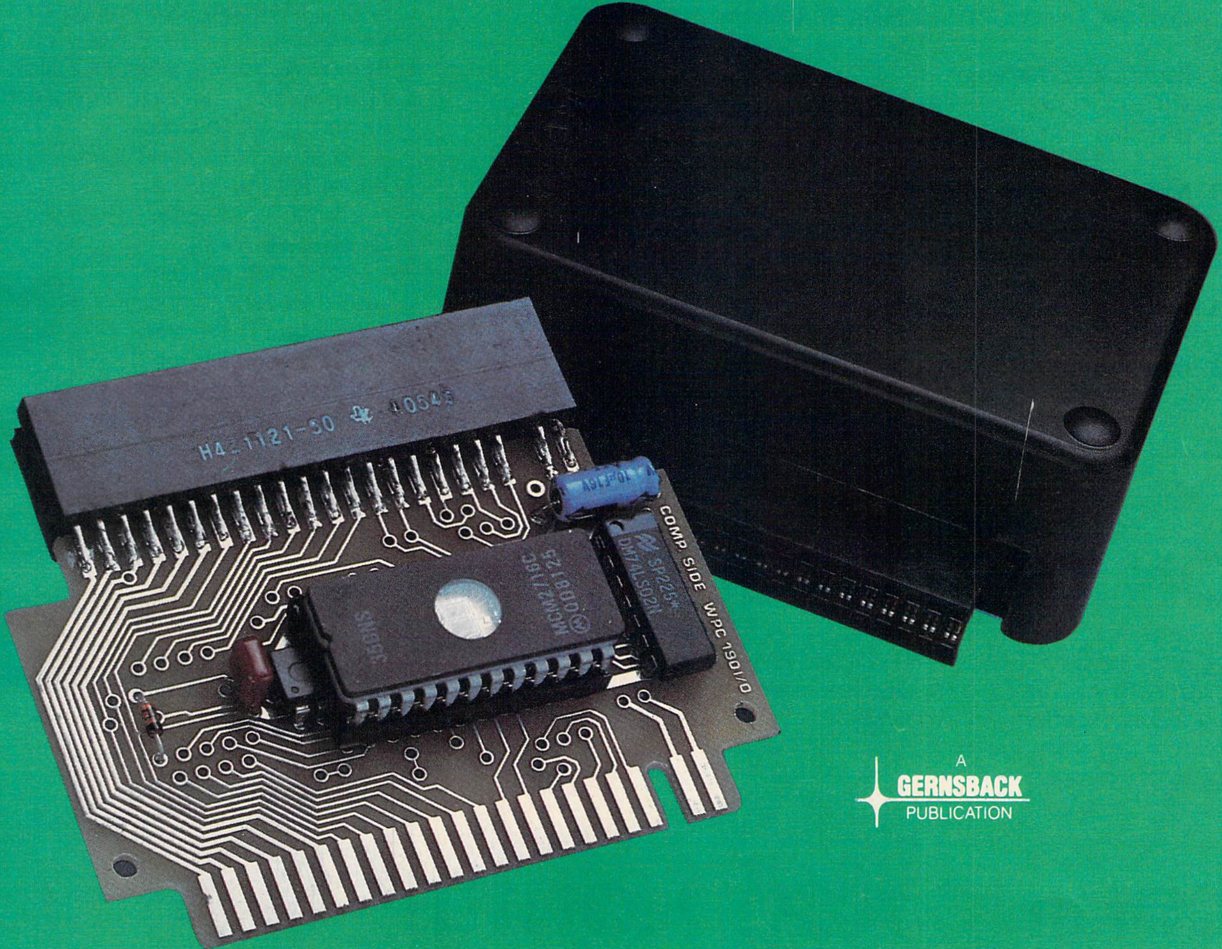
VOL. 2 NO. 11 November 1985

COMPUTER DIGEST

NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

BUILD THE FIRMWARE CARD

Place an EPROM in the USR Memory of your Timex.



A GERNSBACK PUBLICATION

RAMDISK TECHNOLOGY

Instant-Access Mass Storage.

BUILD THIS MODEM FOR YOUR COMMODORE 64

Part I of a Two-Part Article.

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ON THE COVER

The Firmware Card (See page 4) will add an element of additional flexibility to your TIMEX computer. The small amount of time and cost makes the effort well-worthwhile.

COMING NEXT MONTH

A really jam-packed issue you won't want to miss. Learn how your computer can take the drudgery out of designing attenuatrors and pads, How to use PERCOM to double your storage density, how to enhance and tune the 1541 disk drive the easy way, and we'll start a two-part article on building your own modem for your Commodore.

ComputerDigest is published monthly as an insert in Radio-Electronics magazine by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Second-Class Postage Paid at New York, N.Y. and additional mailing offices.

COMPUTER DIGEST

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Gernsback Publications, Inc.
200 Park Ave. South
New York, NY 10003
Chairman of the Board: M. Harvey Gernsback
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ADVERTISING SALES 212-777-6400
Larry Steckler
Publisher

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200 Park Ave. South
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212-777-6400

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LETTERS

Hackers

I resent your recent editorials on Hackers. Anybody that tinkers with computers is a hacker, and I've been doing this for years, trying to improve my system. I do not consider myself a moron!—B. G. Jerrolds, Waseca, MN.

Watch my lips. You're not a hacker. You're a computer experimenter. Read some of the mail we received and see if you don't agree with me.

More On Hackers

I'm a hacker and a student of computer science. I do break into other systems but don't crash them. I just look around to see what they're doing and how they're doing it, then quietly leave. All I'm really trying to do is educate myself. Is that wrong?—Monorail Red, Orlando, FL.

And if you were studying interior decorating, would it be all right to break into your neighbor's home just to see how it was furnished?

Still More

I'm a hacker, and I look upon a computer system as a challenge. It's like a puzzle I'm trying to solve. If I can break in, why it simply means I solved the puzzle. What harm is there in that?—R. D. Falcon, Atlanta, GA.

How do you feel about picking your neighbor's front-door lock? That's a puzzle, too.

It Goes On

Did it ever occur to you that we hackers are performing a service? If we can break into a computer system, anybody else can, too! It makes the system operator look again at his security methods. Frank Cheyney, Billings, Mont

Sure, Frank; in the same way that a bank robber helps the bank!

And On

There are some very famous and important heads of business in the computer industry that started as hackers. What do you have to say about them?—Sam Pace, Indianapoilis, IN.

The same thing I say about **all** hackers.

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

PORTABLE COMPUTER, the *Bondwell 16,* features a 10-megabyte hard disk drive, 128K RAM memory, built-in voice synthesizer, and bundled software. It also features a 9" non-glare monitor, 91-key detached fullstroke keyboard, with a separate numeric keypad, built-in modem, and a 5½" floppy-disk drive.

