

# **The CHALLENGER C2-4P Technical Report**

**A comprehensive discussion  
of the C2-4P  
and  
C2-4P MINI DISK  
Computer Systems**

**Oct. 1978**

## **Introduction:**

The C2-4P Mod 2 Technical Report was compiled by Ohio Scientific's engineering department to provide an overview of the C2-4P 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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## C2-4P Mod 2 Technical Report

) The Challenger 2P series, specifically the C2-4P and C2-4P mini-disk systems, are Ohio Scientific's professional portable series computer products. The C2-4P series incorporates the most desirable features of mass produced personal computers and much more expensive general purpose computer systems in a portable package. The C2-4P systems utilize easy-to-use and immediately available BASIC-in-ROM or on mini-floppy disks. They incorporate a high resolution video display with graphics capability, an upper/lower case and user programmable keyboard, cassette or mini-floppy I/O and considerable expansion capability. The C2-4P system utilizes a unique blend of mass production technology with its associated low cost and general purpose BUS computer organization making it modular for service and updating as well as facilitating economical expansion. The C2-4P

) Mod 2 is currently in the forefront of computer technology for portable computer systems. This 12 lb. package contains the highest resolution and most elaborate graphics capability in personal computing in conjunction with fastest BASIC program execution and other advanced features.

The C2-4P is clearly a premium performance portable computer. However, even more important than its current capabilities is the fact that it is an evolutionary product. That is, the C2-4P series is being constantly updated. This is possible because it utilizes modular architecture. It contains a separate power supply, computer BUS backplane, CPU board, video board, keyboard and in the case of mini-floppy systems, a separate memory board. It also has open slots for expansion. This modularity means that one module of the computer

system can be updated to the new state-of-the-art without obsoleting other portions of the computer. For example, the original C2-4P did not have graphics. It also used a conventional 53-key ASCII keyboard. The current C2-4P Mod 2 has elaborate graphics capability and upper and lower case keyboard with user programmability. Owners of the C2-4P systems can have their units upgraded by replacing the keyboard and one chip on the video display board at a mere fraction of the cost of buying a new unit. This capability to upgrade constantly to the state-of-the-art is simply not possible in any other computer system within the price class of the C2-4P because other personal portable computers are built on a total of one or two PC boards requiring a total replacement of the system on upgrades. Ohio Scientific has had a long standing commitment to constantly upgrade the C2-4P and the C2-8P large mainframe line to be on the leading edge of technology. This virtually guarantees the end user to be able to maintain a state-of-the-art computer system at a fraction of the cost of totally replacing his computer system every year or two. Planned future extensions of the C2-4P are discussed in the technical section of the manual.

#### Comparing A C2-4P Mod 2 To Other Ohio Scientific Computers

The C2-4P is Ohio Scientific's premium grade portable computer. It is suited for professional and personal use. Professional uses include scientific calculations, engineering, educational and business consulting applications. Personal uses include personal finance, gaming, education, and financial consulting. The C2-4P system costs more than the Challenger 1P and Superboard II but has advantages over these models in that it utilizes a 32 x 64 character

display instead of the 32 x 32 character display of the Challenger 1P. It also benefits from BUS architecture, providing more expansion capability as well as modularity for service and upgradeability to maintain the state-of-the-art. The C2-4P should be selected over the Challenger 1P in serious long term applications of a portable computer. The C2-4P provides as many features as possible as compared to the C2-8P, however, the C2-8P being an 8-slot mainframe BUS computer offers far more expansion capability, large storage capacity and a broad base of software via its compatibility with 8" floppies. The C2-8P system will provide no benefit over the C2-4P in educational, personal, games and personal financial applications. It, however, can provide tremendous advantage in business applications and advanced experimental areas because of its ability to run Ohio Scientific's bit system business software and its tremendous expansion capability allowing the utilization of advanced experimental boards such as the voice I/O board the multi-processing CPU expander. The C2-8P is non-portable and significantly more expensive than the C2-4P. So, in cases where cost, size or specific applications for personal, educational, gaming and financial analysis are of primary importance, the C2-4P is an excellent choice over the C2-8P. The C2-4P system has only limited applications in business because of the mini-floppy disk storage capacity. The C2-4P system is as suitable as any other computer system in business applications which do not require large amounts of data storage capability. However, situations such as inventory control and other large data base applications, 8" floppy disks and/or large capacity hard disk systems are required. The Ohio Scientific C2-8P series and Challenger III series are ideally suited for such applications.

