ATTAK 286™ MODEL 1A

TECHNICAL REFERENCE MANUAL

ADVANCED 286 MOTHERBOARD USING THE CHIPS AND TECHNOLOGY CHIPSET

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Trademarks

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Introduction to the ATTAK 286 Model 1A

The ATTAK 286 Model 1A is a complete PC/AT Professional Computer motherboard compatible with the IBM PC/AT (Registered Trademark of International Business Machines). The ATTAK 286 Model 1A provides not only this compatibility but improved performance and function. The ATTAK 286 Model 1A is a form fit and function equivalent and meets applicable commercial standards including FCC class B RFI emission standards.

A complete computer can be assembled by the addition of a cabinet, power supply, keyboard, video display adapter, disk controller, and disks to an ATTAK 286 Model 1A motherboard. The resulting computer is fully IBM PC/AT compatible and provides significant architectural and performance improvements.

This manual has been developed to assist the purchaser in obtaining the maximum from their ATTAK 286 Model 1A motherboard. The manual is divided into eight sections and nine appendices each covering a major topic. The manual is written in several experience levels from operating instructions for the casual user to the technical engineering level needed by system integrators and value added retailers. This broad range of information covers the large application base of the ATTAK 286 Model 1A motherboard.

Sections one through three are related to the description of the ATTAK 286 Model 1A and it's incorporation into a complete computer. These sections are needed if the user plans to assemble their own computer. They are written at a level which would allow a typical computer oriented person to assemble a system. Users are encouraged to read these sections before deciding if they are comfortable with assembling their own system. Many computer outlets use the ATTAK 286 Model 1A motherboard in their systems and allow users to purchase completely assembled and tested ATTAK 286 Model 1A computers.

Sections four and five cover the aspects of firmware and software. They also discuss compatibility issues and options that the user may select. These include adding custom firmware and software to the ATTAK 286 Model 1A and in improving execution of existing software.

Sections six through eight are for the technically inclined who like to really get into the computer. They cover how the ATTAK 286 Model 1A works and how to fix it when it has a problem. Section seven has troubleshooting procedures for users who by choice or necessity need to repair their system. These sections allow a detailed engineering analysis of the board and can give insight into the use of the ATTAK 286 Model 1A in applications not yet developed. These sections are written at a engineering level and are very thorough.

Finally, the manual is supported by nine appendices which include bulk information in condensed form including memory, I/O allocations and hardware schematics.

1.0 ATTAK 286 MODEL 1A Description

The ATTAK 286 Model 1A is a high performance 80286 based computer motherboard. The design is based on advanced Large Scale Integration (LSI) technology and is designed for reliable high speed operation at a reasonable cost. The design is fully IBM PC/AT computer compatible. The motherboard is designed to form the basis of a high performance, reliable, low cost personal computer.

The ATTAK 286 Model 1A is form fit and functionally equivalent to the Personal Computer industry wide standards of compatibility started by IBM. Advanced Intelligence Technology Corporation then developed and incorporated many performance and architectural improvements. Compatibility has been paramount in the development of the ATTAK 286 Model 1A. This was achieved by using the industry standard microprocessor, support components and firmware to achieve hardware and software compatibility. The performance and architectural improvements have been achieved through the use of advanced LSI technology. The architectural improvements where derived from evaluation of user and software/hardware developer suggestions.

1.1 Physical Dimensions

The ATTAK 286 Model 1A motherboard has the same physical dimensions as the IBM PC/AT. The board is approximately 12 inches wide by 13.8 inches long and weighs 1.2 pounds. The board has the same mounting holes as the IBM PC/AT and uses the same mounting hardware as supplied by the industry standard cabinet manufacturers. The position and connector types for all the external connections to the ATTAK 286 Model 1A are the same as the IBM PC/AT.

1.2 Microprocessor and Numeric Coprocessor cluster

The ATTAK 286 Model 1A uses an 80286 microprocessor and 80287 numeric coprocessor. These are the industry standard for personal computers. The 80286 provides upward software compatibility with the 8088 microprocessor of the PC/XT. The 80286 provides extra instructions and improved memory and I/O interfacing. The 80287 numeric coprocessor provides enhanced capability equivalent to the 8087 which it supersedes.

The 80286 microprocessor and 80287 numeric coprocessor are linked together to form a processor block capable of conventional data manipulation and advanced number crunching. The ATTAK 286 Model 1A has improved the design of the clock drivers to the processor cluster. This allows the optimum performance for various speed selection of microprocessor and numeric coprocessor by allowing them to operate at different speeds.

1.3 Chips and Technology LSI

The ATTAK 286 Model 1A uses the latest in technology including the Chips and Technology LSI chip set. This chip set reduces the number of integrated circuits on the motherboard by 75 parts. This results in lower manufacturing costs, improved switching speed, higher reliability, and most importantly increased space for architectural improvements.

The Chips and Technology chip set consists of five parts which perform most of the low level logic functions of the mother board. These include address and data buffering and control decoding as well as timing and command control development. The five parts are functionally divided to minimize interconnects and simplify packaging.

1.4 Memory

The ATTAK 286 Model 1A is equipped with 64 kilobytes of Read Only Memory (ROM) and 1 megabyte of Dynamic Random Access Memory (DRAM). The ROM sockets are designed to support different parts by the selection of two jumpers. The sockets are fully compatible with Basic Input Output System (BIOS) ROMs. The DRAM sockets are designed to support 64 and 256 kilobyte DRAMs with access times from 60 to 150 nanoseconds. Five jumpers are provided to allow memory size and speed selections.

The ROM sockets are 28 pin byte wide parts with two jumpers to allow the use of various parts. One jumper allows the use of either Masked Dynamic ROMs or static Erasable ROMs. The second jumper allows the use of either 16 or 32 kilobyte size parts. Typical parts are the 27128 and 27256 EPROMs and their equivalent masked versions. The ROMs must have an access time of 200 or 170 nanoseconds access respectively for 8 and 10 MHZ CPU speed selections.

The DRAM sockets are 16 pin 64 or 256 kilobit memory part pinouts. The address buffers and decoding are defined to support the two memory parts by the setting of two jumpers. These two jumpers select the type and memory allocation of the DRAM parts. Timing of the memory cycle is selectable by three jumpers. These jumpers allow the selection of RAS to address multiplex time, Address multiplex to CAS, and the overall length of the memory cycle.

1.5 Support components

The ATTAK 286 Model 1A motherboard uses the same support components used on the IBM PC/AT motherboard. These parts provide both hardware and software compatibility. The support parts provided on the ATTAK 286 Model 1A are suitable for clock speed operation of 8 and 10 MHZ. Operation of the ATTAK 286 Model 1A at 12 MHZ requires the replacement of some support components with selected high speed parts.

The support components of the ATTAK 286 Model 1A include two DMA controllers, Two interrupt controllers, A counter timer, Battery backed up clock and CMOS configuration RAM, and a single chip microcontroller. The DMA controllers provide 7 channels of direct memory access of which two channels are assigned for floppy and hard disk usage. The two interrupt controllers provide 15 interrupts at various levels of priority. Four of the 15 interrupts are preassigned leaving 11 interrupts for the user. The counter timer contains three 16 bit timer counters of which all are used by DOS. The user may install software that can use the 18.2 HZ timer tick. The battery backed up clock and configuration RAM are used to keep the date and time as well as hardware configuration information. The single chip microcontroller is used to handle the keyboard and to provide an interface to the front panel and some hardware jumpers for RAM and video selections.

1.6 Expansion slots

The ATTAK 286 Model 1A provides eight fully IBM PC/AT compatible slots. Two of these slots do not have the extra 16 bit data expansion connector so that older PC/XT boards with skirts will install correctly. These connectors can be added by the user if desired as the mounting holes and traces are present. The address, data, and control lines to the expansion connectors are fully buffered allowing the user to reliably use all eight slots. Power for the expansion connectors is provided via multilayer internal power planes providing excellent grounding and power capacity.

1.7 Firmware and software

The ATTAK 286 Model 1A is shipped with the industry standard Phoenix ROM BIOS with additional AIT installed utilities. The Phoenix BIOS is compatible with industry standard software and firmware. AIT has added to the Phoenix BIOS a ROM based Setup utility eliminating the need for a disk based program to set up the clock and configuration RAM of the mother board.

AIT does not supply the Disk Operating System (DOS) with the ATTAK 286 MODEL 1A. DOS may be purchased from nearly any computer dealer. The ATTAK 286 Model 1A will operate with almost any operating system or software written for the IBM PC/AT. This includes "UNIX" like operating systems such as XENIX (Registered trademark of Microsoft Inc.).

1.8 IBM compatibility

Compatibility was a major goal of the ATTAK 286 Model 1A design. Much effort was placed into maintaining compatibility with the IBM PC/AT standard design. The only significant incompatibility is the speed of operation. A very few programs exhibit a problem with the 33% speed increase from 6 to 8 MHZ (This is usually due to some form of copy protection.). Operation of the ATTAK 286 Model 1A at 10 MHZ does appear to cause some problems with a few games and some hardware interfaced drivers such as PROM programmers.

The software and firmware compatibility of the ATTAK 286 Model 1A is an industry leader. The use of the Phoenix BIOS, Chips and Technology LSI, and identical support components produces a motherboard that requires very special test software to detect any differences. Having all I/O address and memory allocations identical to the IBM PC/AT, as well as having the entry addresses to the BIOS the same, results in excellent compatibility.

2.0 Assembling the ATTAK 286 into a System

The user can assemble the ATTAK 286 Model 1A into a system by adding a cabinet, power supply, memory parts, keyboard, and expansion adapters. Many manufacturers provide the ATTAK 286 already assembled into a system at very reasonable prices. Additionally these value added retailers will provide turn key systems and maintenance in line with other computer dealers.

The assembly of an ATTAK 286 Model 1A into a system can be done with no more than simple hand tools. In most situations no soldering or manufacturing of cables or wiring is needed. The user should first read through this section and the section on adapters before starting. After reading these sections the user should make up a list of the parts needed for the assembly of their system. These parts should be obtained before starting assembly of the system.

2.1 Cabinet selection

The ATTAK 286 Model 1A is compatible with all IBM PC/AT style cabinets. Most cabinet manufacturers supply the needed hardware to complete a system. The user will probably have some extra screws and other parts left over after assembly. These should be saved for any future additions and revisions to the system. The user has many cabinet styles to chose from with the only significant differences being the power switch location, disk mounting brackets, cover installation, and quality.

The power switch can be located on the side or on the rear of the cabinet. The selection of the power supply dictates the cabinet selection or vice versa. The selection of the power switch location is more important than might be surmised. The position of the computer in the end configuration is very important in the selection of the power switch location. If the computer will be on a desk top with clearance on all sides then the side switch is more easily accessed. If the computer will be placed in a vertical under table mount or in an enclosed slide out cabinet or table then the rear power switch is preferred.

There are several different ways of installing disks in the cabinet. The standard method provides for one full height hard drive mounted behind the cabinet cabinet cover and a space for three 1/2 height drives with an opening for two of the drives to the outside on the right side of the cabinet. This cabinet is the largest of the selections and provides the most internal space. Another cabinet design eliminates the hidden hard disk area and makes the cabinet smaller. These cabinets usually are equipped with one 1/2 height hard disk and two 1/2 height floppy drives. The result of a smaller cabinet is useful in some space sensitive applications but it does limit the user to smaller hard disks as the larger capacity drives are usually full height.

The cover on the original IBM PC/AT is a slide on assembly with fasteners at the back of the cabinet. This approach makes access to the inside of the cabinet difficult. In applications were the user is not inside the cabinet frequently this cabinet (which is the lower cost choice) is preferred. A second cabinet style uses a hinged top allowing access to the cabinet by simply opening the top of the cabinet. These cabinets are useful in applications were the user must access the inside of the cabinet frequently. The fliptop cabinets do not have a good FCC emission rating and may not meet the FCC emission standards.

The quality of the cabinets and the hardware provided with the cabinet kits varies considerably. The cabinet kits include a variety of materials including card guides, connector covers, slot covers, battery box, disk drive mounts, front panel, and feet. Some kits are more complete than others and the user should be aware that you get what you

pay for. The cabinet is the most visible portion of the computer and should reflect the quality of the internal parts like the ATTAK 286 Model 1A.

2.2 Power supply requirements

The ATTAK 286 Model 1A has a very low power consumption allowing the use of 195 Watt power supplies with fully populated expansion slots. The use of power supplies of up to 275 Watts presents no problems as long as the user loads the expansion buss when using the large power supplies. Note that the power supplies are switching supplies and must have a minimum load to operate properly. Using a large power supply in a minimal system can cause problems so do not be led into a large supply unless you intend to load the expansion buss significantly.

The power supply is a sealed unit with a power connector and fan on the rear side. The fan provides cooling for the power supply as well as the computer cabinet. The power input connector is integral to the supply cabinet and uses the universal three prong connector. The third wire of this cable is connected to the cabinet and is a safety ground. Plug this connector only into a three wire power plug. To do otherwise will remove the electrical protection and shielding of the earth safety ground. There is also a power plug for the display monitor which is a special three wire connector to prevent incorrect connection to the power cable. This is usually used to power the video monitor although other uses are permissible. Adapters to run standard power plugs are available.

The power supply is installed into the cabinet by four screws that fasten the power supply to the back of the cabinet. The user should be careful not to trap any of the power wires under the cabinet of the power supply during installation. Route the wires of the power supply so that the disk cables are near the disk mounts and the motherboard connectors are out of the way for the installation of the motherboard. The cables consist of two connector with six wires each that provide power to the motherboard and two to four power cables with four pin connectors for powering the disk drives.

The two six pin connectors provide power for the motherboard and indirectly the expansion slot adapters. Both cables have black wires which are the ground wires. The location of these and the red + 5 Volt power leads is used to correctly orient the power connectors for installation. **WARNING: IMPROPER INSTALLATION OF THE POWER CONNECTORS CAN CAUSE PERMANENT DAMAGE TO THE ATTAK 286 MOTHERBOARD.** The black ground wires should line up side by side when the two cable connectors are correctly aligned for installation into the motherboards 12 pin connector. The resulting assembly of 12 pins should then install into the motherboard with the red + 5 Volt power wires on the side of the connector nearest to the center of the mother board.

The motherboard is equipped with polarized connectors but not all power supply manufacturers correctly key their connectors. In fact, some do not even cut off the universal keys and this must be done by the user. When there are doubts, the user should consult the connector pinouts in appendix F and the pinouts supplied by the power supply manufacturer to correctly define the cable connections.

The four pin power connector for the disk drives are designed to fit into the power connectors on the drive assemblies. These are polarized connectors that usually have four wires of which two are black. These are ground wires and some supplies only have one to save money. This has no significant effect as the drives always short these two inputs together. If you have purchased a supply with only two connectors and have more drives than

connector, there are sources of what are basically Y adapters that have a single female connector wired in a Y to two male connector for two drives.

Note that the power supply covers one of the board mounts that secure the motherboard into the cabinet. This board mount should be installed before the power supply is mounted in the cabinet otherwise it is difficult to install.

2.3 Configuring the memory

The ATTAK 286 Model 1A motherboard is designed to use various memory types and amounts. The user can configure the memory from 128 kilobytes through 1 megabytes of memory on the motherboard. Additional memory may be added to the expansion slots of the motherboard. There are two shorting jumpers that must be set to tell the hardware how much memory is located on the motherboard.

More than any other element, the users application determines how much memory will be needed to efficiently perform the desired function. Most applications will operate in 256 kilobytes of memory while improved performance may be achieved if more memory is present. There are virtually no applications that will not run in 640 kilobytes of memory as this is the limit for PC/XT computers. Many programs written before the IBM PC/AT have been adapted to the form of memory called Lotus-Intel-Microsoft Expanded Memory (Registered Trademarks of the respective companies) used in the Intel Above Board while others use the expansion slot memory addressed above the 1 megabyte address space of the PC/XT.

The on board memory can be configured for 128 kilobytes through 1 Megabyte of capacity. This is done by setting two shunting jumpers and populating the two banks of memory sockets with the proper memory parts. There are two banks of memory sockets on the ATTAK 286 Model 1A and they are labeled as bank 0 and bank 1. Each bank of memory contains 18 parts and must be fully populated to function correctly. Bank 0 and 1 can be populated with either 64 or 256 kilobyte memory parts depending on the jumper selections.

The 128 and 256 kilobyte memory capacities use 64 kilobyte memory parts in both banks. One bank of 64 kilobyte memory parts gives 128 kilobytes of memory, two banks of 64 kilobyte memory parts provide 256 kilobytes of memory. This configuration is the most economical and is very low cost. Additional expansion slot memory can be added if 256 kilobytes is installed. The 128 kilobyte mode does not allow additional memory to be added in the expansion slot, as the second bank of memory parts, while not populated, is not disabled.

The 512 kilobyte memory configuration is based on populating bank 0 with 256 kilobit memory parts. This configuration allows the expansion of the memory by expansion slot adapters. The 640 kilobyte memory configuration is obtained by adding 64 kilobit memory parts to bank 1 with 256 kilobit memory parts in bank 0. This configuration provides a full lower memory equivalent to the PC/XT and is the best configuration for the ATTAK 286 Model 1A.

The 1 megabyte memory configuration is based on both bank 0 and bank 1 having 256 kilobit memory parts installed. This memory allocation splits the memory into 512 kilobytes in lower memory and 512 kilobytes in memory addressed above the 1 megabyte address boundary. This configuration is useful with programs that use the extended memory to exceed the 640 kilobyte memory barrier of the XT. The user cannot configure the 1 megabyte memory into 640 kilobytes and 384 kilobytes, as this is not supported by the Chips and Technology chip set.

2.4 Configuring the board jumpers

There are many jumper configurable options on the ATTAK 286 Model 1A motherboard. These jumpers should be set before the motherboard is installed in the cabinet. Although most of the jumpers are accessible when installed, it is easier to set them before the board is mounted in the cabinet. A complete listing and description of the setting of these jumpers is covered in appendix E of this manual.

The ATTAK 286 Model 1A comes with all the shorting jumpers needed to configure the motherboard. These jumpers are available from many sources if they are lost and wire wrap may be substituted if needed.