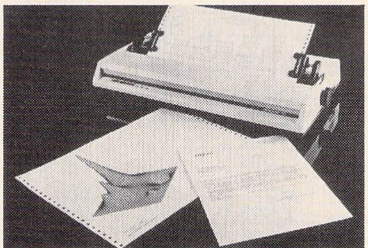
Equipped with the upgraded CP/M 3.0 operating system, the 30-pound computer is better able to use its 128K RAM memory in the application of the five business-software programs bundled with the system: WordStar, MailMerge, CalcStar, DataStar, and ReportStar. The model *Bondwell 16* is priced at $1995.00.—*Spectravideo, Inc.,* 3300 Seldon Court #10, Freemont, CA 94539.

CIRCLE 11 ON FREE INFORMATION CARD

DOT-MATRIX PRINTERS, the Microline model *192* and its wide-column companion, model *193,* (shown in photo), feature three different print modes, a re-inking cartridge ribbon, and user-friendly operation.

Both printers come in standard versions to interface with most personal computers, as well as specially configured IBM-compatible models. (The IBM-configured printers come with free software to work with the IBM-*PC, PC Jr.,* and *PX/XT.)* The software provides type styles similar to courier, italic, gothic, and scientific characters.

The Microline model *192* comes with an adjustable pin-feed mechanism, while the model *193* has a tractor feeder.



CIRCLE 12 ON FREE INFORMATION CARD

The model *192* is a compact unit, measuring 14.6" × 10.9" × 3.2.6" and weighs just 9.9 pounds. It is priced at $499.00. The model *193* handles wide-column applications, such as spreadsheets. It prints up to 136 columns at 10 characters per inch, 163 at 12 CPI, and 17.1 at 233 CPI. It can print between 68 and 233 characters per line. It measures 20.6" × 10.9" × 5". It is priced at $699.00.—*Okidata,* 532 Fellowship Road, Mt. Laurel, NJ 08054.

FIRMWARE CARD

Build this and you don't have to store everything above RAMTOP.

MARK W. LATHAM

■From teletext terminals to solar heating controllers people seem to discover new uses for the Timex/Sinclair 1000 and its upgraded successors. Those who write the software for these applications often forego BASIC and program either partially or completely in machine code. Such programs not only have precise control of the computer and fast execution times, but lend themselves perfectly for placement on a firmware card.

How do you know that your program has been written completely in machine language? If it loads into the BASIC area and then transfers itself above RAMTOP, it probably is. The area above RAMTOP is not the only place to put machine code programs. USR calls can be directed to any location in the 0-32K area.

The firmware card described here lets you place either a 2K or 4K EPROM anywhere in the USR memory area. It can serve as an interface card for custom projects. It fits into Radio Shack's smallest project box and operates much like an Atari game cartridge. Once you plug it in, all that is necessary is to call the program.

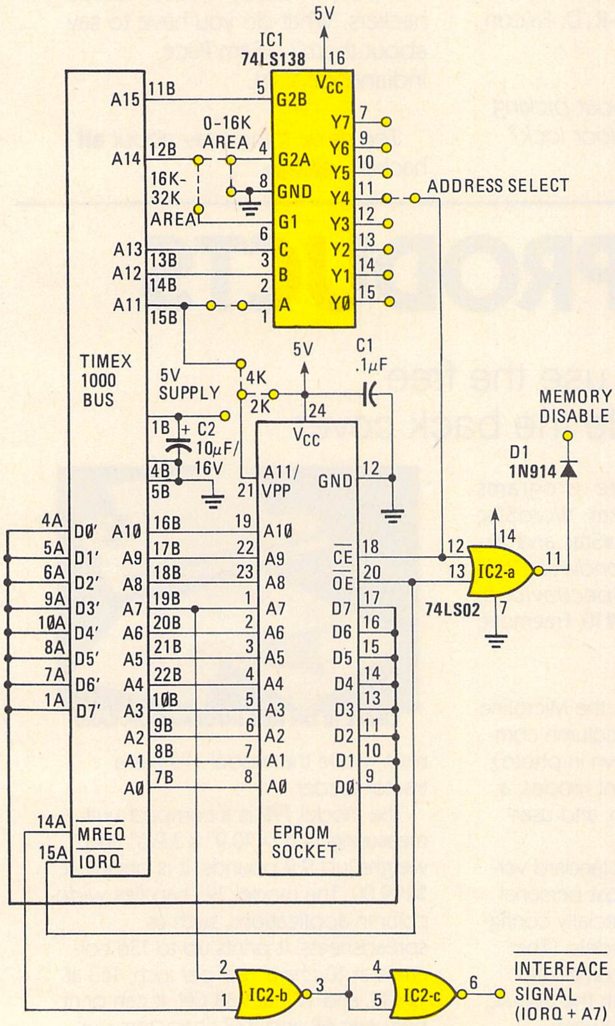


Fig. 1—SCHEMATIC DIAGRAM OF FIRMWARE CARD can easily be modified by cutting certain of the trace lines to suit your needs. See the text for additional information.

Circuit operation

The schematic diagram is shown in Figure 1. The one-of-eight decoder, IC1, reads address lines A11-A15 and provides a decoded output. Just a few jumpers allow this IC to activate the EPROM anywhere in the USR area.

When a 2K EPROM is used, address A11 is jumpered to the decoder's least significant address input, pin 1. The decoder's eight outputs will then each represent a 2K block of memory. Address A14 is jumpered to either pin 4 or pin 6 of the decoder, allowing these eight outputs to activate for addresses in the 0-16K or 16-32K areas, respectively.

For a 4K EPROM, the decoder's pin 1 is left open and A11 is jumpered to the most significant EPROM address pin. With this jumper configuration, the decoder activates only the odd-numbered of the eight outputs, each of which represents a 4K block of memory.

Usually the decoded address signal is ORed with /MREQ (computer's memory request) before being fed to the EPROM's /CE (chip enable). Such a configuration provides for the least power dissipation possible. In this case, however, the decoded address signal is connected directly to /CE, and /MREQ is connected to the EPROM's /OE (output enable). For a rare compromise in power, access time is then extended allowing even the slow 480ns memories to work.

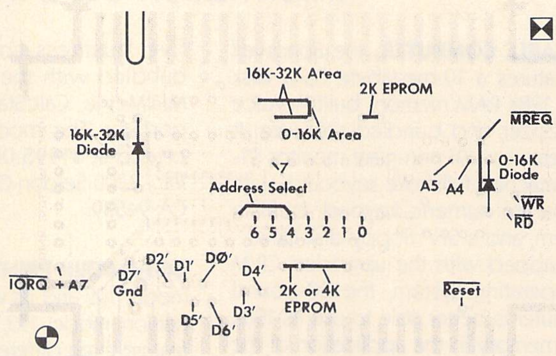


FIG. 2—SIGNAL LOCATIONS are called out on diagram above. Refer to text for further clarification.

