The CHALLENGER 1P Technical Report

A comprehensive discussion

of the Ohio Scientific ;

SUPERBOARD II

CHALLENGER 1P

CHALLENGER 1P MINI DISK

Personal Computer Systems

Aug. 1978

Introduction:

The C1P series technical report was compiled by Ohio Scientific's engineering department to provide an over view of the C1P product line for computer dealers, prospective customers and authors. The paper can be read from cover to cover or "accessed" a section at a time.

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Ohio Scientific reserves the right to enhance system specifications and options without notice.

THE CHALLENGER 1P TECHNICAL REPORT

The Challenger 1P family of computers is composed of three factory configured models and specific accessories. The factory configured models are the Challenger 1P, which is a fully-packaged personal computer ready to run as delivered; the Superboard II, which is a single-board computer less case and power supply; and the Challenger 1P Mini-Disk system, which is a ready-to-run BASIC-in-ROM computer in conjunction with a single-drive Mini-Floppy and BASIC oriented disk operating system.

Accessories include a 610 expander board, memory expansion kits, mini-disks, and a Model 620 BUS Expander, which allows the Challenger 1P series computers to use Ohio Scientific's full line of OSI-48 BUS Compatible products.

Comparing C1P Series Computer Products To the Rest Of The Market.

The C1P series is Ohio Scientific's formal entry into the low-cost mass-marketed personal computer marketplace. The C1P incorporates high performance standards in conjunction with ultra low-cost single-board computer architecture, made possible by Ohio Scientific's experience in microcomputers. Thus, the C1P series maintains most of the high performance standards of top-end microcomputer systems while maintaining an extremely low retail price. The C1P series computers contain all the necessary ingredients for a successful personal computer including these fundamentals:

1. Keyboard Input via a computer industry standard 53 key ASCII like keyboard.
2. Complete video display capability via conventional NTSC standard video output complete with scrolling and character editing capability.

3. A complete cassette storage subsystem utilizing the highly reliable Kansas City Standard for audio cassette storage. This allows direct interchangeability between computers, and, provides high cassette data storage integrity.

4. C1P series computers also have a unique feature in that the user can view the information as it is loaded from the cassette. The user need not wait until the cassette is loaded to see if he has the right program, an error, etc.

5. All machines include standard 8K BASIC-in-ROM. This BASIC is written by Microsoft and is compatible with the industry standard nomenclatures for BASIC.

6. All machines include at least 4K of user RAM, making even the smallest machines highly useable.

7. C1P series computers include a complete machine code monitor-in-ROM, allowing direct accessibility to machine code programming.

Along with these fundamental features, C1P series incorporates many deluxe features which set the unit apart from personal computer competitors. These features include:

1. Full upper/lower case capability, allowing practical word-processing and professionalized programming.

2. Elaborate graphics capability, which includes a full set of standard ASCII characters for text editing, graphics, lines, geometric figures; and a full set of gaming elements such as tanks, boats, cars, airplanes, etc.

3. Challenger 1P's sophisticated character graphics system allows elaborate video graphics capability without extensive programming.

4. Challenger 1P is extremely fast in execution of BASIC. Its 6½ digit BASIC-in-ROM achieves an ideal balance between the program execution speed and arithmetic capability, giving the user the fastest full-feature BASIC in the microcomputer industry. He can easily program real time applications in BASIC, such as video animations or control functions and still maintain full arithmetic capability for scientific and financial calculations. No other BASIC-in-ROM personal computer, other than the Ohio Scientific line, currently offers fast BASIC execution for real time applications, in conjunction with full arithmetic capability.

The Challenger 1P series also incorporates a highly noise free video display. Many other small personal computers have excessive noise or image break-up when the screen is rapidly accessed. It is important that a small personal computer have fast execution, graphics capability, and a noise-free display for animation or real time graphics displays. The Challenger 1P series achieves, by far, the highest "performance to cost" ratio in this area.

The Challenger 1P series personal computers also have facilities for data storage to allow user's data to be stored in cassette-based files in a limited fashion. This allows the user to explore more advanced applications, particularly in small business environments.

The serious limitation of most personal class computers is their lack of economical expansion capability and the sacrifice of any semblence of portability when expansion is made. This problem has been most carefully considered by Ohio Scientific and virtually eliminated by designing the Challenger 1P system as a complete computer system from the start. A fully expanded Challenger 1P system was developed, including up to 32K of RAM memory and dual mini-floppies, before the Challenger 1P was introduced. With expansion facilities already developed, the Challenger 1P can be directly and economically expanded. Primary expansion in the Challenger 1P series is via the 610 accessory board. This board holds up to 24K of additional RAM memory, a dual mini-floppy disk controller, a BUS expansion facility to Model 620 BUS adapter, and switching circuitry to route the 600 board's serial interface to both the modem and printer as

well as an audio cassette. Thus, a fully expanded Challenger 1P system can have BASIC-in-ROM, 32K of RAM memory, dual mini-floppies, cassette, printer, modem, and full BUS expansion capability to the OSI 48 line BUS through which over 40 accessories can be added (A/D, D/A, voice, I/O, more memory, etc.).