2.5 Adding the numeric coprocessor

The 80286, like most microprocessors, is good at handling byte and word data but is relatively poor at handling floating point number crunching. The 80287 numeric coprocessor adds the necessary hardware to the 80286 microprocessor to allow a ten fold improvement in numeric number crunching. The 80287 numeric coprocessor may be located under the hard disk mounting bracket in some cabinets so it should be installed before the motherboard is installed in the cabinet.

There are several speed grades for the 80287 numeric coprocessor. These refer to the speed of the clock that runs the numeric rather than the speed of the 80286 microprocessor. There are two clocks into the 80287 numeric coprocessor, one is for microprocessor synchronization and the other is for internal processing in the numeric coprocessor. The ATTAK 286 Model 1A, unlike most motherboards, supports running the numeric coprocessor and microprocessor at different speeds. This option is selectable by shorting jumpers discussed in Appendix E.

The 80287 numeric coprocessor speed grades are 6, 8 and 10 MHZ allowing the user a 60 % increase in numeric performance at very little expense. The user simply buys the high speed numeric and then sets the jumpers as needed.

The software and interrupt interface of the numeric follows the IBM PC/AT format and is fully compatible. This includes all exception and fault interfaces used by many computer aided design and simulation programs.

2.6 Cabinet mounted components

There are several cabinet mounted components including the battery box, front panel, disk drives, cable connectors, and the speaker. These elements are mounted all over the cabinet and the following notes are generalized to assist the user in deciphering whatever instructions that may be supplied with the cabinet kit.

The Speaker may be mounted in various places in the cabinet. The most common spot is between the card guide mounting plate and the front of the computer. This allows simple cabling to the speaker connector. Caution should be exercised when handling the speaker so as not to damage the paper cone or bend the metal frame of the speaker. This damage will either cause the speaker to not work or the sound to be distorted. The direction the speaker cone is facing when mounted makes little difference to the outside volume. The plastic speaker holder from most kits are mounted with a self tapping screw along with a single pin for alignment.

The front panel consists of a switch and two LEDs (Light Emitting Diodes). The switch locks the keyboard when shorted, preventing unauthorized use of the computer. One LED (usually green in color) indicates power and the other LED (usually red in color) indicates access to the internal hard disk drive.

The keyboard lock switch is an input to the keyboard controller and can be read by software which is actually inhibiting the keyboard entry as the keyboard still sends data to the motherboard. The power LED is powered by the motherboard and indicates power from the +5 Volt lines only. The drive select LED is connected to a connector on the dual floppy and hard disk controller and is not connected to the motherboard.

Some cabinets include a front panel reset switch which may be connected to J10 which is located beside the reset switch mounted on the motherboard.

The battery box holds four AA batteries used to provide battery backup to the motherboard. This is usually equipped with double sided tape allowing the holder to be mounted to the side of the power supply. Caution: place the box so that access to the extra connector openings in the rear of the cabinet are not blocked by the battery box. The ATTAK 286 Model 1A has a battery holder for two 3 volt lithium coin cell batteries. These will provide backup of the clock and configuration RAM although the external battery box provides a longer battery life. **DO NOT put batteries in the external battery box and the motherboard battery holder at the same time, as this may damage the motherboard and/or the batteries.**

The mounting of disk drives is done by a slide arrangement to help prevent placing stress on the drive frames. The older mounting used in the XT caused stress on the frame of the disk drives and sometimes resulted in poor disk operation. The slides are attached to the sides of the disk drive and then the drive is slid into the slots on the cabinet. Note that the slides are polarized and can be mounted as needed to position the drives so that the front of the drives is located properly with respect to the front cabinet bezel. There are small metal brackets (held in place by screws) that are used to hold the drives captive in the slides.

Note that some cabinets require the removal of the front bezel of the hard disk drive to be removed before installation in the cabinet. If the front cover will not seat properly, then the user should check this area for clearance.

The routing of the disk cables can be a problem as most are either too long or too short. The floppy disk cable is designed so that the farthest connector from the disk controller card is drive A: and the other connector is drive B:. The hard disk has two sets of cables. One is a parallel cable with multiple connectors similar to the floppy cable. The other is designed for one drive at a time. A small cable must be provided for each hard disk drive. The standard hard disk controller card can control only two hard drives and two floppy drives. Both the floppy and the hard drive cables have a twist in the cable between the two drive connectors; the floppy cable has lines 10 - 16 reversed, and the hard drive cable has lines 25 - 29 reversed.

2.7 Keyboards

There are as many keyboards for the personal computer as there are computer applications. The user is advised to shop with their fingers by trying the keyboards they are planning to purchase. The ATTAK 286 Model 1A can operate with any IBM PC/AT compatible computer keyboard. The user should therefore try several keyboards and then buy the one that is best for his use.

The major differences in keyboards are the number of keys, position of function keys, separate numeric keypad, tactile feedback, and special options. The keyboard of the IBM PC/AT is actually a small computer containing a single chip microcomputer. The microcomputer scans the keys and performs debounce functions. The number of keys is

somewhat application dependent. Users of word processing systems usually use the extra keys as single key commands to simplify fast editing while touch typing. A small number of keys may be useful to hunt and peck typists who get lost on large keyboards.

Some special keyboards have appeared with features such as built in bar code readers and voice recognition. These keyboards are very application specific and should not be purchased unless a real application exists.

2.8 Expansion slot adapters

There is an explosion in the use of personal computers with hundreds of applications available which were not dreamed of when it was originally conceived. This is possible because the IBM PC/AT has expansion slots in which interface cards can be installed. An industry has developed to generate expansion slots cards for almost any application. There is a basic set of expansion cards used in most computers which are discussed in section three of this manual.

The cards selected for installation in the ATTAK 286 MODEL 1A motherboard should be assembled and examined for interconnect cabling. The disk controller card usually is located as close to the drives as possible to simplify cabling. There are cables to the drives and the front panel. The other cards that may have additional cables include multifunction and multiprocessing interface cards which require more connectors than can be fit on the back of the card.

3.0 Expansion slot adapters

The design of the personal computer from the very beginning was based on the concept of a base unit adapted to the users needs by add in I/O cards. The original PC had only five 8-bit slots. The ATTAK 286 Model 1A has eight full length expansion slots. Six are 16-bit and two are 8-bit. This section is intended to cover the most common cards used to build a system. The system can be configured in a very large number of ways, some of which will not work. This section is intended to assist the user in selecting the components needed for the desired application.

3.1 Video display adapters

The most visible adapter is the video display adapter and monitor. There are two basic display modes and two major divisions of display technology. There are alphanumeric only and alphanumeric and graphics displays. The display technologies are monochrome and color. The adapter chosen for the system determines what display can be connected and what future upgrades can be made.

The three most common display cards in present use are the color card, enhanced color card, and the Hercules Graphics card. Each of these cards requires special displays and cannot usually be interchanged. There are some multifunction display cards that can emulate each of these adapter cards. There are other display cards but they are limited in their use to special applications. There are new multiformat video monitors which can operate with all of these display cards.

The color card is the most used display adapter in the PC. This adapter is an alphanumeric and graphic display driver with both monochrome and color capability. The color card has two text modes of 80 characters by 25 lines and 40 characters by 25 lines. These display formats can be operated in monochrome or color modes. Two graphics modes are commonly used and are 640 by 200 monochrome and 320 by 200 color. A maximum of 4 colors can be on the screen at the same time. The color card can use conventional TV monitors in low resolution modes, a monochrome composite monitor, or a RGB digital color monitor.

The enhanced color card is a second generation version of the color card. The card can be operated as a color card using the same monitors as the color card or in an enhanced mode. The enhanced mode requires a special monitor to use the enhanced display modes. The enhanced text displays provide better resolution characters than the color card with total color card compatibility. The graphics modes include a 640 by 350 display with 16 colors from a palette of 64. This mode requires software written for the card and is not compatible with color card software.

The Hercules graphics adapter is a monochrome only adapter designed early in the PC/XT period and is one of the best monochrome only adapters. More software has been written for this adapter than any other display adapter other than the color card. The text display mode of 80 characters by 25 lines (using 9 by 14 cells) is the best of any display. This adapter is very good for text editing. The graphics mode of this adapter is 720 by 350 with two pages of display. This graphics mode is very usable in low cost CAD and business graphics applications. The adapter requires a TTL monochrome display monitor.

The user planning to use the computer for games should choose the color card as most of the games have been written for this format. The business user should consider the Hercules adapter due to its high quality display and graphics when monochrome is selected. For businesses using color the enhanced color adapter is the best choice.

3.2 Disk controllers

There are several disk controller adapters available for the ATTAK 286 Model 1A including the original adapters for the PC/XT. The standard adapter for the IBM PC/AT is the combined floppy and hard disk controller. This controller allows the use of 5 1/4 floppy disks of 360K and 1.2 megabyte capacity as well as 3 1/2 inch disks of 720K and 1.4 MEGABYTE capacity. The controller handles virtually all of the full and half height hard disks available. The limitation here is the disk tables of the BIOS which define the number of heads, cylinders, and track density.

The Hard disk controller of the XT computers will function properly in the ATTAK 286 Model 1A although much slower. The controller is defined as a drive type of 0 (no hard drive) in the configuration RAM. The BIOS finds the controller during the initialization and does not need the configuration definition. The floppy controller of the XT may be compatible with the ATTAK 286 Model 1A depending on the BIOS. The XT controllers will not operate with the high density 1.2 megabyte disk drives.

The combined hard floppy disk controllers are all compatible with the ATTAK 286 Model 1A. This card is the best disk interface as it provides full disk compatibility and the high speed data transfers. The card also supports the front panel drive select LED which the XT cards do not support.

3.3 Tape controllers

Hard disk backups require a large number of floppy disks and can be very time consuming. Tape drives have been developed for the PC to solve this problem. These drives can be internal or external but the controller cards are inserted into the expansion slots. The 1/4 inch format for the tape is the preferred format. There are also 9 track tape drives available with controller cards that allow the use of main frame computer tapes.

3.4 Parallel printer interfaces

The most common printer interface to the PC is the parallel printer interface. This interface consists of 8 data lines, a strobe, and printer status lines. The interface is very standardized so that almost any of the parallel printer ports will work on the ATTAK 286 Model 1A. There can be some problems (mainly timing related) with this interface. The strobe duration and printer time outs are software based and are affected by CPU speed.

3.5 Serial interfaces

The RS-232 serial interface is based on the 16450 or the 8250 and is very standardized. The major difference in the serial interfaces is the connector configuration. Some are female and some male without any significant reason. The user can correct the configuration problem with a cable adapter.

3.6 MODEM cards

The use of telecommunications has exploded with the advent of personal computers. The ability to link a PC to the main frames of the country and to data bases is a very powerful feature. There are two basic MODEM formats and a new format emerging. These are the 300 and 1200 BAUD and the 2400 BAUD data transfer modes.

The data transfer modes are actually known by AT&T and international standard name, but most computer users simply use the data transfer rates to identify the format. The AT&T 103 standard has a data transfer rate of 300 bits (30 characters) per second and is the most reliable format. The AT&T 212 format has a data transfer rate of 1200 bits (120 characters) per second and is

the most popular format. The latest format is the V2.4 which has a data transfer rate of 2400 bits (240 characters) per second and is fast but is not always reliable over most phone lines.

The expansion slot modems fall into one category, Hayes compatibility. The Hayes company developed a MODEM that uses commands transferred over the same serial link used for data transfer. This simplified the control of the MODEM by software and has become the industry standard. The user should purchase a Hayes compatible unless special software that does not support the Hayes is needed. The MODEM cards usually have two RJ-11 modular telephone plugs, one for the telephone line and one for the users telephone.

3.7 Memory expansions

The ATTAK 286 Model 1A is capable of accessing up to 16 megabytes of memory of which 15 megabytes can be located in the expansion slots of the mother board. The expansion memory cards available for the IBM PC/AT will work in the 8 MHZ ATTAK 286 Model 1A. When operating the ATTAK 286 at 10 MHZ and above there are some memory cards that may not work properly.

3.8 Multifunction adapters

The multifunction adapters combine the functions defined above into a single board. The most common combination is two serial ports, a parallel port, game adapter, and a block of memory expansion. This memory can be added to the lower or upper address space. Multifunction adapters are useful only when the expansion slots are filling up and the user needs extra space.

4.0 Firmware

The ATTAK 286 Model 1A comes equipped with 64 kilobytes of Firmware stored in 27256 Erasable Read Only Memory (EPROM). This code is written in assembly language and is used to initialize the computer after power up and to provide consistent I/O interfacing for the operating system and user applications. The Firmware is called the Basic Input Output System or BIOS for short.

4.1 ROM BIOS

The ROM BIOS is divided into several sections each with a specific task. The major sections are initialization, diagnostics, and I/O services. The initialization sets up the hardware of the ATTAK 286 Model 1A to a known configuration. The diagnostics test the hardware of the ATTAK 286 Model 1A and report errors via two methods. The I/O services support the operating system and user applications. These services are called by loading registers and executing an INT n instruction. A complete discussion of the BIOS interrupt calls is provided in Appendix C.

4.2 Keyboard Controller

The keyboard controller is an 8742 single chip microcomputer programmed to read the keyboard and interrupt the 80286 when a key code is ready. Data is received serially from the keyboard by the 8742 and presented to the 80286 as a byte. Data may also be written to or read from the 8742s on chip RAM. Commands may be sent to the keyboard through the 8742. These include programming special function keys with data sequences to be sent when the function key is pressed.

The 8742 communicates with the 80286 through a status register, an input register, and an output register. The status register is an 8-bit read only register accessed by an IN AL,64H instruction. Commands may be written to the 8742 by executing an OUT 64H,AL instruction with the data in the AL register of the 80286. Data or parameters for commands to the 8742 may be written with an OUT 60H,AL instruction. Key codes may be read from the 8742 with an IN AL,60H instruction. The status register bits are defined as follows:

BIT 7: If set then the 8742 detected a parity error.
BIT 6: If set then the 8742 timed out attempting to receive a data transmission from the keyboard.
BIT 5: If set then the 8742 timed out attempting to send a command to the keyboard.
BIT 4: If zero then the keyboard is inhibited.
BIT 3: This bit reflects the address of the last write to the 8742 from the 80286. If I/O address 64H was used then this bit is set, or if I/O address 60H is used the the bit is cleared.
BIT 2: Set or reset by the 80286 for use during exit from protected mode.
BIT 1: If zero then the 8742 input buffer is empty and the 80286 may write a command or data to I/O address 60H or 64H. If one then the 80286 must wait for the 8742 to take the previous byte written.
BIT 0: If zero there is no data available to the 80286 in the 8742s output register. If one a key code or data is waiting to be read.

The 8742 uses software timing loops to communicate with the keyboard and is therefore sensitive to the system clock speed. The 8742 that is presently being shipped is good for speeds to 10 Megahertz. The keyboard clocks data into the 8742 serially. A counter/timer is used to "timeout" transmissions between the keyboard and controller that fail. The timeout periods will be too short if a clock input to the 8742 greater than 10 megahertz is used.

The keyboard sends data to the controller as 1 start bit, eight data bits, 1 parity bit and 1 stop bit. The keyboard supplies the clock on a line separate from the data line. If the 8742 receives a byte of data from the keyboard with a parity error it will issue a resend command to the keyboard. If a keyboard transmission does not occur within a fixed time (dependent on system clock speed) then a hex FF will be placed into the keyboard buffer.

The 8742 uses the byte at offset 20H in its on chip RAM as a command byte. The 80286 may write to this byte to change the operating mode of the 8742. A command of 20H will cause the 8742 to place the contents of the command byte into its output buffer. If keyboard interrupts are enabled, the keyboard interrupt routine in the 80286 ROM bios will attempt to use the status byte as a key code. If keyboard interrupts are disabled, an IN AL,60H will read the command byte from the buffer once the status register indicates output buffer full. An OUT 64H,AL instruction with AL containing 60H followed by an OUT 60H,AL with AL containing the new command byte will update the command byte.

The bits of the command byte are:

BIT 7: reserved -- write as a zero.
BIT 6: IBM PC compatibility mode -- not supported by BIOS at this time. If this bit is set then scan codes received are converted to those used by the IBM PC.
BIT 5: IBM PC mode -- not supported by BIOS at this time. If this bit is a 1 then the 8742 does not check for parity, convert scan codes, or send commands to the keyboard.
BIT 4: Writing a 1 to this bit tells the 8742 to disable the keyboard.
BIT 3: Writing a 1 to this bit overrides the above keyboard inhibit function.
BIT 2: The value written to this bit is placed in bit 2 of the status register for use by the 80286 BIOS.
BIT 1: RESERVED for input buffer empty interrupt, write a zero to this bit.
BIT 0: Output buffer full interrupt. A 1 must be written to this bit to enable keyboard interrupts.

Commands accepted by the 8742 are:

00-1F will read a byte from the 8742 on chip RAM. The command is written to I/O address 64H and the data is read from I/O address 60H. The data is read from the location in 8742 RAM calculated by adding the command to the value at the offset of 2BH in the 8742 RAM. 2BH is initialized to 20H at power on.

20-3F will read a byte from the 8742 on chip RAM using the command as an address. A command of 20H will read the command byte. A command of 2BH will read the byte used as a base address by commands 00 through 1F and commands 40 through 5F.

40-5F will cause the next data byte received by the 8742 to be written to a location in the 8742 RAM calculated by subtracting 40H from the command and adding the value stored at 2BH in the 8742 RAM.

60-7F will cause the next data byte received at I/O address 60H to be written to the 8742 RAM address calculated by subtracting 40H from the command. A 60H written to I/O address 64H followed by a byte written to I/O address 60H will replace the command byte.

AA commands the 8742 to perform a self test. If the self test is passed, a 55H is placed into the output buffer. If the self test fails, the next command must be a 0AAH self test command and the keyboard remains disabled.

AB commands the 8742 to test the two interface lines to the keyboard. The

result placed into the output buffer is coded as follows:

00 No error detected.
01 The keyboard clock line is always read as low.
02 The keyboard clock line is always read as high.
03 The keyboard data line is always read as low.
04 The keyboard data line is always read as high.