Project interface

For those readers who have built custom add-ons such as those described in "Interfacing The ZX-81" (see Radio-Electronics, July-September, 1984) or "Machine Code Development System" (see ComputerDigest, January and March, 1985) the firmware card allows you to interface your project and keep the computer bus too. To separate the display and printer commands from the project's I/O signals, the computer's /IORQ and address A7 have been ORed to provide an interfacing signal. The locations of this and other useful signals on the firmware card is shown in Figure 2.

Memory disable

In order for the firmware card to work properly, it must disable any other memory device working in the same area. A memory disable signal is made by NORing (via IC2a) the decoder's output with /MREQ and then connecting the NOR output through diode D1 to the control line of the memory to be disabled.

As shown in Figure 2, D1 can be placed to disable either the ROM (0-16K) or the RAM (16K-32K) of the computer's internal memories. The firmware card can also disable an external RAMPAK that cannot be manually switched off in the card area. This is done by replacing the /MREQ trace with a 680-ohm resistor and then connecting the 16K-32K diode's cathode to the end of that resistor. The RAM is then plugged in behind the firmware card.

PARTS LIST

D1—1N914 or 4148 Switching Diode
IC1—74LS138 One-Of-Eight Decoder
IC2—74LS02 Quad 2-input NOR gate
C1—.1μF Disc or Metalfilm Capacitor
C2—10μF 16V Electrolytic Capacitor
Miscellaneous—Edge connector, 24-pin socket, circuit board, project case, hardware.

An etched, drilled and cut printed circuit board is available for $12.95 (price includes shipping and handling) from WILDONICS, Box 1763, Boise, ID 83701. For custom cards, write.

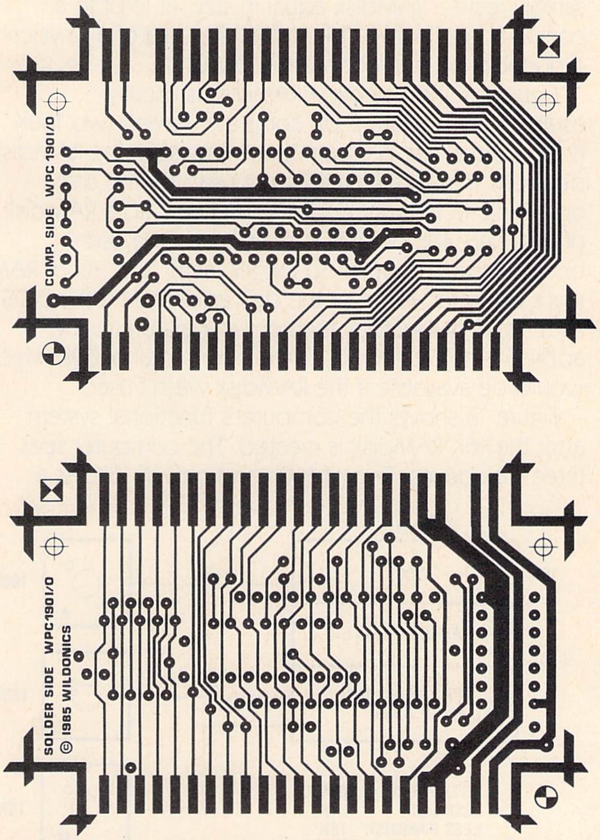


FIG. 3—IF YOU'D LIKE to make your own circuit board, full-size patterns are offered here for both sides. Above is the component side, below, the solder side.

Contruction

The component and solder sides for the firmware card are shown in Figure 3. This circuit board can be made at home or can be ordered from the supplier given in the parts list. The pattern shown includes jumper traces that place a 2K EPROM in the 8K-10K memory area. To change the EPROM size or memory placement, these traces must be broken and wire jumpers used as shown in Figure 2.

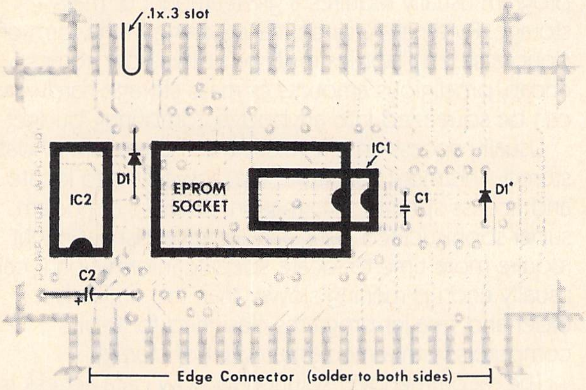


FIG. 4—PARTS PLACEMENT is shown here. Note that IC1 is mounted directly to the board beneath the EPROM. See text.

The parts placement is shown in Figure 4. Note that IC1 is mounted directly to the board under the EPROM. To allow space for this IC, the EPROM socket can be modified on one end, resulting in a U-shaped socket.

Once wired, the firmware card can be placed inside Radio Shack's smallest project case. This case should be sprayed on the inside with aluminum paint and then cut ½-inch up on each side to allow for the edge connectors. On one end of the aluminum cover place adhesive foam. On the other end, two holes should be drilled ¼-inch away from parallel with the two case holes. Plastic ¼-inch spacers and ½ × 4-40 screws thread directly into the board to complete the assembly.

Other uses

The firmware card can provide many other useful functions missing on the Timex computer. A nice accessory, for instance, would be a Reset button that can be made by connecting a normally open, momentary contact switch between /RESET and ground.

The EPROM socket can also hold an HM6116 2K RAM by changing pin 21 from 5V to the /WR signal. This makes the card ideal for writing custom software in the 8K-16K area.

The interface output can also be used to power a piezo element. A little experimentation with short bursts of output commands should result in some unique sounds and musical tones.

RAMDISK TECHNOLOGY

Instant-access mass storage

Herb Friedman

■While it might appear that the new super-sophisticated programs do more for the same price—giving something for nothing—a super data-crunching program usually requires a great amount of mass storage. Fortunately, since mass storage in the form of double-sided floppies and hard disks now comes cheap, prodigious amounts of mass storage hardware can be squeezed into anybody's computing budget.

Usually, access time is relative to the amount of data stored: The more you store, the slower it is to locate and access specific information. Because a modern, super-sophisticated data base or spreadsheet might require more time to locate specific information it can usually end up running slower than the similar but older and smaller programs designed for 8-bit computers with a modest amount of storage.

The recommended solution to slow data access is usually something with a catchy high-tech name such as *hyperdrive,*, or *superdrive*, or *turbodrive*. Regardless of what it's called, it is actually a portion of a computer's RAM that's been programmed to emulate a disk drive. Usually, the emulation is so accurate that the computer actually sees the RAMdisk as only a disk drive: As far as the computer is concerned, the RAM used for disk emulation no longer exists as free RAM.

