The Kaypro Column

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So you've read the articles in Micro C about adding extra drives and souping up your CPU, and now you want to be the first kid on your block with a 5 MHz mill and double-sided quads growling under the hood. Here is a summary of the steps involved, including corrections, reader suggestions, and a few ideas of my own.

While you're at it, you can also make the drive select lamps do what they are supposed to do—light up only when a drive is (a) selected and (b) running.

The mods are independent. You can speed up your CPU or add disk drives or do both. To speed up an older Kaypro II from 2.5 MHz to 5 MHz will cut processing time in half—a remarkable improvement if you are recalculating spreadsheets, reformatting text files, or creating a program. (See "Benchmarks" in Micro C issue 19, p. 44.)

Disk Drives

The older Kaypro IIs came with two full-height, single-sided, double-density, 40-track, 191K drives. Track spacing was 48 TPI (tracks per inch), so 40 tracks would occupy 5/6". There are three ways to increase total disk capacity.

You could use double-sided drives, which read and write both sides of each disk, giving you a total of 80 tracks per disk (40 on each side). This is the Kaypro 4 format.

Or, you could use 96 TPI drives (commonly called quad density). They pack 80 tracks per side into the same 5/6" of media, so a double-sided drive reads and writes 160 tracks. (Kaypro 8)

Third, you can use half-height drives, like the newer Kaypros. This allows you to stuff up to four drives into your machine. If the drives are also half-power models (most are), four will load your existing power supply no more than the two original drives.

Or you can do all three. If you plug in four half-height, double-sided, 96 TPI drives you get more than 3 Megabytes total usable capacity (for about $540 if you purchase TEACs from California Digital, see the back of BYTE). I replaced just one of my Tandon drives with two half-wides so I have three units in my system.

You can do the speed-up and add the extra drives yourself. All you need is information, tools, parts, and a little skill.

Useful Back Issues

For background information, read the following issues of Micro Cornucopia. For the actual wiring, I suggest following the steps below.

Issue 12, page 24: "The Kaypro Column" (the original speed-up article);

Issue 15, page 14: "Great Eight Kaypro" (converting your Kaypro II to a 4, and the 4 to an 8);

Issue 18, page 3: Letter from Greg DeHoogh (2732 chip select), page 24: "The Kaypro Column" (cutting traces and soldering on the speed-up), and page 26: The "PRO-8 Plus-4" (MC's monitor ROM and 4-drive decoder).

You should also get a copy of the Kaypro schematic from Micro C ($20.00).

In addition, a useful instruction booklet comes with Micro C's Pro-8 Monitor ROM. More about the ROM later.

Not For Beginners

If a lot of monkeys on a lot of typewriters will eventually produce a "Hamlet," then it seems to follow that if you keep hooking up wires and parts, you could eventually wind up with a Cray 2. Sadly, this could require a great deal of time.

Although no technical wizardry is involved, you should not make this your first electronics project. Static electricity that you can't even feel will ruin MOS chips (the big ones). Excess heat from soldering will lift traces (foil strips) and make a hell of a mess to repair. Other things can also go wrong go wrong. (SIC)

You will need the right tools. A soldering gun and acid core solder won't do it. You should have the following:

Recommended Tools

Soldering pencil: 15 to 25 watt, 3-wire grounded (to kill static)
Solder: 22-guage rosin core (I insist on Ersin Multicore)
Desoldering tool: spring-loaded Soldavac
Needle-nose pliers, 4½" to 5", smooth-jawed (to avoid nicking wire)
Diagonal cutters, semi-flush cutting, 4½" to 5"
Wire stripper: for 30-guage wirewrap wire
Stripper/crimping tool: for stripping larger wire and crimping terminals
Allen wrentch: 7/64" for disk drive mtg screws
Socket: 3/16" for serial connector mtg screws
Exacto knife for cutting traces
Screwdrivers, miscellaneous hand tools
Electric drill for mtg holes for new drives
Gooseneck lamp with magnifier

Speed-up

This is the easiest mod you can make. You route the 2.5MHz and 5MHz taps from U86, pins 4 and 5 respectively, to a toggle switch on the back panel. A third line from the switch delivers the selected clock signal back to the CPU board. The switch is useful because a few programs run best (or run only) at 2.5MHz.