AC dumps 16 bytes from the 8742 unless interrupted by another command.

AD commands the 8742 to disable the keyboard. Bit 4 of the command byte at offset 20H of the 8742 RAM is set to indicate that the keyboard is disabled and the 8742 will drive the keyboard clock line low.

AE commands the 8742 to enable the keyboard. Bit 4 of the command byte is cleared and the keyboard is allowed to drive the clock and data lines.

C0 commands the 8742 to read its PORT 1 I/O lines and place the result into its output buffer. Bits 0-3 are no connect. Bit 4 is 0 for 256k RAM on motherboard and 1 for 512k RAM on motherboard based on jumper J18. Bit 5 reads jumper J15 on the mother board. Bit 6 reads jumper J11 on the mother- board as an indicator of primary display adapter, 0 for color card or 1 for monochrome card. Bit 7 reads pin 4 of jumper J21 to get the state of the keyboard lock.

D0 commands the 8742 to read its PORT 2 I/O lines and place the result into its output buffer. Bit descriptions are under command D1 below.

D1 commands the 8742 to write to its PORT 2 I/O lines the contents of the next data byte written to I/O address 60H by the 80286. A 0 written to bit zero will make reset active to the 80286 and hold it active until power down. A 1 should be always written to bit 0. Bit 1 controls the A20 address gate used for PC compatibility. Bit 2 is an input and should be written as a 1. Bit 2 reflects the state of jumper J19. Bit 3 is a no connect. Writing a 1 to bit 4 enables the output buffer full interrupt signal to IR1 of the 8259 interrupt controller. A 1 should be written to bit 4 for the BIOS keyboard interrupt to work properly. Bit 5 is for an input buffer empty interrupt and is a no connect. Bit 6 is clock out and is inverted before arriving at pin 1 of the keyboard connector to drive the keyboard clock line. Bit 7 is data out to the keyboard.

E0 commands the 8742 to read its T0 and T1 and place the results in the output buffer. T0 is the keyboard clock and is placed in bit 0 of the output buffer. T1 is the keyboard data line and is placed in bit 1 of the output buffer.

F0-FF commands the 8742 to pulse bits 0-3 of PORT 2 with the data taken from the low nibble of the command. For example, the command FE will reset the 80286. This is used by the BIOS to exit from protected mode by resetting the 80286. A code is stored in the CMOS clock RAM and the system flag is set in the 8742 command byte.

4.3 Setup Utility

A setup utility has been added to the ROM BIOS of the ATTAK 286 Model 1A. This setup utility is entered by pressing the CTRL, ALT, and INS keys simultaneously. The exit from setup is to press the ESC key which will cause a system reset. **Do not attempt to run setup in protected mode.**

On entry to the setup utility, various options that may be set into the battery backed up RAM of the CMOS clock chip are displayed on the console screen. Press the up or down arrows to move from one option to the next. Press the right or left arrow keys to toggle options. The time and date must be entered in exactly the format shown with no carriage return. If an error is made while entering time or date then

the cursor returns to the beginning of the data entry field and the date or time must be entered correctly before continuing with the setup.

If a fixed disk does not exist, then its type must be set to zero. This is also the setting for XT hard disk controllers that install themselves via firmware. The first time that setup is run, all options should be changed and then set correctly to prevent invalid data being stored in the battery backed up RAM. **CAUTION: An incorrect fixed disk type may cause loss of data on the fixed disk.** The fixed disk must be first formatted at the physical level, have FDISK run to assign a segment for the operating system, and the soft format run on the disk before the drive will be recognized by the BIOS.

When the ESC key is pressed, the setup data is stored in the battery backed up RAM of the CMOS clock chip and then a far jump is made to F000:FFF0. As the machine reboots, the new setup values are read from the CMOS clock chip.

The setup utility is located at offset zero in the ROM. It occupies less than 4k bytes of ROM leaving the area from 1000 to 7FFF empty. The area from 8000 to FFFF contains the PHOENIX BIOS.

4.4 Utilities disk

The utilities diskette provides the format software for the hard disk using the combined hard floppy disk controller card and an alternate setup utility. The IBM utilities disk will function with the ATTAK 286 Model 1A although there may be an error reported on the system board due to the different BIOS code check sum and copyright notice. These are not errors only differences required to comply with copyright laws.

The utilities disk is booted on the first floppy drive and will prompt the user for input. The format utility is used to perform a physical format on the hard drive and should only be used on new or crashed hard disks.

4.5 ROM BASIC

The IBM PC/AT has Microsoft BASIC in the BIOS ROM and it starts the BASIC if it can not boot the operating system from disk. Advanced Intelligence Technology does not provide ROM BASIC.

4.6 IBM Compatibility

The ATTAK 286 Model 1A firmware is compatible with all major industry standard software and operating systems for the IBM PC/AT. The Phoenix BIOS and compatible hardware of the ATTAK 286 combine to provide as close to 100 % compatibility as is possible without violating IBM copyrights.

5.0 Software

The ATTAK 286 Model 1A is designed to function as a form fit and function compatible with the IBM PC/AT computer. All software written to the industry standards will work on the ATTAK 286 Model 1A with two exceptions. Software that uses direct calls to the ROM BASIC and speed sensitive routines will be incompatible. The programs that use direct entry to the ROM BASIC violate the intent of IBM in the use of firmware. The speed related problems are usually caused by routines that perform either hardware I/O or copy protection schemes.

5.1 Diagnostics

The ATTAK 286 Model 1A is provided with built in ROM based diagnostics and hardware for automated external diagnostics. The ROM BIOS performs extensive diagnostics after power up to determine if a problem exists. These routines report problems in one of two ways, first by speaker beeps and second by displayed messages.

The Phoenix BIOS performs some initial hardware tests before the status of the display adapter has been determined. Since the display is not available and the hardware for the speaker is so simple it was determined to use beeps as a means of informing the user of hardware faults that are very severe. When a fault is less severe then a display message is provided that is generally terse but sufficient to define the problem. A list of the beep codes, display messages, and their probable causes is provided in section 7.2 on trouble shooting.

5.2 Disk Operating System

The ATTAK 286 Model 1A is compatible with all operating systems compatible with the IBM PC/AT. These include IBM DOS and Microsoft XENIX (Registered trademark of Microsoft) a derivative of UNIX (Registered Trademark of AT&T corporation). The Disk Operating System (DOS) is loaded by the BIOS and provides a uniform environment for applications software.

The reasons for this uniform environment are many, but the most common is ease of transportability of software, user consistent interface, and simplified software development. The average user sees the advantages of the operating system as a simple interface to the power of the computer. The most common operating system is the Microsoft DOS also known as IBM PC-DOS. This DOS is supported by the industry almost to the exclusion of all others.

Purchasers of IBM PC-DOS are provided with a manual that covers the operation of the DOS including booting and execution of application programs. The DOS operating system is continually being improved and as each improved version is made available then a new version number is assigned. The most supported version is DOS 2.1 although the present version in release is DOS 3.2 which incorporates many improvements over DOS 2.1. FOR PROPER OPERATION OF THE ATTAK 286 Model 1A, DOS 3.0 OR LATER IS REQUIRED.

DOS 3.0 provides the combinations of the CP/M (Registered trademark of Digital Research) and UNIX operating systems into a single DOS. DOS 3.2 adds to these features, the hooks for local area networks and multiformat disks. There are also minor additions in utilities such as keyboard programming, file manipulation, and program development.

DOS may be booted directly from the distribution floppy disk by placing the disk in drive A: and resetting the system. DOS may also be transferred to the hard disk so that the operating system can boot from the hard disk. The DOS manual provides information for installing the DOS on hard disks.

5.3 DOS Utilities

The Disk Operating System is supported by a number of utilities. The most important of these is the Command Interpreter. The Command Interpreter is how the user first communicates to the operating system before an application program is loaded. Other utilities include a sort program, filter programs, keyboard control programs, editor, disk format program, Debug program, and BASIC.

The majority of these utilities are used by programmers to improve productivity and may never be used by the casual user. Examples are the Sort and filter programs. The Sort utility allows the user to sort an input and provide the sorted input to some output. The filters work like the sort in that an input is filtered and put to an output. DOS 2.1 and above provide what is known as standard I/O. The user can define input as the keyboard, a file, or a hardware device and output can be defined as the display, a file or a hardware device.

The keyboard programs allow the user to redefine the function of the keyboard keys. This includes defining the keyboards as foreign with special symbol keys. These were developed to allow the user more control over the keyboard.

The editor is a very simple, and to some people intolerable, line based text editor. The editor is provided to allow the generation of text files such as autoexec.bat and config.sys although some users like using it for software development. The editor has basic insert, delete, move, and file merge capabilities.

The program debugger (Debug) is provided to allow the user to trace programs developed by the user and others and to debug and setup certain hardware related elements. Debug allows the user to trace code, display memory, perform input and output, and control binary files. Debug also includes a mini assembler and disassembler that is available to the user. The user is cautioned about using Debug as it can easily crash DOS.

5.4 Disk BASIC

The ROM BASIC contained in the IBM PC/AT is limited in it's capability especially in the disk file capability. Therefore a disk based BASIC was developed and can be used on the ATTAK 286 Model 1A. The disk based BASIC is available as GW-BASIC and by other names and is compatible with the IBM PC/AT disk BASIC.

Programming in disk BASIC is recommended for new users as this programming language is easy to learn and is very versatile. There are many books covering programming in disk BASIC and the user should obtain one of these before deciding on disk BASIC.

5.5 IBM Compatibility

The ATTAK 286 Model 1A is as software compatible as is possible without violating IBM copyrights. The only significant incompatibility is ROM BASIC and speed incompatibilities. The ROM BASIC can be obtained from various sources and installed although disk BASIC and compiled BASIC are preferred over ROM BASIC. Speed related problems are overrated as very few software manufacturers do not want their software to run as fast as the competition. If a user finds a package that doesn't run the user should contact the software manufacturer and see if a speed rated version of the program is available. Many software publishers fix speed problems in later versions of their software.

6.0 Theory of Operation

This section covers the operation of the ATTAK 286 Model 1A at the technical level. The ATTAK 286 Model 1A is a sophisticated high performance personal computer using complex Large Scale Integration and a forth generation microprocessor. The design is compatible with the industry standard IBM PC/AT with increased performance and architectural enhancements.

6.1 Block Diagram overview

A block diagram of the ATTAK 286 Model 1A is provided as figure 6. This block diagram will be used to provide an overall view of the design and the data flow of the ATTAK 286 Model 1A. The design is based around the Chips and Technology Chip set which uses five integrated circuits to integrate over 75 Small Scale Integration (SSI) and Medium Scale Integration (MSI) parts used on the IBM PC/AT. The block diagram shows these five parts as separate blocks which are described in detail in appendix G of this manual.

By referring to the block diagram, the overall relationships of the major blocks of the ATTAK 286 Model 1A can be seen. The CPU and numeric cluster is located in the lower right portion of the block diagram. This cluster contains an 80286 microprocessor and 80287 numeric coprocessor. The cluster is supported by the Chips and Technology Chip set which surrounds the CPU and Numeric cluster. The block diagram shows this relationship of the chip set with the CPU and numeric cluster very well. This relationship also appears in the schematic of the the ATTAK 286 Model 1A.

The 82C201 is a CMOS part that provides the timing and CPU control decode of the chip set. The part is equipped with two crystals that define the general OSC frequency and the CPU speed. The OSC signal is used to develop timing for the board so that the CPU speed can be changed without affecting fixed timing functions such as the timer counter inputs. The OSC frequency is set to 14.31818 MHZ to be compatible with the XT and the IBM PC/AT. The CPU crystal can be set at 12 through 24 MHZ which results in CPU speed of 6 through 12 MHZ. The 82C201 must be speed compatible with this crystal frequency as they are 8 and 10 MHZ parts and some 10 MHZ parts that can be selected to run at 12 MHZ.

The 82C202 is a CMOS part that provides decoding of the address ranges and develops control signals for the real time clock. The address decoding is used to define the on board memory addresses and to decode some of the on board peripherals chip selects. The part interfaces with the 82C201 for certain status and interrupt functions including DRAM refresh. The decoding of the type and memory locations of the ROM and DRAM are defined to the 82C202 by two inputs driven by jumpers J18 and J19. There are four memory allocations defined by these jumpers and they are described in appendix E. The decoding of the on board peripherals involves detecting the addresses for the real time clock and the emulation registers of the 8255 emulation.

The 82A204 is a bipolar part that provides address buffering and multiplexing for the chip set. The first function of the part is to provide latching of the address from the CPU during the status cycle of the CPU. This address is available for only one clock period and must be made stable for buss and local memory use throughout the buss cycle. The part also provides the address multiplexing for the DRAM memory. This involves multiplexing the row, column, and an internal refresh counter into a 8 bit multiplex buss. The part as mentioned also has an eight bit refresh counter used in place of the DMA channel 0 used on the PC/XT. There are three address busses supported by the 82A204 which are labeled the S, X, and CPU address

busses. The S address buss is used on the expansion slots and is bidirectional to allow buss masters to send addresses to the motherboard. The X address buss supports the on board peripherals and the ROM. This buss is bidirectional so that the DMA controllers can generate address to both the expansion buss and the local memory. The CPU buss is unidirectional as the CPU can only generate addresses.

The 82A205 is a bipolar part that provides the data buss buffering and byte control logic. The data buss buffering allows four busses labeled S, X, M, and CPU data buss. The S buss is the expansion slot data buss and is connected to the byte control logic. The X data buss connects the on board peripherals of the motherboard and connects to the byte control logic. The M data buss feeds the ROM and DRAM of the motherboard and is not connected to the byte control logic. This is done to reduce any propagation delays in the byte control logic. The CPU data buss is the central focus of the buss drivers connecting the CPU to the rest of the hardware. The byte control logic handles the conversion of 8 bit devices to the 16 bit buss of the 80286. This is done for compatibility with the older PC/XT.

The on board memory of the ATTAK 286 Model 1A is divided into ROM and DRAM. The two memories are connected to the M data buss together but receive their address and control signals from separate sources. The ROM receives its decode from the 82C202 directly and uses the X address buss. The ROM control is very simple, just a chip select enable and address combined with the read data signal from the 82C201 chip enable the ROM. The DRAM on the other hand requires considerable timing and decode support. This logic is shown between the 82C202 decoder and the DRAM and contains jumpers described in appendix E to set DRAM timing. The address for the DRAM is developed in the 82A204 and is a multiplexed 9 bit buss. The 82A204 provides 8 bits while a separate multiplexer provides the ninth bit.

The Expansion buss consists of eight connectors wired in parallel and connected to the address, data, and control signals of the motherboard. The 82A203 is a bipolar part of the chip set that buffers and coordinates the control on the expansion buss. The part works with the on board peripherals and the 82A204 and 82A205 to complete the expansion buss interface. The expansion buss is fully IBM PC/AT compatible.

Finally, the ATTAK 286 Model 1A contains the standard set of peripherals on the motherboard to support the basic computer functions. These include DMA, Interrupts, Timing, Keyboard interface, and configuration storage. The DMA is supported by two 8237 DMA controllers and support hardware providing 7 channels of DMA. There are 15 interrupts supported by two 8259 interrupt controllers that provide vectored 8086 maskable interrupts. Timing is provided by an 8254 three channel timer counter and a battery backed up MC146818 real time clock and storage RAM part. This part also provides configuration storage for the ATTAK 286 Model 1A. Finally there is an 8742 single chip microcontroller that provides keyboard interfacing as well as process monitoring and reset control.

6.2 CPU and Numeric Cluster

The ATTAK 286 Model 1A uses the industry standard Intel 80286 microprocessor and companion 80287 numeric coprocessor. These two parts are designed to operate as a single piece of hardware as far as the programmer is concerned. The 80286 microprocessor is optimized for data manipulation and program control using byte and word size variables. Software can perform more complex math and data conversion but is slow in comparison to the numeric coprocessor. The numeric

coprocessor is optimized for number manipulation using an 80 bit floating point format. Together, the cpu and numeric cluster forms a powerful processing core with approximately 1 Mega Instructions Per Second (1 MIPS) performance.

Referring to the schematic, the user will find the CPU and numeric cluster on the right side of sheet two of the schematic. The 80286 microprocessor is housed in a 68 pin package of either the pin grid or leaded chip carrier formats. The 80286 is reference designator U24 on the schematic with the numeric coprocessor as U25. The numeric coprocessor and microprocessor share the same data and address buss as well as the numeric coprocessor monitoring some of the control lines of the 80286 microprocessor. The numeric coprocessor is housed in a 40 pin dual inline package.

The 80286 is designed to append the 80287 to itself during power up after the reset signal application. During this period the 80286 looks to see if the numeric coprocessor is present by a hardware handshake test. If the 80287 is present then the 80286 sets an internal flag and allows numeric instructions to function. If the numeric coprocessor is not present then a flag is reset and the 80286 faults numeric instructions to an exception vector where software can emulate the numeric operation.

Although the numeric coprocessor and 80286 work together they do not have to operate at the same speed. Only the communications need the same clock for reference. This feature has been exploited in the ATTAK 286 Model 1A by providing two clock generators, one for the 80286 and one for the 80287. This allows the two to operate at their respective optimum speeds allowing as much as a 60% improvement in execution over other manufacturers boards. The logic and buffers for this are shown next to the numeric coprocessor and the jumper setting are discussed in appendix E.

6.3 Chips and Technology LSI

The core of the ATTAK 286 Model 1A is the Chips and Technology chip set which integrates the majority of the SSI and MSI logic of the IBM PC/AT design. The chip set consists of five integrated circuits using various package formats. Three of the parts use bipolar technology and two use CMOS technology. This CMOS parts perform timing and decode functions requiring complex low power logic functions while the bipolar parts perform buffering and buss driving functions. A complete description of the CHIP SET is provided in appendix G.

The chips are reference designated as U23 for the address buffer, U18 for the data buffer, U16 for the control and expansion buss controller, U26 for the peripheral controller, and finally U17 for the CPU and clock support logic. Each of these parts integrates many SSI and MSI parts of the original IBM PC/AT design into a set of five parts.