## Applications

The C2-4P system is well suited to personal finances, games, scientific calculations, education and many other categories. The following is a short discussion of its application in some of these areas.

### Personal or Home Computing

Challenger 2P'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 2P 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 2P'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 ownership 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 2P'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 2P will be hundreds of times faster than the most powerful scientific calculators in "number-crunching" applications.

## Education

Challenger 2P 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 micro wave 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 2P'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 2P 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 gallows, 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 2P utilizes the most popular upper level language, BASIC, in a very complete and concise implementation. With a Challenger 2P, the user can teach BASIC in conjunction with any of the commonly available text books on the BASIC programming language. The 2P 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 machines so that students can be introduced to the concepts of assembler programming and editing.

The Challenger 2P 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 2P 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 2P'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 2P terminals makes a 2P based 65U Level I system a very economical educational network.

### Advanced Applications

There are many other applications of the basic 2P 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 2P is highly expandable, directly and economically. 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 2P 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 2P 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 C2-4P for small business applications.

We have already touched on the power of the mini-floppy in education in that it allows the educator to make use of a large data base 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 2P's further expansion via the OSI 48 line BUS makes it extremely interesting to advanced hobbyists and advanced educational users. The user can add many 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

) The C2-4P system is available in two fundamental configurations. These configurations are a BASIC-in-ROM model which the end user can expand to mini-floppy operations and C2-4P mini floppy systems configured for mini-floppies at the factory. The following table highlights each of these configurations.

Table 1  
C2-4P Configurations

| Computer                         | RAM     | Open Slots | Boards   | Mass Storage         | Cases  |
|----------------------------------|---------|------------|--|----------------------|--------|
| C2-4P Mod 2                      | 4-8K*   | 2          | 502/540  | Cassette             | 1      |
| C2-4P Mini-disk                  | 16-24K* | 1          | 505/527/540                                      | 1 or 2 mini-floppies | 2 or 3 |
| End User added                   |         |            |  |                      |        |
| ) C-3P on C2-4P<br>(Mini-floppy) | 16-32K  | 0          | 500 or 502<br>527 RAM<br>540 Video<br>470 Floppy | 1 or 2 mini-floppies | 2 or 3 |

\*Note in these configurations, another 527 can be added for up to 24K of additional memory.

## General Architecture

The C2P series is based on a BUS oriented microcomputer architecture using 48 signal lines on its BUS. Table 2 shows the signal line allocation of the OSI 48 line BUS.

Table 2  
OSI 48 Line BUS

|          |   |
|----------|---|
| 8 to 16  | Bi-directional signal lines               |
| 16 to 20 | Address lines                             |
| 6        | Control lines                             |
| 6        | Power lines                               |
|          | Unused address or data lines are "spares" |

The OSI 48 line BUS is an ultra high speed, highly optimized microcomputer BUS. It should be clear from signal line allocations that it will support microcomputer advancements far into the future with its 16 data bit and 20 address bit capability. The simple BUS design along with active termination yields BUS band width in excess of 10 MHz indicating that as micro circuit technology improves, the physical hardware of the C2P system will be able to be directly expanded to computer systems rivaling the performance of today's high end minicomputers and small mainframes.

The C2P series machines utilize UL recognized power supplies which have adequate capacity for a fully loaded machine.

#### Physical Design

The C2-4P system utilizes up to two types of cases. The C2-4P is packaged in a typewriter like case. It is approximately 15" x 12" x 4" high and weighs approximately 12 lbs. The top of the unit will support a video display monitor and/or a matching mini-floppy disk which is approximately 12" wide by 8" deep by 4" high to complement the C2-4P in styling. The optional mini-disk unit can be placed on top of or next to the C2-4P. A second mini-disk unit can be directly attached and mounted likewise. The power cord, fuse and on/off switch are at the rear of each unit. Connectors for the video display, audio cassette interface as well as an optional EIA standard connector for RS-232 are provided at the rear. The C2-4P incorporates a 4" cooling fan to insure long life by maintaining the internal electronics near room temperature.

