5. At any time, pressing the RESET switch causes control to return to the monitor and the prompt to be output.

## 4-8 PROM MONITOR GENERAL INFORMATION

The PROM monitor is a system program that permits the examining and changing of any memory location or series of locations, and outputting the contents of any range of memory locations in a predetermined format. The PROM monitor allows a program to start execution at any specified address.

The input routines in the PROM monitor will accept only valid octal digits (0-7) and the "space" character. When waiting for input, the routines expect either three or six digits. All of the expected digits need not be input. The first space character terminates the input routine and may be used to delimit separate inputs. If no digits have been entered before the delimiting space is entered, the input routine will return a value of zero. Whenever the delimiting space is used, the carry bit is set, and the return is made. During a normal return (i.e., one in which no space was used), the carry bit is always clear.

The PROM monitor is 377 (octal) bytes (256 decimal) long and is assembled to operate with a starting address of 176400 octal. It must be located at this point in memory or it will not operate correctly. The PROM monitor establishes a stack with a top address of 176000 octal when it is entered. The monitor never has more than four levels of subroutine calls at any one time so only eight bytes are actually used in the stack. The stack itself usually resides in the 1K of RAM that is part of the Turnkey Module. It is the user's responsibility to see that there is RAM available at the stack location. Otherwise, the monitor cannot operate correctly, if at all.

All necessary registers and the stack pointer should be saved before jumping from a program to the monitor, since the monitor destroys the contents of the stack pointer and and all registers upon entry. Restoration of the registers must be handled by the user's program.

Errors in data input can be corrected easily before the last character is typed. Simply type a non-octal character (except space) and the monitor will print a question mark and a period. The command may then be typed again.

When the octal input routines are requesting input, they do not check for over-range conditions on the input data. For example, when using the M function (see Command Section), three complete valid octal digits must be input in order to deposit new data into a memory location. Since the ATTACHE' is organized around an eight-bit byte, the largest valid octal number that can be input is 377. In fact, 777 can be input without the monitor detecting an error. The actual value that is deposited in the memory location in that case is not equal to 777 octal, but depends upon the binary representation of the most significant digit input to the routine. For example, 477 causes the routine to deposit

octal 077 into the memory location. The same possible error condition is present when addresses are input, except that the maximum value that may be typed is 1777777. Anything larger will not be flagged as an error, but the effective address will depend upon the binary representation of the highest order digit.

## 4-9 PROM MONITOR COMMANDS

The PROM monitor has three commands:

| | |
|---|---|
| M | Memory examine and change |
| D | Memory dump |
| J | Jump to user program |

### THE M COMMAND

The M command allows the user to examine and change any location in the ATTACHE' memory. The form of the M command is as follows:

```
Mxxxxxx
```

where xxxxxx stands for from zero to six valid octal digits. The PROM monitor opens the location specified and displays the three digit octal contents of that location. The monitor then waits for three valid octal digits. Three complete octal digits must be input; the space character cannot be used as a delimiter in this case. When this valid data has been received, the monitor attempts to place the data into the opened location. Once the deposit has been made and verified, the M function closes the current location and opens the following location. If the user tries to deposit information into non-existent memory, ROM, or protected RAM, the bad deposit causes "?" to be output and control to return to the PROM monitor. Assuming a valid deposit, this sequence continues until a non-valid character (any character except the digits 0-7) is input. This non-valid character is flagged with a "?" and control returns to the PROM monitor. This is the normal way to return to the monitor.

If a space is input instead of a valid octal character, the M function closes the present location without making any changes and then opens the next consecutive location. While the M command is looking for input, the space character may be used at any time to close the current location without change, and open the following location. Therefore, even though one or two valid octal digits may have been input, when the space has been received, the location is closed without change. To deposit new data, three complete valid octal digits must be input.

### THE D COMMAND

The D command allows the user to dump the contents of the ATTACHE' memory between any two locations. The D command has the following form:

```
Dxxxxxx xxxxxx
```

To use the D command, enter a D in response to the monitor's prompt character. The D function will then wait for the starting address (zero to six valid octal digits). If six digits are input, the D function outputs a space and then waits for the ending address (zero to six valid octal digits). The

ending address must be greater than or equal to the starting address. If less than six digits are input during the starting address, the D function echoes the delimiting space character, but does not output one of its own.

Once the D function has received valid starting and ending addresses, it punches a leader of 60 octal 302's followed by 60 nulls (zero bytes). It then punches out the contents of memory starting at the first address up to and including the end address in the ATTACHE' binary Absolute Load Tape format, (shown below). (The word "punch" is used here to refer to the output of the D command, no matter what output device is actually used.) If the number of bytes to be punched is greater than 377 octal, the D function punches as many blocks of 377 octal bytes as necessary until the number of bytes left to punch is less than 377 octal bytes. The last block punched may have less than 377 octal bytes. If the number of bytes to be punched in the last block is equal to zero, a zero block is not punched. Upon completion of the dump, the D function performs a carriage return and line feed and then returns to the PROM monitor.

THE J COMMAND

The J command allows the user to transfer control between the PROM monitor and another program. The J command has the following form:

Jxxxxxx

where xxxxxx is the starting address of the user routine (zero to six valid octal digits). Once the J function has received a valid address, it will load the program counter with the address and start execution of the user program at that address.

Begin/Name Record

| Byte | Contents | Comments |
|---|---|---|
| 1 | 125 Octal | Begin Sync |
| 2-4 | Name | Program name |
| 5-N | Comments | Program version and data, etc. |
| N+1 | 15 Octal | Terminates program name record |

Program Load Record

| Byte | Contents | Comments |
|---|---|---|
| 1 | 74 Octal | Load sync byte |
| 2 | 0-377 Octal | Number of load bytes |
| 3 | L.S. Byte | Least significant byte of Load address |
| 4 | M.S. Byte | Most significant byte of Load address |
| 5-N | Data Bytes | |
| N+1 | Checksum Byte | Generated by adding all bytes except the first two without carry |

End-of-File Record

| Byte | Contents | Comments |
|---|---|---|
| 1 | 170 Octal | Paper tape/Audio Cassette EOF |
| 2-3 | | Execution start address |

Absolute Load Tape Format

# 5 OPERATOR MAINTENANCE

## 5-1 OPERATOR TROUBLESHOOTING PROCEDURES

Problem symptoms an operator may encounter are shown on the facing page. Possible causes for each symptom are listed. A suggested corrective action is described; however, if this action does not correct the fault, contact your nearest MITS dealer.

Operator Troubleshooting Guide

| SYMPTOM | CAUSE | ACTION |
|---|---|---|
| Power indicator not lit. | 1. No AC to unit.<br>2. LED is burned out.<br>3. No +8V on bus.<br>4. Keybord-to-Video Board cable not connected or connected incorrectly. | 1. Check power cord, fuse. (If fan is operating, AC power is present.)<br>2. Check monitor for cursor. If cursor is present, LED indicator is burned out.<br>3. Check power cord, fuse. (If fan is operating, AC power is present.)<br>4. Check cable. |
| Power indicator not lit; no cursor on monitor, fan is operating. | 1. DC power supply problem. | 1. Call your MITS dealer. |
| Monitor dark. | 1. No AC power to unit.<br>2. Cable connection.<br>3. Monitor brightness or contrast incorrectly set.<br>4. Video board not in ATTACHE. | 1. Check power connection to wall and fuse.<br>2. Check cabling is secure.<br>3. Refer to monitor adjustment procedure in monitor manual.<br>4. Install video board. |
| Monitor on, but no communication from keyboard possible. | 1. Loose cabling.<br>2. Keyboard problems. | 1. Secure cables.<br>2. Check for stuck keys and check for foreign material between keys. |
| Auto Start (RESET) does not initialize system. All other indications are normal. | 1. Program not jumping to correct address due to PROM, memory, or CPU addressing malfunction. | 1. Check Turnkey Board switch settings. If OK, call your MITS dealer. |

# 6 INSTALLATION

## 6-1 INITIAL PROCEDURE

When the ATTACHE' is to be first installed, the procedure listed below should be used.

1. Remove the two screws located at the front (bottom) of the machine. Raise the top of the computer.

2. Visually inspect the machine for any damage which may have occurred in shipping.

3. Visually inspect each printed circuit board for loose or broken parts.

4. The Video boards should be located in the last motherboard slot (nearest the rear panel).

5. All boards should be inserted with the components facing forward.

6. Identify Video board #1 (this is the board which plugs into the 100-pin connector). The switches located on Video board #1 select the baud rate for the serial port of the Video board. The Turnkey board was factory set for 9600 baud; therefore, the Video board should be set for 9600 baud. The baud rate switches are off when positioned to the left side of the board. Select only one baud rate at a time (only one switch should be on, or to the right, at any time).

   Switch 1 on = 300 baud.
   Switch 2 on = 600 baud.
   Switch 3 on = 1200 baud.
   Switch 4 on = 2400 baud.
   Switch 5 on = 4800 baud.
   Switch 6 on = 9600 baud.
   Switch positions 7 and 8 are not used.

   The switch located on Video board #2 selects positive or negative video. For white characters, black background, position switch 2 to the left side (off). For black characters, white background, position switch 1 to the right side (on). Switch 2 is not used.

7. Connect the Video board BNC connector to the bulkhead connector as shown on the facing page.

8. Located at the rear of the machine is a 34-pin conductor cable; this cable is connected to the video board as follows:

   a) Looking at the keyboard, the 34-pin conductor cable should have a dark blue stripe along its left side (facing upward) at the

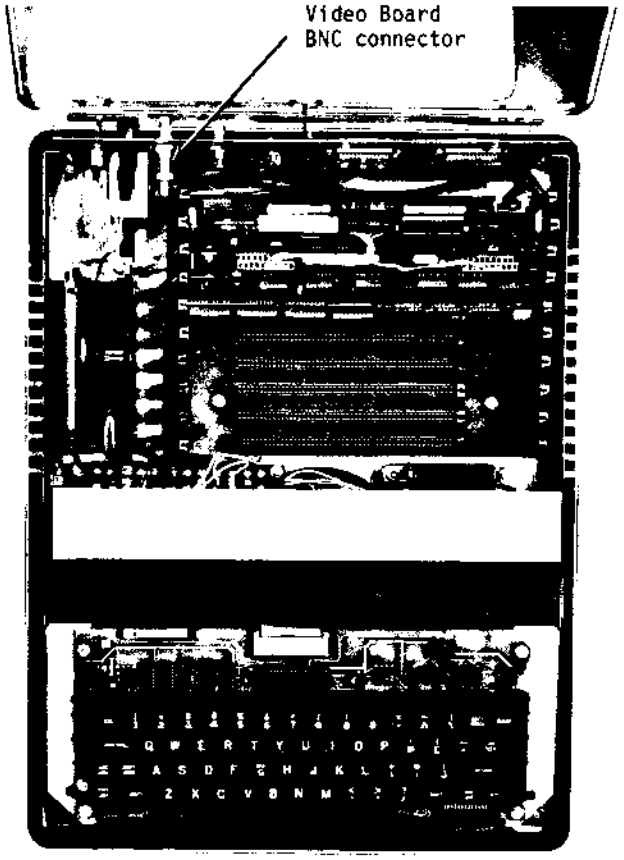
keyboard's connector. This dark blue stripe identifies pin 1 (pin 2 of the keyboard and Video board are the leftmost finger on the component side of the board).

b) Insert the 34-pin edge connector onto the stub of the Video board, making sure the dark blue stripe is on the left side of the machine (this will require the blue stripe to be facing downwards).