The reason why RAMdisk data access is faster than a conventional disk is because to access data on a physical floppy or hard disk the disk must start, come up to speed, and the read/write head must be positioned before it can locate the desired data or an empty space into which new data can be written. A RAMdisk has no such delays because reads and writes are from RAM to RAM: The only delays are those of the applications program and the computer itself as it moves electrical impulses through RAM.

The way in which RAMdisk is used depends on the particular software, the computer and the user. In general, particularly with 64K 8-bit computers, the user employs special software to reserve a portion of conventional memory as a RAMdisk only as large as needed for the disk file. The computer recognizes the RAMdisk the same way it recognizes a physical disk. For example, if the computer has physical drives A: and B: the RAMdisk might be C: or D: or M: or whatever. Once the RAMdisk is established in memory the user can read or write to the RAMdisk, or copy the desired data from a physical drive to the RAMdisk by using the conventional DOS PIP or COPY command. Assuming the RAMdisk was assigned the identifier M:, if the user wanted to browse through a computerized mailing list of customers who purchased TV service contracts for the past 5 years he would copy the data file—assume its filename is CONTRACT.DAT—from the floppy or hard disk to the RAMdisk with the command:

PIP M: = CONTRACT.DAT (for CPM)

or

COPY CONTRACT.DAT = M: (for PC/MS-DOS).

Using an in-memory word processor, a data base editor, or the computer's LIST or TYPE command, the user could browse through the mailing list—move forward and back—without having to wait for the computer to seek and load from the disk.

How it's done

If the computer's RAM were unlimited, one could safely create a RAMdisk equal in size, at least to a conventional floppy disk and all the data of a physical disk could be copied into the RAMdisk.

Figure 1A shows how a RAMdisk is usually established in a 64K 8-bit computer having two 160K floppy disks. The program that establishes the RAMdisk positions it in an area that is not used by the disk operating system (DOS). If the user sets up a RAMdisk of 16K, only 48K of RAM is available to the user because the computer no longer "sees" the 16K of RAM that's been set aside for the disk emulation. If the DOS uses 4K, only 44K total memory is available to the applications program in contrast to a total of 60K which would be available if the RAMdisk wasn't used.

Figure 1B shows the computer's functional system after the 16K RAMdisk is created. The computer sees three disk drives: Two of 160K and one of 16K. As a

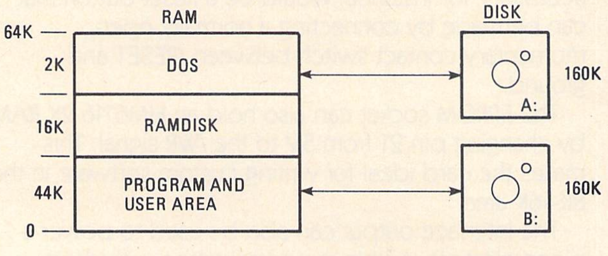


FIG. 1A—IN A CONVENTIONAL 8-BIT COMPUTER the RAMdisk is created from the basic 64K of memory. The memory used for the RAMdisk is no longer available to the applications program.

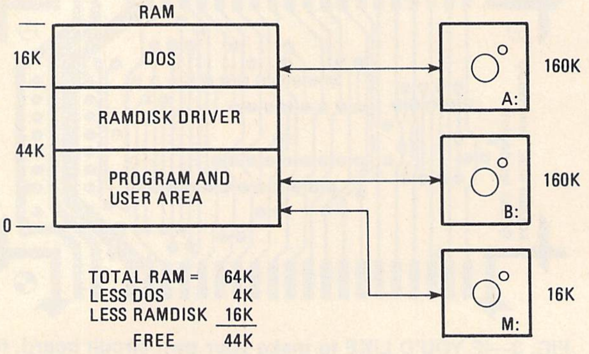


FIG. 1B—IF A 64K RAMDISK is created, the functional computer now has three disk drives, but 16K less RAM.

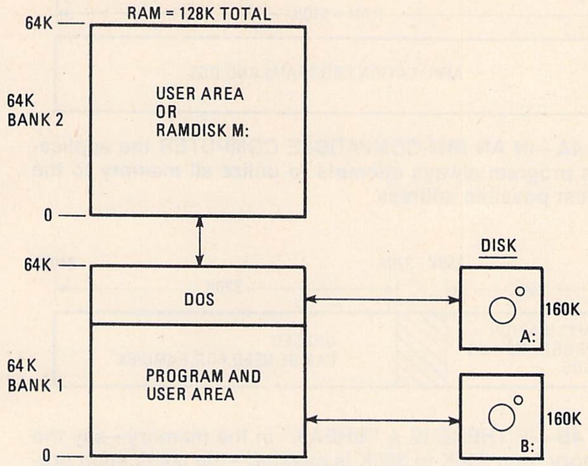


FIG. 2A—SOME OF THE LATEST 8-bit computers provide a second bank of 64K of memory, part or all of which can be partitioned for use as a RAMdisk or as user RAM.

general rule, this configuration lasts until the computer is turned off: The memory utilized for the RAMdisk cannot be reprogrammed for use as conventional RAM.

In a 64K computer, the RAMdisk must be as small as possible; if it is made too large, there might not be sufficient memory left to run the applications program. But if enough memory is left for the applications program, the RAMdisk is usually too small for effective handling of the associated data.

But the RAMdisk becomes more useful when the computer can address memory independent of the main computer. For example, the Radio Shack Model 4 was the first 64K machine to accomodate an extra internal 64K bank of memory which could be used for a RAMdisk independent of the main memory, leaving almost all of the conventional 64K in the first bank available for the applications program. Unfortunately, Radio Shack made no provisions for CP/M applications use of the additional 64K. Aftermarket vendors however, provided software which configured the entire extra 64K to function as a RAMdisk. As shown in Figure 2A, the RAMdisk uses the entire second bank of memory, all 64K, for the RAMdisk, while the main computer retains almost its full 64K of RAM (less a smidgen for the RAMdisk software). This results in the system configuration shown in Figure 2B, 64K of memory computer memory plus two full-size floppies

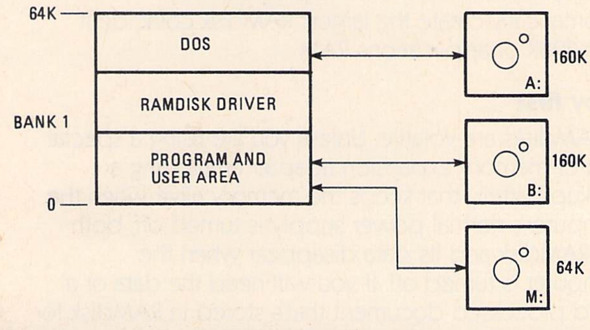


FIG. 2B—IF THE ENTIRE 64K OF MEMORY in the second bank is used for a RAMdisk the functional computer has three disk drives, but a full 64K of memory (from the first bank of 64K).

and a 64K RAMdisk; which is far more advantageous for conventional applications programs than the configuration shown in Figure 1B where part of the original 64K of memory is partitioned for a RAMdisk.