The address buffer U23 performs all address related functions except decode for the on board peripherals which is handled by U26. The address from the microprocessor is latched and buffered by this part. The outputs of the part are used to drive the expansion slots, ROM memory, and the multiplexed address for the DRAM. Control of the address buffers and multiplexers is provided by U17 and the memory timing control logic.

The data buffer U18 performs all data buffering functions. The data buss from the microprocessor is 16 bits wide and must be buffered and converted to and from 16 and 8 bit busses. This conversion and buffering process provides compatibility with the older 8 bit PC/XT software and hardware. U18 also performs parity generation and detection as well as latching these

outputs. The part generates two data busses, one for the expansion slots and the second buss for the on board ROM and DRAM. Because the DRAM and ROM are on the same buss it is possible for the DRAM to prevent error messages by crashing this buss.

U16 is the expansion buss buffer and control logic part. This part interfaces the expansion slots to the motherboard logic. The expansion slot uses a set of signals developed from the PC/XT with additional signals for the 16 bit buss of the IBM PC/AT. This part provides the interface between the DMA and the CPU as well as the expansion slots. The part also provides the emulation of the 8255 PPI port of the PC/XT for compatibility.

The peripheral controller U26 handles interfacing the onboard peripherals and the memory address decoding and control. This part provides peripheral port decoding for the real time clock as well as conversion of the Intel control signals to Motorola control signals for the MC146818 clock chip. The part also performs the memory mapping for the four memory allocations defined through out this manual.

U17 is the central part of the Chip Set as it performs the clock generation, microprocessor control decode, and buss master decode. This part ties the other four parts of the chip set together. The part receives the control signals from the microprocessor and generates the controls for the rest of the system. The part also handles the buss ownership decode receiving the DMA requests, refresh requests, and the CPU requests. The result of this arbitration is release of the buss to the selected device.

6.4 Memory

The ATTAK 286 Model 1A is equipped with two forms of memory parts. These are Read Only Memory (ROM) and Dynamic Random Access Memory (DRAM) with a maximum of 64 kilobytes of ROM and 1 megabyte of DRAM. The ATTAK 286 Model 1A can have additional memory up to a maximum of 15 megabytes added into the expansion slots of the motherboard. The memory is located on the second sheet of the schematic.

The ROM parts are reference designators U19 and U21 and are byte wide 28 pin pinouts. There are two jumpers allowing the use of different ROM parts. Note that the address for the ROM is the X address buss of the motherboard. This buss is the internal buss used for all non CPU address generation from the DMA and the master expansion controller. Address decoding for the ROM is performed by U26 of the chip set. The address for the ROM is decoded as two addresses one at the top of memory from FF0000 through FFFFFF hex and the lower XT compatible 0F0000 through 0FFFFF hex. This dual decoding is done for PC/XT compatibility and the operating mode of the 80286 which truncates addresses after a far jump from the reset address of FFFFF0 hex in the real addressing mode.

The DRAM consists of 36 16 pin memory sockets compatible with 64 and 256 kilobit memory parts. The control of address multiplexing and buffering is done by U23 of the chip set. The address multiplex for 64 verses 256 kilobit memory is handled by U39 a dual 4 to 1 multiplexer. This part performs the mux of the added A8 address of the 256 kilobit memory parts. Note the selection of addresses SA17 and SA18 into the multiplexer. This eliminates shifting the lower addresses when a switch is made between 64 and 256 kilobit memory parts.

Timing and control for the DRAM memory is performed by U26 of the chip set, a delay line U52, and a group of AND and NAND gates. The DRAM cycle consists of setting the row address followed by enabling the Row Address Strobe (RAS). RAS is decoded to one of

the two banks except during refresh. RAS latches the row part of the address. After a delay determined by the delay line and tap selection the address is switched to the column address. The delay line then enables Column Address Strobe (CAS) to the decode gates. The decode gates enable CAS to only one bank and to either or both the upper or lower byte of the 16 bit data word. This completes the data access from the DRAM and only the end of the cycle need be completed. The delay line delays the removal of RAS and CAS until a minimum period required by the DRAMs is meet.

6.5 DMA Controllers

The ATTAK 286 Model 1A is equipped with two 8237A-5 Direct Memory Access (DMA) controllers and support components. These controllers provide seven channels of direct memory access of which four are capable of byte transfers and three are capable of 16 bit word transfers. The support components consist of a memory address mapper, two 8 bit latches, D Flip Flop, and several SSI Logic gates. The allocation of the DMA channels is defined in appendix D. The DMA logic is on the first sheet of the schematic.

The DMA parts are referenced as U8 and U15 with U8 handling the 8 bit data transfers and U15 handling the 16 bit data transfers. The 8237A-5 is a direct memory access controller capable of transferring data to or from memory every microsecond. This allows a data rate of 500 kilobytes per second for the 8 bit channels and 1 megabyte per second for the 16 bit channels. Data transfer of the DMA is of the combined transfer cycle. This type of cycle overlaps the memory and I/O cycles allowing transfer directly from memory to I/O without a temporary storage device. This also increases the data transfer rate by eliminating two cycles and only extended the one cycle by a small amount.

The DMA controllers are housed in 40 pin packages and do not have enough pins for full address and data as well as control signals. This is solved by using multiplexed address and data lines which must be demultiplexed to match the motherboard busses. Additionally, the DMA controllers are intended for 64 kilobyte memory spaces so they must be memory mapped into the 16 megabyte address space of the ATTAK 286 Model 1A.

The memory mapping of the DMAs is handled by U57 which provides sixteen 8 bit address extension registers. The 8 bit registers are used to extend the 16 bit address of the DMA parts to the 24 bit address of the motherboard. The 8 bit DMA parts use seven bits of the expansion registers while the 16 bit DMA parts use all eight bits of the registers. Eight of the 16 registers are used in this application and the selection is based on a simplified decoding scheme. Note that the microprocessor can access all of these registers and some programs use these for other than DMA applications.

The demultiplexing of the address and data busses are accomplished by U55 and U56 two 74ALS573 latches. The latch signals for the parts is provided by the associated DMA part. Decoding for the memory mapping logic and the enables of the demultiplex latches is provided by the decode logic in the upper left corner of the schematic. The NAND gates U10 and U12 decode the active DMA from the DMA acknowledge signal that is active. This in turn enables the associated address latch and tells the chip set about the size of the DMA transfer. The signals are also used by the memory mapper to access the correct address extension. The flip flop and write decode logic are used to correct a timing flaw in the DMA controller parts.

6.6 Interrupt Controllers

The ATTAK 286 Model 1A is equipped with two 8259A-5 interrupt controllers. These controllers provide 15 vectored interrupts using the maskable interrupt logic of the 80286 microprocessor. The first 7 interrupts duplicate the original IBM PC functions with one vector stolen to implement a slave controller of 8 interrupt vectors. The allocation of the interrupts is defined in appendix C.

The interrupt controllers are referenced at U7 and U14 and have no significant support logic. The 8259 interrupt controller provides vectored interrupts with various priority schemes for eight inputs. U7 is operated as a master interrupt controller and actually generates the interrupt to the microprocessor. U14 acts as a slave controller and reports interrupts to U7 which forwards them to the microprocessor. The two parts then operate as a single 15 interrupt controller. Normal programming of the controllers is positive edge sensitive with all but the ROM BIOS supported interrupts masked.

The interrupt controllers vector program control, after saving the running programs CPU status, to code pointed to by vectors at the base of memory. Each of these vectors consists of an offset and code segment pointing to the service routine. The user is responsible for performing an End Of Interrupt command (EOI) to the interrupt controllers to reset the in service flag of the interrupt line. Failure to clear this flag will inhibit this interrupt from future interrupts.

6.7 RTC and Timer Counter

The ATTAK 286 Model 1A is equipped with a battery backed up real time clock and configuration RAM in addition to a counter timer. These components provide the timing and configuration functions of the ATTAK 286. The real time clock and configuration memory is provided by an MC146818 part backed up by either an on board battery or external battery via connector J12. The counter timer is provided by an Intel 8254 triple counter timer part.

The real time clock U4 is a combined battery backed up clock and configuration RAM. The clock provides date and time storage as well as 54 bytes of configuration memory. The part is a Motorola MC146818 which uses synchronous data transfer control signals. These control signals are developed from the asynchronous Intel data transfer signals by U26 of the chip set. The configuration RAM is used to configure the computer for automatic power up and as a check of the hardware determined by the diagnostics. The setting of this configuration is discussed in section 4.3 of this manual.

The counter timer,U28, is an 8254 triple channel 16 bit counter timer circuit which is used by the motherboard for several functions. Channel 0 of the part is used to provide a fixed rate interrupt to the microprocessor to maintain a real time clock and to time certain hardware functions such as disk motor shut down. Channel 1 is used to time the period between DRAM memory refresh cycles. This period is set to 15 microseconds by the ROM BIOS thereby refreshing the 256 rows in the DRAM every 4 milliseconds as required by the DRAM memory parts. Channel 2 is used to generate speaker sound outputs. This channel is used for beep generation and sound effects as well as game timing.

6.8 Keyboard Interface

A single chip microcontroller is used by the ATTAK 286 Model 1A to provide a keyboard interface in addition to some status inputs. The 8742 single chip microcontroller U3 handles interfacing the keyboard to the system and certain other functions. The 8742 operates as a separate CPU to off load the time consuming task of supporting the

keyboard from the microprocessor. The 8742 also provides a way to reset the microprocessor to exit protected memory mode to real memory mode.

The keyboard interface consists of a serial data transfer with synchronous clock. The interface is bi-directional allowing the 8742 to send programming data to the keyboard and the keyboard to send key and status information to the 8742. This transfer is different that the XT keyboard interface which is unidirectional.

The 80286 microprocessor has two modes of address operation; real, or native mode, and protected mode. The real mode emulates the 8086 processor and is limited to 1 megabyte of memory. The protected mode allows access to 16 megabytes of memory but once entered can not be exited to real mode. The only method is a reset command. The 8742 provides a way to generate a quick reset to set the microprocessor to real mode. A complete description of the 8742 interface can be found in section 4.2 of this manual.

6.9 Expansion Slots

The expansion slots of the ATTAK 286 Model 1A are fully compatible with the IBM PC/AT. There are eight expansion slots with 6 configured as 16 bit slots and two as 8 bit slots. The only difference is the omission of the extra 16 bit expansion connector which can be added to the board to make all eight slots into 16 bit slots.

The address, data, and control signals to and from the expansion slots are buffered by the Chip set. The timing of the buss is identical to the IBM PC/AT with the exception of overall speed. The ATTAK 286 Model 1A is 33% faster than the equivalent IBM machine running at 6 MHZ. Operating the ATTAK 286 Model 1A at 10 and 12 MHZ increases the speed of the expansion buss and may prevent some cards from functioning properly.

6.9.1 ATTAK 286 Model 1A Block Diagram

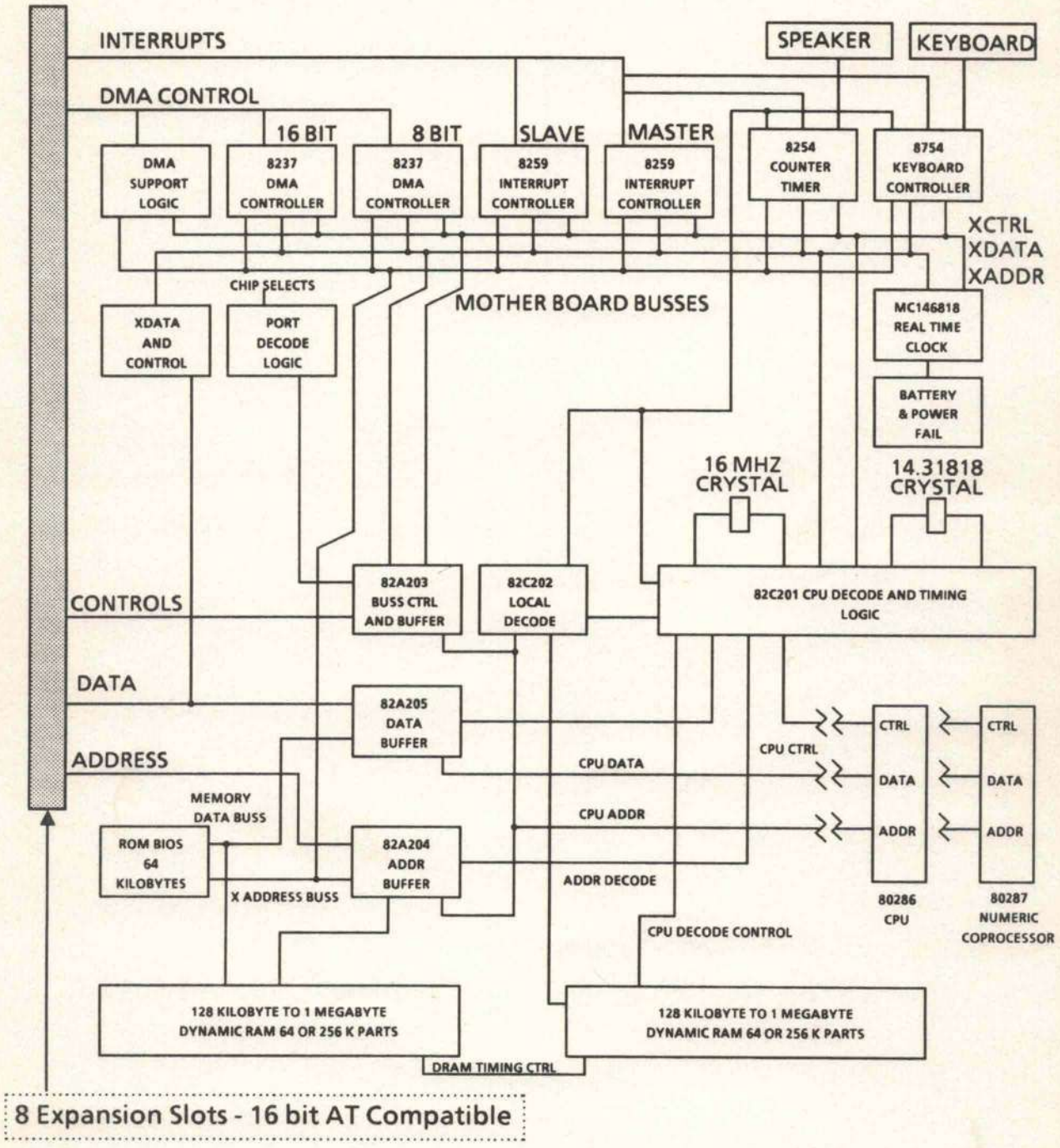


FIGURE 6 - 1

7.0 Troubleshooting

This section is intended to assist the user in solving a problem after assembling the ATTAK 286 MODEL 1A into a system or failure after normal operation. Both of these problems have significant differences, the trouble shooting of a new system which may have more than one bug and is tougher than troubleshooting after a failure on a working board which will usually have only one bug. The following section covers the debugging of new systems in more detail as the debugging of a failure on a working board.

7.1 DOI (Dead on Installation)

Nothing can be more depressing than assembling your ATTAK 286 Model 1A into a system and when the power switch is thrown having nothing happen. When the ATTAK 286 MODEL 1A is totally dead after power up the problem is usually related to power, bad cable connections, improper adapter installation, or bad memory.

The power supply is the most important starting point in troubleshooting of any system. Without proper power no computer, no matter how well it is built, will work properly. The power supply has a fan that tells the story. If the fan is not running at all then the supply is either not getting power or is in over current protection. The user should observe the FAN during the power up procedure. If the fan tries to turn then the supply is trying to come up but is either loaded too much or too little. That's right, too little loading of the switching supplies can cause the power shutdown! A dead supply should be replaced and a over current supply should first be tested for overload by shedding load.

A common problem is a short in a device such as the motherboard or the disk drives. Try removing connectors from the drives and motherboard one at a time to isolate the failure. A common fault is a short between the bottom of the motherboard and the cabinet. This usually occurs near the mounting studs where the two screws hold the motherboard in the cabinet. Shorts can also occur at the disk drives and the front panel and speaker locations.

Connecting cables can also cause the power problem as most cables have every other line grounded which can produce a short. Additionally, the adapter cards can cause problems as they are powered from the motherboard. Memory parts occasionally short due to being plugged in backwards and can be very difficult to find. Usually the best way is to remove all of the memory and then install it in chunks of 8 then 4 then 2 then 1 to find the bad parts.

7.2 BIOS Error Messages

The ROM BIOS has two ways of telling the user where it hurts when a problem develops. One is beeps emitted from the speaker and the second is messages displayed on the system console. The beep error codes are used for major failures that prevent bringing up the video display. The display messages are usually less severe and can some times be over ridden by the user.

The beep messages are developed by pulsing the speaker in a pattern consisting of beeps and pauses and more beeps. The following list defines the beep codes and the probable cause and remedy for the problem. The beeps are emitted as a series of three tone bursts. Each of the three bursts consists of from 1 to 4 beeps. The list shows the three burst beep codes for the BIOS.

1-1-3 CMOS Failure

The error indicates that an attempt to test the CMOS RAM failed. This error is usually caused by an expansion adapter crashing the data buss. The user should remove all adapters and try again. If the error changes then an expansion

adapter is probably bad and if not then the MC146818 part is probably bad.

1-1-4 BIOS Checksum

This indicates that the firmware ROM Checksum has failed and is usually caused by a failed ROM or the improper addition of user installed firmware.

1-2-1 Timer Failure

The 8254 timer counter has failed and should be replaced, although a failed adapter in the expansion buss could simulate this failure.

1-2-2 DMA Failure

One of the 8237 DMA controllers has failed a test of its operation and is usually a bad part. An expansion adapter can cause a failure by pulling the DMA interface lines to abnormal levels.

1-2-3 DMA Page Failure

The DMA uses a page register memory mapping part which has failed a write and read storage test. Replace the 74LS612 part.

1-3-1 Refresh Failure

The refresh logic has failed or is at the wrong timing value. This error is not repairable by the user as it is difficult to locate the failure.

1-3-3 Base RAM Failure

The first 64 kilobytes of DRAM must be functional for the BIOS to continue to display operation and has failed. The failure is multibit meaning a major failure that can not be pin pointed.