You'll need a faster CPU chip, a Z80B, in U63. The B means it will operate up to 6MHz.

You'll also need a faster Monitor ROM, U47. The selection you make depends on your intentions regarding disk drives. If you're sure you'll never be adding extra drives, or replacing the present ones with higher-capacity models, then you could scrimp by buying a blank 2716 rated at 350 nanoseconds or less, and having someone copy the code from the original ROM into the faster part. Or you could buy the Pro-Monitor II from Micro C (it is a 250 ns 2732 which is burned to look like a 2716).

However, if you plan to increase drive capacity, either now or later, I recommend replacing U47 with Micro C's Pro-8 ROM. It should satisfy all your present and future requirements. It will run at 5MHz, and it will allow your CPU to access up to four 5 1/4" drives, single- or double-sided, 48 or 96 TPI, in any combination. In addition, it contains some fancy features. The Pro-8 plugs right into the U47 socket; you'll merely have to cut two traces and add two wires (see below).

Also pick up a small connector to wire in-line between the switch and the CPU board (so you won't have to unsolder wires every time you decide to remove the CPU board in the future).

Parts

1. Z80B CPU chip. Get a Zilog or Mostek part. Leave the chip in its anti-static foam until ready to use!
2. A faster Monitor ROM for U47
3. SPDT (3-terminal) toggle switch
4. Three-terminal connector (male and female pair)
5. 30-gauge wirewrap wire, to make the changes under the CPU board
6. 20-gauge stranded, tinned hookup wire, to connect between the CPU board and toggle switch (get red, white, black, and green if you plan to add extra drives later. These are the colors used in the drive power cable).

Procedure

Unplug your computer from 120 VAC. Then decide where you want to mount the toggle switch. The back panel is recommended, because you won't be using it very often. (Also, if you try to shift gears during operation, the logic will hang up and you'll have to reset, losing everything in memory.) A convenient place is in a ventilation slot, near the reset switch. (I moved my reset switch up front and mounted my toggle switch in the hole it left.)

Remove 10 screws from the sides and top and remove the cover.

Unplug the four connectors on the board: J1 (video), J5 (power), J6 (drives), and J7 (reset switch and LED). Be careful not to bend the pins when removing the disk drive ribbon cable. Use a large flat-tip screwdriver to gently pry up each end of the connector, a little at a time.

On the back panel, use a 3/16" socket to remove the mounting bolts from the serial connector, J4. With a small phillips head screwdriver remove the mounting screws from the parallel connector, J2. Two more screws on the back panel secure the CPU board. Two remaining screws secure the board to the long spacers. After removing these two, put them back into the spacers to keep them apart from the others.

Remove the copper shield from the bottom of the CPU board. After removing the two screws, put them back into the brackets to keep them separated.

Glance at Figure 1 for a review of IC pin-numbering. Counting always starts at the notch. (On some ICs a dimple marks pin 1.) When you're looking at the component side of the board, the pins are numbered counter-clockwise from the notch.

Orientation

In the following directions let's assume you are holding the CPU board in your hands like a book, looking at the component side, with the keyboard connector upward. Locate the 20MHz crystal (in a silver-colored can) at the bottom of the board, near the center. Directly above the crystal is U67. Left of U67 is U66. Right of U67 is U86. Between U67 and U86, and slightly upward, are blank outlines for C6 and Q1 (Kaypro decided these two components were not necessary).

The C6 outline contains two plated-through holes. The bottom hole (nearest the edge of the board) makes a convenient tie-point for the switched clock signal returning to the board. Using your soldering pencil and solder sucker (on opposite sides of the board), open the hole.

Run a 4" 20-gauge stranded wire from this hole to the center pin of the female in-line connector. From the center pin of the male section, run a 12" wire of the same color to the common terminal of the toggle switch (usually the center terminal).

Temporarily remove U86 from its socket (use a small, flat-head screwdriver at one end and carefully pry it out). With your needle nose pliers bend pins 4 and 5 outward just enough so they won't go into the socket when you replace the chip. (We're talking about the bottom row of pins, 4th and 5th from the left end, viewed from the component side—right?) These are the 2.5MHz and 5MHz clock signals.

Solder 4" wires to these two pins and run them to the two outside terminals of the female connector. Now run two 12" wires from the male connector to the two remaining terminals of the toggle switch.