9. Connect the composite video coax cable from the rear panel to the video monitor.

10. Install the Turnkey Module board in the slot next to the Video board. Plug the small red molex connector onto the Video board with the solid red side facing outward from the board. Install the large white molex connector with three leads on the connector located to the right side of the Turnkey board. The slots on the molex connector must face outward. Install the remaining white molex connector (4 wires) on the left side of the Turnkey board. The slots must face outward.

11. Install all remaining printed circuit boards in the ATTACHE'. Since the ATTACHE' uses the S-100 bus the boards may be placed in any order.



# 6 INSTALLATION

## 6-2 88-UIO BOARD SET-UP

The 88-UIO board can be set to use ATTACHE' standard or KCACR format. Switches on the board select format, I/O port address, and ACR port address.

Switches to the left side of the board are off. Check the 88-UIO board for a label located on the UART. This label will specify whether the board was aligned for ATTACHE' standard or KCACR. If no label is found, the board was aligned for KCACR standard. To change from one standard to the other, both the switch and trim pot must be changed. (Refer to the 88-UIO manual for aligning the trim pot.)

1. Switch selection.

   - Switch 1 off selects ATTACHE' standard; on selects KCACR. Be sure the switch agrees with the board (as aligned).
   - Switch 2 should be on (to the right). This selects I/O port address 30, 31. If off, the port will be at address 20 and 21; this will interfere with the Turnkey board's serial port.
   - Switch 3 selects ACR port address 6 and 7 when off, and address 16 and 17 when on. It is normally off.

   NOTE

   Refer to the 88-UIO Manual for baud rate and data level jumpers, if required. Jumpers are not needed unless using the 88-UIO's serial port.

2. Connect the 88-UIO's ACR cable with the slots facing outward.

3. Mount the fiberglass ACR plate in the top center DB25 slot, using #4 hardware. Mount any other cables needed for the system in any of the remaining rear panel slots.

# 6 INSTALLATION

## 6-3 POWER-UP PROCEDURE

The following procedure should be used to power-up the ATTACHE' after installation.

1. Insert the ATTACHE' and video monitor's power cords into an outlet. Make sure the ATTACHE's on/off switch (located on the rear panel near the machine's power connector) is up (off). Turn on the video monitor and allow it to warm up.

2. Leave the ATTACHE's top raised when first turning on the machine. Push the ON/OFF switch down (on). The fan should start running and the left-most LED (power indicator) will light. The video monitor will display a cursor in the lower left-hand portion of the screen. Adjust the monitor's horizontal and vertical holds as required to stabilize the cursor.

3. Lock the LINE LOC key on the keyboard in the down position. Place the SHIFT LOCK and CAPS LOCK keys up. Start typing using any keys. Lower case characters and numbers will be displayed. Lock the CAPS LOCK key down and type again. Capital letters and numbers will be displayed. Holding the SHIFT key, or pressing the SHIFT LOCK key while typing displays capital letters and upper case symbols marked on keys (!, ", #, etc.). Press the CLEAR key; the screen should blank and display the cursor at the lower left-hand position. Unlock the LINE LOC key and SHIFT LOCK keys. Normally, the CAPS LOCK key is down when using BASIC. 4.1 BASIC requires capital letters to initialize BASIC. It will interpret lower case characters in a program and rewrite them into capital letters. Any print statement using quotations will be printed exactly as entered. (If lower case is used in a print statement, BASIC will print the lower case characters on the monitor).

4. The ATTACHE's top cover should be closed after checking that the system functions correctly. This will prevent foreign objects from being dropped into the ATTACHE', and will enhance the cooling of the printed circuit boards.

# 6 INSTALLATION

## 6-4 LOADING BASIC WITH A PROM

**This section describes loading BASIC from various sources. These procedures utilize PROMs.**

**Use the chart below to determine which PROM is required to load the BASIC program (it is helpful to use the monitor PROM to control the MBL or DBL PROM).**

| LOADING FROM | PROM REQUIRED | TURNKEY SOCKET LOC. |
|---|---|---|
| Cassette Tape | MBL | J1 |
| Paper Tape | MBL | J1 |
| Disk | DBL or MDBL | H1 |
| ROM BASIC | None Required | |
| Loading machine code without language, special Boot Loaders, etc. | Monitor PROM | K1 |

With a monitor PROM installed, proceed as follows (all switches refer to Turnkey board and are ON when positioned to the right side of the board):

1. Set switches to use monitor PROM:
   a) PROM address at $176000_8$ (A15, A14, A13, A12, A11, A10, $\overline{A9}$, $\overline{A8}$).
   b) SIO address at $020_8$ (switch 4 of switch-4 on).
   c) Start address at $176400_8$ (A15, A14, A13, A12, A11, A10, $\overline{A9}$, A8).
   d) Sense switches as required for MBL, MDBL, or DBL PROM (consult MBL, MDBL, or DBL User's Manual).
   e) If MBL is used, enter J177000 on keyboard.

NOTE

As the last zero is entered, the MBL PROM will be accessed. Be sure the tape, etc., is at the appropriate place before entering the last zero. If for some reason a reset is required, the monitor PROM can be used to return to BASIC (address zero); otherwise, the machine would return to the PROM and BASIC would be lost.

Enter J177400 on keyboard if MDBL or DBL PROM is used.

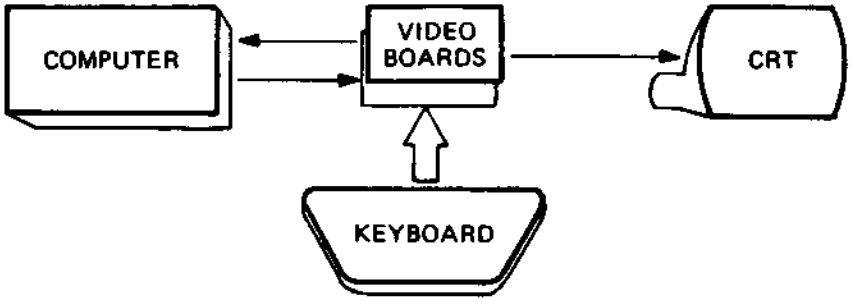
Ram at $174000_8$ (A15, A14, A13, A12, A11, $\overline{A10}$, $\overline{A9}$, $\overline{A8}$). All sense switches down for disk. RAM must also be located at $000000_8$ for the MBL.

2. If using the MBL PROM instead of the monitor PROM, proceed as follows:
   a) PROM address at $176000_8$ (A15, A14, A13, A12, A11, A10, $\overline{A9}$, $\overline{A8}$).
   b) RAM address at $000000_8$ ($\overline{A15}$, $\overline{A14}$, $\overline{A13}$, $\overline{A12}$, $\overline{A11}$, $\overline{A10}$, $\overline{A9}$, $\overline{A8}$).
   c) If optional memory is installed for program storage, make sure that the RAM on the Turnkey board doesn't conflict with other memories. The requirement for the MBL is that there be some RAM at $000000_8$. This could be a memory board or the RAMs on the Turnkey board.
   d) SIO address at $020_8$ (switch 4 of switch-4 on).
   e) Start address at $177000_8$ (A15, A14, A13, A12, A11, A10, A9, $\overline{A8}$).
3. To load BASIC from disk, install a DBL or MDBL PROM in socket H1: proceed as follows:
   a) PROM address at $176000_8$ (A15, A14, A13, A12, A11, A10, $\overline{A9}$, $\overline{A8}$).
   b) RAM address must not conflict with other memory boards needed for loading BASIC or with PROM address.
   c) SIO address $020_8$ (switch 4 of switch-4 on).
   d) Start address $177400_8$ (A15, A14, A13, A12, A11, A10, A9, A8).
   e) Sense switches all down.
4. To load BASIC from ROM, proceed as follows:
   a) ROM BASIC does not dump into RAM memory; therefore, it is actually not loaded in the normal sense. ROM BASIC occupies the top 16K of memory, and care must be taken to ensure that the turnkey PROM and RAM addresses do not conflict with ROM BASIC or other memory boards.
   b) PROM and RAM addresses must be below $140000_8$ and not conflicting with other memories.
   c) 88-UIO or SIO address $020_8$ (switch 4 of switch-4 on).
   d) Start address $140000_8$ (A15, A14, $\overline{A13}$, $\overline{A12}$, $\overline{A11}$, $\overline{A10}$, $\overline{A9}$, $\overline{A8}$).
   e) All sense switches down.

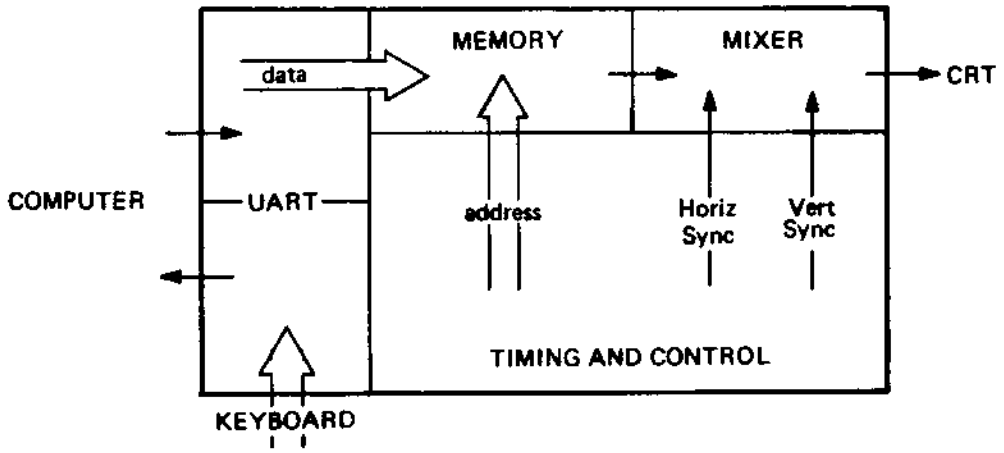
APPENDIX A

VIDEO BOARD THEORY OF OPERATION

The video boards integrate a CRT, keyboard, and computer. Parallel information from the keyboard is serialized and sent to the computer. The boards store and transform serial data from the computer for display on the CRT. Other than characters, the CRT requires synchronization signals for scanning.