By direct use of this economical "610" expansion system, the user can expand his memory and add mini-floppy disks. A mini-floppy disk drive has several advantages over cassette. Its first and foremost advantage is that programs can be loaded and stored virtually instantaneously instead of requiring the several minutes typically needed to load and store cassette-based programs.

The other important application of mini-floppy is for data files. OSI's mini-floppy based operating system directly supports sequential as well as random access files directly in BASIC, which allows data storage in applications such as those in small businesses.

Thus, the Challenger 1P series incorporates all the fundamental necessities of a personal computer; a standard 53-key keyboard, video display, cassette storage, industry standard 8K BASIC-in-ROM, sufficient RAM memory, and machine code facilities. The series also incorporates features normally associated with high-end computers such as upper/lower case, graphics, very fast program execution, noise-free display for animation, and extremely economical and open-ended expansion. These features are all integrated into an extremely compact and light-weight package, making the Challenger 1P a truly portable "under-one-arm" computer system.

Specific Comparisons Against Competitors

There's virtually no bona fide computer system in the price class of the Challenger 1P. Other computers in the $300 price class are, in fact, "souped-up" video games. They can be spotted by the absence of complete computer keyboards; and they usually use a very small subset of BASIC, or do not have upper level language program ability at all. The closest competitors to the Challenger 1P series are computers in the $600-$1000 price class. While these specific competitors' products cost far more than the Challenger 1P, they are, in reality, much less powerful and versatile. Each competing computer in the $600-$1000 price class is missing one or more of the fundamental features that we have found necessary for a successful and enjoyable personal computer.

Some of the specific things we have frequently noted as missing on competitors' products include poor or non-existent graphics in conjunction with very slow program execution. This means that one of the most interesting facets of personal computing - its animation and graphics capability - cannot be effectively utilized. Slow program execution means that complex (and therefore interesting) tasks become impractical because of the long time it takes for the computer to perform such tasks.

Other fundamentally lacking features include the use of the calculator-style keyboard instead of a full ASCII-type keyboard. The computer or typewriter keyboard is really a necessity for convenient interaction with the computer. Even a non-typist will become very annoyed with a calculator-style keyboard on a personal computer.

Some personal computers lack necessities such as the decimal arithmetic capability and scientific math functions. A user cannot even perform simple arithmetic on the computer immediately after he turns it on, and instead must load a long program to perform many simple math functions. Some personal computers do not even have cassette/data storage capability, so it's impossible to store any type of data files on cassette.

From this discussion, it should be obvious that the Challenger 1P is truly a dramatic breakthrough in the "performance to cost" ratio of personal computers.

The C1P series personal computer is specifically designed for first-time personal computer user and for use in educational environments. Its fundamental and advanced features provide the widest range of home applications of all computers in its general class. Below, some of these applications are explained in detail.

Personal or Home Computers

Challenger 1P's advanced character graphics, noise-free display, programmable keyboard, and extremely high execution speed BASIC make it capable of spectacular video games, cartoons, animated advertisements, and elaborate computer games. Ohio Scientific offers an extensive library of one and two player video games very similar to conventional arcade games as well as a standard complement of computer-type games. Ohio Scientific's software library also includes examples of cartoons, advertisements, and educational games which make extensive use of graphics and programmable keyboard inputs. Challenger 1P comes with the Challenger character graphics reference manual which includes simple-to-follow instructions on programming graphics, and utilizing the polled keyboard. The computer's fast program execution makes such applications a snap to program.

Personal Finances

Challenger 1P's decimal arithmetic capability in conjunction with its cassette storage abilities make it practical for many forms of personal finance aid and analysis. Ohio Scientific's cassette library includes a check book balancing program, savings account program, several types of annuity, and loan analysis. Budget planning aids include home owner-

ship cost analysis and expense accounting. Demonstration programs provide personal calendars, phone directory, address book, and other personal services such as dietary analysis.

It should be pointed out that a mini-floppy disk is a practical necessity for advanced applications such as those just mentioned above. However, they can be effectively demonstrated on a cassette system. As in all applications, the ease of programming in BASIC, along with the fundamental features of decimal arithmetic capability and cassette storage, make user-generated applications in these areas easy to program.

Scientific Calculations or Advanced Mathematical Analysis

Challenger 1P's BASIC has full advanced arithmetic capability, including trigonometric functions, logarithms, exponentiation, and full scientific notation. These features are available in the immediate mode of operation as well as the stored program mode. For instance, a user can quickly turn the computer on, type in an equation as a single line, and press return to get an answer. The computer can double as an advanced scientific calculator with much greater ease of use than any available calculator.