1-3-4 Base RAM Byte

This error indicates a problem in the even/odd byte select logic. The probable error is in the memory timing and decode logic.

1-4-1 Address Failure

An error in the address lines to the DRAM has been detected. The error is probably the 82A204 or the 74LS153 mux or the memory timing and decode logic.

1-4-2 Parity Error

An error has been detected in the first 64 kilobytes of DRAM and is probably the 82A205 or the 82C201. The parity memory parts involved are U68 and U83.

2-X-X Memory Error

These error codes define a single memory part error. The second and third beep define which data bit is in error. The following table defines the faulty memory part.

BEEP	PART	BEEP	PART	BEEP	PART	BEEP	PART
2-1-1	U75	2-1-2	U76	2-1-3	U77	2-1-4	U78
2-2-1	U79	2-2-2	U80	2-2-3	U81	2-2-4	U82
2-3-1	U60	2-3-2	U61	2-3-3	U62	2-3-4	U63
2-4-1	U64	2-4-2	U65	2-4-3	U66	2-4-4	U67

3-1-1 Slave DMA Failure

The slave DMA part U15 has failed its register tests and should be replaced. It is possible that an expansion adapter has failed and is causing the error.

3-1-2 Master DMA Failure

The Master DMA part U8 has failed its register tests and should be replaced. It is possible that an expansion adapter has failed and is causing the error.

3-1-3 Master interrupt Failure

This error indicates that the master 8259 U7 failed it's diagnostics test. This could

also be caused by a faulty expansion adapter card.

3-1-4 Slave Interrupt Failure

This error indicates that the slave 8259 U14 failed its diagnostics test. This could be caused by a faulty expansion adapter card.

3-2-4 Keyboard Controller Failure

This error indicates that the 8742 microcontroller U3 failed it diagnostics or does not respond to commands. This error is usually caused by a faulty 8742 although this error can be caused by running an 8742 programmed for a slower speed system clock in a higher speed system. This error is likely if the user upgrades the ATTAK 286 Model 1A to 12 MHZ and does not change the 8742 firmware to account for the speed difference.

3-3-4 Display Memory Failure

The display adapter assigned as the system console has failed memory test. This is occasionally a transient that occurs due to the poor design of some video cards. Retry booting the system and see if the error persists. If it does then the video adapter card is probably bad. Note that improper setting of memory expansion adapters and other video cards can also cause the problem.

3-4-1 Video Controller Failure

This error indicates a problem with the 6845 video display controller on the video display adapter card. The video card is probably bad or there could be a buss conflict from an I/O adapter card in the expansion buss.

3-4-2 Sync Failure

The video adapter cards generate sync signals for the video monitors to control the sweep of the display beam. The adapter cards provide a means to test this signal. This error indicates that this sync is not present or is of the wrong timing. This can cause display monitor failures especially when using older monochrome monitors that require sync to prevent damage. The display card, monitor cable, or monitor could be bad, causing this problem.

4-2-1 Timer Failure

The 18.2 times a second timer tick used to perform background timing in DOS and other programs is not running. This is probably caused by an interrupt failure in U7 or the failure of the timer counter U28.

4-2-2 Shutdown Failure

The ability of the micro processor to shutdown after detecting a failure and executing a shutdown command has failed. This is a serious problem and is indicative of a bad 80286 U24 or a bad 80287 U25. If replacing the CPU and numeric coprocessor does not solve the problem then a ROM, timing, or decode problem is possible causing the inability to get the shutdown command to the processor.

4-2-3 Gate A20 Failure

The emulation of the PC/XT requires that memory wrap from 1 megabyte to 0 which is not the case with the 80286. Hardware to wrap is provided and has failed testing. The problem is in either the 8742 U3, the 82C202 or 82A203, and possibly the 82A204.

4-2-4 Unexpected Interrupt in Protected Mode

A test of the protected mode operation of the 80286 has failed or the loaded inactive trap for protection fault has not been replaced by user software and a protection violation has occurred.

4-3-1 Expansion Address Failure

A test of the high address lines used to access memory above the 1 megabyte XT PC limit has failed. Probably a failure of the 82A204, 82A203, 82C202, or an expansion adapter that is bad.

4-3-3 Speaker Timer Failed

The speaker timer output that drives the speaker for sound effects has failed diagnostic. The beeps generated by the BIOS do not use this timer so the error can be generated. Probable causes are bad 8254 U28, bad 82C201 U17, or bad 82A203.

4-3-4 RTC Stopped

This is a warning indicating that the setup utility has not been run since the replacement or failure of the battery. Replace the battery and or run setup to correct this problem.

The display adapter messages allow the ROM BIOS to report errors to the user via the system console display. The following lists cover the error messages followed by their probable causes and solutions.

Display Adapter Failed; using alternate

This message is given by the BIOS when the configuration memory lists a display adapter other than that given by the jumper feeding the 8742 microcontroller.

No timer Tick Interrupt

This message indicates a hardware error between the timer counter U28 and the interrupt controller U7. This error will cause severe problems with DOS and other software running on the ATTAK 286 Model 1A.

Shutdown Failure

This error indicates that the ability to shutdown the microprocessor via it's internal shutdown command failed. Replace the 80286 microprocessor.

Timer Chip Counter 2 Failed

This error is means that the speaker may not function properly as timer 2 generates the speaker tones. Note that the BIOS error beeps use the alternate 8255 emulation registers to generate the beeps.

Keyboard Failure

This error indicates that the 8742 could not initialize the keyboard and get a valid test response. The keyboard is usually not connected when this message is displayed.

Keyboard Controller Failure

This error indicates the failure of the 8742 microcontroller. This message can sometimes be generated by a faulty reset after power up. If it repeats then the 8742 or port decoding is faulty.

Clock Line Failure

Indicates that the clock line to the keyboard is stuck and indicates either an 8742 or keyboard failure.

Data Line Failure

This error indicates the same errors as the clock line failure shown above.

Stuck Key Failure

This error indicates that a key of the keyboard is stuck in the down position. This error can also occur if the keyboard has something on it when the reset is activated to the ATTAK 286 Model 1A.

Time-of-Day Clock Stopped

This error is generated when the

MC146818 real time clock is stopped. This clock can be stopped by software for synchronization and this error usually occurs after battery replacement. It is corrected by using the setup utility.

Invalid configuration information please run SETUP program

This error is a warning and can be overridden. The user should run the setup utility to correct this problem. If the error returns check the battery for proper installation and good batteries.

Time-of-day not set - please run SETUP program

The status bits in the real time clock indicate that the clock has not been set since the battery was replaced. Run setup to correct this problem.

Keyboard is locked - please unlock

This is a status indicator and is a warning message. The keyboard lock is engaged and access is restricted. Unlock the keyboard lock to correct.

ROM bad checksum = 00h Optional

This error is a bad error and indicates either a bad ROM or possibly incorrect setting of the ROM type jumpers. This error is rare as a bad check sum usually means that the board will not come up.

Gate A20 Failure

This error message indicates that the gating for the XT memory allocation mode is not functioning. This error can be overridden in most cases. The 8742 and the chip set can cause this problem.

Unexpected Interrupt in Protected Mode

This error indicates that the BIOS has detected a failure in the protected memory mode of the 80286. Replace the 80286 microprocessor.

Decreasing Available Memory

This error indicates that the BIOS has detected a memory problem and is trying to continue with reduced memory so that the user can use advanced diagnostics to find the problem. Usually the problem is caused by a memory part failure. Note that a failure in the first 64 kilobytes of memory prevents the BIOS from getting to this point.

-064K Base Memory, -00000K Extended

This is not an error message it indicates the memory found during the diagnostics in the lower and upper memory address spaces.

Memory tests terminated by keystroke

The user can terminate the memory tests by hitting the space bar during the test procedure. This is usually done to start up the ATTAK 286 Model 1A quickly after a reset.

odd/even logic failure

Indicates a failure in the convert logic used to allow 8 bit devices on the 16 bit data buss.

Diskette Read Failure

Indicates an error in the reading of a diskette through the combined floppy hard disk controller. The drive could be at fault or even the diskette.

Not a boot diskette

The disk in the boot drive is not a DOS system disk. The user must use a DOS system disk to boot the disk.

No boot device available

No disk drive was found and since there is no ROM BASIC the BIOS reports a fatal error condition. This BIOS must be used with a disk based operating system.

Hard disk read failure

This error usually means that the drive is not formatted, has wrong software format, or has not spun up to operating speed in time for the delay for data tests after power up.

No boot sector on hard disk

Attempt to boot an non-system hard disk which does not have a boot sector. The boot sector is placed on the disk by the soft format with system install switch.

Strike F1 to Retry Boot

Prompt for user to retry the reading of a drive for the boot sector. This can be used to correct the slow start up of some disk drives.

Strike the F1 key to continue

Prompt for the user to override and error message and proceed, the user should take this step with caution as some errors can be fatal to data contents.

Hard disk configuration error

The hard disk data contained in the configuration memory does not match the hardware found. This error usually indicates an undetected change in the configuration memory or incorrect setting of the memory.

Hard disk controller failure

The diagnostic of the hard disk controller has failed. This is usually a failure on the combined hard floppy disk controller card.

Hard disk failure

Indicates a failure in the hard disk drive and is usually a spin up failure, format failure, or hard disk error.

Diskette subsystem reset failed

Attempt by the BIOS to seek the hard drive to track zero has failed. Usually a hard disk fault.

Diskette drive X seek failure

Failure to home the heads of either drive 0 or 1 and is usually caused by a bad drive or configuration of a drive that is not present.

Unexpected SW XX interrupt

The default interrupt handler was executed indicating a software interrupt call to an undefined interrupt.

I/O card parity

An expansion adapter card has indicated a parity error and a prompt to shut off NMI is given to the user. The usual cause is bad memory on an expansion memory card.

Memory parity

Parity error detected on mother board memory. Check on board memory for bad parts.

Type (R)eboot, other keys to continue

Prompt message after a parity error allowing the user to continue. The user may be able to continue and save data but usually the error is fatal.

7.3 Power problems

The power supply inputs to the ATTAK 286 Model 1A should be checked with a digital voltmeter. Any supply out of range should be reason to replace the power supply. Expansion adapters and disk drives should be reduced to the minimum to boot the system with a floppy. This unloads the power supply and eliminates a large number of possible failure items.

7.4 Jumper Selection Checks

Incorrect jumper settings are a major problem with most ATTAK 286 MODEL 1A problems. Almost all of the jumpers can be incorrectly set and cause the ATTAK 286 MODEL 1A to malfunction. The jumper settings should be checked against the descriptions in Appendix E.

7.5 Expansion Adapter Conflicts and Faults

The expansion slots of the ATTAK 286 MODEL 1A are in line with the data and address busses of the mother board. As a result it is possible for an expansion slot adapter to crash the ATTAK 286 MODEL 1A. If two adapters have the same address then the boards conflict and prevent proper operation. Always bring up a system, with the minimum boards and then add boards till the system is complete.

7.6 Keyboard Faults

The keyboard controller is designed to perform a self test on itself and the keyboard. The results of this test are returned to the BIOS and reported as messages to the user. The test are defined in section 4.5 covering the keyboard controller.

8.0 Optional user upgrades and modifications

This section is intended for users with considerable hardware and software experience. The section covers modifications and firmware additions to the ATTAK 286 Model 1A to improve the design for particular applications. The modifications covered include clock speed increases, memory timing configuration, zero wait states, numeric speed selection, and firmware additions.

8.1 Processor clock speed changes

The ATTAK 286 Model 1A is designed with reliability and performance in mind. The design will reliably run at very cold and hot temperatures far beyond which any reasonable person would use the computer. When a user is going to operate the ATTAK 286 Model 1A in an office environment of 68 degrees the ATTAK 286 Model 1A can be operated at higher clock speeds with good results.

There are two basic speed upgrades in common use, the 10 MHZ and 12 MHZ upgrades. The upgrade to 10 MHZ is a simple process requiring only minor work. The upgrade to 12 MHZ while simple requires the purchase of high performance parts not shipped with the ATTAK 286 Model 1A. This section first describes the changes necessary for 10 MHZ upgrade followed by the additional changes required for 12 MHZ operation.

8.1.1 10 MHz Operation

The modifications for 10 MHz include replacing the 8 MHz processor with a 10 MHz part, followed by exhaustive burn-in.

8.1.2 12 MHz Operation

12 MHz operation also requires the replacement of several chips, including: 10 MHz Chips & Technology chip set, high speed 8237 DMA chips, 8259A-2 interrupt controllers and a memory timing change.

8.2 Memory timing modification

The ATTAK 286 Model 1A is designed to support various speed memory parts. The jumper selection of the memory timing are detailed in appendix E of this manual. There are three timing periods that can be modified by jumpers on the ATTAK 286 Model 1A. These are RAS to address switch, Address switch to CAS, and total RAS period.

Referring to the second schematic sheet, a timing delay line U53 is used to develop these times. The socket is designed to support two formats of delay lines, one having 5 taps and the other having 10 taps. The part shipped with the ATTAK 286 Model 1A has 5 taps at 40 nanoseconds per tap. This delay is sufficient for 8 MHZ operation.

8.3 High speed numeric coprocessor configuration

The selection of various speed numeric coprocessors allows the user to optimize the numeric processing of the ATTAK 286 Model 1A. These jumper selections are covered in appendix E of this manual.

8.4 Firmware additions

Firmware additions to the Phoenix BIOS should be performed by Advanced Intelligence Technology for the user. This is due to the complex interaction between AIT installed utilities and the Phoenix BIOS.

Memory Allocation

The ATTAK 286 Model 1A is designed to support the IBM PC/AT compatible memory allocation. Additionally the ATTAK 286 adds the ability to have either 640 kilobytes or 1 megabyte of DRAM on the mother board.

Address Range	Description
000000 - 0AFFFF	Base DRAM 640 kilobytes XT compatible
0B0000 - 0CFFFF	Video Display memory 128 kilobytes
0D0000 - 0EFFFF	Expansion adapters, user ROM, etc...
0F0000 - 0FFFFF	First ROM BIOS memory space
100000 - FEFFFF	15 Megabytes of expansion memory
FF0000 - FFFFFF	Second ROM BIOS memory space

I/O Allocation

The Input and Output address allocation of the ATTAK 286 Model 1A is identical to the IBM PC/AT. The following list defines the port allocation of the ATTAK 286 Model 1A. The address range of the PC/XT was based around 10 bit address decodes resulting in 1024 port addresses. The ATTAK 286 Model 1A integrates this decode with a full 16 bit decode by using the reserved ranges of the 1024 ports with the additional 6 address bits. This results in an additional 8192 ports on the expansion slots. There are an additional 16,128 ports that map to the onboard 256 locations with the upper 6 address lines other than zero. These I/O address spaces have become named as the motherboard address space, expansion slot I/O address space, and finally the N buss I/O address space.

Port Range	Description
000- 01F	DMA controller U8 for 8 bit data transfers
020- 03F	Interrupt controller U7 the master controller
040- 05F	Timer counter U28
060- 06F	Keyboard controller U3 an 8742
070- 07F	Real time clock U4 an MC146818
080- 09F	DMA address mapping registers U57 a 74LS612
0A0- 0BF	Interrupt controller U14 the slave controller
0C0- 0DF	DMA controller U15 for 16 bit data transfers
0E0- 0EF	Reserved for future use
0F0	Reset the numeric coprocessor busy latch
0F1	Reset the numeric coprocessor part
0F2- 0F7	Reserved for future use
0F8- 0FF	Numeric coprocessor interface space

Interrupt Allocations

This appendix tabulates the interrupts supported by the ATTAK 286 Model 1A hardware and BIOS. The 80286 microprocessor allocates the first 1024 bytes of memory as 256 interrupts with 4 bytes assigned to each interrupt. The 4 bytes are the offset in the code segment for the service routine of the interrupt. The interrupts are named by their hex address divided by 4 resulting in interrupts from 00 through FF hex.

The following table defines the hardware interrupts so that compatibility can be maintained by the user.

INTERRUPT	DESCRIPTION
IRQ0	Timer 0
IRQ1	8742 keybd cntr intrpt
IRQ2	Expanded as follows
IRQ8	Real time clock
IRQ9	SW redirected IRQ2
IRQ10	Reserved
IRQ11	Reserved
RQ12	Reserved
IRQ13	80287 interrupt
IRQ14	Fixed Disk controller
IRQ15	Reserved
IRQ3	Alternate Serial port
IRQ4	Primary Serial port
IRQ5	Alt. parallel printer port
IRQ6	Diskette controller
IRQ7	Prim. parallel print port

INT 0 DIVIDE ERROR EXCEPTION

A trap to interrupt 0 occurs on divide overflow. The BIOS does not provide a handler. The return address points to the instruction causing the exception.

INT 1 SINGLE STEP INTERRUPT

The BIOS does not provide a handler for this interrupt. The single step interrupt occurs after each instruction if the trap flag is set in the flags register. The trap flag is cleared on entry to this or any interrupt handler and the return address points to the next instruction.

INT 2 NON-MASKABLE INTERRUPT (real address mode only)

This will print a message indicating a parity error has occurred and attempt to locate the address where the error occurred. Additional functions can be implemented using hardware on the ATTAK 286 to poll the source of the NMI.

INT 3 BREAKPOINT INTERRUPT

Execution of the one byte INT 3 instruction causes this interrupt to occur. The BIOS does not provide a handler. The return address points to the byte after the INT 3 instruction. This interrupt is used by debuggers to set break points in code.

INT 4 OVERFLOW DETECTED INTERRUPT

This interrupt occurs on execution of an INTO instruction when the overflow flag is set. The BIOS does not provide a handler.

INT 5 PRINT SCREEN

This routine is called from the keyboard hardware interrupt handler when the SHIFT-PRTSC keys are pressed. A byte at address 50:0 is used as a flag to prevent it from being reentered. If the BOUND instruction is executed and the given range is exceeded then an INT 5 will

occur. The BIOS does not detect the BOUND instruction as a source for this interrupt.