Internally, the C2-4P supports one or two open frame UL approved 5 volt 4.5 amp power supplies. These power supplies are

) mounted to the top of the unit and provide the bracket for the 4-slot OSI 48 line BUS backplane. The OSI 542 polled keyboard is independently mounted to the top of the case. This keyboard features a standard 53-key keyboard with upper and lower case via a shift lock key and is also user programmable as desired. The break key on the keyboard serves as a master reset for the computer system. A standard C2-4P is delivered with one power supply and one empty power supply bracket. When a C2-4P is upgraded to mini-disk operation and on factory supplied mini-disk systems, a second 4.5 amp power supply is present to provide a total of 9 amps at +5 volts. The individual board complement within the system varies on whether the system is factory assembled with the mini-disk or not as shown in Table 1. Individual boards of the C2-4P are discussed in the electronics section.

) Mini-Floppy Case

The mini-floppy incorporates its own +12 and +5 volt power supply and is connected to the C2-4P by an approximately 4 ft. long ribbon cable. The ribbon cable utilizes edge connectors both at the mini-floppy and at the interface board within the computer. The mini-floppy disk includes a red LED activity indicator on the front.

## Electronics Of The C2-4P Series

The following specifications are common to both the standard C2-4P and the factory configured C2-4P mini-disk system. Both C2-4P configurations utilize a 1 MHz 6502 microprocessor, system monitor, ROM, RAM memory, video display interface, audio cassette interface, keyboard and OSI 48 line BUS compatibility. The ROM monitor routines on the CPU contain floppy bootstrap or BASIC-in-ROM's support routines in conjunction with built-in machine code monitor which performs normal computer "front panel" functions.

### Audio Cassette

The audio cassette portion of the system is supported by a 6850 asynchronous communication 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 capabilities. Although the transfer rate is 300 baud, the extremely high data reliability indicates that the actual transfer times for programs is less than many systems which advertise higher baud rates. On standard C2-4P's the baud rate is provided by a 555 oscillator which is both adjustable and strappable for a wide range of standard rates. On factory configured disk systems, the baud rate is crystal controlled and strappable from 300 to 19,200 baud. In both systems, the CPU board incorporates the capability for RS-232 interface and contains the PC foils but not the components for a high speed synchronous interface for distributed processing applications. In theory, the C2-4P units are capable of supporting an RS-232 port for modems, printers and terminals. However, to make

) use of these features, the user or computer dealer will have to  
wire in a connector and a selection switch if cassette capability  
is to be maintained. Furthermore, depending on the characteristics  
of the particular RS-232 interface in the printer, modem or terminal,  
it may be necessary to provide a negative voltage to the interface  
from the peripheral. This is because the C2-4P does not have a  
negative supply voltage, however, the RS-232 standard requires a  
negative voltage.

#### Video Display Interface

) The C2-4P utilizes Ohio Scientific's highly refined 540 video  
display board. The 540 video display is a direct access 2K byte  
video display located at D000 hex up. This display memory is  
normally accessed by display circuitry constantly to display  
characters on 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 of  
64 columns of 8 x 8 dot or pixel characters. The 8 bit code of  
each of the 2048 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/lower case,  
alpha, numeric, special punctuation, graphics and gaming elements.  
The video display utilizes special circuitry which minimizes the  
disturbance of the screen during video accessing. This means there  
is a minimal amount of interference on the display as the processor  
accesses memory (an important feature for animation). All sync  
signals are crystal controlled and conform closely to the NTSC  
) standards for composite video output, however, separated sync  
output is also available. The C2-4P with 540 display can also be

programmed for 32 x 32 operation for square character cells for gaming and graphics applications. The 32 x 64 character mode, the pixel band width is nearly 12 MHz indicating that it must be used with a high quality video monitor for proper picture rendition. Ohio Scientific provides a suitable combination television set/video monitor for such applications. If used with an external RF converter, satisfactory results may not be obtained in 64 character mode. It may be necessary to switch down to 32 character mode so it is highly recommended to use a high quality video monitor to take the full advantage of the spectacular graphics animation capabilities of the system.

#### Keyboard

The C2-4P 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.