An even more advanced RAMdisk system for 8-bit machines uses a completely independent memory external to the original computer. As shown in Figure 3A, a RAMdisk program within main memory manages all of the external memory as a RAMdisk. Since the external memory is really under software rather than inherent computer or operating system control it can be almost any affordable size. 320K is not uncommon. Once a RAMdisk is greater than approximately 160K it can represent one or more floppy disks, and depending on the particular software that creates the RAMdisk(s) everything on the physical disk including the directory can be written or copied to the RAMdisk. If the external RAM is sufficiently large it can be software partitioned to emulate several disk drives. Figure 3B shows how 320K of external memory can represent two independent 160K RAMdisks.

Once we can create a RAMdisk at least equal in size to a conventional floppy, the speed by which an applications program works can be increased by several orders of magnitude.

But if the disk overlay files are copied to RAMdisk the program operation is almost instantaneous because the program no longer has to wait for disk access. Both the reads and writes to "virtual memory" are made to and from RAM. The value of RAMdisk is even more apparent if WordStar is used with a spelling checker. A spelling checker's dictionary—its list of words—is generally so large it must be maintained on its own disk. If the document being spell checked is being stored on a separate data disk (which is usually the way it's done) two disk drives are needed only for the spelling check, and it's often necessary that the dictionary disk be swapped with the word processing software disk in order to randomly access the spelling checker. This is slow, it's frustrating. However, if the spelling checker

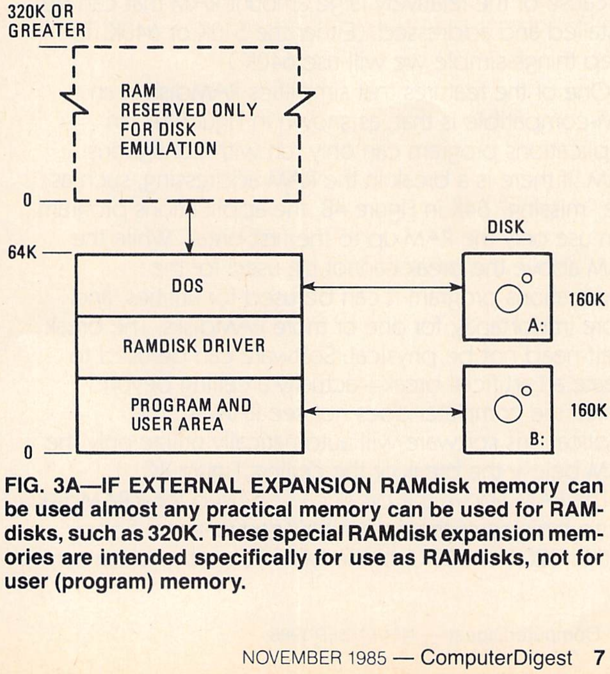


FIG. 3A—IF EXTERNAL EXPANSION RAMdisk memory can be used almost any practical memory can be used for RAMdisks, such as 320K. These special RAMdisk expansion memories are intended specifically for use as RAMdisks, not for user (program) memory.

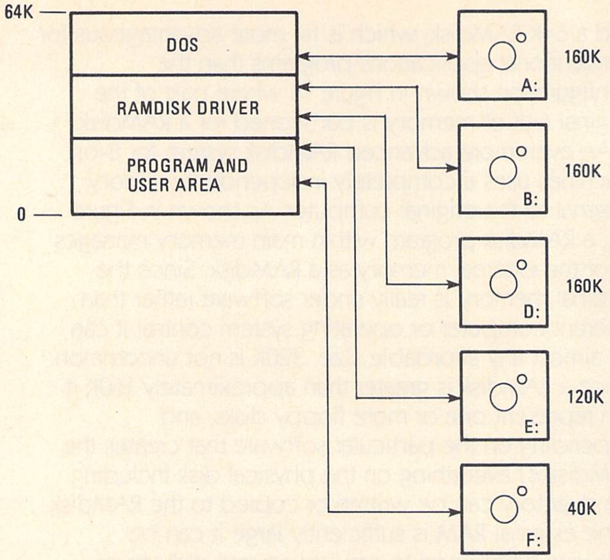


FIG. 3B—EXPANSION RAMDISK MEMORY can be partitioned almost any way the user wants it. For example, 320K might be configured to provide three additional drives so the computer sees a total of five.

software is copied into a RAMdisk the program can easily shift back and forth between WordStar and the RAMdisk spelling checker almost instantaneously.

Full size RAMdisks

Disk emulation in IBM-compatible computers can be handled in several different ways, depending on the amount of installed RAM. If the computer has 256K of RAM disk emulation it's the same as for 64K computers in that part of the RAM is programmed to function as a RAMdisk. But since RAMdisks provide maximum convenience when the emulation is at least equal in size to the floppy with the computer, it makes no sense to create small RAMdisks when the computer has the capacity to emulate full-size disks, for in this way a complete floppy can be easily copied to the RAMdisk. This is easily done in an IBM-compatible computer because of the relatively large amount RAM that can be installed and addressed. (Either the 510K or 640K. To keep things simple we will use 640K.)

One of the features that simplifies RAMdisk in an IBM-compatible is that, as shown in Figure 4A, an applications program can only run with contiguous RAM. If there is a break in the RAM addressing, such as the "missing" 64K in Figure 4B, the applications program can use only the RAM up to the first break. While the RAM above the break cannot be used for the applications program it can be used for utilities, and more importantly, for one or more RAMdisks. The break itself need not be physical: Software can be used to create an artificial break—actually a ceiling beyond which the computer does not see RAM, so the applications software will automatically utilize only the RAM below the break or the ceiling. Figure 4C.

The RAM above the break can be used for a RAMdisk up to the size of the computer's conventional floppy (either 320K or 360K), or the RAM above the break can be partitioned into a full-size RAMdisk and a smaller RAMdisk, or several smaller RAMdisks. The precise disk emulation depends on what the user needs and the software that creates the RAMdisk(s). Others permit any amount of reserved RAM to be used for several RAMdisks of random size.

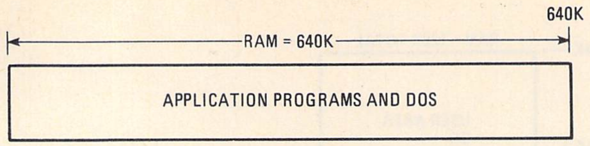


FIG. 4A—IN AN IBM-COMPATIBLE COMPUTER the applications program always attempts to utilize all memory to the highest possible address.