Its program storage and alpha numeric capability make it extremely valuable to engineers, students, professors, etc., for solving scientific, engineering and mathematical analysis problems. Ohio Scientific's cassette library includes several advanced mathematics oriented programs including a programmable calculator simulator and a math function library in which the user can place his most commonly used math functions. For example, an engineer could place his most commonly used equations in the computer at one time and select them via a menu. The library also includes applications programs such as definite integrals, statistical analysis, and other complex math functions. In general, the Challenger 1P will be hundreds of times faster than the most powerful scientific calculators in "number-crunching" applications.

Education

Challenger 1P series personal computers really excel in educational computing applications. Once the user gets involved in educational applications of these machines, he will quickly consider them a necessity in the educational process. This will become obvious from the following discussion.

Let's first consider the application with children in the kindergarten to grade six range. One startling point is that very young children are very quickly and easily attracted to computers. Children are now accustomed to

new technological improvements as a way of life, and have no apprehensions or reservations about something new and exotic such as a personal computer. It is viewed as just another fact of life like microwave ovens, color television, tape recorders and jet airplanes. We have found it common place for even a kindergarten level child to quickly master some basic operations of the computer. He or she is usually able to interact with the computer according to his or her reading ability at the moment. It is not at all uncommon for six year old children to respond to math problems interactively on a personal computer. Children's natural fascination with computers in conjunction with the 1P's cartoon-like interactive capability make the computer highly valuable in a modern educational environment. Programs which teach, tutor, and drill students in virtually all areas of education can be very easily programmed on the Challenger 1P system. By utilizing alpha numeric prompting, interaction, and correcting the child's errors; the computer can easily maintain the child's attention. Ohio Scientific has a full library of several types of educational games which can be used as an example in programming such applications. These programs range from a simple Sesame Street type arithmetic cartoon through mathematics drills, to word games such as spelling from a phonetic representation. Other examples provide multiple choice questions, and exciting interactive games such as "Hangman" where a gallow, noose, and person are actually constructed graphically as the child attempts to guess the letters of a word.

Use of highly animated interactive educational games is possibly the most valuable use of personal computers today. In higher grades, a computer can be used for much more advanced topics through its advanced math and data storage capabilities. An example of such an application is the Trig Tutor program in Ohio Scientific's program library which graphically depicts angles of triangles. By incorporating a mini-floppy disk on the machine, the educator will have the capability of a large quick-access data base and can actually develop an interactive text book for any normal educational topic.

Another broad area of education is in teaching the fundamentals of computing itself. The Challenger 1P utilizes the most popular upper level language, BASIC, in a very complete and concise implementation. With a Challenger 1P, the user can teach BASIC in conjunction with any of the commonly available text books on the BASIC programming language. The 1P series machines have full machine code accessibility including the machine code monitor so that students in advanced areas can enter, edit, and execute machine code programs. A very fast and interactive assembler/editor is available to run on 8K Challenger 1 machines so that students can be introduced to the concepts of assembler programming and editing.

The Challenger 1P system computers are designed to support high speed synchronous interfaces such that they can be networked in a distributed processing system under an OS-65U Level I system. This means that any Challenger 1P system can be used as an interactive intelligent terminal in an OS-65U Level I system. Ultimately, what this means to the educator is that 16 Ohio Scientific personal computers such as 1P's can be tied to a centrally located large Ohio Scientific computer which has floppy disks, hard disks, and other shared resources such as a line printer. Each one of these personal computers can load and store programs from the central data base as well as make use of central shared line printers. Each computer can also communicate with the master console. The master console continually monitors the status of the terminals and their communications such that the OS-65U Level I system is equivalent to a language lab for computer teaching. This provides individual stations for the students as well as a complete control console and centrally located resources for the educator. The low cost of the Challenger 1P terminals makes a 1P-based 65U Level I system by far the most economical educational network available.

Advanced Applications

There are many other applications of the basic 1P machines that have not been mentioned here. We would now like to touch on some of these advanced applications made possible by the expansion of the computer.

As mentioned earlier, the Challenger 1P is highly expandable, directly and economically, by use of the 610 board which adds up to 24K of additional RAM for a total of 32K. The 610 board also interfaces dual mini-floppies, modem, a line printer and an expansion of the OSI 48 line BUS on a 620 adapter board. Ohio Scientific considers an 8K RAM machine the practical upper limit for cassette based computers because of the load time required for programs into an 8K work space. As the user goes to 16K of total RAM, he would also naturally like to have mini-floppy disks. A 16K single mini-floppy disk-based Ohio Scientific computer has complete program loading, storage, and execution capability; random access and sequential data file capability; and quick access to an interactive assembler/editor, on-line debugger, and machine code programs. These resources in a very modestly priced configuration make the 1P a very appealing machine to the more advanced hobbyists or personal computer enthusiast, that is, a person who desires to do program development and/or some interfacing on his own.