#### Electronics Unique To Factory Configured C2-4P Mini-Disk Systems

Factory configured C2-4P mini-disk systems utilize the following board complement, 505 CPU floppy disk controller, 527 RAM memory board, 540 video display board. As stated earlier, factory configured mini-floppy systems incorporate 9 amp power supplies and utilize Ohio Scientific's 540 video display in conjunction with the 540 keyboard. The system's 505 CPU board incorporates a 1 MHz crystal controlled CPU clock in conjunction with crystal control baud rate generator for the ACIA based audio cassette interface as well as an optional RS-232 and high speed synchronous interface. The 505 board also incorporates a dual mini-floppy interface based on Ohio Scientific's field proven 470 board's circuitry. Thus, on one PC board, the CPU, CPU clock, serial interface, audio cassette, RS-232 port, floppy disk bootstrap, machine code monitor, mini-floppy interface and OSI 48 line BUS drivers are present.

## RAM Memory

The C2-4P mini-disk system has all of its RAM memory on one 527 RAM board. This RAM board supports up to 24K of 2114 4K static RAM chips. This board comes only configured with 16 or 24K of RAM, and is available as an add-on option for C2-4P systems as a CM-7P (8K), CM-8P (16K) and CM-9P (24K). In all cases, the 527 can be fully expanded to 24K by use of Ohio Scientific's 4K add-on memory kit, 4KP. On factory provided mini-floppies, the 527 board is powered directly from the second 4.5 amp power supply so that the other three slots of the system are powered by the main 4.5 amp power supply. This power supply configuration allows any standard OSI 48 line BUS board to be plugged in to the fourth open slot of the system including another 24K 527 board (+5 only). This indicates that the maximum configuration for a C2-4P factory configured mini-floppy system is 48K of static RAM in conjunction with two mini-floppies. By adding a rotary selector switch and an EIA jack, the user can also add a modem, line printer and RS-232 terminal, thus constructing an extremely impressive portable system.

## C2-4P Standard Configuration

The standard C2-4P system incorporates a model 502 CPU/RAM/ROM serial interface board in conjunction with the model 540 video board and 542 keyboard. The standard unit utilizes a single 4.5 amp 5 volt power supply and an unpopulated power supply bracket in the second power supply position.

## Model 502 CPU Board

The model 502 CPU board incorporates a 1 MHz 6502 microprocessor in conjunction with disk bootstrap, BASIC support, machine code monitor ROM, 8K BASIC-in-ROM, 4 or 8K of 2114 type 4K static RAMS, ACIA

) interface and Kansas City standard audio cassette output and/or RS-232 and/or high speed synchronous interface as well as the 48 line BUS compatibility. The monitor and 8K BASIC-in-ROM are documented in the software portion of this manual. The system is normally provided with 4K of static RAM and can be expanded to 8K by use of Ohio Scientific's 4KP 4K static RAM memory kit. This standard configuration leaves two open slots for expansion.

#### Adding Memory To The Standard Configuration

The standard 527 memory board as a CM-7P, CM-8P, or CM-9P can be added directly to the standard C2-4P Mod. Each 8K block of the 527 board can be independently strapped on 8K boundaries so the 527 will directly accomodate 8K of RAM on the CPU board without any readdressing of the CPU's memory. The standard C2-4P system with a single power supply will support up to 24K of low power static RAM ) in addition to the normal CPU and 540/542 video keyboard combination. When adding more than 24K or more than 16K with a mini-floppy, it is necessary to add the second 4.5 amp power supply and power one 527 board from that power supply.

#### Adding A Mini-Floppy To A Standard System

The C2-4P mini-floppy system requires a minimum of 16K RAM to operate and a minimum of 20K RAM to facilitate user creation of named files. The 24K system is a nice practical system for use in conjunction with mini-floppies. It is recommended that the C2-4P system be returned to the factory for mini-floppy installation. The installation of a mini-floppy system is covered as a separate price in the price list. This installation fee includes the cost of reconfiguring the CPU board, adding the floppy disk interface )

and adding additional 4.5 amp power supply. The factory installation charge does not, however, cover expanding the system to 16K of RAM memory. The user must do this separately by adding 4KP kits and/or 527 options as necessary. The factory configuration of the standard C2-4P to mini-disk is as follows:

1. More memory is added to the system if specified on the customer order.
2. The second 4.5 amp power supply is added to the computer.
3. A selector switch is added to the back of the computer and routed to the 502 CPU board. This selector switch will select floppy disk bootstrap or BASIC support ROM so that with the switch in one position, the computer will be a floppy disk only system and with the switch in the other position, it can be used with its internal BASIC-in-ROM.
4. Model 470 floppy disk controller configured for mini-floppy use is added to the system.
5. The mini-floppy disk is connected and tested.
6. The system is returned to the user complete with 65DV3.0 diskettes and operator's manual.