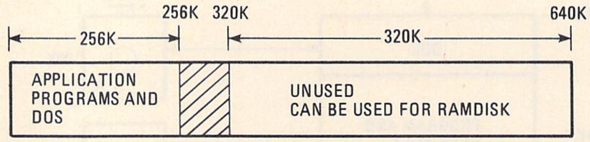


FIG. 4B—IF THERE IS A "BREAK" in the memory—say the memory from 256K to 320K is missing—the application program will run only in the contiguous memory starting from zero. The memory above the break can be used for RAMdisks or anything else other than the applications program.

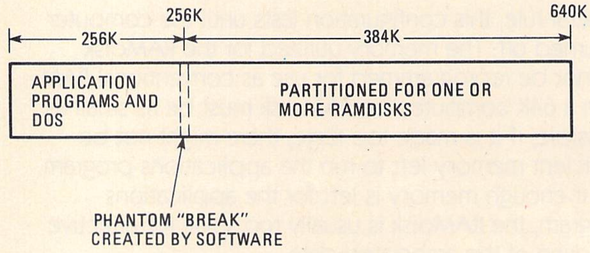


FIG. 4C—RAMDISK SOFTWARE CREATES a "phantom break" and configures the memory above the break for one or more RAMdisks. How and in what size the RAMdisks are created are a function of the RAMdisk software.

An IBM-compatible computer doesn't have to be "fully loaded" with memory to create a RAMdisk. If the computer is equipped with only 256K of RAM most of the disk emulation software will permit one or more RAMdisks to be created as long as a minimum of 128K remains for the applications program (including DOS and the RAMdisk software). Often, if the user attempts to create a RAMdisk that will leave less than 128K for the applications software the program will automatically create the largest RAMdisk coincident with 128K of applications RAM.

Copy first

RAMdisks are volatile. Unless you are using a special kind of memory expansion adapter employing a backup battery that keeps the memory alive when the computer's normal power supply is turned off, both the RAMdisk and its data disappear when the computer is turned off. If you will need the data or a word processed document that's stored in RAMdisk for use at nother time, it must be copied to a physical disk before the computer is turned off.

YOU CAN BUILD THIS MODEM FOR YOUR COMMODORE 64

PART I

Sure you can build your own modem... And save a lot in the process!

JIM STEPHENS

■Modems are expensive but not all that complicated. In fact, they can be quite simple once the function of the main components is understood. Basic modems have two main sections, a modulator and a demodulator. Once these have been built, the rest is easy. Here's how to build your own originate-only modem and save a bundle.

What makes it possible, are two new integrated circuits sold by Radio Shack and other suppliers. The catalog description said that the XR2211 IC was an "FSK decoder used for RTTY and modems." Next to it was another IC, the XR2206 FSK Generator, which had the same caption. The result was better then expected, it worked, and it worked reliably. The circuit could do what it took several dozen IC's in other circuits to do and it did it at less than half the cost of some of the more popular modems for the Commododre 64.

A modem is a circuit that converts serial digital data coming from the computer into tones that can be sent over a single audio channel such as the telephone line. This conversion, called modulation, sends one tone for a digital one and a different tone for a digital zero. The other section of a modem converts tones from the telephone line to either a digital one or zero depending on the tone's frequency. This function is called demodulation.

Since the telephone is built to handle voice communication, the plus and minus voltages which are generated by the computer cannot be handled by the telephone circuits. If a circuit could recognize a certain voltage and convert that voltage to either high or low tone, digital generated tones could be sent over the telephone line and could be reliably picked up at the other end.

That is exactly what the modem does.

To speed things up a bit, modems actually operate using four tones of different frequency. Two tones are used by the sending terminal and two separate tones of another frequency range are used by the receiving terminal. This way, it is possible for both units to talk at the same time and not interfere with each other's data.

The telecommunications terminal that calls up another terminal is called the originating terminal. Its tones are set at 1070 Hz and 1270 Hz for a digital zero or a one. The receiving terminal is the answering unit and its tones are higher with a one represented by 2225 Hz and a zero represented by 2025 Hz. When the two tones are changed from one frequency to the next, they are not stopped and started, but shifted up or down in frequency. This is called "frequency shift keying" or FSK. A demodulator circuit recognizes this shift and changes the digital output at its output pin accordingly. The modulator circuit senses a digital one or zero on its keying input pin from the computer and shifts its output frequency either up or down depending on the level of voltage at this input.

Although it is possible to have both the originating and answering capability in one modem, the need for more-complicated circuits outweigh the benefit. After all, most of us would only use our computer to call up another terminal such as Compuserve. We rarely use it to answer unless we are running our own bulletin board. The simple unit shown here is an originate-only modem, but it could easily be converted to answering capability by changing the values of the components as shown in Table I and setting the output tones of the modulator to the higher set of frequencies. It might even work if a separate set of components were on the board and switched into by a set of switches. This would make the modem capable of both origination and answering.

The most expensive part of telecommunicating can be the modem software that generates and converts the digital data once the modem has accomplished its task. The unit shown here works with most of the available software for Commodore modems. It was used with Smart Terminal 64, Victerm, and with Term 64. Many good terminal programs have been published recently in several of the Commodore publications.

The modem circuit

There are four ICs that make up this modem circuit, but the two major ones are the 2211 FSK demodulator and the 2206 FSK modulator.

As shown in Figure 1, the 2211 demodulator receives the 2225 Hz tone from the earpiece. The level of the received tone is amplified by IC3 which is an LM386 low power audio amp. The descrete components that connect to the 2211 actually set the response frequency of the demodulator. Table I shows the values of the components that set the frequencies at which the demodulator responds. Since we want the demodulator to react to the incoming 2025 Hz and 2225 Hz tones, we have chosen the values for the five components listed under the higher frequency range. Note that the capacitors here should be good quality mylar types to improve the stability of the circuit. Pins 11 and 12 of the 2211 are the oscillator control of the demodulator and this oscillator is peaked by a 5K variable resistor, R7. This is a standard linear taper pot. The tones are transmitted from the earpiece by a small inexpensive speaker.

When a tone in the proper frequency range is detected by the 2211, the demodulator's data output pin goes either high or low depending on the frequency. A tone of 2225 Hz will cause it to go high while a tone of 2025 Hz will cause it to go low. Adjustment of R7 causes the oscillator to lock onto this frequency range and these adjustments will be discussed in detail later.

The heart of the modulator section is the 2206 FSK generator. Figure 1 shows that it appears as simple as the demodulator but its adjustment is much more complicated than the 2211. It generates a tone of either 1070 Hz or 1270 Hz at pin 2 when either a digital zero or a digital one is detected at its keying pin number 9. The 2206 is capable of producing most any frequency so exact adjustment is necessary in order to produce the correct frequency output.