By adding a modem to a serial port of the computer, the computer becomes a terminal, and can be used intelligently and interactively with a time sharing service or other computer systems over the phone lines. A line printer can

be directly added which is valuable for program development and educational applications. The fast and convenient data file operations of the mini-floppy make the Challenger 1P a deluxe personal services computer giving the user easy access to phone numbers, personal calendar, addresses and other file-type information.

The system can also be used in a limited fashion for small businesses. However, any moderate size small business will require more data storage capability than is available on any mini-floppy. Therefore, Ohio Scientific strongly recommends that any small business computer user utilize at least an 8" floppy based computer system. The Ohio Scientific Challenger C2-8P series computers are by far the most effective small business computer systems available. They should be considered instead of a Challenger 1P for small business applications.

We have already touched on the on the power of the mini-floppy in education in that it allows the educator to make use of a large data basis for sophisticated topics in education. It is also a convenience in programming courses because each user can very quickly load and save his programs, so that the machine is not tied up with cassette loads and dumps.

The Challenger 1P's further expansion via the 620 adapter board to the OSI 48 line BUS makes it extremely interesting to advanced hobbyists and advanced educational users. With this adapter board, the user can add any of the broad line of OSI 48 line-compatible boards and interfaces. Some notable boards for advanced applications in remote control, process control, home interfacing, and advanced experimentation in education are included at the end of the hardware section of this paper.

TECHNICAL INFORMATION

General Architecture

The Challenger 1P family has four physical components. The model 600 single-board computer, model 610 expansion board, a Challenger 1P case and a Challenger 1P mini-floppy. The fully populated 600 single-board computer is available as a Superboard II complete with manual and demonstration software library. The same 600 board is available packaged in a Challenger 1P case which is virtually identical to the Challenger C2-4P case and includes a 5 volt, 4.5 amp power supply. The model 610 board is available as an expansion option for either of these models. In a Challenger 1P application, the 610 adapter board mounts inside the 1P's case directly underneath the 600 board. With the Superboard II, the 610 board mounts directly over the circuit portion of the board. The Challenger 1P mini-disk is a fully packaged mini-floppy and power supply in a two-tone metal case which matches the Challenger 1P. It can be placed on a table side by side with a Challenger 1P, or placed on top of the Challenger 1P. For portable operations, it can be permanently fastened to the top of the Challenger 1P. The system is available fully packaged with a 600 board, 610 board, 16K of RAM memory encased in a Challenger 1P case, and a Challenger 1P mini-disk drive as a Challenger 1P mini-disk system. A second mini-disk can be added at any time by simply plugging in the additional cable.

Physical

The model 600 single-board computer is a single G-10 Epoxy circuit board containing a keyboard, CPU, BASIC-in-ROM, RAM, video display and audio cassette interface. It also has provisions for expansion and provisions for an on-board power supply except for the transformer and series pass regulator element. The board is approximately 14½" long by 12" wide. When supplied as a Superboard II, it has seven rubber feet on it so that it can be used directly on a table top. The Superboard II does not have the power supply portion of the PC board populated, but has a reverse voltage protection diode, LED power indicator and over current protection fuse along with two 12" leads, black for negative and red for positive. The board requires approximately 2½ amps at +5 with at least 5% regulation. Interconnection harnesses to cassette recorder and video monitor is provided with the Superboard II unit.

The Challenger 1P incorporates the same electronics in conjunction with the Challenger 1P metal case which is identical to the Challenger C2-4P case. It incorporates a 4½ amp power supply, external DC fusing, line cord, switches and RCA phono jacks at the back of the unit for audio cassette and video monitor. Cables approximately 18" long are provided with the unit to connect to an audio cassette recorder and video monitor.

The model 610 board is an expansion interface for the model 600 single-board computer. The board is approximately 10 x 12 inches and is about the same size as the circuit portion

of the 600 board (less keyboard). The 610 unit can be mounted directly above or below the model 600 CPU board on stand offs through corresponding holes in it and the 600. The unit connects to the 600 board via a short 40 pin ribbon cable. In some configurations, the model 610 can derive its power completely from the 600 board. If 24K of medium or high power consumption RAM memories are used, it is necessary to utilize a separate voltage regulator in conjunction with the 610 board because the full board set can draw more than 5 amps at +5.

The 610 board has a 24 pin Molex connector which accepts single or dual mini-floppy cable and has a 40 pin ribbon connector to mate with the model 620 BUS expansion board. The model 620 system expansion board includes a 4 ft. ribbon cable and a PC board which plugs in one slot of any OSI 48 line BUS backplane. This allows the Challenger 1P series computer to interface directly to OSI 48 line BUS equipment.