#### C2-4P Mini-Disk Electrical Specifications

##### C2-4P Mini-Disks

The Challenger 2P mini-disks are physically identical to the C1P 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 V3.0 it is in excess of 70,000 bytes formatted. Please keep in mind that this if 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. The floppy system requires 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 into the C2-4P. However, there are several practical limitations in the implementation. First of all, it would not be desirable to utilize other BUS compatible boards in place of the standard 502/505/527/540 hardware. Also, one must provide his own power supply if +12 and/or -9 voltages are required. Thus, the restrictions on the boards which can be plugged in will be dictated by the power supplies provided in the system.

#### Possible Boards For Consideration

Possible boards for the C2-4P 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 port 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 C2-4P Series

As stated in the beginning of this technical report, the C2-4P is somewhat unique in that it is an evolutionary product. Ohio Scientific is constantly exploring ways to upgrade each of the individual modules of the C2-4P. Options for possible future release include color capability, sound output, joy sticks, numeric key pads, voice output, and later voice recognition capability, AC power line

remote capability and, of course, higher speed operation and more memory capacity. As in the past, these options will be designed to be added modularly to the system without obsoleting the majority of the existing product.

### Software

The software for the Challenger 2P 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 502 board supports up to 768 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 out runs 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 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.

#### Standard Cassette Software

Ohio Scientific offers a full library of very economical cassette programs for the Challenger 2P system. The library is constantly growing and currently includes several programs in each of the following categories. The C2-4P software library is considerably larger than the C1P library.

#### 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

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 2P system.

) OS-65U 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 a 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 2P 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 misuse, abuse, or any user modifications 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 2P 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 2P series products.

Ohio Scientific, Inc.  
1333 S. Chillicothe Rd.  
Aurora, Ohio 44202

) Phone (216) 562-3101

Ohio Scientific West  
15461 Chemical Lane  
Huntington Beach, CA 92649

Phone (714) 891-2457

## C2-4P LIST

### Computers

- C2-4P 4K (expandable to 8K with one 4KP)
- C2-4P Mini-disk 20K mini-system (expandable to 24K with one 4KP) \*Note \$1464 + 69 for 4 more K.

### Expansion Accessories

- 4KP (adds 4K)
- CM-2P 4K memory board (non-expandable!)
- CM-7P 8K memory board (expandable to 24K)
- CM-8P 16K memory board (expandable to 24K)
- CM-9P 24K memory board
- C-D3P "B" Drive mini-floppy

### Peripherals

- AC-2P tape recorder with counter
- AC-3P version 2, 12 inch combination TV/monitor
- AC-10P 1P/2P printer
- AC-11P 1P/2P modem

### System Upgrades\* (Installed)

- U2P1 "A" mini-floppy addition (requires polled keyboard and 16K RAM minimum) includes drive, power supply, bootstrap ROM, operating system, diskettes and manuals.
- U2P2 Update older conventional display to graphics
- U2P3 Update old ASCII keyboard to polled keyboard

\*System upgrades are performed at the factory and require an RA (return authorization) number on the system being sent in.

### Software

#### Cassettes

- Assembler/Editor
- Extended Machine Code Monitor

#### Applications Software Cassettes

Most run in 4K (some require 8K)  
(Virtually all programs on mini-disk are available separately on cassette.)

#### Mini-diskettes require from 16 to 24K

- Game Disk 1 Arcade Type Video Games
- Game Disk 2 " " " "
- Game Disk 3 Popular Conventional Computer Games
- Game Disk 4 " " " "

Personal Disk 1 Checking/saving/loans/investments/etc.

