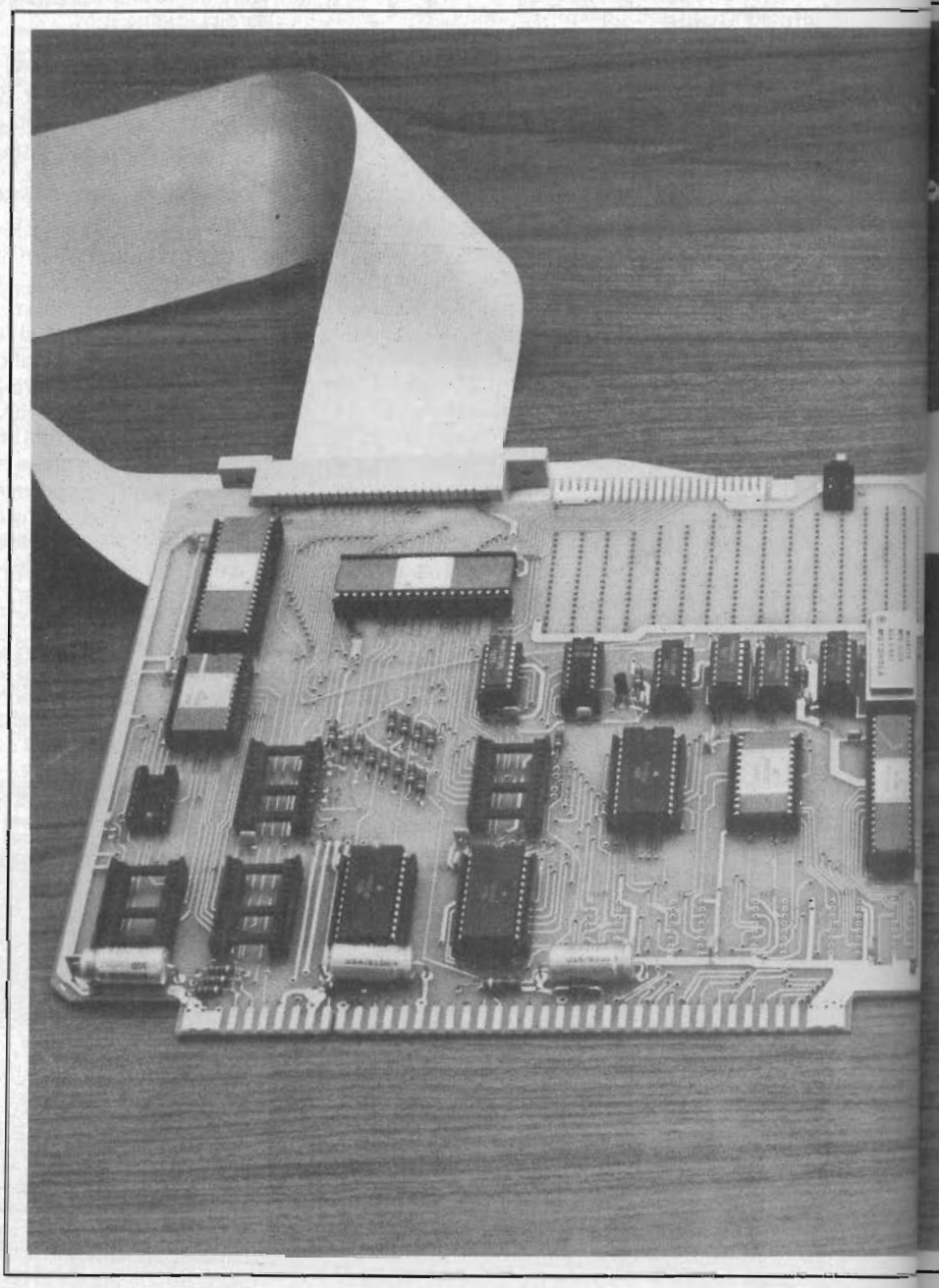
# Motorola's MEK 6800



by Stanley F. Lundgren

When I decided to become familiar with microprocessors, I wanted a system that would give me experience with both hardware and software. The Motorola MEK 6800 D2 evaluation kit is such a system.

My decision to purchase the kit was mainly economic. I did not make a study of the hardware, software or bus structures. I found that for less than $300 I could have a microprocessor-driven computer system.

My interest was a system with both machine le and high level language capabilities. This system m the requirement.