The Challenger 1P mini-floppies are physically identical to the Challenger C2-4P mini-floppies and are packages in a case which closely matches the appearance and size of the Challenger 1P case less the keyboard portion. The units are connected via a 4 ft. ribbon cable and have their own AC power cord, switch and fuse. Each mini-floppy drive has its own +12 and +5 power supply. Each drive features an activity light showing when it is selected. The Challenger 1P mini-floppies must be purchased as A or B drives. The first drive on any system will be A Drive. The user must have a 610 adapter board and a total of 16K or more of RAM memory to utilize single mini-floppies. The Challenger 1P weighs less than 12 lbs. making it one of the most

portable small computers available today.

ELECTRONICS OF THE 1P SERIES

Model 600 Single Board Computer

The model 600 single-board is a complete single-board computer system incorporating a CPU, 8K BASIC in Read Only Memory, RAM, video display, cassette storage, keyboard and optional power supply on a single board. We will further discuss the board by these sub-modules.

CPU

The Challenger 600 board incorporates a conventional 6502 microprocessor. It operates with a single-speed crystal controlled clock at approximately 1.0 MHz. The computer is master reset by the break key of the keyboard. The two system interrupts are not utilized in the base configuration but are routed to the model 610 expander board and optionally outward to the 48 line expansion BUS. The system supports Ohio Scientific 8K BASIC-in-ROM which occupies address AØØØ to BFFF (hex). The system can support either four 16K bit 2316B-type masked ROMS or one 64K bit masked ROM via a jumper option. An ambitious user could optionally place 2716 EPROMS on the board in place of these ROMS if desired. In addition to these four masked ROMS for the 8K BASIC, another 2K byte or 16K bit ROM is utilized for system monitor and support functions. The overall functions of this firmware module are covered in the software section.

Audio Cassette

The audio cassette portion of the system is supported by a 6850 asynchronous interface adapter which is connected to a Kansas City Standard 300 baud audio cassette interface. This

interface incorporates reasonable transfer speeds in conjunction with high reliability and good computer program exchange ability. Although the transfer rate is 300 baud, the extremely high data reliability indicates that the actual transfer time for programs is less than many systems which advertise higher baud rates of transfer. The baud rate for the interface is crystal-controlled at 300 baud. The board incorporates a switching network and connections for a 300 baud RS-232 port specifically for a modem, and an output-only RS-232 board for a printer. To make use of these two features, the user will have to wire in a selection switch and connectors; and, depending on the characteristics of the particular RS-232 interfaces in his printer and modem, may optionally have to provide a negative voltage to the interface. The RS-232 standard specifies a negative voltage swing but no negative is available with the PC board.

In addition to its modem, printer and audio cassette interface capabilities, the serial interace can support higher baud rates in asynchronous mode, and can be operated fully synchronously in conjunction with an OS-65U Level I distributed processing system. As mentioned in other Ohio Scientific documentation and elsewhere here, this allows the 600-based system to be utilized as an intelligent terminal in conjunction with a network of other personal computers primarily in an education environment.

Video Display Interface

The Challenger 1P utilizes a direct access 1K byte video display memory located at DØØØ hex. This display memory is normally accessed by display circuitry constantly put out to

the video screen. When the processor wishes to update this display memory, it gains control of the memory and makes modifications as desired. The display format is 32 rows/32 columns of 8 x 8 dot or pixel characters. The 8-bit code in each of the 1024 memory locations is fed to a proprietary Ohio Scientific character generator ROM which specifies one of 256 discrete 8 x 8 dot characters. This character set includes upper case, lower case, alpha, numeric, special punctuation, graphics characters, and gaming characters. The video display utilizes special circuitry which minimizes the disturbance of the screen from the video accessing. This means that there is a minimal amount of interference on the display as the processor accesses memory. All sync signals are crystal-controlled and conform closely to the NTSC standard for composite video output. Separated sync output is also available. The effective video data transfer rate out of the video interface is approximately 4 MHz making it possible to use a conventional television set or home standard video equipment such as 1" Videcon based television cameras and home video tape recorders.

The video display circuit system does not incorporate any guard bands vertically or horizontally into the display, such that the first character location comes out immediately after the sync pulses. Normal television equipment has over-scan which means that the scan starts off the screen and runs off the other end both horizontally and vertically.

This phenomena occurs for two reasons. One, there is a considerable cost savings in the circuitry for not having guard bands. Secondly, and most importantly, the use of guard bands

would increase the effective data rate of the screen such that it would be impossible or very difficult to display with a standard television. The required character resolution would exceed the resolution capability of the television monitor making characters hard to read. What this means is that normal television equipment will show about 24 rows of 24 columns of the numeric information and graphics. More information can be shown if the user has the equipment and the initiative to modify his display device to under-scan. All Ohio Scientific published software for the C1P series computer assumes 24 rows by 24 columns of visible screen so there will be no problem using conventional over-scan television sets with the system.