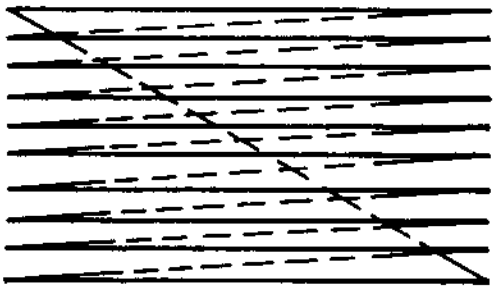

A universal asynchronous receiver transmitter (UART) performs the serial-parallel task between keyboard and computer; and computer and video memory. The video memory refreshes the screen. Timing and control logic addresses the memory and creates synchronization signals (syncs). The characters of the memory are mixed with the sync signals and are made available to the CRT chassis through a coaxial cable.




The Timing and Control Section is composed of a timing chain, character insertion logic, power up clear, character generator, and a cursor comparator. The timing chain creates the sync signals and supplies the cyclic memory addresses. The character insertion logic respondsto the UART, inserting the new character at its cursor address without disturbing the refresh. Power up clear removes all images from the CRT with carriage return characters. The character generator transforms parallel ASCII forms from memory to serial dots and no-dots for the screen. The cursor comparator places a white square on the CRT so the operator may pin-point his location along the bottom row.

Timing and control is a dot refresh cycle, cleared upon power-up, capable of adding new characters, which provides an operator cursor.

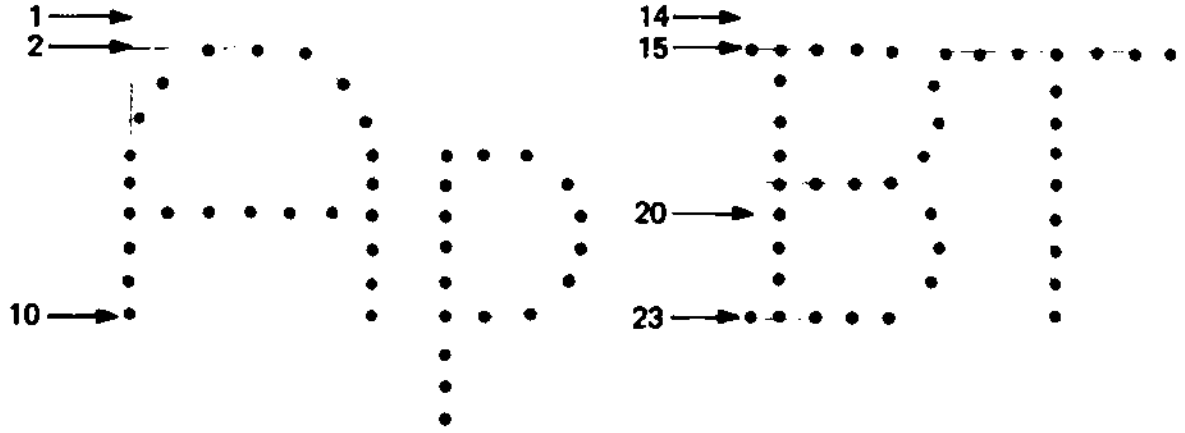
The CRT requires a Composite Video signal. The 13.4784 MHz dot frequency is related to the CRT raster by the 15.75 KHz horizontal sync and the 60 Hz vertical sync. These signals are separated in the CRT chassis by band pass filters. The raster scan traverses the screen in the following manner:



Horizontal: frequency = 15.75 KHz
period = 63.5 μsec

Vertical: frequency = 60 Hz
period = 16.67 msec

The dashed raster retraces are very quick and occupy little of the scan time. The slope of the horizontal trace is about 60 Hz/15.75 KHz or 0.0038. The entire screen is crossed by about 256 very nearly horizontal traces. Each row of characters is composed of 13 traces leaving about 50 unused traces divided above and below the full character screen. The 13 MHz wave turns the beam on and off for dots while the syncs trigger the raster at its endpoints along the margins of the scan. In painting the two rows shown below the beam must make 26 passes. On row 15 below, B's top then T's top is painted before retracing and lower sections are refreshed.




The data frequency is switching the beam on and off. The blank row between the p and t is produced by the generator itself. Vertical blanks between the characters is loading time for the shift register which follows the character generator. Each row is constructed of strata. All of this information in the Composite wave passes through a coaxial cable.

On the board the Composite wave is synthesized. The data wave from B-4, the sync wave from B-6, and the cursor wave from B-12 are added at the node below R9. The relative amplitude of the waves are set through resistors R11, R10, and R12. M-5 is the vertical sync, Y-5 the horizontal sync, Z-6 the data wave, and D4 is the cursor wave. R9 matches the impedance of the coaxial cable.

All the different frequencies needed to generate the data as well as the sync pulses range from 60 Hz to 13 MHz. The 13 MHz wave is available at chip R pin 10. Chip T uses the 13 MHz to convert the parallel dots from the generator C1, to a serial stream for the video. Chip S converts the 13 MHz dot rate to a slower character rate. A rate about one eighth as fast is available at S-11 (MSCLK) and A-12. S-11 is used to load the shift register T with a new dot character from the generator. A-12 synchronizes the timing chain. E1 and F address one line of characters. E-3 forms a sharp negative going pulse rate at the beginning of each line, which is used to clear the RS flop at E-8 and E-6 to unblank for the new line. E-3 resets F at pin 9 as the new row is to begin. We recall that 13 passes are needed to paint a character row. C-6 with the aid of N-10 decodes G and looks for a 13 to increment H via A-10. H is the character row counter. When H counts out (16 rows) it toggles P to the set state, which in turn presets H to 12 and blanks the screen until H counts out again. After 4 counts H toggles P again, ending the vertical blank period which lasted 1/5 of total time (16+4)/4). Once at the top of the screen dots may pass through to Z-6. P also provides a level from its Q side to the pulse shaping circuitry of the vertical sync at M-2. Before leaving the timing chain, G-14 to G-11, are used to inform the generator of the present strata of the character row we are on so that it lays out the proper layer of dots for the character presently being painted.

The majority of the time, the video boards are merely refreshing the CRT with the RAMS. When a key is struck on the keyboard or information is received from the computer, changes occur.

The keyboard pulls pin 23 of the UART low to signal the validity of the data bus over pins 26-33. Over pin 25 the UART transmits the ASCII key at a rate specified by 1/16th of pin 40. If in local a low from the keyboard shall select the K-14 to K-13 path back to the UART at pin 20. A line high from the keyboard enables the K-2 to K-3 path to let the computer send data to pin 20. Pin 20 is set to receive data at 1/16th the rate specified at pin 17. The baud rate figures in the sketch account for this division by 16.

When a signal is received at pin 20, the UART sets DA-H. It will remain high until the interstate machine is done and resets it. DA-H raises pin 7 of W allowing it to count, beginning at zero. At the count of 1, pin 2 falls as pin 1 joins the rest of the outputs at a high level. The high fan-in flip-flop at T brings CA-SEL to a low, which selects the cursor address for RAMS rather than the refresh address of the timing chain. At the count of 2, pin 3 falls pulling RAM R/W low. With the cursor address available to the RAMS, the character present on the RD0 to the RD6 lines from the UART is written into

the memory at the cursor location. After pin 3 rises RAM R/W rises and pin 4 falls.

Pin 4 puts a low at M-3 anticipating a possible carriage return which will be valid until pin 6 time, when the RS flop M is reset. If the key was a carriage return, then the cursor row counter H is to be incremented through N-1, P-11, and H-8. During pin 5 time, the CA-SEL is no longer low and CRDET-L may reset the cursor count through pin 6 of P. At pin 6 time besides disabling CRDET-L's from bumping the cursor row count, chip E is bumped advancing the cursor address. If a control character is detected through CTL-L no advance of the cursor is possible. Notice the chips E and F which hold the cursor address within a line may advance the row count at H through P12. This provides an automatic line advance on the CRT. At pin 9 time, the CA-SEL is brought low again, and the RS flop L output FCR-L is lowered. FCR-L via L-6 tri-states the UART from the RD0-RD6 bus and places a carriage return on the bus with the drivers U and D. At pin 10 time, the CR is written into the RAMS as RAM R/W falls low. The CR is a dummy used to blank the remaining portion of the row as it is placed immediately after the newly inserted character. The DA-H level of the UART is reset as RDA-L falls. The machine will then finish counting to zero when pin 1 will fall breaking the loop through X-5. The interstate machine has written the new key into the RAMS at the old cursor address, updated the address by one, written a dummy blank CR at the new cursor address, and reset the flag in the UART. The refresh cycle may resume.

There is another possible interruption to the refresh cycle - a clear. When Vcc comes up on the boards, C16 begins to charge up through R7. Until Q1 is switched on, Q2 is off holding the j side of the flop J high and its k side low. When VA4 clocks the flop is set with PUP-H. PUP-L tri-states the RD0-RD6 pins of the UART and places a CR on the bus through the U and D drivers. PUP-H enables the interstate machine at X-12. The J-K flop J will reset after 16 cycles since the MSCLK at W-2 is 16 times faster than VA-4 at J-9. Each CR will force a CRDET-L to bump the cursor row counter through N-3 at H-8, since it will be valid between W-4 and W-6 time. VCR-L will blank out a memory with all sixteen rows led by a carriage return. A clear button on the keyboard is also provided a line to the base of Q1 to simulate a power on clear.

The cursor row is always presented at the bottom of the CRT due to the activity of chip K. K adds the cursor row address to the timing row address (PVA6-PVA9) making the video row relative to the cursor row in time. The relation between the PVA count and the vertical blank sets the cursor row at the bottom of the screen.