Personal Disk 2 Advanced mathematics for students & engineers

Business Disk 1 Depreciation/return on investments/etc.

Business Disk 2 Inventory demo/mailing list/address list/etc.

Education Disk 1 Education Games

Education Disk 2 BASIC tutor series

Education Disk 3 Tests/drills/tutoring

BE SURE TO SPECIFY C2-4P SERIES SOFTWARE WHEN PURCHASING!..

Cassettes for Challenger 1P, C2-4P and C2-8P. Be sure to specify system when ordering.

Personal Programs

- ) \_\_\_\_\_ Annuity I
- ) \_\_\_\_\_ Annuity II
- ) \_\_\_\_\_ Interest on Loans
- ) \_\_\_\_\_ Loan Finance
- ) \_\_\_\_\_ Uneven Cash Flows
- ) \_\_\_\_\_ Personal Calendar
- ) \_\_\_\_\_ Checking Account
- ) \_\_\_\_\_ Savings Account
- ) \_\_\_\_\_ Calorie Counter
- ) \_\_\_\_\_ Biorhythm
- ) \_\_\_\_\_ Kitchen Aid

Game Programs

- ) \_\_\_\_\_ Tiger Tank
- ) \_\_\_\_\_ Lunar Lander
- ) \_\_\_\_\_ Breakout
- ) \_\_\_\_\_ Hectic
- ) \_\_\_\_\_ Frustration
- ) \_\_\_\_\_ Star Trek 8K
- ) \_\_\_\_\_ 4K-Trek
- ) \_\_\_\_\_ Tic-Tac-Toe
- ) \_\_\_\_\_ Torpedo
- ) \_\_\_\_\_ Kaleidescope
- ) \_\_\_\_\_ Bomber
- ) \_\_\_\_\_ Destroyer
- ) \_\_\_\_\_ Hide & Seek
- ) \_\_\_\_\_ Star Wars
- ) \_\_\_\_\_ Black Jack
- ) \_\_\_\_\_ New York Taxi
- ) \_\_\_\_\_ 23 Matches
- ) \_\_\_\_\_ Lander 8K
- ) \_\_\_\_\_ Cryptography
- ) \_\_\_\_\_ Etch-A-Sketch
- ) \_\_\_\_\_ Space War 8K
- ) \_\_\_\_\_ Battleship 8K

Cassettes for Challenger 1P, C2-4P and C2-8P. Be sure to specify system when ordering.

Educational Programs

- \_\_\_\_\_ Hangman 8K
- \_\_\_\_\_ Homonyms 8K
- \_\_\_\_\_ Counter 8K
- \_\_\_\_\_ Trig Tutor
- \_\_\_\_\_ Mathink
- \_\_\_\_\_ Bar Graph
- \_\_\_\_\_ Definite Integral
- \_\_\_\_\_ Basic Math
- \_\_\_\_\_ Presidents 8K
- \_\_\_\_\_ Powers
- \_\_\_\_\_ Trend Line
- \_\_\_\_\_ BASIC Tutor Series
- \_\_\_\_\_ Electronics Equations
- \_\_\_\_\_ Spelling Quiz
- \_\_\_\_\_ Solar System Quiz
- \_\_\_\_\_ Continents Quiz
- \_\_\_\_\_ Add Game
- \_\_\_\_\_ Math Intro
- \_\_\_\_\_ Base Ten Converter
- \_\_\_\_\_ Math Blitz 8K

Business Programs

- \_\_\_\_\_ Straight & Constant Depreciation
- \_\_\_\_\_ Inventory Demo
- \_\_\_\_\_ Ratio Analysis I
- \_\_\_\_\_ Ratio Analysis II
- \_\_\_\_\_ Bond Evaluation
- \_\_\_\_\_ Break Even Analysis
- \_\_\_\_\_ Advertisement
- \_\_\_\_\_ Address Book 8K
- \_\_\_\_\_ Word Processor 8K
- \_\_\_\_\_ Programmable Calculator
- \_\_\_\_\_ Statistics I
- \_\_\_\_\_ Salary Demo 8K

# Ohio Scientific BASIC for the 6502.

## 8K version 3.2

### Commands

|      |      |     |      |     |
|------|------|-----|------|-----|
| CONT | LIST | NEW | NULL | RUN |
|------|------|-----|------|-----|