RAM Memory

The 600 board has sockets for up to 8K of 2114 memory chips. The memory must have an access speed of at least 550 ns and it is recommended that low power memory chips be used to keep the system power consumption down. The base machine is delivered with 4K of RAM. It can be ordered with 4 additional K at time of delivery. Alternately, memory chips can be ordered separately which the user can plug in later.

Keyboard

The model 600 utilizes a conventional computer type 53-key keyboard. The keys and key caps are standard computer quality utilizing double shot key caps, which means that the legends of the keys cannot be rubbed off because they are molded right into the keys. It utilizes standard locations and nomenclature on all the keys. The keyboard fully supports upper and lower case characters by use of the shift lock key. The keys themselves

are very high quality sealed-contact key switches that are rated for at least 10 million operations. Electronically, the keyboard is a scanned array. In normal operation, a keyboard routine in ROM is utilized to scan the keyboard for key closure. When key closure is detected, the ASCII code for that key is returned to the calling routine.

This intelligent keyboard has several additional features. The keyboard has full auto repeat. By holding down any key, one will first get one character output, and after approximately a half second delay a repeat rate of approximately 5 characters per second.

The fact that the keyboard can be directly accessed by the microprocessor means that keyboard functions can be programmed. The user may program directly in BASIC to program individual key strokes for specific functions. Furthermore, up to 8 key closures can be detected simultaneously allowing real time video games for multiple players. The ambitious user can directly connect other switch or joy stick devices to the keys from a discarded video game. For instance, to convert existing video games in Ohio Scientific's library such as Tiger Tank to joy stick operation, it is only necessary to connect switches in parallel with the existing key switches on the PC board.

Power Supply

The 600 board is laid out to accept a power supply except for the transformer and pass element. The Superboard II comes with two wire leads for connection to an external power supply. The Challenger 1P has a complete modular power supply in its

case, or a transformer and populated power supply on a PC board. The board will accept a full-wave or center tapped transformer configuration in conjunction with conventional 5 amp series pass regulator IC and necessary bypass and filter capacitors. The board incorporates an over-current protection fuse and reverse polarity diode for protection. The Superboard II also utilizes a "power-on" LED indicator.

MODEL 610 EXPANSION BOARD

The model 610 expansion board can be mounted directly above or below the model 600 CPU board. In a Challenger 1P, it's below and on a SuperboardII, it would be above. The connection is via a short 40 pin ribbon cable, and power can be optionally drawn directly from a 600 board or raw DC can be passed through an external series pass regulator element to the 610 board if it is configured for high power consumption.

The board contains the following modules:

Up to 24K of RAM

Dual mini-floppy controller

Real Time Clock

Expansion interface to a model 620 BUS adapter.

The board is always fully populated except that in some configurations it has only 8K of RAM on board. Sockets are provided so that the user can easily add 16K additional 2114 RAMS if required.

RAM Memory

The RAM memory is a straight 24K array which starts 8K up from the base address (it is assumed that the user has 8K of RAM on a 600 board before adding a 610). 16K of RAM is

required for mini-floppy operation. 24K of RAM is recommended for mini-floppies. As with the 600 board, the unit utilizes 2114 1K x 4 fully static RAMS. It requires a minimum access of 550 ns and it is highly recommended that the memory chips be low power to preclude power supply and heat problems. The use of fully static RAMS means that the system will have very high reliability as opposed to many other computers which use low cost, but inherently less reliable, dynamic RAMS.

Floppy Disk Interface

The dual mini-floppy interface is designed after Ohio Scientific's extremely popular and successful 470 floppy disk controller. This floppy disk controller and encoding technique has been field proven for several years in thousands of floppy disks and is believed to be one of the most reliable floppy disk configurations in existence. Although the Challenger 1P product line is new, it has the advantage of the experience of a company which has been building high performance microcomputers for several years.

Real Time Clock

The 610 board also incorporates a real time clock that can be strapped to generate interrupt at several intervals between one second and one milisecond. These interrupts are used to control IRQ in conjunction with real time clock supporting software. This option is fully populated and tested on the system board but is not jumpered in the active state as delivered. The board also incorporates full buffering for additional system expansion by another 40 pin ribbon cable connector which mates with model 620 adapter board to an OSI 48 line BUS.

Power Consumption

The 610's power consumption is highly dependent on the number of 2114's on the board and the specific power consumption of the 2114's. Power consumption of the board will be approximately 1 amp plus the 2114 load which can range from 35 to 100 milliamps per chip depending on the quality of the 2114's used. Ohio Scientific provides 2114L's typically in a power consumption range of 40 milliamps indicating that the total board consumption is in the neighborhood of 3 amps.

Model 620

The model 620 is simply a passive connector board and ribbon cable adapter from the 610 to an OSI 48 line BUS backplane.