NOTE: These are the only two IC pins which you will have to bend out or solder to! All other wiring can be done quite neatly (and out of sight) on the foil side.

Turn the board over and look at the foil side. The keyboard connector is still upward, as before. The disk drive ribbon cable connector, J6, is now on your left.

Hints

When you cut a trace, use your exacto knife and make two cuts a fraction of an inch apart. Scrape away the foil in between. If you accidentally cut the wrong trace, don't try to drop a blob of solder between the broken ends. Instead, lay a short piece of 30-gauge wire across the break and tack-solder it to the foil.

Use the 30-gauge wirewrap wire to add jumpers on the foil side of the board. When adding a wire, strip little more than 1/16" insulation from each end, to avoid shorting to nearby terminals or traces. To connect to an IC pin, make a J-shaped hook with your needle nosed pliers. To connect to a foil solder pad, lay the wire flat and tack-solder to the pad.

Don't ever keep the iron on any trace, solder pad, or IC pin more than 5 seconds MAXIMUM. With good solder and clean, shiny surfaces you shouldn't need more than 2-3 seconds to do the job. Too much heat for too long will lift traces.

Remember—on the foil side, IC notches are on your right, and pins are numbered clockwise. U66-4 means pin 4 of U66.

Cut trace from U66-4 to solder pad near bottom end of C65.

Add wire from U66-3 to the previous solder pad.

Cut trace from U66-5 to solder pad below U49-2.

Add wire from U66-4 to the previous solder pad.

If you are replacing your 2716 Monitor ROM (U47) with a 2732 (like the Pro-8), then perform the following steps:

Cut trace from U59-2 to U60-1 (address line A11B).

Cut trace from U47-21 to U47-24.

Add wire from U59-2 to U47-21 (address line A11B).

Add wire from U60-1 to U60-8 (ground).

That's all the wiring for the speed-up. Now replace the Z80 CPU (U63) with the Z80B, and the 2716 Monitor ROM (U47) with the faster part—either the faster 2716 which you had burned with the old code, or the Pro-8 2732.

(continued next page)

Caution

Before handling the CPU or ROM chips, always discharge yourself by touching some bare metal on your machine. This puts you and your Kaypro at the same potential and helps prevent zapping gates on the MOS wafer (you need good eyes and tiny tools to repair a gate). All the larger chips (and memory) are MOS. Be especially careful in low humidity. Assembly line workers keep themselves grounded with a wrist strap to the chassis of whatever they are working on.

More Disk Drives

I bought two Mitsubishi M4853s for only $175 each. They are half-height, half-power, double-sided, quad density (784K each), with DC brushless, direct-drive motors. They claim track-to-track access time of only 3ms. When these little hummers go out looking for data, they really rip-snort! The only complaint I have so far is that the disk does not always eject when I pop the door open. I just pull the upper latch down part way and let it snap up a second time.

Adding Extra Drives Requires The Following:

1. Drilling holes in the bracket and physically mounting the new drives
2. Installing address jumpers on all drives and terminators on the last drive
3. Adding connectors onto the ribbon cable for data and control lines
4. Extending the drive power cable and adding connectors
5. Installing a new Monitor ROM, such as the Pro-8 (the original 2716 can address only two single-sided, 48 TPI drives)
6. Adding a four drive decoder on or near the CPU board (the existing hardware can address only two drives)
7. Modifying your CP/M to a 63K system

Parts

1. The drives themselves
2. One 34-pin edge connector for each drive. (Examples: Ansley #609-3415M; Alpha #FCC-170-34; 3M #3463-0001.) If you add both connectors now, you can easily add up to four drives later. (For TEAC drives, see note in Micro C issue 17, p. 19.)
3. One 4-pin power connector for each new drive, AMP 1-480424-0. You also need pins, AMP 60619-1, four per connector. (The Mitsi's come with a connector and pins.) Get four extra pins, for daisy-chaining the wires (explained later).
4. One 3/16" (.188") female push-on connector for each new drive, for the ground wire (AMP 60972-1). Get one extra for daisy-chaining.
5. A new Monitor ROM to replace the 2716 in U47. See discussion under Speed-Up Parts, above. Recommended: Micro C's Pro-8.
6. One 74S04 to replace the 74LS04 in U73
7. 20-gauge and 30-gauge wire (see Speed-Up Parts)
8. Socket-head screws, 6-32 X 3/8", and flat washers. Four each to mount new drives.
9. Four-drive decoder. You can buy Micro C's Plus-4 Decoder Board or you can buy a 7445 chip and a 16-pin socket and make your own.