Pins 7 and 8 of the 2206 connect to the timing resistors that produce the two output frequencies. The value of these resistors is set to produce the two separate tones. Two variable resistors (R13 and R14) have been chosen so that the exact frequency of the tones can be set by hand. R11 is the volume control that determines the intensity of the tone being sent to

PARTS LIST

Resistors
All resistors ⅛-watt
R1, 4—1,000,000 ohms
R2, 10, 12—5100 ohms
R3—510,000 ohms
R5—200,000 ohms (see table 1)
R6—18,000 ohms (see table 1)
R7—5000 ohms Variable
R8, 13, 14, 16—10,000 ohms Variable
R9—10 ohms
R11—25,000 ohms Variable
R15—200 ohms

Capacitors
C1, 4, 7, 10—.1μF ceramic
C2, 8, 11, 14—10 uF electrolytic
C3, 15—5 μF electrolytic
C5—.005 μF ceramic
C6—.05 μF ceramic
C7—.1 μF ceramic
C9, 12—1 μF electrolytic
C13—100 μF electrolytic
C16—.022 μF mylar (see table 1)
C17—.0047 μF mylar (see table 1)

Semiconductors
IC1—XR2211 FSK Decoder
IC2—XR2206 FSK Generator
IC3, 4—LM386 Low Power Audio Amp
IC5—4049 CMOS Hex Inverter
Q1—2N2222 NPN Transistor

Miscellaneous
SW1—SPST Switch
SPKR—8 ohm .5 watt Speaker
Connecto-Edge Connector (Cinch #50 24A-30)
Perfboard
(1) 14 pin WW Socket
(3) 16 pin WW Socket
NOTE: - A ten-minute cassette tape containing five minutes of continuous telecommunications data and examples of both originating and answering tones may be ordered by sending $4.00 to Syntronics, 2324 Dennywood Dr., Nashville, TN 37214.

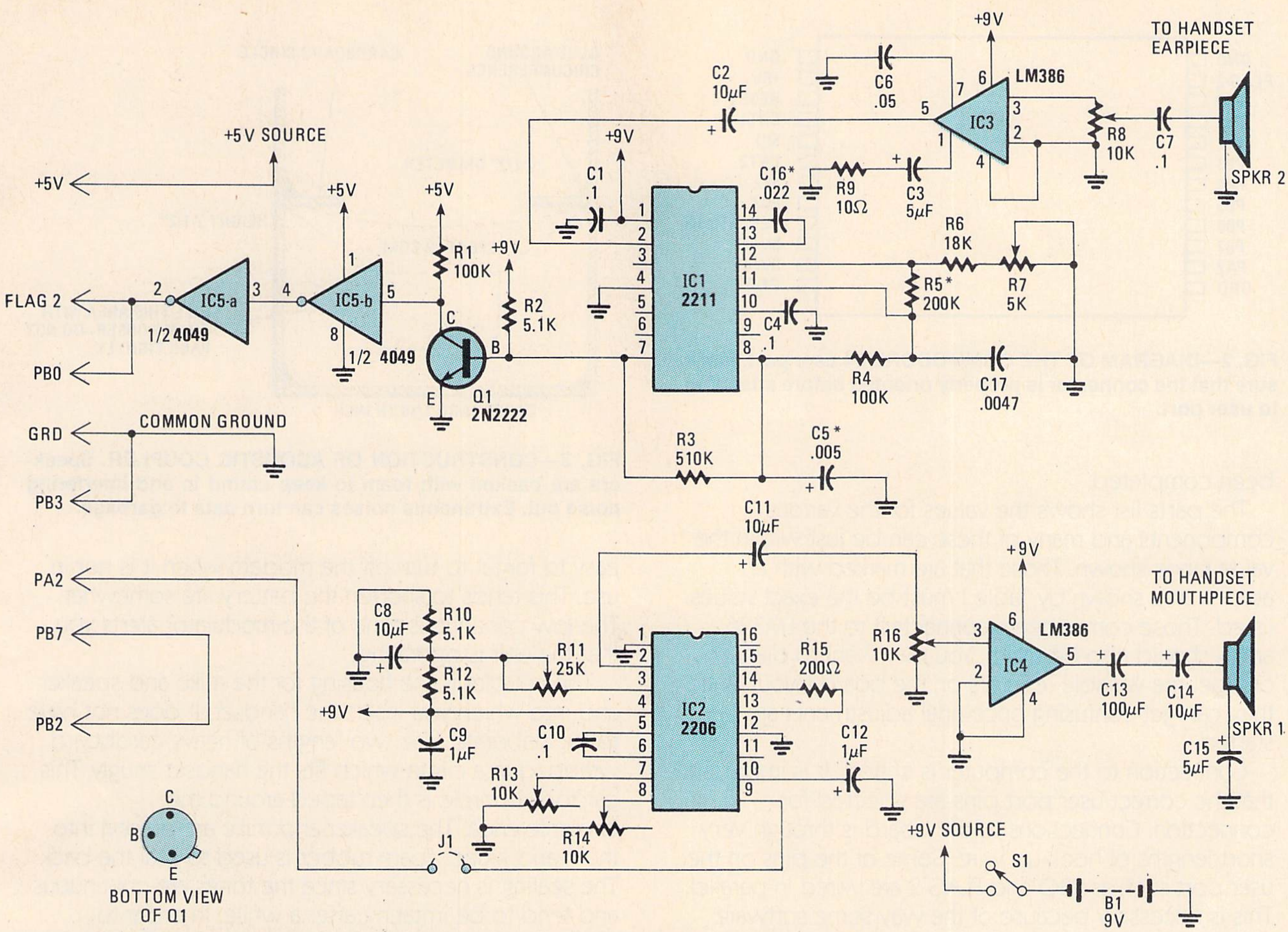


FIG. 1—SCHEMATIC DIAGRAM OF THE MODEM. Heart of the system is two IC's, IC1 and IC2 which are an FSK Decoder and an FSK Generator. Balance of circuit is straightforward and supports these devices. *See Table 1 for values.

IC4 which is an LM386 low power audio amp. The audio amp also has a 10K pot that adjusts the level of the final output to the 8 ohm speaker.

Circuit power

Notice that both the 2211 and the 2206 are powered by 9 volts. This voltage is necessary because the 2206 will not operate at less than 8.5 volts. Since direct current at 9 volts is not present on the user port of the Commodore 64, we use a 9 volt transistor battery. A small separate power supply could be built to provide this voltage. The modem only draws around 25 ma so the battery should last some time depending on use.