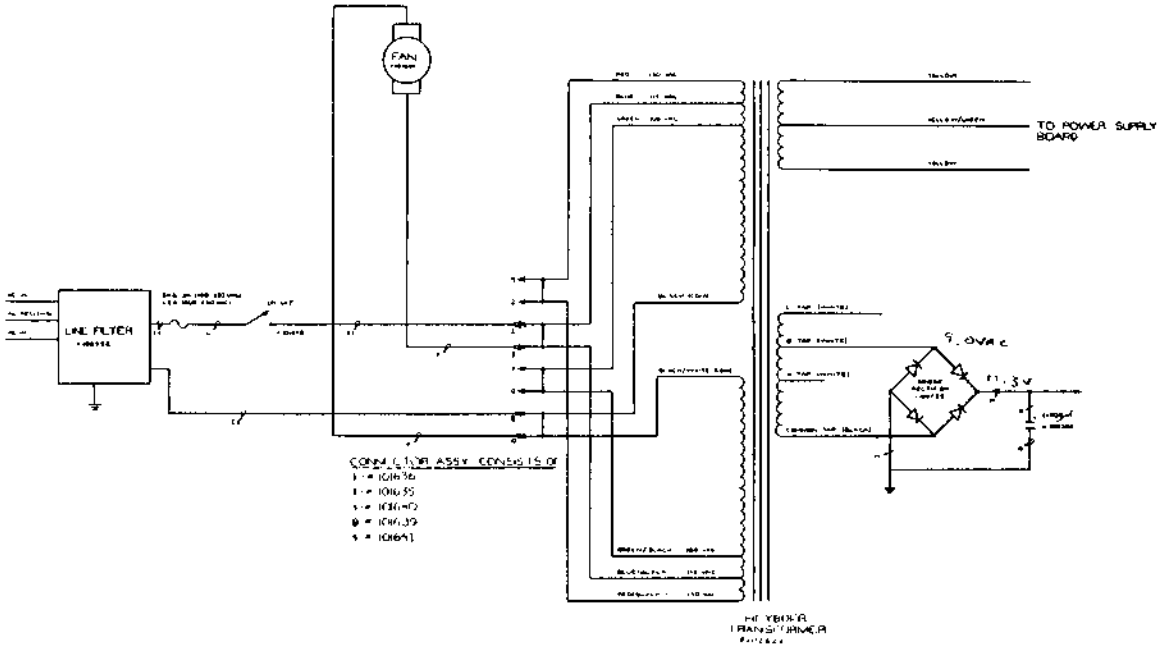
The cursor, unlike the rest of the characters, is placed on the screen by means of a comparator and pulse shapers. W, a comparator, puts out a high at pin 13 when the VA and CA lines are in agreement. The other inputs are related to the blanks that appear at the lower Z nand gate. C8 then represents a cursor sync. Passing through the first single shot the cursor is delayed to appear at the appropriate moment just after the last inserted character. D-1 takes this delay and widens to the appropriate pulse width, so that the cursor may appear at standard character width of 7 dots. After the 7406 open collector inversion the 680Ω resistor holds the intensity of the cursor down as it is

actually drawn with bars as opposed to dots. From here on, the cursor resembles a regular character, except the cursor is taller and dimmer.

The sync pulses are to be shaped also, before they may join the composite video. The rough vertical sync pulse is high going at M-2. This single shot is used to narrow the square wave available at M-4 by means of the 50K pot. A narrow sync pulse is made at M-5 of the square wave at M-10. The pulse width at M-5 is fixed, but may be delayed due to the width of the square wave at M-10. This delay is relative to the timing chain and the dot stream at Z6. As a result the image may be moved vertically on the screen. The horizontal sync is formed in a similar manner and may be used to move the image horizontally as well.

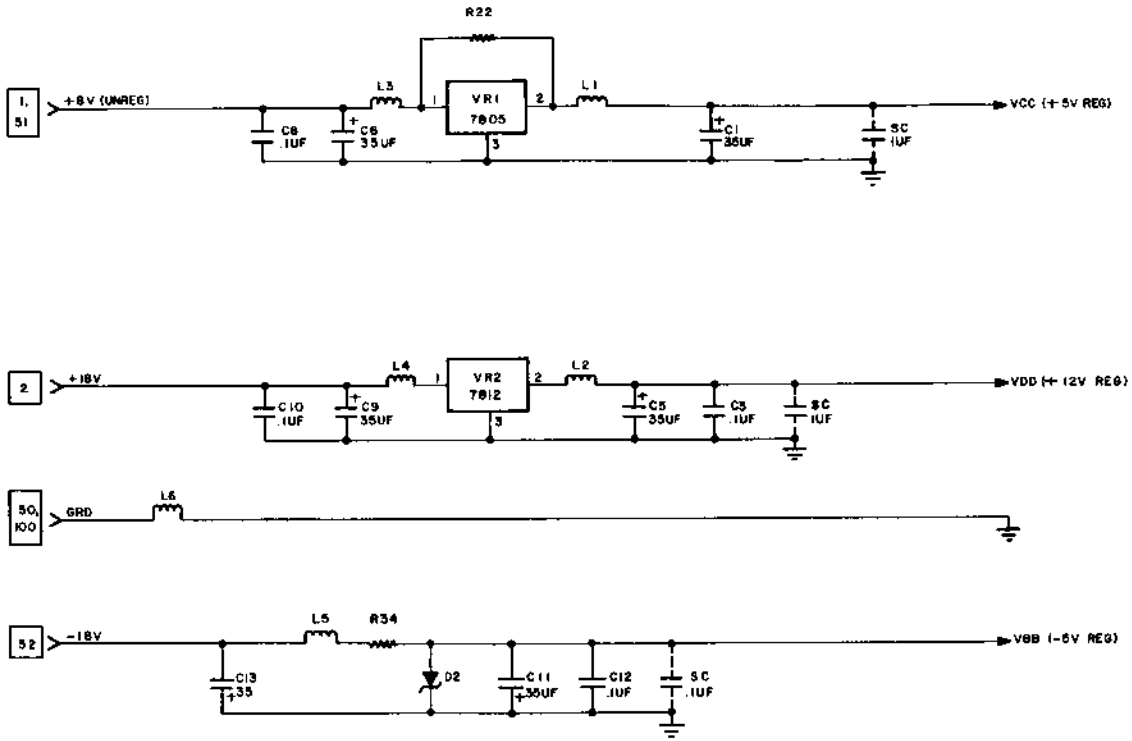
AC INPUT VOLTAGE CHART

| INPUT VOLTAGE | CONNECT AS FOLLOWS: |
|---|---|
| 100-130 VAC | USE COMMONING TABS BETWEEN PINS 4 & 2, 1 & 3, 7 & 9, and 8 & 10. |
| 100 VAC | ONE "F" WIRE CONNECTED TO PIN 10, THE OTHER "F" WIRE CONNECTED TO PIN 3. E1 CONNECTED TO PIN 7. E2 CONNECTED TO PIN 8. |
| 115 VAC | ONE "F" WIRE CONNECTED TO PIN 10, THE OTHER "F" WIRE CONNECTED TO PIN 3. E1 CONNECTED TO PIN 1. E2 CONNECTED TO PIN 8. |
| 130 VAC | ONE "F" WIRE CONNECTED TO PIN 10, THE OTHER "F" WIRE CONNECTED TO PIN 3. E1 CONNECTED TO PIN 2. E2 CONNECTED TO PIN 8. |
| 200-260 VAC | REMOVE ALL COMMONING TABS EXCEPT ON PINS 8 & 10. |
| 200 VAC | ONE "F" WIRE CONNECTED TO PIN 10, THE OTHER "F" WIRE CONNECTED TO PIN 3. E1 CONNECTED TO PIN 7. E2 CONNECTED TO PIN 9. |
| 230 VAC | ONE "F" WIRE CONNECTED TO PIN 10, THE OTHER "F" WIRE CONNECTED TO PIN 7. E1 CONNECTED TO PIN 1. E2 CONNECTED TO PIN 3. |
| 260 VAC | ONE "F" WIRE CONNECTED TO PIN 10, THE OTHER "F" WIRE CONNECTED TO PIN 3. E1 CONNECTED TO PIN 4. E2 CONNECTED TO PIN 2. |




ATTACHE' SCHEMATIC DIAGRAMS
AC WIRING

(TO BE SUPPLIED)