INT 6 INVALID OPCODE EXCEPTION

This exception will occur if an attempt is made to execute an undefined opcode. Some protected mode instructions cause this exception in real address mode. The interrupt may also occur if a register is specified as the effective address for a BOUND, LDS, LES, or LIDT instruction. The return address points to the instruction causing the exception. The BIOS does not provide a handler and will immediately return to the instruction which caused the exception and attempt to execute it again.

INT 7 PROCESSOR EXTENSION NOT AVAILABLE

This exception occurs when an ESC or WAIT instruction is executed and EM bit in the Machine Status Word is 1 and the MP bit is 0 or when the MP bit is 1 and the TS bit is 1. The return address points to the first byte of the ESC or WAIT instruction which caused the interrupt. The BIOS does not handle this exception but returns to the instruction which caused the exception and attempts to execute it.

INT 8 HARDWARE INTERRUPT LEVEL 0

This is the BIOS handler for the interrupt from the 8254 timer channel 0. It occurs about 18.2 times per second and updates a count stored at address 40:6C and 40:6E with overflow byte at 40:70. This routine also decrements a counter at address 40:40 and turns off diskette motors when zero. A call is made to INT 1CH to run user installed routines. A exception will vector to this routine if an LIDT instruction was executed that changed the interrupt descriptor table limit to a value less than 3FFH and an interrupt occurs which attempts to vector to a location outside of the limit in real address mode. The BIOS does not check for an interrupt table too small exception as the source of this interrupt.

INT 9 HARDWARE KEYBOARD INTERRUPT

This is the output buffer full interrupt from the 8742 keyboard controller. This routine also may make calls to INT 5 or INT 15H or INT 1BH. INT 9 will also occur if a 80287 operand extends across a segment boundary. The bios does not check for a processor extension overrun as the cause for this interrupt. If a processor extension overrun exception occurs, the BIOS will return to the instruction that caused the exception and attempt to execute it causing another exception and the insidious reentrant loop of death.

INT 0AH Redirected hardware interrupt level 9

The BIOS does not provide a handler for this interrupt, it is the responsibility of the user to install a handler if needed.

INT 0BH Hardware interrupt 3

Reserved for COM2 serial. BIOS does not provide a handler.

INT 0CH Hardware interrupt 4

Reserved for COM1 serial. BIOS does not provide a handler.

INT 0DH Hardware interrupt 5

Reserved for alternate printer. BIOS does not provide a handler. This interrupt may also be caused by any instruction that attempts to access a 16 bit word at offset 0FFFFH. If a segment overrun exception occurs, the return address will point to the instruction that caused the exception.

INT 0EH Hardware interrupt from diskette controller

The BIOS supports this interrupt to control the disk controller hardware.

INT 0FH Hardware interrupt 7

Reserved for the primary printer. BIOS does not provide a handler.

INT 10H VIDEO I/O

This interrupt allows hardware independence of the display interface by providing a fixed set of functions using a fixed call sequence. The function code is placed into the AH register and an INT 10H instruction is executed.

If AH = 0 the set mode according to value in AL:

- AL = 0 for 40x25 black and white
- AL = 1 for 40x25 color
- AL = 2 for 80x25 black and white
- AL = 3 for 80x25 color
- AL = 4 for 320x200 color graphics
- AL = 5 for 320x200 black and white graphics
- AL = 6 for 640x200 black and white graphics
- AL = 7 for monochrome adapter

AH = 1 sets the cursor size with CH containing the start line for the cursor in a character cell and CL containing the ending line for the cursor.

AH = 2 sets the cursor position to DH = row and DL = column and BH = page with (0,0,0) in upper left corner of the first screen.

AH = 3 reads the cursor position with BH = page number and returns DH = row and DL = column and CX = cursor size as in function 1 above.

AH = 4 reads the light pen position and returns AH = 0 for no data or AH = 1 for valid data. It returns the position as DH = character row, DL = character column, CH = raster line, BX = pixel column.

AH = 5 selects as active display page the page in AL.

AH = 6 scrolls up the window in the active display page. AL = number of lines to scroll up or AL = 0 to blank entire window. CH = character row for upper left corner of window, CL = character column for upper left corner, DH = character row for lower right corner of window, DL = character column for lower right corner, BH = attribute to be used on blank lines inserted at bottom of window.

AH = 7 scrolls down the window in the active display page. AL = number of lines to scroll down or AL = 0 to blank entire window. CH = character row for upper left corner of window, CL = character column for upper left corner, DH = character row for lower right corner of window, DL = character column for lower right corner, BH = attribute to be used on blank lines inserted at top of window.

AH = 8 reads the character and attribute at cursor position with BH = display page and returns with the character in AL and the attribute in AH.

AH = 9 sets BH = display page, CX = count of characters to write, AL = character, and BL = attribute of character or color if graphics mode. If graphics mode and bit 7 of BL is set then exclusive or character pattern with data in frame buffer.

AH = 0AH writes a character only at the current cursor location with the page in BH, CX = number of times to repeat the character and AL = character to write.

AH = 0BH sets the color palette of the color graphics adapter if current mode is 320x200 graphics. BH = 0 selects background color in BL of 0 to 15, BH = 1 selects if BL = 0 the green/red/yellow palette or if BL = 1 the cyan/magenta/white palette.

AH = 0CH writes the graphics pixel to DX = row, CX = column, and AL = color value. If bit 7 of AL is set then the dot is

exclusive-ORed with current contents of that pixel.

AH = 0DH reads the graphics pixel from DX = row, CX = column and returns the pixel value in AL.

AH = 0EH writes a character emulating TTY to the active page. The character to be written is in AL and, if in graphics mode, the foreground color is in BL. Carriage return, line feed, and bell are used as commands instead of as printable characters.

AH = 0FH returns the current mode in AL, number of character columns in AL, and active page number in BH.

AH = 13H writes a string pointed to by ES:BP of CX = length at DX = cursor position, BH = page number. Carriage return, line feed, and bell are used as commands and not as printable characters. If AL = 0 then BL = attribute and string is byte character codes and cursor position is left unchanged. If AL = 1 then BL = attribute and string is byte character codes and cursor position is updated. If AL = 2 then string is alternating character codes and attribute bytes and cursor position is left unchanged. If AL = 3 then string is alternating character codes and attribute bytes and cursor position is updated.

INT 11H EQUIPMENT

Returns in AX the equipment flags stored at address 40:10 by the power on diagnostics. The bits in AX indicate:

bit 15,14	=	number of printers found
bit 13,12	=	undefined
bit 11,10,9	=	number of RS232s found
bit 8	=	undefined
bit 7,6	=	number of diskette drives-1 if bit 0 = 1
bit 5,4	=	initial video mode
00	=	undefined
01	=	40x25 bw using color card
10	=	80x25 bw using color card
11	=	monochrome card
bit 3,2	=	undefined
bit 1	=	80287 present
bit 0	=	diskette installed

INT 12H MEMORY SIZE

Returns in AX the number of contiguous 1k blocks of RAM found at reset. The routine reads address 40:13 to obtain the value stored there by the power on diagnostics.

INT 13H DISKETTE I/O

The function code is placed into the AH register and an INT 13H instruction is executed. For read, write, verify, and format operations DL contains drive number 0 or 1 for diskette or 80H or 81H for fixed disk, DH contains head number, CH contains track number, CL contains sector number and if a fixed disk is specified the high 2 bits of the cylinder number are placed in the high 2 bits of CL, AL contains number of sectors, and ES:BX points to the buffer. On return the carry flag is set to indicate an error and AH contains the diskette status byte with value defined as 1 for bad command, 2 for address mark not found, 3 for write attempted to write protected diskette, 4 for requested sector not found, 6 for media removed(if combination hard disk/floppy controller), 8 for DMA overrun on operation, 9 for attempt to DMA across a 64k boundary, 10H for bad CRC on read, 20H for diskette controller failure, 40H for seek failed, 80H for time out error. An error code of 11H indicates recoverable data error on a fixed disk and is provided for information even though the data read is probably good. Error code of 0AAH indicates drive not ready, error code of 0BBH indicates undefined error, and error code of 0CCH indicates write fault.

On input:
AH = 0 resets diskette drive by sending reset command to controller.

AH = 1 returns the status from the last diskette operation in AH.

AH = 2 reads specified sectors.

AH = 3 writes specified sectors.

AH = 4 verifies specified sectors with buffer.

AH = 5 formats specified track. For the format operation, the buffer pointed to by ES:BX must contain the desired address fields for the track so that sectors may be located for read or write. Each field is 4 bytes: track number, head number, sector number, and sector size. Sector size is coded as 00 for 128 byte sectors, 01 for 256 byte sectors, 02 for 512 byte sectors, and 03 for 1024 byte sectors. There must be an entry in the buffer for every sector on the track. Before formatting a diskette, it is necessary to make an INT 13H BIOS call with AH = 17H to set the diskette type. To format a 360k diskette the gap length should be set to 050H and then restored to its original value when done. The gap length is located in the diskette parameter table pointed to by interrupt vector 1EH. The end of track parameter must be set to the number of sectors desired per track.

AH = 08 returns current fixed disk parameters as DH = number of drives found, DL = maximum head number, CH = maximum usable cylinder number, CL = high bits of cylinder number and maximum sector number.

AH = 09 initializes fixed disks using parameters pointed to by INT 41H and INT 46H.

AH = 0AH reads 512 bytes + 4 bytes ECC

AH = 0BH writes 512 bytes + 4 bytes ECC

AH = 0CH seek

AH = 0DH Alternate disk reset

AH = 10H Test drive ready

AH = 11H Recalibrate

AH = 14H Controller self test

AH = 15H returns the drive type in AH (if carry set then error). On return AH = 01 for diskette with no diskette changed line available to read, AH = 02 for diskette with a change line, and AH = 03 for a fixed disk. DL is used to indicate the drive number.

AH = 16H returns AH = 00 if diskette change line not active and returns AH = 06 and carry set if diskette change line is active. Use DL to indicate drive number 0 or 1.

AH = 17H sets drive type for format operation. AL = 01 for 360k diskette in 360k drive, AL = 02 for 360k diskette in a 1.2 megabyte drive, AL = 03 for 1.2 megabyte diskette in a 1.2 megabyte drive. Use DL to indicate drive number 0 or 1 if using combination hard disk/floppy controller.

INT 14H RS232 I/O

At address 40:0 are four words containing the I/O base addresses for up to four serial ports. When calling INT 14H, DX should contain the port number and AL should contain the function number. If AH = 0 then the serial port is initialized according to the parameters in AL. The initialization parameters are defined as:

bits 1 & 0 = 10 for 7 data bits or 11 for 8 data bits
bit 2 = 0 for one stop bit or 1 for 2 stop bits
bits 4 & 3 = 00 for no parity, 01 for odd, 11 for even
bits 7-5 = = 000 for 110 baud, 001 for 150 baud, 010 for 300 baud, 011 for 600 baud, 100 for 1200 baud, 101

for 2400 baud, 110 for 4800 baud, and 111 for 9600 baud.
On return AX contains status.
If AH = 1 then the character in AL is transmitted and line status returned in AH with bit 7 indicating time out.
If AH = 2 then wait until a character is received and return it in AL and return AH = 0 if no error occurred or with line status bits in AH to identify an error.
If AH = 3 then return status in AX as follows:

AH = line status:
- bit 7 = time out
- bit 6 = transmit register empty
- bit 5 = transmit buffer register empty
- bit 4 = break detect
- bit 3 = framing error
- bit 2 = parity error
- bit 1 = overrun error
- bit 0 = data ready

AL = modem status:
- bit 7 = received line signal detect
- bit 6 = ring detect
- bit 5 = data set ready
- bit 4 = clear to send
- bit 3 = delta receive line signal detect
- bit 2 = trailing edge ring detect
- bit 1 = delta data set ready
- bit 0 = delta clear to send

INT 15H Miscellaneous Functions

(functions 80H,81H,82H,85H not implemented)
For AH = 0 to 7FH returns with AH = 86H and carry flag set.

AH = 80H open device with BX = device id and CX = process id
AH = 81H close device with BX = device id and CX = process id
AH = 82H program termination, BX = device id
AH = 83H event wait. If AL = 0 then set timer, if AL = 1 cancel
ES:BX point to byte in callers memory that will have high bit set when specified time has elapsed. CX,DX contain the number of microseconds to wait before setting the flag in user memory.
AH = 84H reads the joysticks, DX = 0 to return switch settings in bits 7-4 of AL, DX = 1 to return AX = joystick A x value, BX = joystick A y value, CX = joystick B x value, DX = joystick By value.
AH = 85H called by keyboard hardware interrupt routine if SYS REQ key pressed. AL = 0 for make of key, 1 for break of key.
AH = 86H waits CX,DX number of microseconds before returning.
AH = 87H moves memory block of size CX words using global descriptor table pointed to by ES:SI. The source and target descriptors must have limit of at least 2*CX-1 and data access rights set to CPL0-R/W = 93H. The first descriptor must be a NULL descriptor set to zeros, the second should point to the global descriptor table as an alias, the third descriptor should point to the source for the move, the fourth descriptor should point to the destination for the move, the fifth descriptor should be initialized to zero and will be used by the function to create a code segment, and the sixth descriptor should be initialized to 0 and will be used by the function to create a stack segment. Maximum word count is 8000H words. Returns AH = 0 if successful, AH = 1 if NMI occurred, AH = 2 if exception occurred, AH = 3 if address line A20 gate failed. Interrupts are disabled and time of day may need to be adjusted by user. The 8742 is commanded to reset the 80286 to return it to real address mode and the CMOS clock chip RAM indicates to the reset code that this is a return from the memory move function and restores the callers stack and returns. A sample entry for the global descriptor table follows.

```
;structure to define individual descriptors
DESC            STRUC
LIMIT           DW   ?      ;offset of last
                            byte in segment
BASE_LOW        DW   ?      ;low 16 bits of 24
                            bit base address
```

```
BASE_HIGH DB   ?          ;high 8 bits of 24
                          bit base address
ACCESS         DB   93H   ;access rights byte
RESERVED       DW   0     ;must be 0 for
                          compatibility with
                          80386
DESC           ENDS
;
GDT            LABEL     WORD
NULGDT         DESC <0,0,0,0,0>  ; N U L L
                                 descriptor
GDTALIAS       DESC <SIZE DESC * 6, OFFSET
               GDT, 0, 93H,0>
SOURCEDESDESC <BYTES_TO_MOVE, L O W 1 6 S R C ,
                              HIGH8SRC, 9 3 H ,
                                        0>
DESTDESC       DESC <BYTES_TO_MOVE,LOW16DEST,
               HIGH8DEST, 93H, 0>
BIOS_CS        DESC <0,0,0,0,0>  ;initialized
                                 by BIOS
BIOS_SS          DESC <0,0,0,0,0> ;initialized
                                  by BIOS
;
```

AH = 88H returns in AX the number of contiguous 1k blocks of memory above address 100000H found at power on reset.
AH = 89H puts 80286 into protected mode. Caller must set up descriptor tables and provide BIOS routines for I/O. ES:SI should point to a global descriptor table, BH = offset into the interrupt descriptor table for the first 8 hardware interrupts, BL = offset into the interrupt descriptor table for the second eight hardware interrupts. The first entry in the global descriptor table must be a NULL descriptor, the 2nd entry must be an alias for the global descriptor, the 3rd entry must point to the callers interrupt descriptor table, the 4th entry must be for the callers DS segment, the 5th entry must be for the callers ES segment, the 6th entry must be for the callers SS segment, the 7th entry must point to the callers code segment, the 8th entry is used by the BIOS to establish a temporary code segment for initialization. The real address mode interrupt vectors must not be overwritten. Control is returned to the caller in protected mode with interrupts disabled.
AH = 90H Device Busy function does nothing but clear the carry flag and return to the caller. Not implemented in ROM.
AH = 91H Interrupt complete. Not implemented in ROM.

INT 16H KEYBOARD

AH = 0 reads the next keyboard character or waits for a keypress if none available. The ASCII character code is returned in AL and a scan code in AH. If AH = 1 then return with zero flag set if there is no character in the keyboard buffer or with zero flag clear if a character is waiting. If a character is waiting, it will be returned in AX as above but the queue pointers will not be updated until a subsequent call to INT 16H with AH = 0.

AH = 2 returns the shift status in AL. The shift status bits in AL are: bit 0 = right shift key depressed, bit 1 = left shift key depressed, bit 2 = control key depressed, bit 3 = ALT key depressed, bit 4 = scroll lock ha been toggled, bit 5 = NUM Lock has been toggled, bit 6 = caps lock has been toggled, bit 7 = insert state is active.

INT 17H PRINTER

For all INT 17H calls, DX contains the printer number 0-3 and AH contains the function code. AH = 0 prints the character in AL and return printer status in AH. The least significant bit of the status indicates a time out if set. If a call is made to INT 17H with AH = 1 then the printer control port will be initialized using the I/O address stored at 40:8 through 40:E for printers 0-3. Printer status is also returned in AH if INT 17H is called with AH = 1. If AH = 2 when calling INT 17H then the printer status will be returned in AH. The printer status bits are defined as bit 0 = time out occurred if set, bits 1 and 2 are unused, bit 3 indicates I/O error if set,

bit 4 indicates selected if set, bit 5 indicates out of paper if set, bit 6 indicates an acknowledge, and bit 7 indicates not busy if set.

INT 1AH TIME OF DAY

AH = 0 returns BIOS timer tick count as CX = high portion of count, DX = low portion of count, AL = 0 if no 24 hour overflow, or non-zero if not same day.

AH = 1 Sets the BIOS timer tick count to the value in CX:DX

AH = 2 Reads the CMOS clock chip and returns CH = hours in binary coded decimal, CL = minutes BCD, DH = seconds BCD or carry set if error.

AH = 3 Sets the time in the CMOS clock chip to CH = hours BCD, CL = minutes BCD, DH = seconds in BCD, DL = 1 for daylight savings option else 0.

AH = 4 Reads the CMOS clock chip and returns CH = century in BCD, CL = year in BCD, DH = month BCD, DL = day BCD or carry set if error.