### Statements

|       |           |            |           |       |      |
|-------|-----------|------------|-----------|-------|------|
| CLEAR | DATA      | DEF        | DIM       | END   | FOR  |
| GOTO  | GOSUB     | IF...GOTO  | IF...THEN | INPUT | LET  |
| NEXT  | ON...GOTO | ON...GOSUB | POKE      | PRINT | READ |
| REM   | RESTORE   | RETURN     | STOP      |       |      |

### Expressions

#### Operators

, +, \*, /, ↑, NOT, AND, OR, >,<,<>, >=,<=,=      RANGE 10<sup>-32</sup> to 10<sup>32</sup>

#### Variables

A, B, C, . . . , Z and two letter variables

The above can all be subscripted when used in an array

String variables use above names plus \$, eg. A\$

### Functions

|        |         |        |        |        |        |
|--------|---------|--------|--------|--------|--------|
| ABS(X) | ATN(X)  | COS(X) | EXP(X) | FRE(X) | INT(X) |
| LOG(X) | PEEK(I) | POS(I) | RND(X) | SGN(X) | SIN(X) |
| SPC(I) | SQR(X)  | TAB(I) | TAN(X) | USR(I) |        |

### String Functions

|          |          |          |               |          |                  |
|----------|----------|----------|---------------|----------|------------------|
| ASC(X\$) | CHR\$(I) | FRE(X\$) | LEFT\$(X\$,I) | LEN(X\$) | MID\$(X\$, I, J) |
|          |          | STR\$(X) |               |          | VAL(X\$)         |

### Special Characters

● Erases line being typed, then provides carriage return, line feed.

← Erases last character typed.

CR Carriage Return -- must be at the end of each line

:

 Separates statements on a line.

CONTROL/C Execution or printing of a list is interrupted at the end of a line.

"BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.

CONTROL/O No outputs occur until return made to command mode. If an Input statement is encountered, either another CONTROL/O is typed, or an error occurs.

? Equivalent to PRINT

# The OSI 48 Line BUS

offers the broadest line of BUS compatible micro-computer boards. This line includes several new and exciting products which are not available anywhere else, such as a three processor CPU board, dual port memories and a multi-processing CPU expander.

has delivered approximately 100,000 boards based on our 48 line BUS and is now delivering thousands per week in 17 models of computers and dozens of accessories

**BUS design** incorporates high band width, high density and mass production technology to achieve a truly remarkable performance to cost ratio

Here is just a sampling of the many OSI 48 BUS compatible boards available for the systems user, prototyper, OEM user and experimenter.