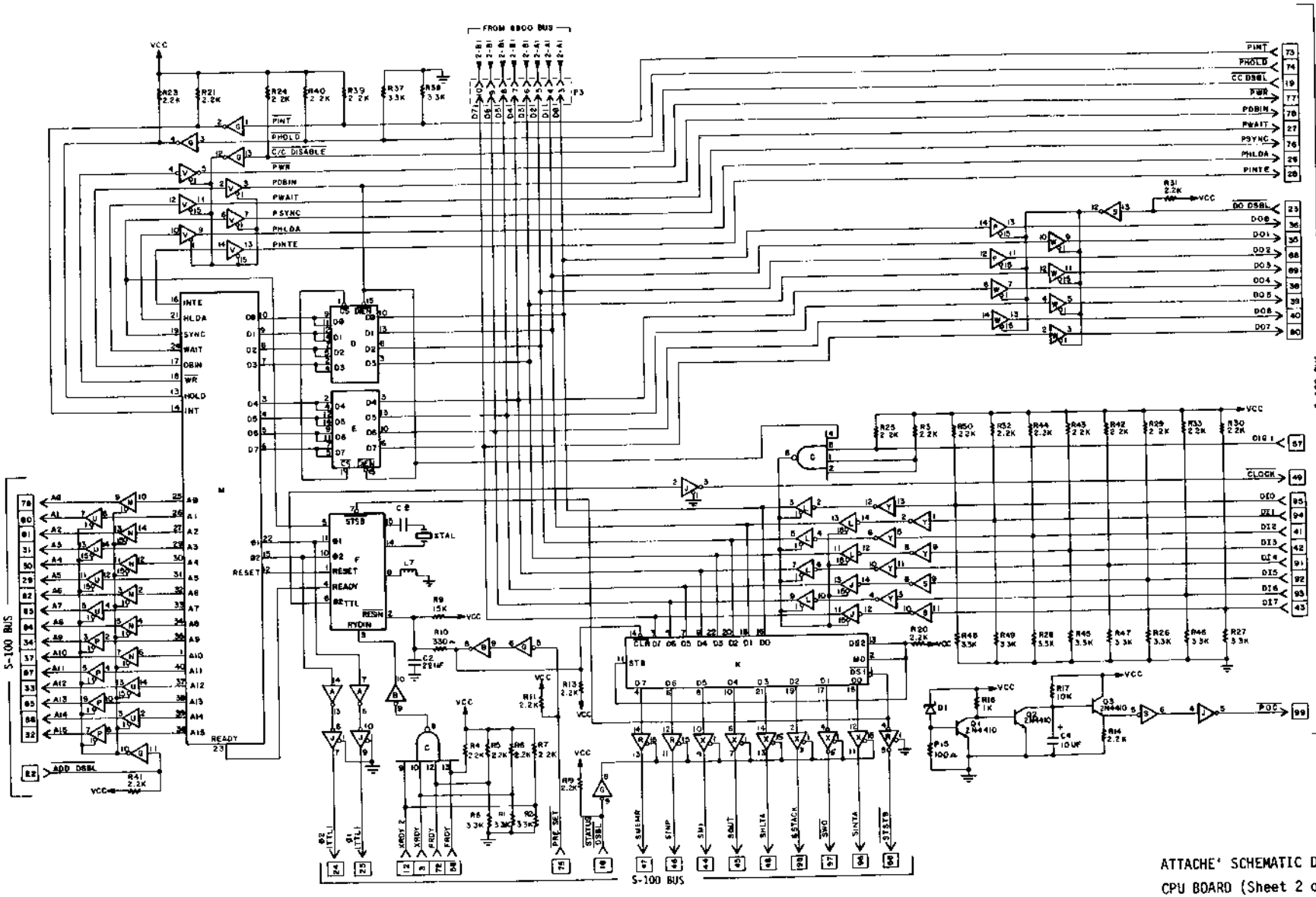

| REF DESIG | TYPE | VCC | GRD | OTHER |
|---|---|---|---|---|
| | | | | |
| G, B | 74LS04 | 14 | 7 | |
| C | 74LS13 OR 74LS20 | 14 | 7 | |
| S, Y | 74LS14 | 14 | 7 | |
| | | | | |
| P, W | 74367 | 16 | 8 | |

| REF DESIG | TYPE | VCC | GRD | OTHER |
|---|---|---|---|---|
| M | 8080A | 20 | 2 | |
| J, X, R, V, N, U, P | 74368 OR 8T98 | 16 | 8 | |
| K | 8212 | 24 | 12 | |
| D, E | 8216 | 16 | 8 | |
| F | 8224 | 16 | 8 | VDD = 9 |
| A | 4009 | 1 | 8 | VDD = 16 |

ATTACHE' SCHEMATIC DIAGRAMS
CPU BOARD (Sheet 1 of 2)



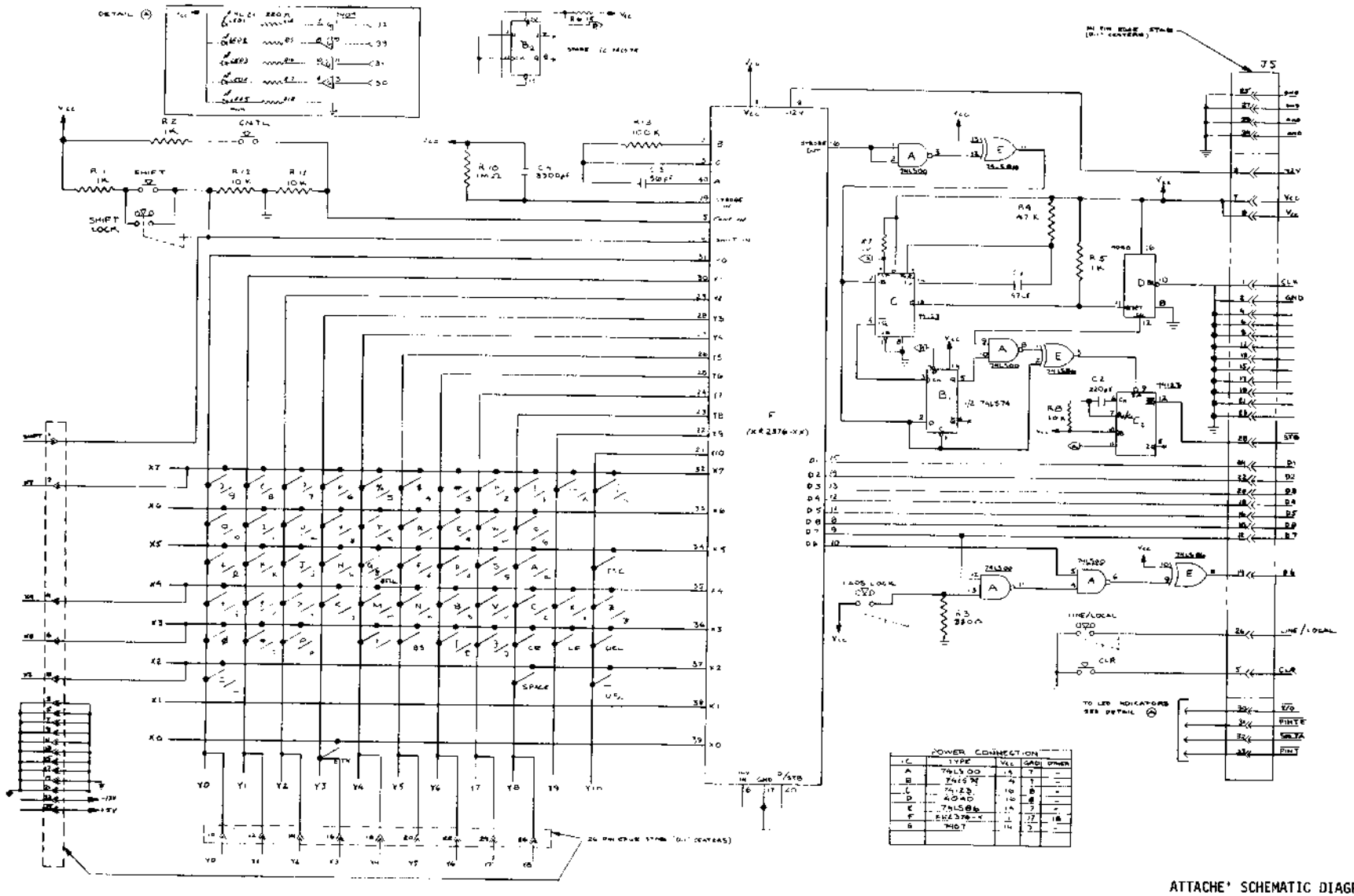
250272A



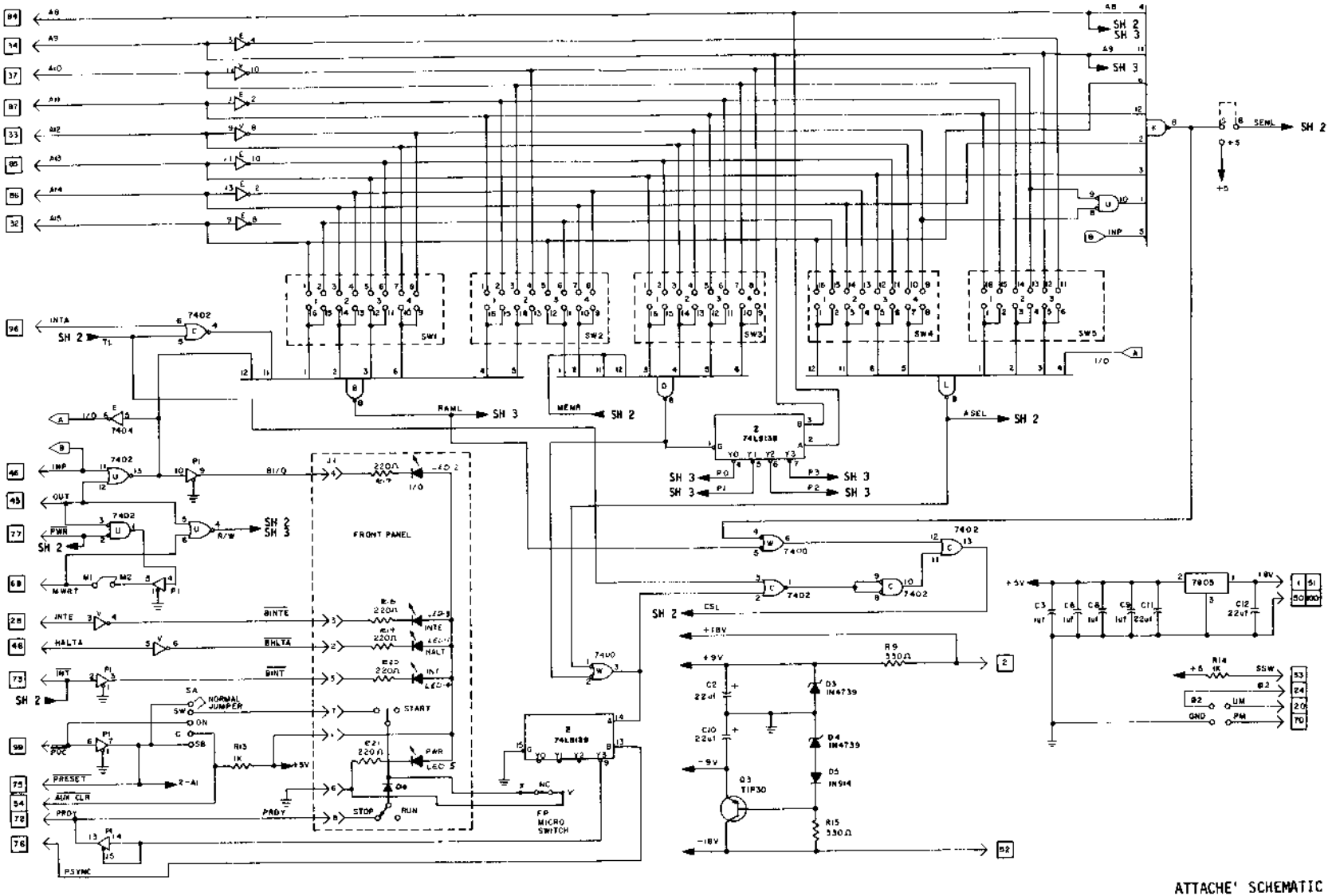

ATTACHE' SCHEMATIC DIAGRAMS
CPU BOARD (Sheet 2 of 2)