AH = 5 Sets the date in the CMOS clock chip to CH = century BCD, CL = year BCD, DH = month BCD, DL = day BCD

AH = 6 Sets the alarm function of the CMOS clock chip. The alarm may set for up to 23:59:59 after present time. Only one alarm function may be active at any one time. The alarm routine must be supplied by the caller and must be pointed to by Interrupt Vector 4AH. The alarm time is set to CH = hours BCD from present, CL = minutes BCD, DH = seconds BCD.

AH = 7 Clears the alarm.

INT 1BH

Keyboard hardware interrupt calls this when the CTRL-BREAK key combination is detected. The BIOS points to an IRET instruction.

INT 1CH TIMER TICK

The BIOS initializes this interrupt vector to point to an IRET instruction. A user may install a routine pointed to by this vector that will be called approximately 18.2 times per second.

INT 1DH VIDEO PARAMETERS

Points to initialization parameters for a 6845 video controller.

INT 1EH Diskette Parameters

Points to parameters uses to control diskette drives.

INT 1FH GRAPHICS CHARACTER EXTENSIONS

This vector is initialized to zero but may be pointed to bit patterns for graphics characters with codes 80H - 0FFH.

INT 40H

This interrupt is used by fixed disk and diskette BIOS routines.

INT 41H

This interrupt vector points to parameters used to control the first fixed disk.

INT 46H

This interrupt vector points to parameters used to control the second fixed disk.

INT 4AH ALARM

This vector may be initialized by a user to point to code to be executed when an alarm interrupt occurs.

INT 70H CMOS CLOCK INTERRUPT HANDLER

This routine handles the hardware interrupt from the CMOS clock chip and updates wait flags set by calls to INT

15H, functions 83H and 84H, and does INT 4AH for alarm if set.

INT 71H

Redirected to INT 0AH.

INT 75H

BIOS handler sends end of interrupt to controller and then executes an INT 2 instruction.

INT 76H

Hardware interrupt from hard disk controller.

DMA Allocation

This appendix defines the assignment of the direct memory access controllers. There are two type of data transfers; one 8 bit, and the other 16 bits. The following table defines the type and preassigned function if available.

CHANNEL	TYPE	DESCRIPTION
DRQ-0	8 BIT	Spare was refresh in PC/XT
DRQ-1	8 BIT	Serial data link controller
DRQ-2	8 BIT	Floppy diskette controller
DRQ-3	8 BIT	Spare
DRQ-4		NA -- Used to cascade the two DMA controllers
DRQ-5	16 BIT	Spare
DRQ-6	16 BIT	Spare
DRQ-7	16 BIT	Spare

The address of the DMA controllers is limited to 64 kilobytes and is extended by the use of a memory mapping register array. Each DMA channel is assigned a register in this array and this register is added to the address from the DMA to generate a 24 bit 16 megabyte address range. The mapping of that memory mapping is defined as follows:

REG ADD	DMA CHANNEL	TYPE	REMARKS
0087	DRQ-0	8 -BIT	8 bit extension to address
0083	DRQ-1	8 -BIT	8 bit extension to address
0081	DRQ-2	8 -BIT	8 bit extension to address
0082	DRQ-3	8 -BIT	8 bit extension to address
008B	DRQ-4	16-BIT	7 Bit extension to address
0089	DRQ-5	16-BIT	7 Bit extension to address
008A	DRQ-6	16-BIT	7 Bit extension to address
008F	DRQ-7	16-BIT	7 Bit extension to address

ATTAK 286 Model 1A Jumper Options

The ATTAK 286 Model 1A has ten jumpers for selecting some fixed installation functions. These options define the speed of the numeric coprocessor, size and type of Dynamic RAM and EPROM, number of wait states on the expansion buss, and the type of display card in use. There is an additional jumper which can enable factory test procedures in the BIOS.

The jumpers must be properly configured before the ATTAK 286 Model 1A is powered up. Failure to set these jumpers will not harm the ATTAK 286 Model 1A but it will not function properly if they are not set correctly. This appendix contains a description of each jumper option and the settings for each option.

Jumper Block J11 Display selection

This jumper, which is located in the upper right of the ATTAK 286 Model 1A, defines to the BIOS which type of display card is installed in the expansion slot for use as the system console. Note that there can be two or more display adapters in the expansion slots, including monochrome, color , enhanced color, professional graphics, and other high resolution cards. The J11 jumper tells the BIOS which display you are expecting the BIOS to use for BIOS and DOS messages. The jumper has two positions, one for the monochrome display adapter and one for the color card adapter as follows.

J11	Startup Display Type
1⇔2	Specifies the monochrome display
2⇔3	Specifies the color card or compatible

Note that the enhanced color, professional graphics, and other color based cards usually install a driver from a card mounted ROM and do not always require the setting of this jumper. The user is cautioned that setting the wrong adapter position will cause a sign on error on some BIOS's and nothing at all on others.

Jumper Blocks J16 and J17 ROM Type Selection

The ROM sockets of the ATTAK 286 Model 1A are designed to accept several different type and technologies of ROM's. These include 27128 and 27256 EPROMs and their equivalent masked ROM's. The two jumpers allow this versatility in the selection of ROM's by modifying the address and chip selects.

Jumper J16 specifies the type of chip select for the ROM with position 1-2 specifying address only qualification and position 2-3 specifying address and read memory command qualifiers. The 1-2 position is used where a static ROM such as an EPROM is used and provides extra access time. The 2-3 position is used with the dynamic masked ROM's that require a cycle of the chip select for each access.

Jumper J17 specifies the connection of the VPP/A14 address pin difference between 16 and 32 kilobyte EPROM's. The 1-2 position is used for 32 kilobyte ROM's and connects the A14 address line to the ROM. Position 2-3 is used with the 16 kilobyte EPROM's and connects the VPP pin to 5 volts.

J16	J17	Description of ROM
1⇔2	1⇔2	32 Kilobyte EPROM 27256-1
1⇔2	1⇔3	16 Kilobyte EPROM 27128-1
2⇔3	1⇔2	32 Kilobyte Masked ROM
2⇔3	2⇔3	16 Kilobyte Masked ROM

Jumper Blocks J18 and J19 RAM Type Selection

These jumper blocks tell the Chips and Technology LSI parts the memory type and allocation desired by the user. There are four configurations of these jumpers and each is usable. The following table defines the memory type and allocation as seen by the 80286 processor.

Memory Allocation

J18	J19	Bank 0	Bank 1	Total
1⇔2	1⇔2	512K	512K	1024K
1⇔2	1⇔3	512K	NONE	512K
2⇔3	1⇔2	512K	128K	640K
2⇔3	2⇔3	128K	128K	256K

The allocations shown are the only configurations possible as the Chips and Technology LSI sets these restrictions. The 1 Megabyte memory allocation is always 512 in lower memory and 512 in extended memory and can not be split as 640K in lower and 384K in extended memory.

Jumper Blocks J22 and J23 I/O Channel Wait States

These jumpers allow the user to select the number of wait states added to expansion buss transfers with 8 bit peripherals. The PC/XT peripherals were not designed to operate at the speed of the PC/AT and need extra time for data transfers. The Chips and Technology LSI allows the addition of 2,3 or 4 wait states to all 8 bit data accesses to the expansion buss. All other accesses are one wait state defaults. The following table defines the setting of the jumpers:

J22	J23	Number of I/O Wait States
1⇔2	1⇔2	DO NOT USE
1⇔2	1⇔3	2 Wait states
2⇔3	1⇔2	3 Wait state
2⇔3	2⇔3	4 Wait states

Note that many cards from the PC/XT will function only with 4 wait states as used in the IBM PC/AT design. This option is to be used only if the User has tested the cards and find that they function correctly with 2 or 3 wait states. Also many cards will not function at 10 MHZ and higher even with 4 wait states. These cards can not be used in any high performance PC/AT.

Jumper Blocks J26 and J27 Numeric Speed Select

These jumpers allow the selection of what speed the Numeric coprocessor will operate. Most PC/AT mother boards always run the numeric at 1/3 the CPU clock speed. Therefore an 8 MHZ PC/AT CPU will have a numeric running at 16/3 or 5.333 MHZ. Placing an 8 MHZ Numeric Coprocessor in these machines results in a lower performance increase as the numeric will be running at 60% of full speed. The ATTAK 286 Model 1A supports running the Numeric at full speed by providing a special clock driver and clock generation circuit. The user can also use the 10 MHZ numeric coprocessor if the ATTAK 286 Model 1A has been speed selected for 10 MHZ. The following table defines the possible CPU speed and Numeric speed selection possible with the jumpers and crystal changes.

J26	J27	CPU Clock	Numeric Clock
1⇔2	1⇔2	8 MHZ	8 MHZ
1⇔2	1⇔2	10 MHZ	10 MHZ
1⇔2	2⇔3	DO NOT USE	DO NOT USE
2⇔3	2⇔3	8 MHZ	5.33 MHZ
2⇔3	2⇔3	10 MHZ	6.66 MHZ
2⇔3	2⇔3	12 MHZ	8 MHZ
2⇔3	2⇔3	16 MHZ	10.6 MHZ

Note: The user must supply the correct speed numeric coprocessor as several speed grades exist. Use of a numeric processor with a lower speed grade will cause various errors in normal programs and can damage the 80287.

Jumper J15 BIOS Manufacturer test

This jumper is used during manufacturing tests to enable BIOS ROM based diagnostics. These diagnostics allow the downloading of test programs into the ATTAK 286 Model 1A through the keyboard interface. **The user should leave this jumper open in normal operation.**

Connector Pinouts

This appendix covers the connectors of the ATTAK 286 Model 1A defining mating connectors and pinouts of the connectors.

EXPANSION SLOT Connectors J1 through J8

The expansion slot connectors of the ATTAK 286 Model 1A are identical to the expansion slot connectors of the IBM PC/AT. There are two formats of the expansion slots one for 16 bit and one for 8 bit data transfers. The eight bit connector format is a single 62 pin dual row .1 inch centers designed for PC board edge interface using .062 inch thick PC boards. The 16 bit format is and extension of the 8 bit format by adding a single 36 pin dual row .1 inch centers connector.

8 BIT EXPANSION CONNECTOR				16 BIT EXPANSION			
GND	B1	A1	/IO CH CK	/MEM CS16	D1	C1	SBHE
RESET	B2	A2	D7	/IO CS16	D2	C2	LA23
+5 VDC	B3	A3	D6	IRQ10	D3	C3	LA22
IRQ 9	B4	A4	D5	IRQ11	D4	C4	LA21
-5 VDC	B5	A5	D4	IRQ12	D5	C5	LA20
DRQ2	B6	A6	D3	IRQ15	D6	C6	LA19
-12 VDC	B7	A7	D2	IRQ14	D7	C7	LA18
0WS	B8	A8	D1	/DACK0	D8	C8	LA17
+12 VDC	B9	A9	D0	DRQ0	D9	C9	/MEMR
GND	B10	A10	/IO CH RDY	/DACK5	D10	C10	/MEMW
/SMEMW	B11	A11	AEN	DRQ5	D11	C11	D8
/SMEMR	B12	A12	A19	/DACK6	D12	C12	D9
/IOW	B13	A13	A18	DRQ6	D13	C13	D10
/IOR	B14	A14	A17	/DACK7	D14	C14	D11
/DACK3	B15	A15	A16	DRQ7	D15	C15	D12
DRQ3	B16	A16	A15	+5 VDC	D16	C16	D13
/DACK1	B17	A17	A14	/MASTER	D17	C17	D14
DRQ1	B18	A18	A13	GND	D18	C18	D15
/REFRESH	B19	A19	A12				
CLK	B20	A20	A11				
IRQ7	B21	A21	A10				
IRQ6	B22	A22	A9				
IRQ5	B23	A23	A8				
IRQ4	B24	A24	A7				
IRQ3	B25	A25	A6				
/DACK2	B26	A26	A5				
T/C	B27	A27	A4				
BALE	B28	A28	A3				
+5 VDC	B29	A29	A2				
OSC	B30	A30	A1				
GND	B31	A31	A0				

Keyboard Connector J9

The keyboard connector interfaces the keyboard to the ATTAK 286 Model 1A and is IBM PC/AT compatible. The connector is a 5 pin DIN connector facing the rear of the motherboard.

J9	Keyboard Connector
1	Keyboard clock
2	Keyboard data
3	No Connection
4	+ 5 VDC power
5	Ground

Reset Switch Connector J10

This connector is a two pin jumper designed to allow the connection of a remote reset switch.

J10	Reset Switch Connector
1	Reset input
2	Ground

Battery Connector J12

This connector allows the user to connect an external battery for powering the on board clock and configuration memory. The pin out and location is IBM PC/AT compatible and consists of a four pin connector.

J12	Battery Connector
1	+ 6 Volt Battery
2	No connection
3	Ground
4	Ground

Power Supply Connectors J13 and J14

These two six pin connectors provide power for the mother board and the expansion slot adapters. The connectors are keyed and are aligned to form a single 12 pin connector.

J13	Power Supply Connector
1	Power Good
2	+ 5 VDC
3	+ 12 VDC
4	-12 VDC
5	Ground
6	Ground

J14	Power Supply Connector
1	Ground
2	Ground
3	-5 VDC power
4	+ 5 VDC power
5	+ 5 VDC power
6	+ 5 VDC power

Speaker Interface Connector J20

This connector interfaces the mother board to the cabinet mounted speaker. The connector is a four pin jumper located near the front of the motherboard.

J20	Speaker Interface Connector
1	Speaker output
2	No connection
3	Ground
4	+ 5 VDC

Front Panel Connector J21

This connector interfaces the front panel of the cabinet to the mother board. The front panel includes a Power On LED, Disk Access LED, and Keyboard lock switch. The Power LED and keyboard lock switch are interfaced through J21. The connector is a five pin connector.

J21	Front Panel Connector
1	Power LED Anode
2	No connection
3	LED ground
4	Keyboard lock switch input
5	Keyboard lock ground

Parts List

REFERENCE DESIGNATOR	PART	QTY
U1	74ALS245	1
U2	7407	1
U3	8042/8742	1
U4	146818	1
U5	74HC14	1
U6,71	74ALS04	2
U7,14	8259A-2	2
U8,15	8237A-5	2
U9	74F74	1
U10,70	74F08	2
U11	74LS125	1
U12,52,74	74F00	3
U16	82A203	1
U17	82C201	1
U18	82A205	1
U19,21	27128/27256	2
U23	82A204	1
U24	80286	1
U25	80287	1
U26	82C202	1
U27	74ALS138	1
U28	8254	1
U30-38,42-50	64K/256K DRAMs	18
U39	74F153	1
U40,69	330OHM,16PIN,DIP/RES	2
U51,84	74F10	2
U53	DELAY LINE	1
U54	74ALS244	1
U55,56	74ALS573	2
U57	74LS612	1
U58	74F112	1
U60-68,75-83	256K DRAMS	18
U72	74ALS27	1
U73	74S51	1
R1,2,5,7,10,23,24	10K	7
R3,4	470 OHM	2
R6	51K	1
R8	68K	1
R9	100 OHM	1
R11	1K	1
R12	2M	1
R13,14,15,22	300 OHM	4
R16,19	10 OHM	2
R17,18	1M	2
R20	910 OHM	1
R21,28	33 OHM	2
R25	150 OHM	1
R26	30 OHM	1
R27	470K	1

CR1-4	1N4148	4
C1,2	47 PF	2
C3,10,12,13,16,17,25-29,32-37, C40,44-47,50-55,57-60,62-64, C66-69,73-82,85-93,95-98, 100-102,105-113,115-120,124	.1 UF	83
C4-6,8,11,14,15,18-24,31,41, C48,49,70,71,83,94,103,104, C114,121-123	10 UF	28
C7	.0047 UF	1
C9	27 PF	1
C38,39,42,43	10 PF	4
C65	.047 UF	1
C99	20 PF	1
C125	68 PF	1
RP1,3,4,5	10K 8 PIN SIP	4
RP2	1K 8 PIN SIP	1
Y1	32.768 KHZ	1
Y2	16 MHZ	1
Y3	14.31813 MHZ	1
Q1	2N3404	1
Q2,3	2N3406	2
B1	BATTERY HOLDER	1
S1	SWITCH, RESET	1
J1,7	CONN, 62 PIN	2
J2,3,4,5,6,8	CONN, 98 PIN	6
J9	CONN, 5 PIN DIN	1
J10,15	CONN, 2 PIN BERG	2
J11,16,17,18,19,22,23,26,27	CONN, 3 PIN BERG	9
J12,20	CONN, 4 PIN BERG	2
J13,14	CONN, 6 PIN POWER	2
J21	CONN, 5 PIN BERG	1
14	PIN SOCKET	16
16	PIN SOCKET	41
20	PIN SOCKET	4
24	PIN SOCKET ON .6	2
28	PIN SOCKET	4
40	PIN SOCKET	5
48	PIN SOCKET	1
68	PIN SQUARE SOCKET	3
68	PIN GRID ARRAY	1
84	PIN SQUARE SOCKET	1