Procedure

Unplug your computer from 120 VAC. Decide how you want to configure your drives. I made my Mitsi's A: and B:, and my remaining original Tandon C:. This gives me room for all of my most-used programs on A:, lots of data storage on B:, and C: for backup. With A: and B: the same type, I can use fast COPY programs. However, I can no longer use my original version of UNIFORM, which was written for a single-sided, 48 TPI drive in B:. (A number of folks used Kaypro 4 drives in A and B and quad density drives in C and D so they can continue to run everything.)

Remove the CPU board. (Pretty soon you'll be able to do this in your sleep.)

Remove the ribbon cable from the drives.

Unplug the power cable from the drives. On the Tandons, it'll be as tight as a barnacle on a rock. Grab the connector by its little ears and rock it downward.

Remove the socket-head screws. Pull the drives out the front.

On the bottom of the computer remove the four screws that secure the drive mounting bracket. Note that the bracket goes in only one way; keep this in mind when you measure and drill the new mounting holes. If there is a possibility of running four drives in the future, you may as well drill all the holes now. I had to notch my front diagonal brace to get one of the screws to fit.

See Figure 2 for mounting hole pattern. The Mitsi drives seem to be a hair wider than the Tandons. They wouldn't quite squeeze into the top of my mounting bracket, so I simply put the Tandon on top and the two Mitsi's on the bottom.

Be sure to remove all burrs and filings after drilling. (Disk drives are noisy enough as it is.)

Jumpers

Install the address jumpers in your drives according to the instructions that came with them. In your Tandon 100-1s, you have to cut out the jumpers you don't want. Locate the DIP (Dual In-line Package) with the jumpers, near the edge connector. Leave the first jumper (nearest the edge of the board) intact. The second jumper intact = A:; the third jumper intact = B:; etc. If you want your Tandon to be named C:, then you should have the first and fourth jumpers intact; no others. (You may have to bridge a previously cut jumper to set the address you want.)

Some manufacturers specify drive selection as DS0, DS1, DS2, DS3; this is equivalent to the Kaypro's A:, B:, C:, D:.

You have other jumper choices to make. The Mitsubishi drives, for example, have a head-loading solenoid. The heads load (contact the disk) only when the solenoid is energized. If you install a jumper in position HM (not HS), the heads will load whenever the motor runs, and unload when the motor stops. This is normal operation.

Terminators

The drive you decide to install at the bottom (farthest down the ribbon cable from the CPU board) must have terminators installed. No other drive should have them. Most new drives come with terminators installed—remove them from all but the last drive.

My Tandon terminators are contained in a single blue-colored DIP. The Mitsi's use a soldered-in DIP terminator, with 7 individual plug-in jumpers right next to it. To disconnect the terminators, simply remove the jumpers.

Data/Control

To install your newly purchased 34-pin connector onto the ribbon cable, pull off the back and then press the back and front together with the cable in between. You can take your ribbon cable into the shop and have them do it with their special crimping tool, or you can do it yourself with a small vise. Be sure to align the connector carefully with the wires in the cable. The hardest part is getting the connector separated. It takes two people—one to probe with a small, pointy tool in the latch holes, and another to cuss (or discuss).

Power

Note the double wires in the power connector for your uppermost existing drive. To daisy-chain power to your new drives, remove the last connector (with single wires), discard the pins, and install new pins with two wires crimped in each.

Be sure to get the right wires to the right pins. When you copy the existing wiring, note that the connector is keyed to mate only one way.

Daisy-chain the green ground wire in the same way. Cut off the last push-on connector and install a new one with two wires crimped in it.

Circuit Board Wiring

Side Select: Locate the pad labeled E40 (on the component side, it's at right of U73). Now flip the board over to the foil side.

Cut trace from U73-5 to ground bus. Add wire from U73-5 to solder pad E40 (Side Select). Add wire from U73-6 to J6-32.