B-4

250272A



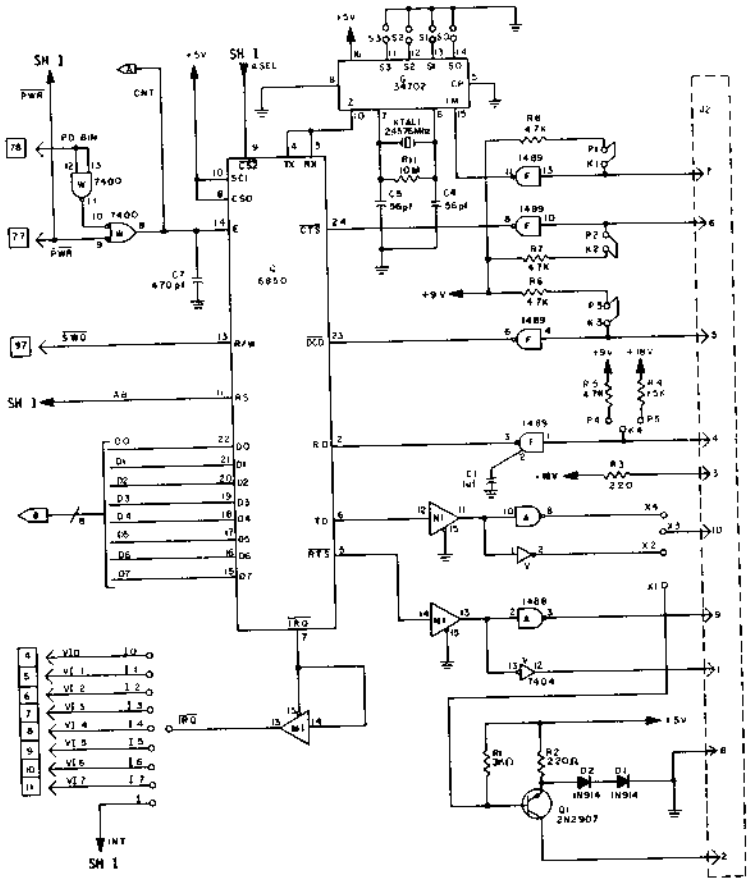
ATTACHE' SCHEMATIC DIAGRAMS
KEYBOARD

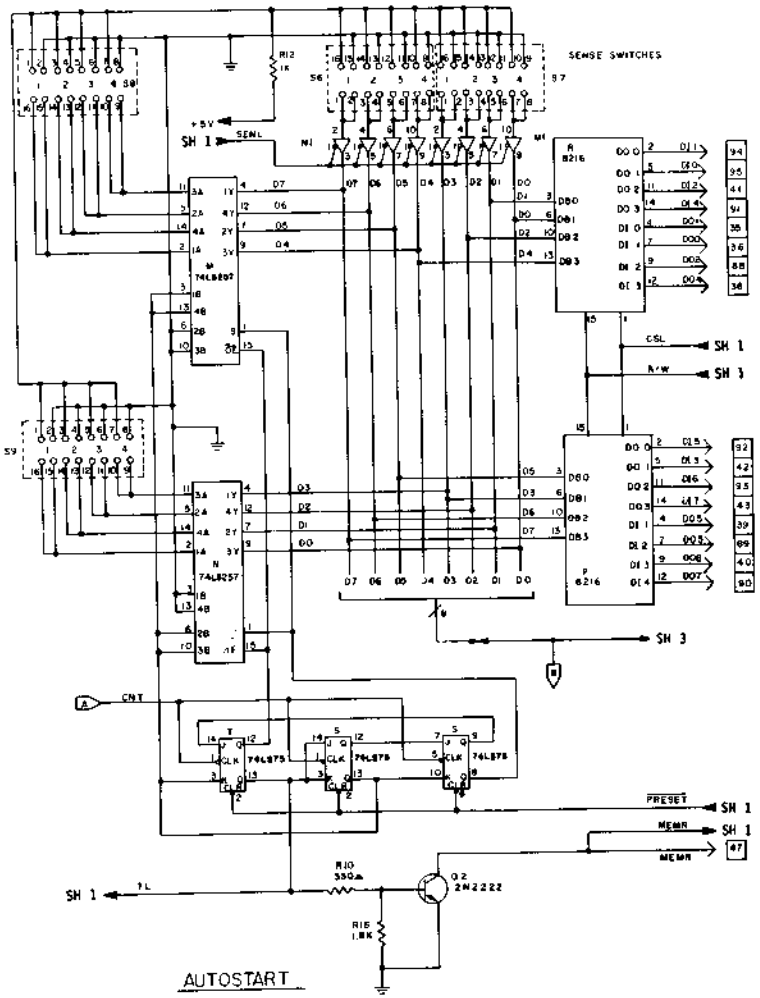



ATTACHE' SCHEMATIC DIAGRAMS
TURNKEY BOARD (Sheet 1 of 3)



250272A

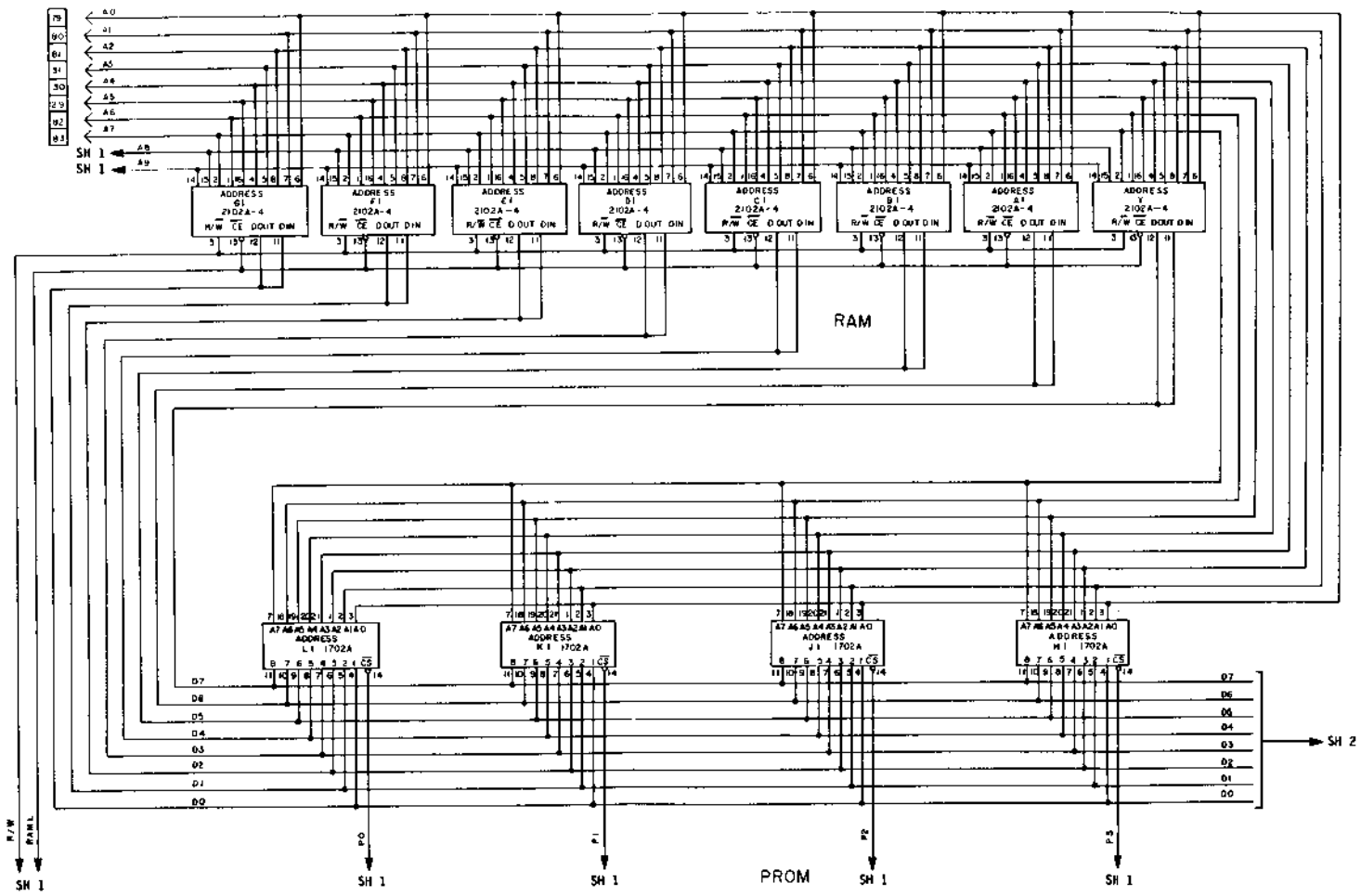



ATTACHE' SCHEMATIC DIAGRAMS
TURNKEY BOARD (Sheet 2 of 3)