C1P Mini-Disks

The Challenger 1P mini-disks are physically identical to the C2-4P mini-disks. They come in matching cases with their own +5 and +12 power supply and mini-floppy disk drive. The mini-floppy disk drive incorporates its own internal data separator and activity light. The format and capacity of each mini-floppy is dependent upon the operating system used; however, in OS-65D 3.0 it is in excess of 70,000 bytes formatted. Please keep in mind that this is formatted capacity and should not be compared with the 90 or 100,000 byte of unformatted capacity that several manufacturers quote. When buying drives separately, the user must specify A or B drive. A drive will directly plug into a 610 equipped system which has at least 16K of memory, and should immediately boot up disk software when D is typed after a system reset.

Advanced Hardware Options

It is physically possible to plug in any of Ohio Scientific's broad line of expansion accessories by use of the 620 adapter board and an OSI backplane. However, there are several practical limitations in the implementation. First of all, it would not be desirable to utilize BUS compatible boards in place of the 600 or 610 board hardware, that is, there are no provisions for additional RAM memory boards or floppy disk controller via this approach. Also, one must provide his own power supply to the backplane. Thus, the restrictions on the boards which can be plugged in will be dictated by the power supplies provided in the backplane. Finally, the address base utilization of the 600 board is slightly different in some areas than other OSI computers such that standardly supplied OSI 48 line BUS boards may have to be readdressed to preclude conflicts. This should not impose any severe restriction since 600 will have unique software drivers for each of these boards anyway.

Possible Boards for Consideration

Possible boards for the 600/610 system include any of the 430B A/D, D/A or RS-232 port options such as a CA-6S, CA-7C or CA-7S. The CA-9 parallel Centronics compatible line printer interface, CA-10X or 550 based 16 port serial board, CA-12 96 line remote parallel interface and CA-14 voice I/O boards may also be implemented. In addition to these boards, PROM boards, prototyping boards and card edge extender boards may also be useful in specialized applications.

Future Expansion of the Challenger 1P Series

Some possible expansions being considered by Ohio Scientific

for the Challenger 1P series and the conventional product line are an educational interface board which provides interfaces to the outside world such as detection of switch closure, TTL outputs, AC on/off control, thermostats, etc. Such a board would be compatible both with the 600 series and with the OSI 48 line BUS. Another such product sharing dual compatibility would be an AC remote interface switch which provides control signals over the AC power BUS. Customers can be assured that Ohio Scientific will be supporting the Challenger 1P series computer as a major product line of Ohio Scientific for several years to come.

SOFTWARE

The software for the Challenger 1P can be broken up into several categories. First, there is the firmware which is the software that is built into the ROMS of the computer. Second, is the optional systems level software, particularly the software that is available on mini-floppy disks and for program development. Third, is the applications software.

Firmware

Firmware is the code which is built into the ROMS of the computer. The 600 board supports up to 2K bytes of monitor and support routines and 8K bytes of BASIC language. The BASIC language is a highly refined and debugged 6502 8K BASIC by Microsoft. This BASIC has 6½ digit precision along with full scientific notation, trigonometric functions, string manipulations, logicals, etc. Even at a 1 MHz execution speed, it is one of the fastest BASICS available for microcomputers. It typically out benchmarks conventional 8080 based computer systems. It outruns

the commonly available competitive personal computers on the market. Ohio Scientific has shown this balance of 6½ digit precision and execution speed to be ideal for the personal computer market.

The BASIC has extremely fast execution speed making animation and real time programming practical while still maintaining full arithmatic capability for day to day "number-crunching". For small business and more demanding applications, a 9½ digit extended BASIC is available on diskette. However, this will run somewhat slower than the BASIC-in-ROM.

The support routines up to 2K include all the I/O support subroutines for the cassette, video display and keyboard such that the computer appears to have a complete terminal. That is, the keyboard acts like any conventional ASCII keyboard. The video display interface scrolls and has all the features of common stand-alone video displays or monitors. In normal BASIC programming operation, the user would not be aware that he is not using a separate stand-alone terminal in conjunction with the computer system. The support ROM also includes a complete machine code monitor program which allows the user to examine memory locations, load machine code and execute machine code programs. The system also includes mini-floppy disk bootstrap routine which will load on the mini-DOS operating system off floppy disks. The firmware also includes logical switching such that the BASIC-in-ROM can be used in conjunction with a RAM memory based mini-DOS instead of cassette I/O. Under this technique, the user has two different systematic approaches to diskette software which will be discussed under a different heading.

Standard Cassette Software

All Challenger 1P cassette based computers come with a demonstration library on cassette which will give the user some insight into the capability of the computers. This demonstration library includes ten very short programs which demonstrate the fundamentals of BASIC programming. The standard library also includes an advanced video game called "Star Wars" which runs in real time, check book balancing program, math introduction program, a math skills drill for children, a base converter for changing number bases (particularly hex to decimal and decimal to hex) which is sometimes valuable in programming, and two educational programs. Also included are "Counter" which is designed to be a child's first introduction to a computer, and a sample of a tutor program called "Trig Tutor" which shows the use of graphics in tutoring complicated concepts. Ohio Scientific offers a full library of very economical cassette programs for the Challenger 1P system. The library is constantly growing and currently includes several programs in each of the following catagories.