Assembly Diagram

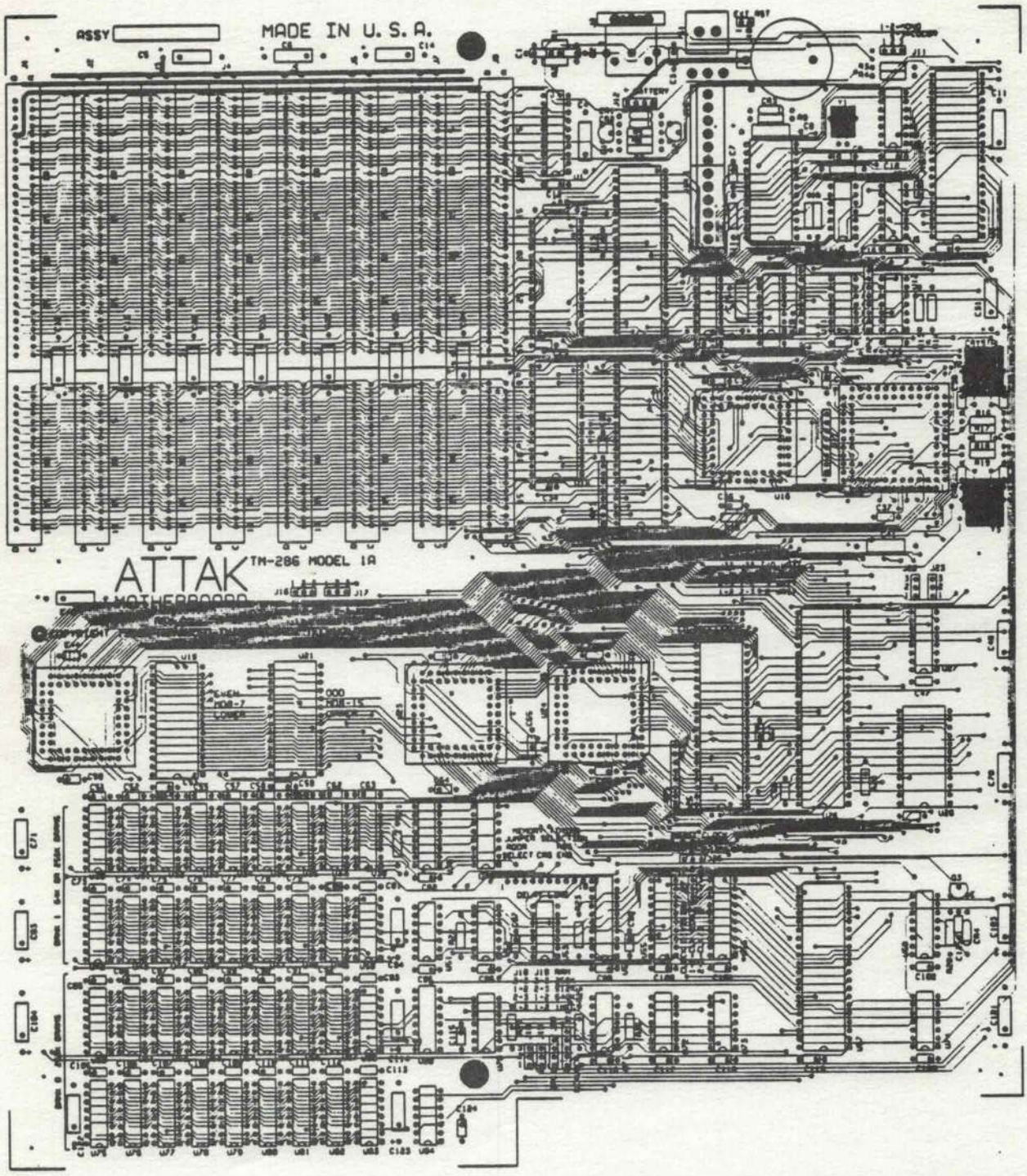


Figure G-1

ATTAK 286 MODEL 1A

Schematics

A

B

C

D

E

F

J

K

L

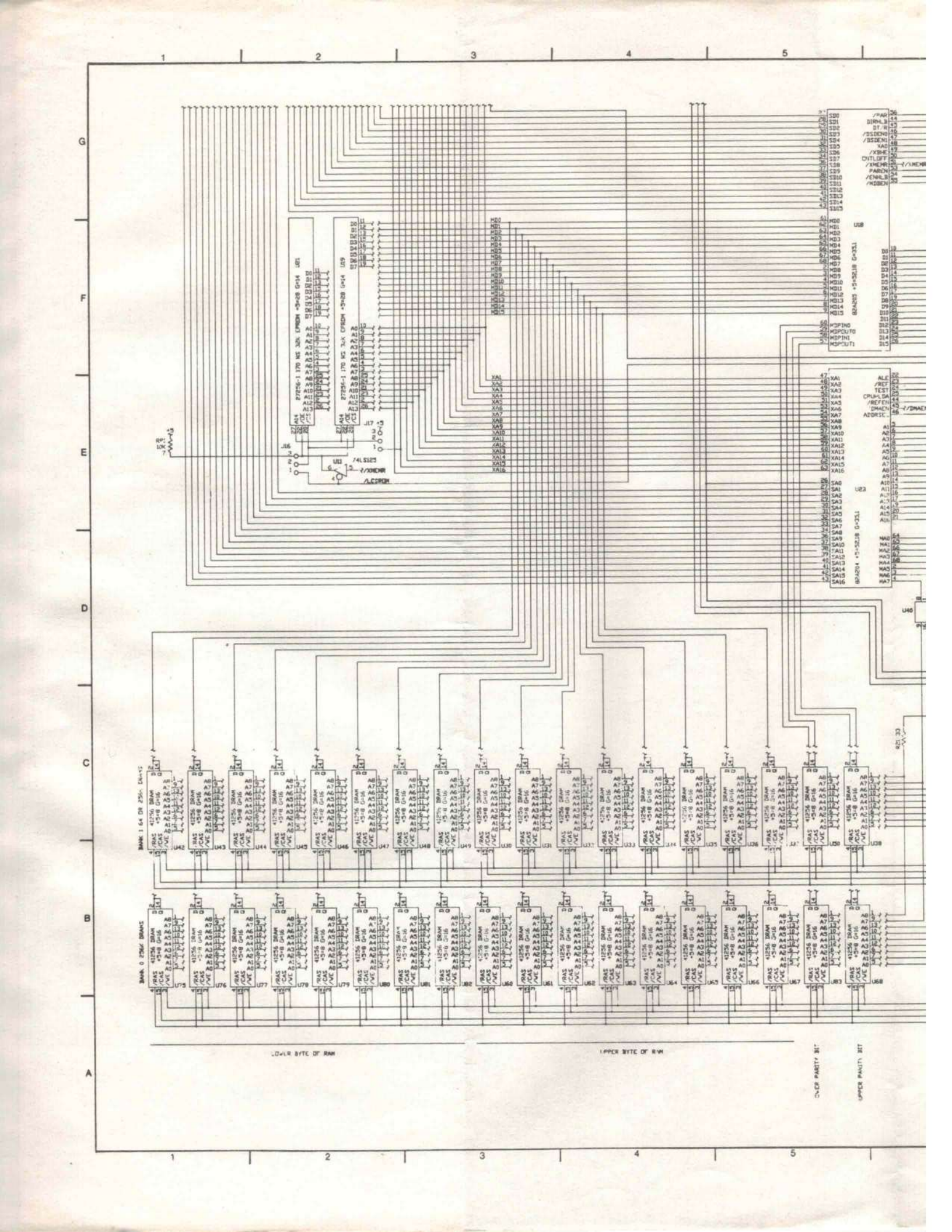
M

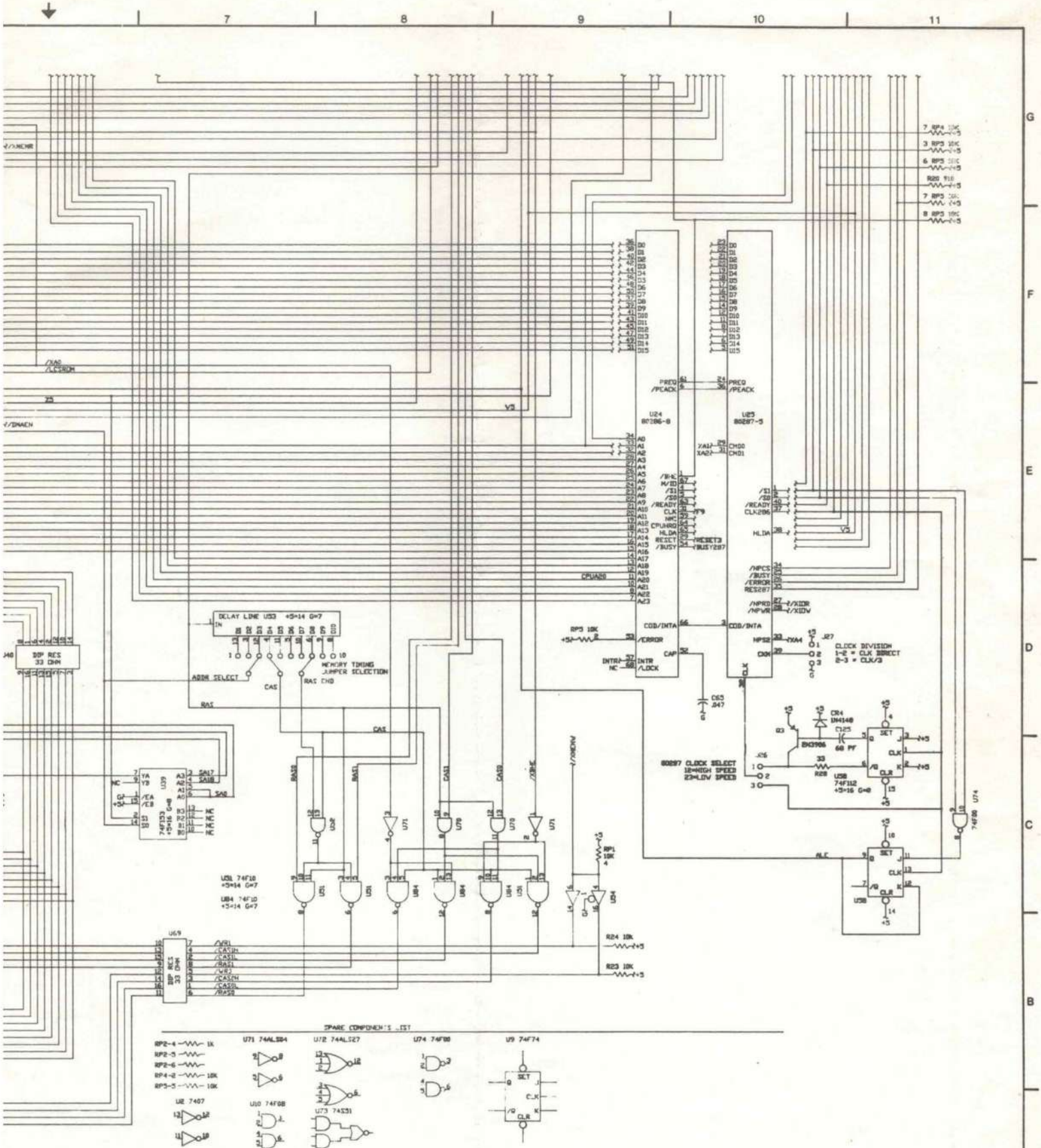
T

W

X

Y


1
2
3
4
5
G
F
E
D
C
B
A
U8
U23
U46
U1
74LS125
/XMEMR
/LCSROM
BANK 1 64 OR 256K DRAMS
BANK 0 256K DRAMS
LOWER BYTE OF RAM
UPPER BYTE OF RAM
LOWER PARITY BIT
UPPER PARITY BIT



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		SHEET 2 OF 2	
		USED ON:	
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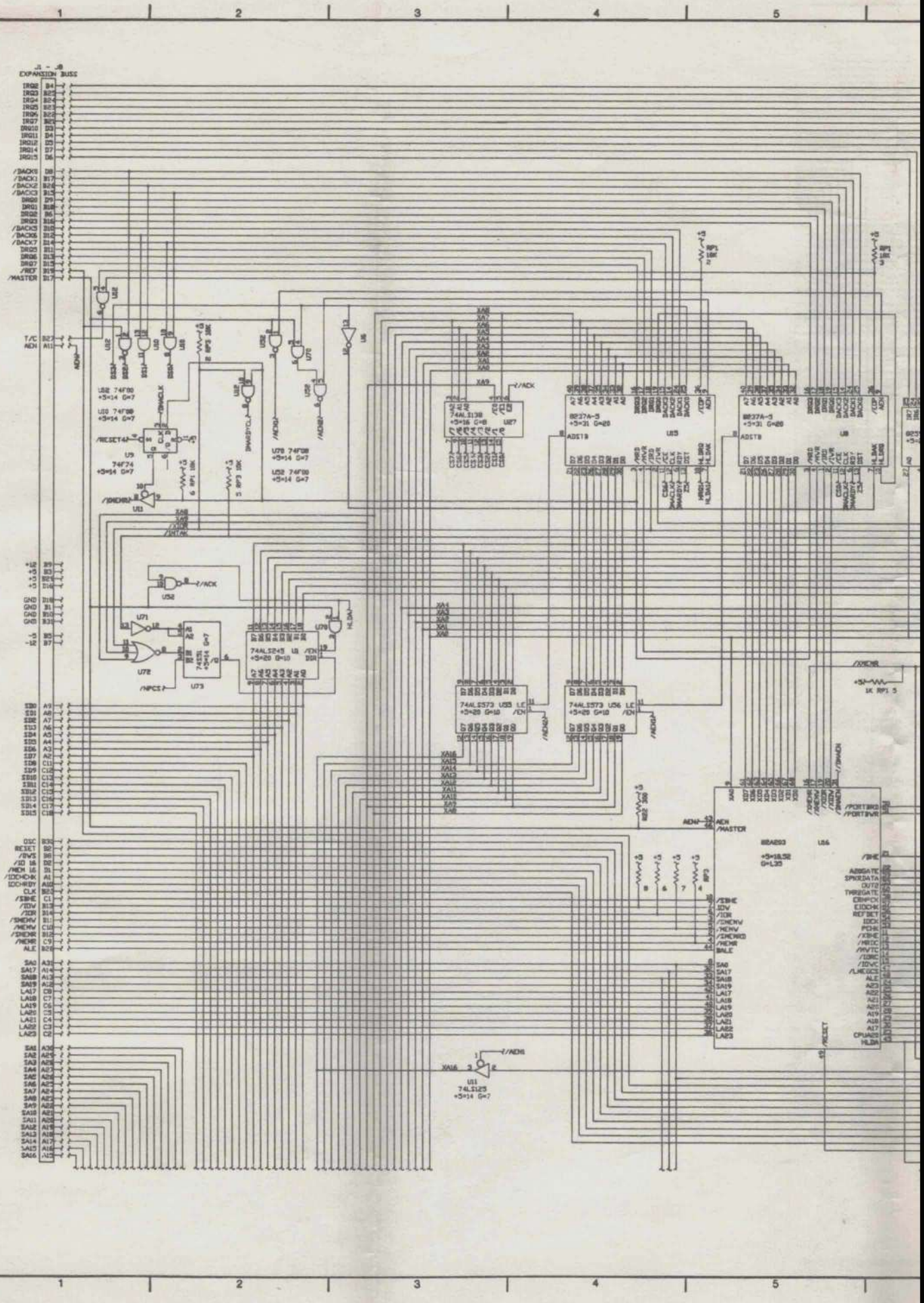

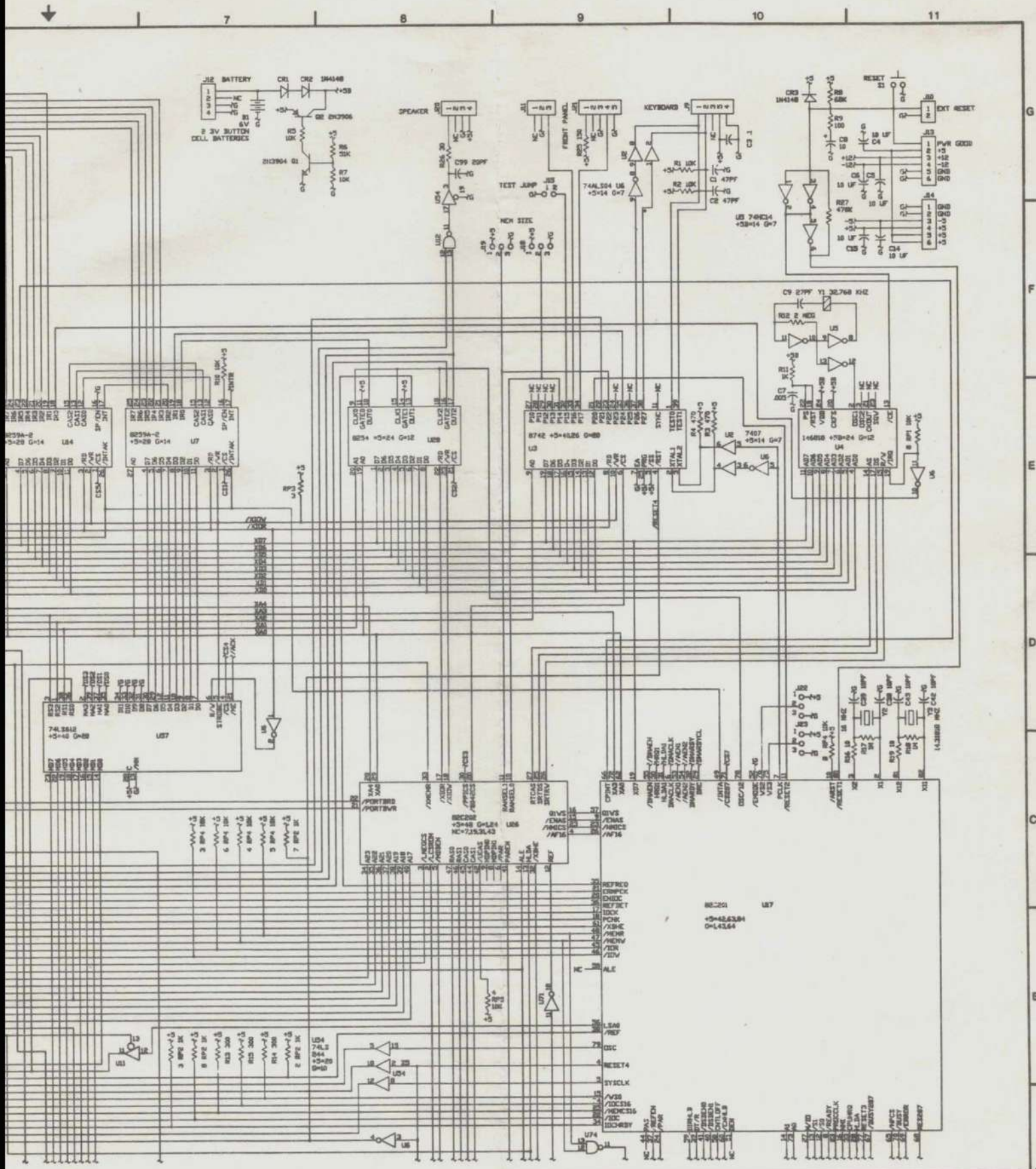

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