NOTE: J6 pins are even-numbered from bottom to top on the inside column. (Labeling is on component side.) J6-32, therefore, is the second pin from the top, inside column.

See directions under Speed-Up for installing a 2732 Monitor ROM. If you haven't done it, do it now.

Now you need to add a four-drive decoder. If you've bought one from Micro C, follow the instructions and install it.

If you're rolling your own decoder, this is your big chance to make the drive select lamps behave the way they always should have.

Locate the blank DIP outline labeled U75, near J6. It's made to order for this application.

Use your solder sucker to clean out the 16 holes. Install a 16-pin socket, orienting the notch like all the other ICs. Solder pins 5, 6, 7, 9, 10, 11 and 16 to hold it in place. Wire it according to Figure 3 and the following table:

Wiring Table

Cut trace from U71-6 to J6-12 (Old Drive B Select)

Cut trace from U71-8 to J6-10 (Old Drive A Select)

Add wire from U71-6 to U75-14 (Drive Decode 0)

Add wire from U71-8 to U75-15 (Drive Decode 1)

Add wire from U81-2 to U75-13 (Motor On)

Add wire from U75-12 to U75-8 (Ground)

Add wire from U75-1 to J6-6 (Select D)

Add wire from U75-2 to J6-12 (Select B)

Add wire from U75-3 to J6-10 (Select A)

Add wire from U75-4 to J6-14 (Select C)

If you have already installed the Micro C decoder board, you can still make the drive select lamp modification. Simply remove the ground from pin 13 of the 7445 on the decoder board, and wire it instead to pin 16 of the ribbon cable connector. This will duplicate the circuit in Figure 3.

Plug the 7445 into U75. Replace U73 with the 74S04. Install your new Monitor ROM in U47, if you didn't do so already in the speed-up mod.

Put it all back together, and connect the power, ground and data cables to the drives. Don't forget the copper shield under the CPU board (copper side away from the board).

Read the instructions with your Pro-8 Monitor ROM for creating a 63K CP/M.

Plug it in, turn it on and stand back!

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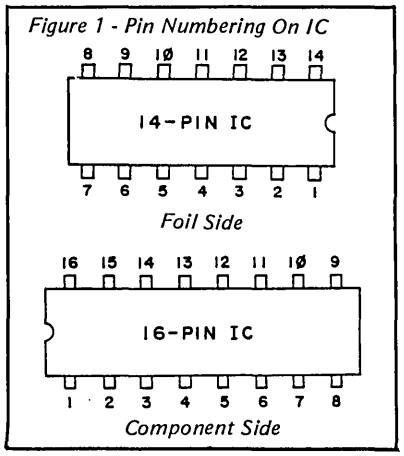

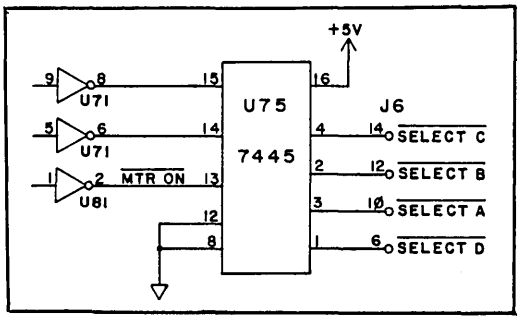

Figure 3 - Four-Drive Decoder With MOTOR ON Monitor

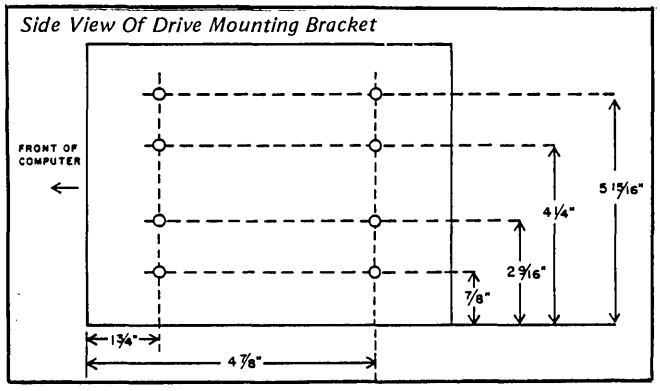

Figure 2 - Dimentions For Half-Height Drives