| Product Description   | Special Features  | Power Supply Voltages Req'd | Board & Doc Part # | Price  | Assembled Product Part # | Price            |
|---|---|-----------------------------|--------------------|--------|--------------------------|------------------|
| <b>CPU</b>  |   |                             |                    |        |                          |                  |
| • Challenger II CPU BASIC in ROM<br>6502 based CPU with serial I/O<br>4K RAM machine code monitor | • Can use four 2716 EPROMS instead of BASIC or can be configured for disk | +5/-9                       | 500                | 39.00  | C2-0                     | 298.00           |
| • Challenger III CPU has 6502A, 6800 and Z80 micros, RS 232 serial port machine code monitor      | • 1 megabyte memory manager software programmable vectors                 | +5/-9                       | 510                | NA     | C3-0                     | 490.00           |
| • 660Z multi processing CPU expander runs PDP 8, Z80 and 8080 code                                | • Runs concurrently with another OSI CPU                                  | +5/-9                       | 560Z               | 125.00 | NA                       | NA               |
| <b>RAM</b>  |   |                             |                    |        |                          |                  |
| • 16K static RAM (ultra low power)  | • 215NS access time automatic power down standby mode                     | +5/+12/-9                   | 520                | 35.00  | CM-3                     | 498.00           |
| • 8K static RAM (low cost)  | • Expandable to 16K   | +5                          | —                  | —      | CM-7                     | 198.00           |
| • 16K static RAM (low cost)   | • Can be expanded to dual port operation                                  | +5                          | 525                | 35.00  | CM-8                     | 339.00           |
| • 24K static RAM (high density)   | • 20 address bits   | +5                          | 527                | 35.00  | CM-9                     | NA               |
| • 4K static RAM (2102 based)  | • Can be populated for 4K by 12 bits                                      | +5                          | 420                | 35.00  | CM-2                     | 125.00           |
| • 16K dynamic (ultra low cost)  | • Uses 4027 RAMS  | +5/+12/-9                   | 530                | NA     | CM-4                     | 249.00           |
| • 32K dynamic   | • 20 address bits   | +5/+12/-9                   | 530                | NA     | CM-5                     | 698.00           |
| • 48K dynamic (high density)  | • 20 address bits   | +5/+12/-9                   | 530                | NA     | CM-6                     | 990.00           |
| <b>EPROM Boards</b>   |   |                             |                    |        |                          |                  |
| • 8K 6834 EPROM board   | • 16 line parallel port and on board programmer                           | +5/-9                       | 450                | 35.00  | NA                       | NA               |
| • 4K 1702A EPROM board  | • 16 line parallel port   | +5/-9                       | 455                | 35.00  | NA                       | NA               |
| <b>I/O Boards</b>   |   |                             |                    |        |                          |                  |
| • Audio Cassette Interface Kansas City standard 300 baud  | • Expandable to CA 7C   | +5/-9                       | 430                | 35.00  | CA-6C                    | 99.00            |
| • RS 232 port board   | • Expandable to CA 7S   | +5/-9                       | 430                | 35.00  | CA-6S                    | 99.00            |
| • Combination audio cassette two 8 bit DACs one fast A/D and 8 channel input mux                  | • Also Features 8 parallel I/O lines                                      | +5/-9                       | 430                | 35.00  | CA-7C                    | 399.00           |
| • Combination RS 232 two 8 bit DACs one fast A/D and 8 channel input mux                          | • Also features 8 parallel I/O lines                                      | +5/-9                       | 430                | 35.00  | CA-7S                    | 399.00           |
| • 32 by 32 character video display interface  | • Keyboard input port   | +5/-9                       | 440                | 35.00  | NA                       | NA               |
| • 32 by 64 character video display interface  | • Upper/lower case graphics and keyboard port                             | +5                          | 540                | NA     | CA-11                    | 249.00           |
| • 16 port serial board RS 232 and/or high speed synchronous                                       | • 75 to 19,200 baud and 250K and 500K bit rates individually strappable   | +5/-9                       | 550                | 35.00  | CA-10X                   | 200.00 to 900.00 |
| • Parallel (Centronics) Line Printer Interface  | • With cable  | +5/-9                       | 470                | NA     | CA-9                     | 249.00           |
| • 96 Line Remote Parallel Interface   | • Interface - Front End remotable via 16 pin ribbon cable                 | +5                          | —                  | —      | CA-12                    | 249.00           |
| • Voice I/O board with Votrax module  | • Fully assembled voice output experimental voice input                   | +5/-9                       | —                  | —      | CA-14                    | 525.00           |
| <b>DISKS</b>  |   |                             |                    |        |                          |                  |
| • Single 8" floppy disk 250 Kbytes storage  | • Complete with operating system software and disk BASIC                  | +5/-9                       | 470                | NA     | CD-1P                    | 790.00           |
| • Dual 8" floppy disk 500 Kbytes storage  | • Complete with operating system software and disk BASIC                  | +5/-9                       | 470                | NA     | CD-2P                    | 1390.00          |
| • 74 Million byte Winchester disk and interface   | • Complete with OS 65U operating system                                   | +5/-9                       | —                  | —      | CD-74                    | 6000.00          |
| <b>OTHER</b>  |   |                             |                    |        |                          |                  |
| • 8 slot backplane board with connectors  | • Can be daisy chained to n slots   | —                           | 580                | 39.00  | NA                       | NA               |
| • Prototyping board   | • Handles over 40 16 pin IC's   | —                           | 495                | 29.00  | —                        | —                |
| • Card Extender   | • With connectors   | —                           | 498                | 29.00  | —                        | —                |

For more information, contact your local OHIO SCIENTIFIC Dealer or the factory at (216) 562-3101

**OHIO SCIENTIFIC**  
1333 S. Chillicothe Road • Aurora, Ohio 44202