Experimental Programs

This includes programs for software development and advanced experimentation with the computer including an assembler/editor for machine code, extended monitor for machine code, diagnostic tests, and programs which perform specific I/O functions in conjunction with optional hardware.

Educational Programs

This includes full range of teaching aids for all ranges of abilities, including educational cartoons, drills, quizzes, tests; and most importantly, interactive games. It also includes programs

specifically for the training of the use of the computer including a complete BASIC tutor series.

Small Business Programs

This includes calculations and consulting programs which are very practical in personal computing, such as calculating payroll, hours from time cards, depreciation; and a series of programs which demonstrate how a larger computer can be used for inventory, etc.

Personal Programs

This includes a complete series of programs on loans and investments, personal calendar, diets, and other personal services.

Games

This includes both word-type games and conventional computer games. These are games of logic, video games which are primarily games of skill, and advanced tactical and strategic games which incorporate both logic and skill.

Disk Software

The Challenger 1P series computers, when equipped with disk, can be used interchangeably in the following configurations:

As a BASIC-in-ROM computer with cassette

As a disk based computer system which does not utilize the BASIC-in-ROM

As a computer system which utilizes BASIC-in-ROM in conjunction with a mini-DOS for disk I/O operations

An advanced personal computer operating system, OS-65D Level 3 is included whenever a mini-floppy drive A is purchased either separately or as part of the initial system purchase. OS-65D Level 3 is a small, very fast, concise disk operating system which fully supports 9 digit precision BASIC with named files,

and random and sequential access data files under BASIC. It further supports a very fast and concise interactive assembler/ editor and on-line debugger. The system also features an I/O distributor which will support the cassette, modem and line printer hardware outputs of a Challenger 1P system. In circumstances where 6 digit precision BASIC is more desirable than 9 digit because of higher execution speed and/or when memory space is at a preium, the system will optionally support the use of the 6 digit precision BASIC-in-ROM in conjunction with limited disk I/O capabilities as an extremely memory efficient operating system. OS-65D Level 3's 9 digit BASIC operation and nomenclature is generally compatible with much larger computer systems in that it supports "open and close files", print to file or I/O device, and input from file or I/O device. It also supports GET and PUT (record number) capabilities. The system maintains a 6 character file name for files and has complete directory capabilities along with DELETE, RENAME and file CREATE capabilities. The system comes complete with additional utilities such as diskette copier and data file dump utilities. All the software available on cassette is available on diskette plus many other programs which are not really practical on cassette. Examples are personal calendar, address book, phone directory and some limited small business programs. However, as we have stated in several other places, Ohio Scientific firmly believes that the serious business user requires an 8" floppy disk. So that again, these programs are considered to be demonstrators.

Generally, Ohio Scientific floppy diskette software is much less expensive than cassette software simply because of the much lower cost of mass duplicating diskettes. For instance, a typical Ohio Scientific applications mini-floppy will have ten programs on it. These same programs would cost an average of $8.00 a piece purchased separately on cassette, or a total of $80.00. This same mini-floppy which is actually more powerful and much easier to use would have a retail price of approximately $29.00. So, along with much faster program LOAD and SAVE capabilities, and random access file capability, if a large software library is contemplated, the mini-floppy system will actually be more cost effective than purchasing a large number of audio cassettes.

Future Diskette Software

Ohio Scientific is planning to convert some of its large system software to mini-floppy. The projects in consideration include mini-floppy word processor system, and a mini-floppy data base management system.

Warranties

Software:

There is no warranty expressed or implied for Ohio Scientific software.

Hardware:

The Challenger 1P series microcomputer systems carry a 60 day limited parts and labor warranty and a one year limited parts-only warranty. Ohio Scientific will repair without charge any failure due to a defect in material or workmanship which has not been caused by abuse, misuse, or other damages on units returned to the factory during the first 60 days of end user ownership.

The user must pay freight back to the plant under these circumstances. After the first 60 days, and for one year, Ohio Scientific will replace defective components without charge provided that the failure was caused by a defect in the component and not due to misues, abuse, or any user modification of the system. The user must pay freight both directions and a labor service charge for such repairs. Ohio Scientific labor service rate is currently $20.00 per hour so that a typical warranty repair in this area might be in the neighborhood of $10 to $40. Typical turn around time for factory repair is two weeks. Check with your local Ohio Scientific dealer for local or extended maintenance programs that he may be optionally offering at additional charge.

How To Purchase

Ohio Scientific Challenger 1P series computers can be purchased from any listed Ohio Scientific dealership. We strongly recommend that you purchase your computer system close to home so that you can get some "hands-on" training and support if you need it. Enclosed is a list of current Ohio Scientific dealers and a current price list for the Challenger 1P series products.

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