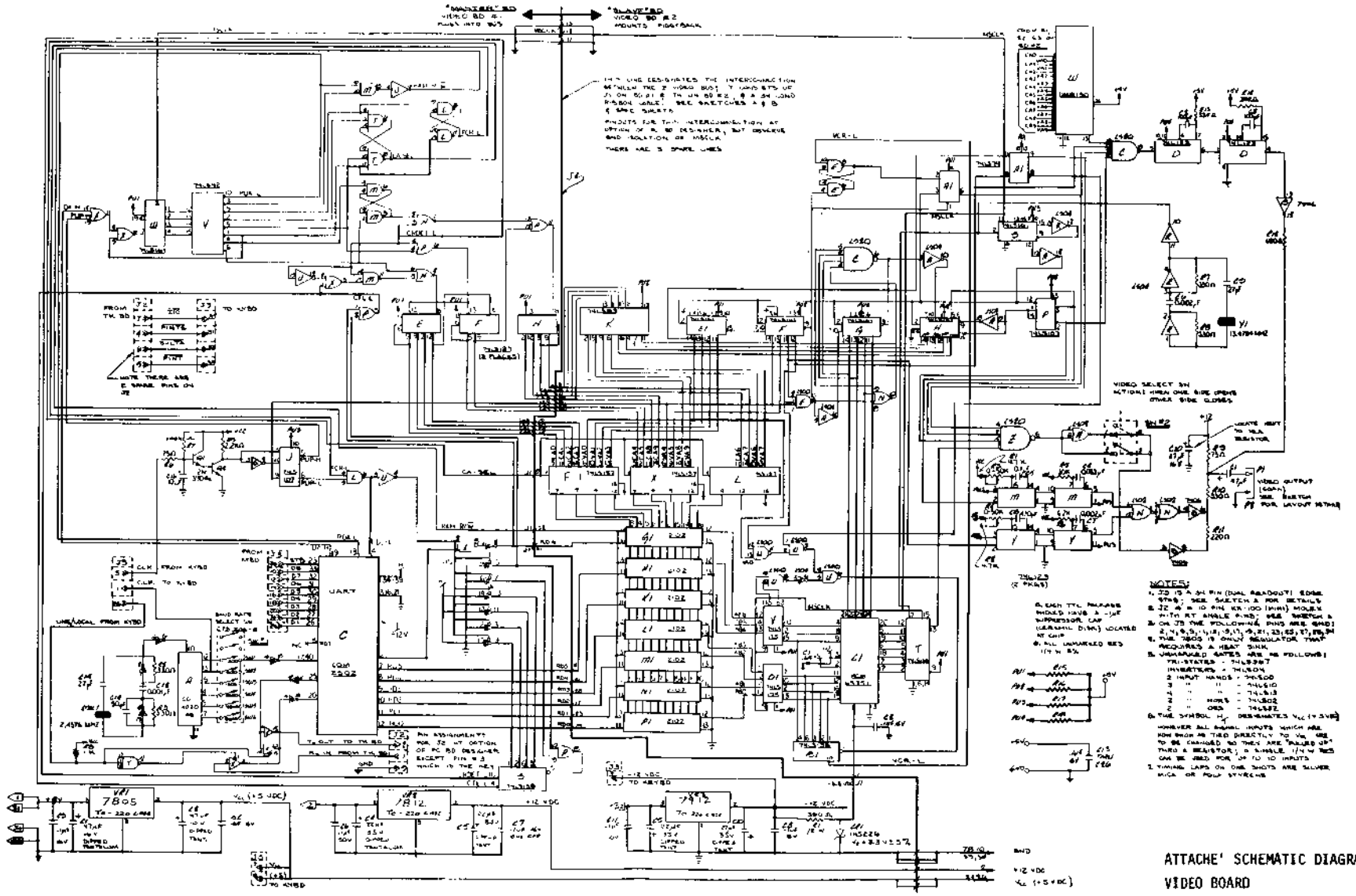
250272A




ATTACHE' SCHEMATIC DIAGRAMS
TURNKEY BOARD (Sheet 3 of 3)



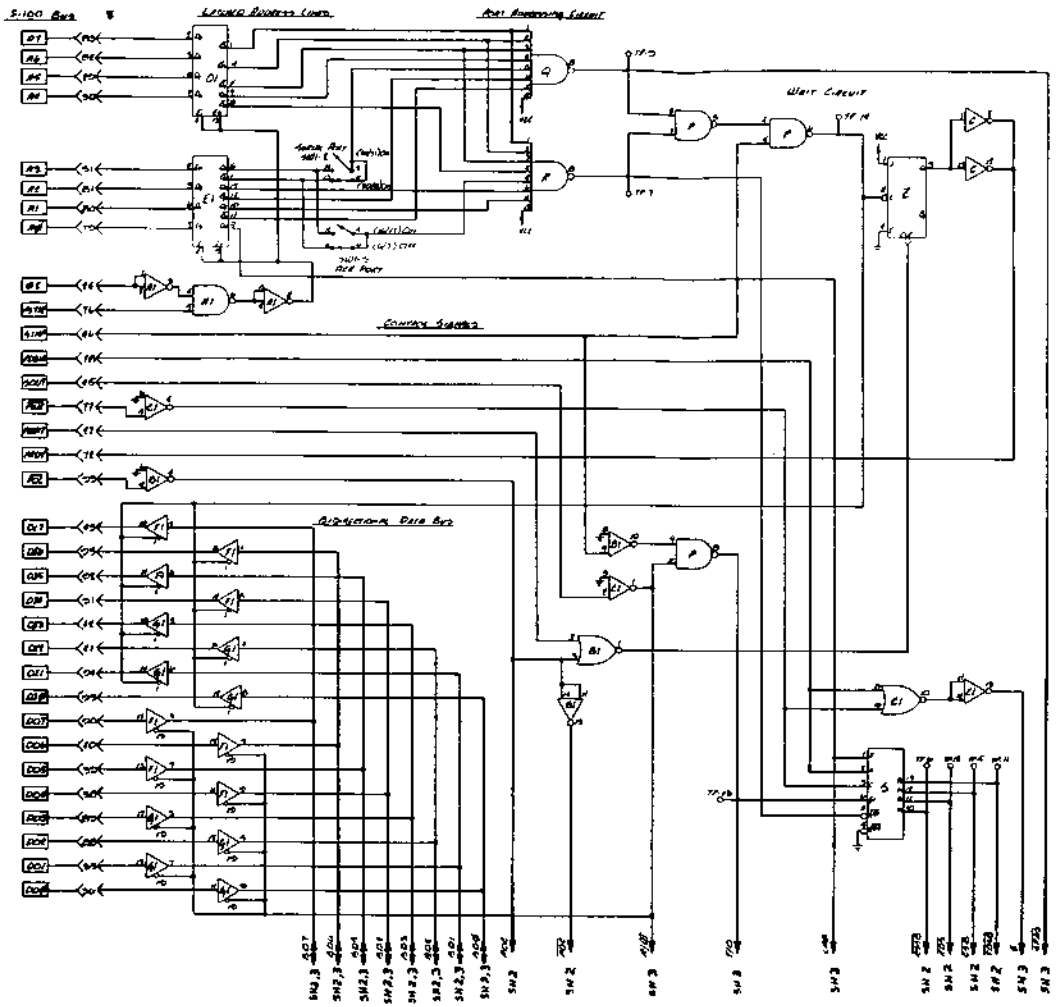
250272A



ATTACHE' SCHEMATIC DIAGRAMS
VIDEO BOARD



250272A



I.C CHART

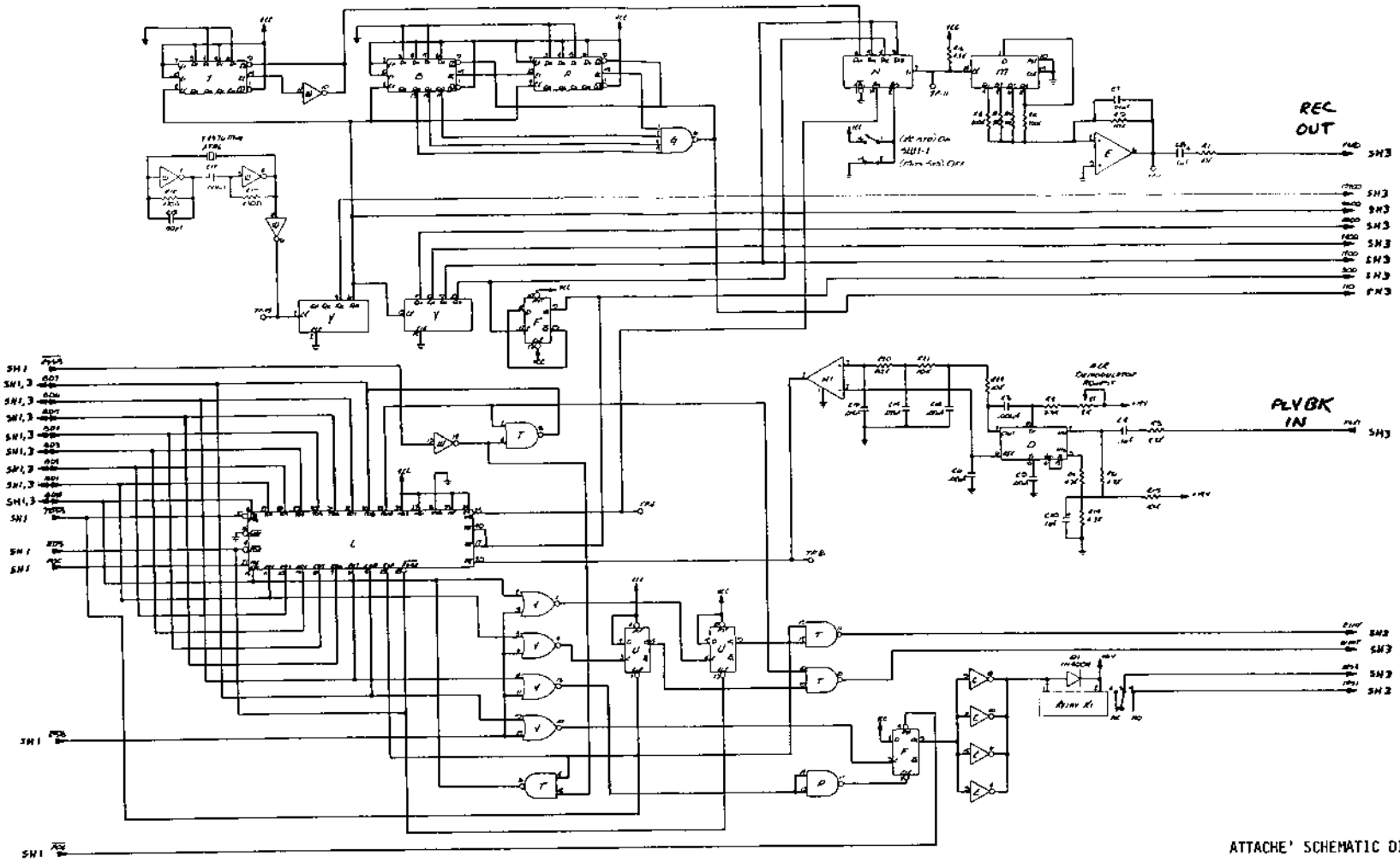
| I.C | TYPE | Vcc | GND | No. of Pins | +5V | -15V |
|---|---|---|---|---|---|---|
| A,B,A | 74LS241 | 16 | 8 | 16 | — | — |
| C | 7404 | 14 | 7 | 14 | — | — |
| D | CD4049 | — | 1 | 16 | 10 | — |
| E | (7725) | — | — | 8 | 1 | 6 |
| F,U | 74LS74 | 5 | 7 | 14 | — | — |
| G | 74LS20 | 14 | 7 | 14 | — | — |
| H | 1488 | — | 7 | 14 | 14 | 1 |
| J | 1489 | 14 | 7 | 14 | — | — |
| K | 8880 | 12 | 1 | 24 | — | — |
| L | MK4-4043 | 1 | 3 | 40 | — | 2 |
| M | 4081B | 14 | 8 | 16 | — | — |
| N | 74LS153 | 16 | 8 | 16 | — | — |
| P,Q | 74LS00 | 14 | 7 | 14 | — | — |
| Q,R | 74LS30 | 14 | 7 | 14 | — | — |
| S | 74LS138 | 16 | 8 | 16 | — | — |
| T | 74LS32 | 14 | 7 | 14 | — | — |
| V,O,E1 | 74H01 | 14 | 7 | 14 | — | — |
| W | 74H04 | 14 | 7 | 14 | — | — |
| Y | 74LS05 | 14 | 7 | 14 | — | — |
| Z | 74LS07 | 14 | 7 | 14 | — | — |
| D1,E1 | 74LS25 | 5 | 19 | 14 | — | — |
| F1,G1 | 74LS244 | 20 | 10 | 20 | — | — |
| H1 | CD811 | — | 4 | 8 | 8 | — |