A transistor battery should never be placed on the user port pins. If this were done, the output port of the 64 could be harmed. The output signal of the 2211 demodulator is connected to the 64 through a 2N2222 NPN transistor which obtains its power from the 5 volts on the user port. The signal is then fed through two stages of IC3 which is a CMOS 4049 inverter. The inverter is powered by the computer's 5 volts. This IC shapes the final digital levels before they are presented to the port. Both power supplies have their ground connection in common for proper signal reference.

After extended use, it will be necessary to replace the 9-volt battery since the lower voltage level will cause the modem's output and lock-on frequency to drift off. This will cause mis-reads in the data. If garbage starts showing up for no reason, suspect low battery voltage. Again, this would not be a problem if a small separate 9-volt supply were constructed, though it would increase the complexity and cost of the circuit. The transistor battery did fluctuate when left off for a long period and would sometimes make re-tuning necessary.

Wiring the modem board

You must keep the components close together and the leads short or risk stray capacitance which upsets the audio circuits. This is especially true of the LM386 amplifiers. You may hear a local disk jockey coming in on the modulator circuit. This interference disappears once the final connections are made. Make sure you use flexible sheilded microphone cable to the speakers. These lines should be no more than ten inches long. They tend to act as antennas and the modem will try to decode the sound of the latest rock group.

IC sockets were used for the integrated circuits and wire-wrap posts for mounting some of the descrete components. One 16 pin IC socket mounted both of the LM386 amplifiers. The sockets were inserted into a 3-inch by 2-inch perf board. Leave the jumper test point (J1) disconnected until the final adjustments have

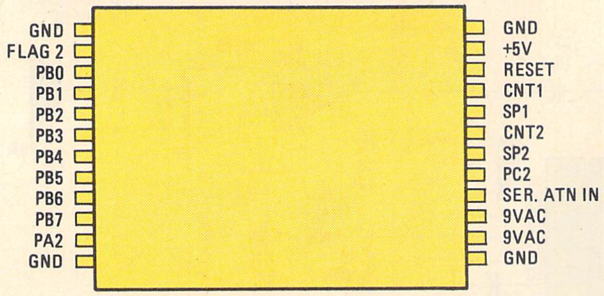


FIG. 2—DIAGRAM OF THE COMMODORE 64 user port. Make sure that the connector is properly oriented before attaching to user port.

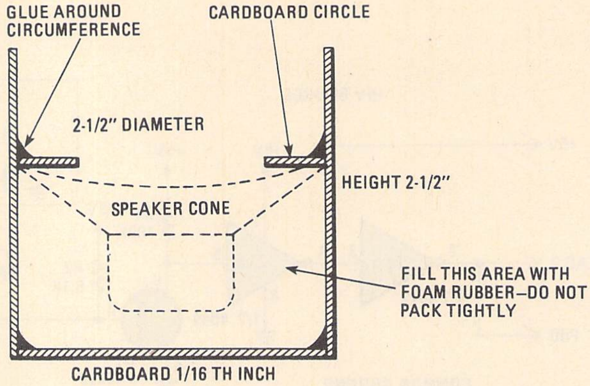


FIG. 3—CONSTRUCTION OF ACOUSTIC COUPLER. Speakers are backed with foam to keep sound in and interfering noise out. Extraneous noises can turn data to garbage.

been completed.

The parts list shows the values for the various components and many of these can be just within the value range shown. Those that are marked with an asterisk and shown by Table I must be the exact values listed. Those components connected to the LM386 amps should also be exact. You may want to diagram or label the variable resistors on the board layout since they can get confusing once final adjustments are started.

Connection to the computer is critical. It is important that the correct user port pins are selected for connection. Connections to the board is through very short lengths of hook-up wire. Some of the pins on the user port such as PBO and FLAG 2 are wired in parallel. This is necessary because of the way some software handles the output and input ports. Figure 2 shows the user port pinout which is viewed as though you were looking at the user port from the back of the computer. The connector to the port must always be inserted with the leads correctly oriented to the port pins. Never insert the connector upside down since this would place the unregulated alternating 9 volts of the port on the data lines. This could harm the port also. Some anti-reversing means such as connector keying might be necessary on the connector to prevent accidental backward insertion. I simply marked one side of the connector as "TOP."

The 9-volt power supply is switched on and off by a SPST toggle switch. The 5-volts for IC5 and Q1 are supplied by the computer and it is activated when the 64 is turned on. With this dual power arrangement, it is easy to forget to turn off the modem when it is not in use. This tends to shorten the battery life somewhat. The low continuous tone of the modulator alerts you that the unit is operating.

The coupler is the housing for the mike and speaker and into which you insert the handset. It does not have to be elaborate. Use two lengths of heavy cardboard wrapped in a circle which fits the handset snugly. This cardboard circle is then taped around the circumference. The speaker and mike are placed into them and glued. Foam rubber is used to seal the back. The sealing is necessary since the tones are continuous and tend to be irritating after a while. In order to prevent damage to the speakers, a stiff cardboard circle was cut and glued over the speakers to keep the handset from touching them. The leads to the couplers should be short and the couplers can be permanently mounted on a board. Again, use flexible sheilded mike cable here. Figure 3 shows how the couplers are constructed. See Figure 4 to examine the author's unit.

TABLE 1

FSK BAND	COMPONENT VALUES
300 Baud frequency 1070–1270Hz	C16–.039μF C5–.005μF C17–.01μF R6–18K R5–100K
300 Baud frequency 2025Hz–2225Hz	C16–.022μF C5–.005 μF C17–.0047μF R6–18K R5–200K

TABLE 1—TABLE OF COMPONENT VALUES for the 2211 decoder. If decoder is built to be an answering device, values in the first part of the table should be used.

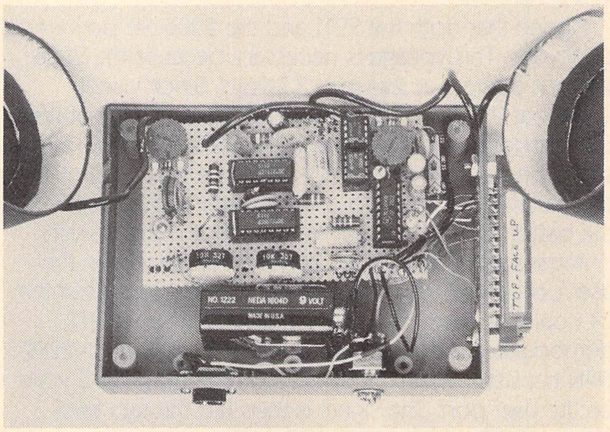


FIG. 4—AUTHOR'S UNIT with cover removed reveals simplicity of wiring. Component placement is not critical and perfboard works well.

That's all the room we have in this issue. However, we'll complete the Modem in the December Issue of **Computer Digest**. There's still much information to come!