ATTACHE' SCHEMATIC DIAGRAMS

88-UIO BOARD (Sheet 1 of 4)
ADDRESS SELECT CIRCUIT



250272A

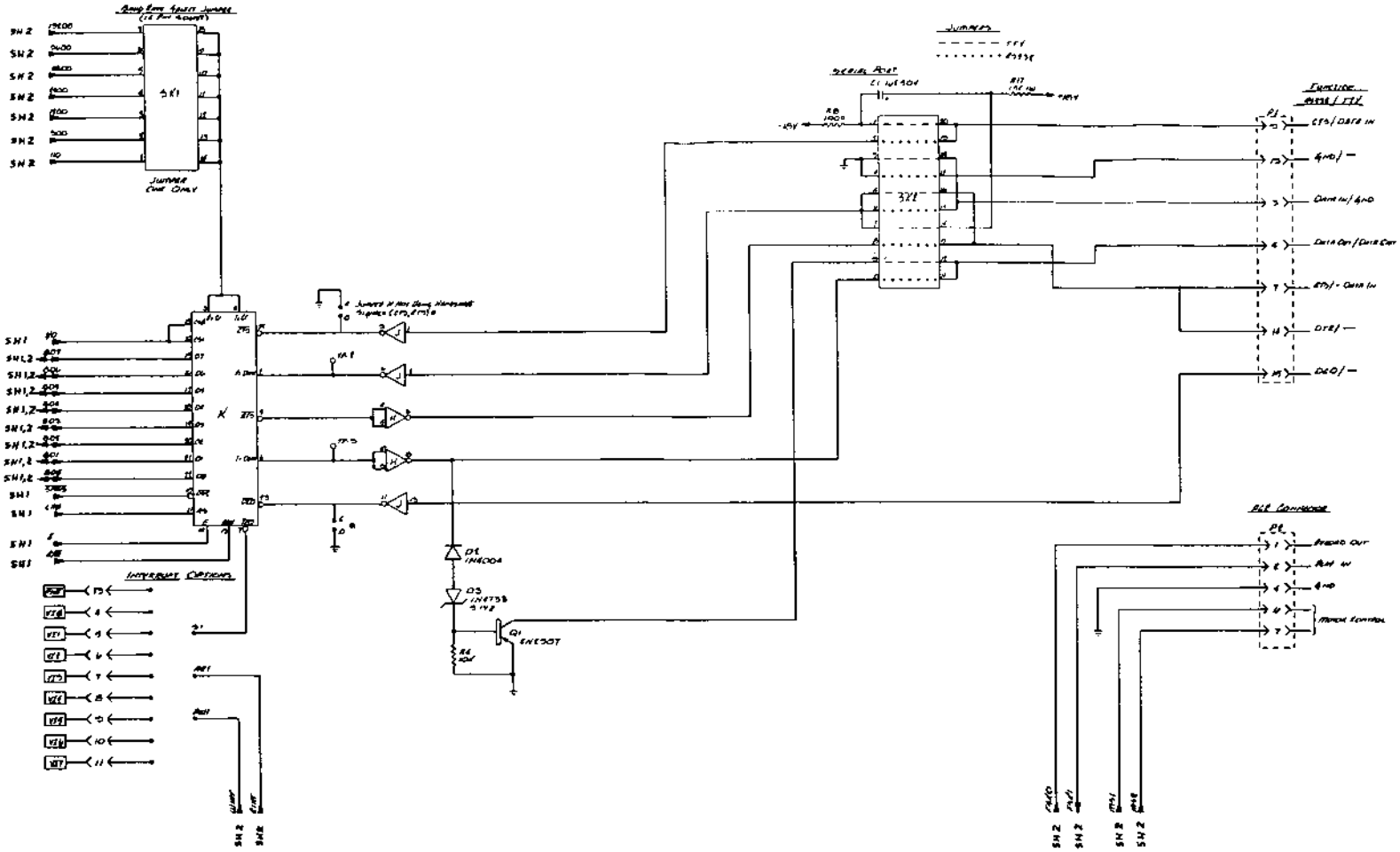



ATTACHE' SCHEMATIC DIAGRAMS

88-UIO BOARD (Sheet 2 of 4)
CLOCK & ACR CIRCUIT



250272A

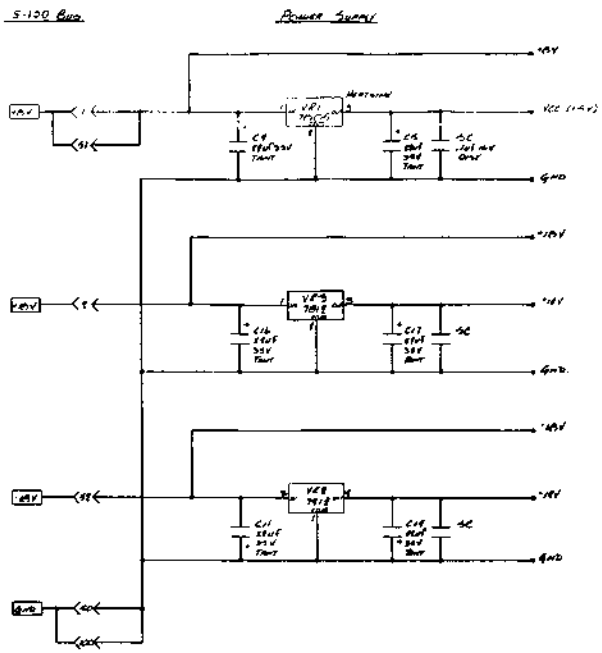


ATTACHE' SCHEMATIC DIAGRAMS

88-UIO BOARD (Sheet 3 of 4)
SERIAL & PARALLEL CONNECTIONS

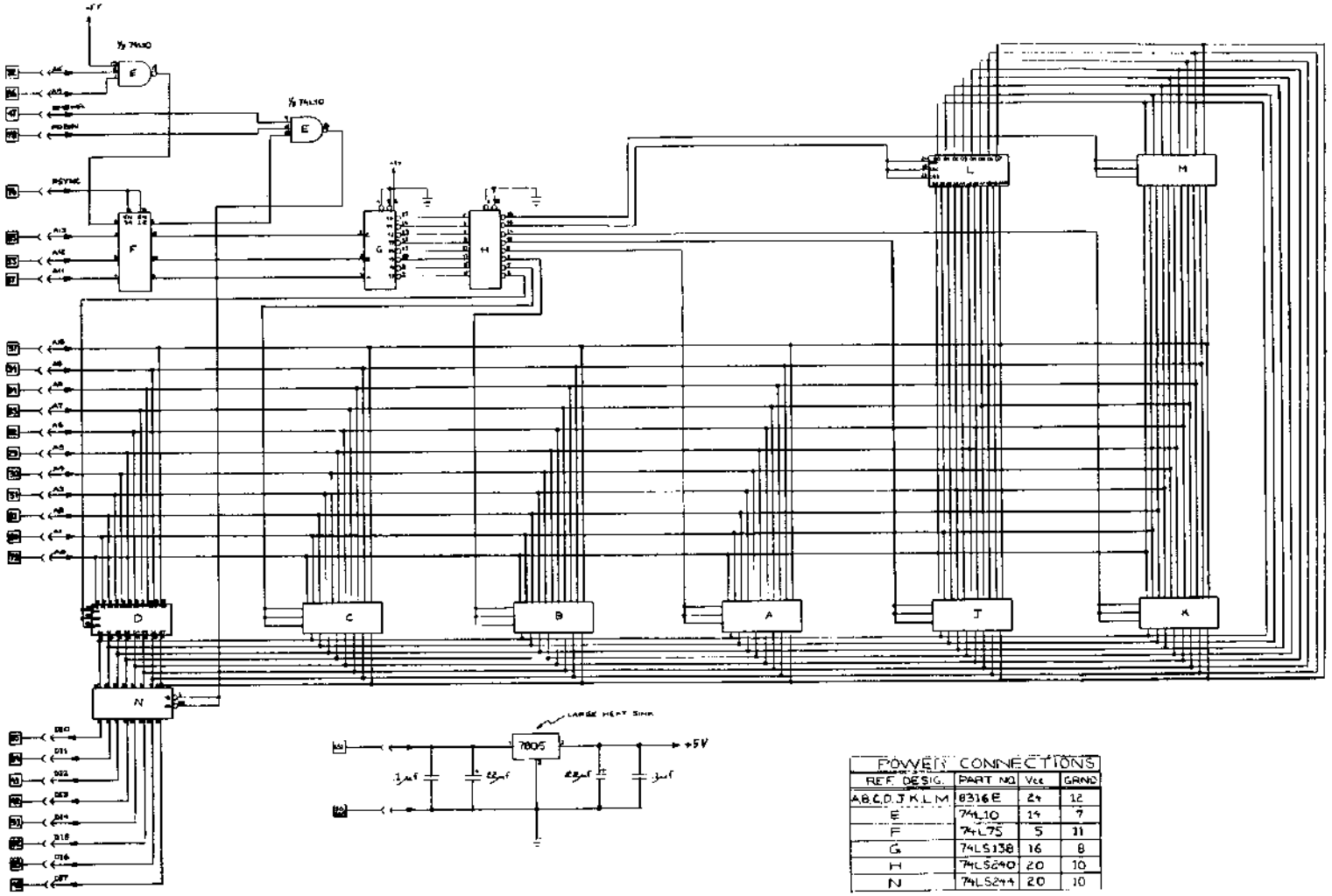


250272A




ATTACHE' SCHEMATIC DIAGRAMS

88-UIO BOARD (Sheet 4 of 4)
VOLTAGE REGULATION




| POWER CONNECTIONS | | | |
|---|---|---|---|
| REF. DESIG. | PART NO. | Vcc | GRND |
| A,B,C,D,J,K,L,M | 8316E | 24 | 12 |
| E | 74L10 | 14 | 7 |
| F | 74L75 | 5 | 11 |
| G | 74LS138 | 16 | 8 |
| H | 74LS240 | 20 | 10 |
| N | 74LS244 | 20 | 10 |

ATTACHE' SCHEMATIC DIAGRAMS
ROM BASIC BOARD



250272A