The kit is an excellent tool for those who wish develop systems with the 6800 microprocessor. All parts needed are supplied, except the power supp The kit is readily expandable into a more comp system by adding memory, firmware and peripheral

The kit is reasonable in price, selling in single qua ties for about $250. After a few hours of assembly and connecting a suitable 5v DC source, machine guage programs can be entered through the kit's he decimal keyboard or the built-in audio cassette interf

# D2 Evaluation Kit

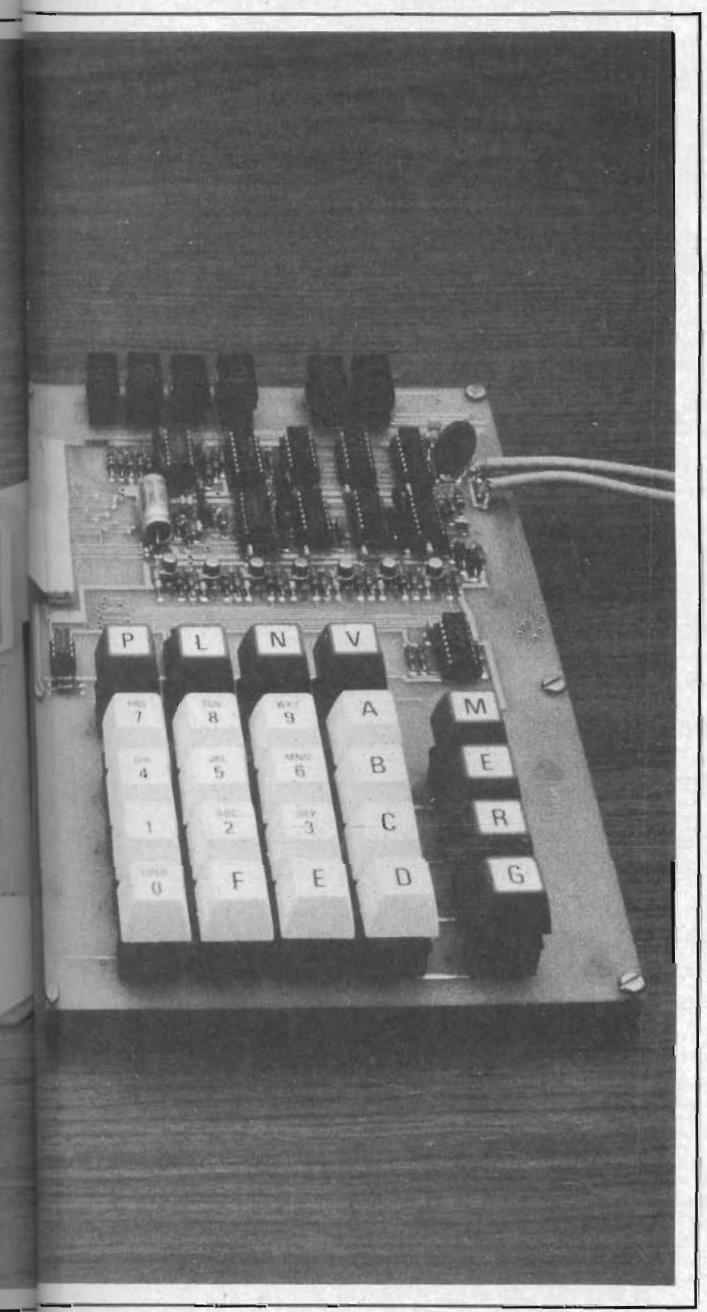



**Photo 1 Assembled Motorola MEK 6800 D2 Kit** *(Photo courtesy of Motorola)*

### Power Supply

This is the heart of the system. Also, in order to interface the D2 to peripherals, you must have an RS-232C interface. Therefore, any well-designed microprocessor power supply must provide the ± 12v DC required by the RS-232 interface. My present ± VDC requirements are:

| Description | I.C. No. | + 12v mA | – 12v mA |
|---|---|---|---|
| Data Out Interface | 1488 | 25 | 15 |
| Data In Interface | 1489 | | 26 |
| Onboard Eprom | 2708 | 100 | |
| Onboard Eprom | 2708 | 100 | |

Another device requiring the + 12v DC is the 2708 Eprom. In planning the power supply, allow at least an additional 200 mA for the two 2708s the D2 has provisions for.

In addition to the above requirements, there are heavy demands put on the power supply by the main memory. The standard semiconductor memory devices such as the 21L02 are rather power-hungry devices. A 21L02 can consume up to 35 mA. One 21L02 is equivalent to 128 bytes. Therefore, each 8K memory board should be allowed:

$$64 \times 35 \text{ mA} = 2.24 \text{ Amps}$$

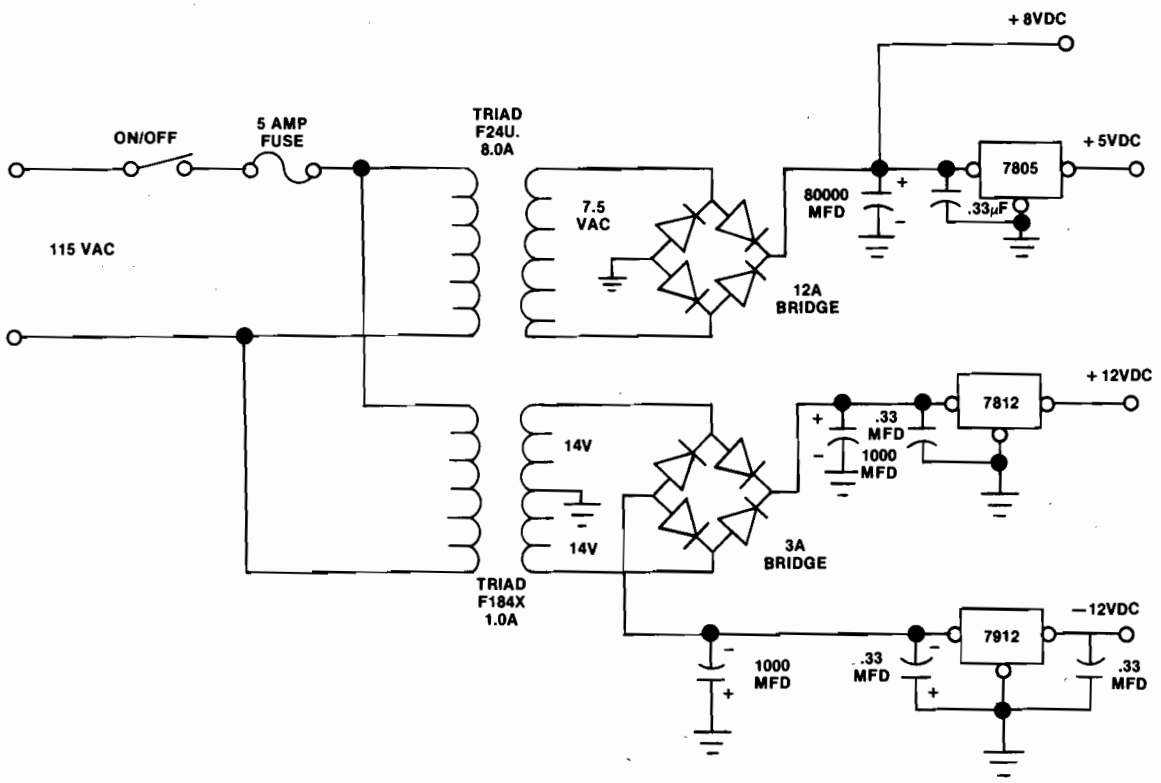



**Figure 1. Power Supply**

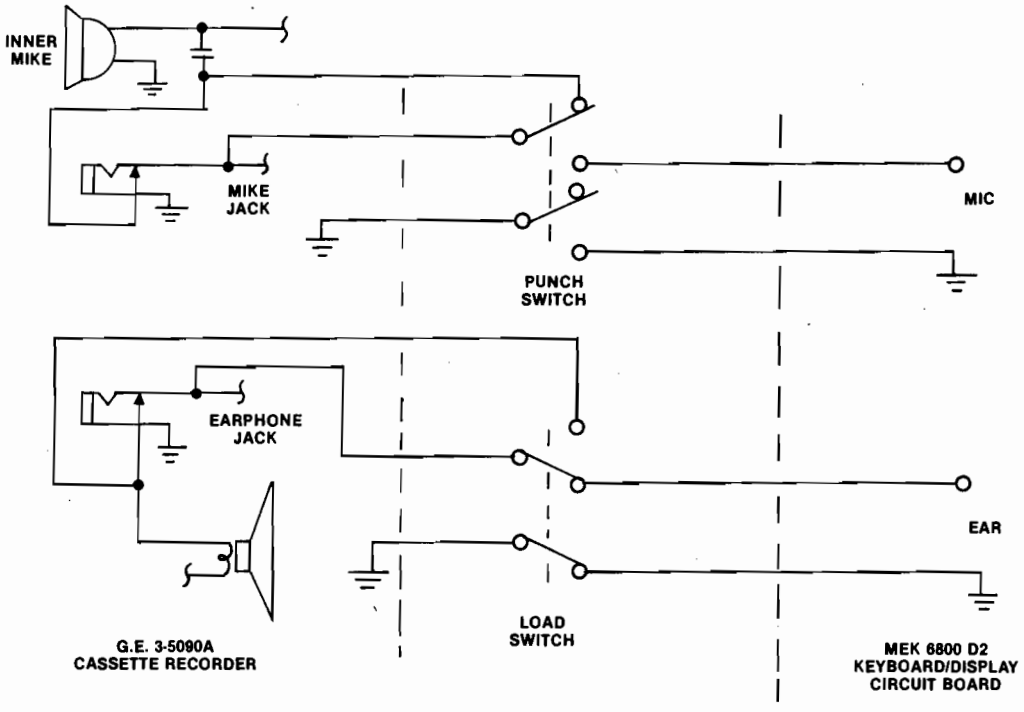
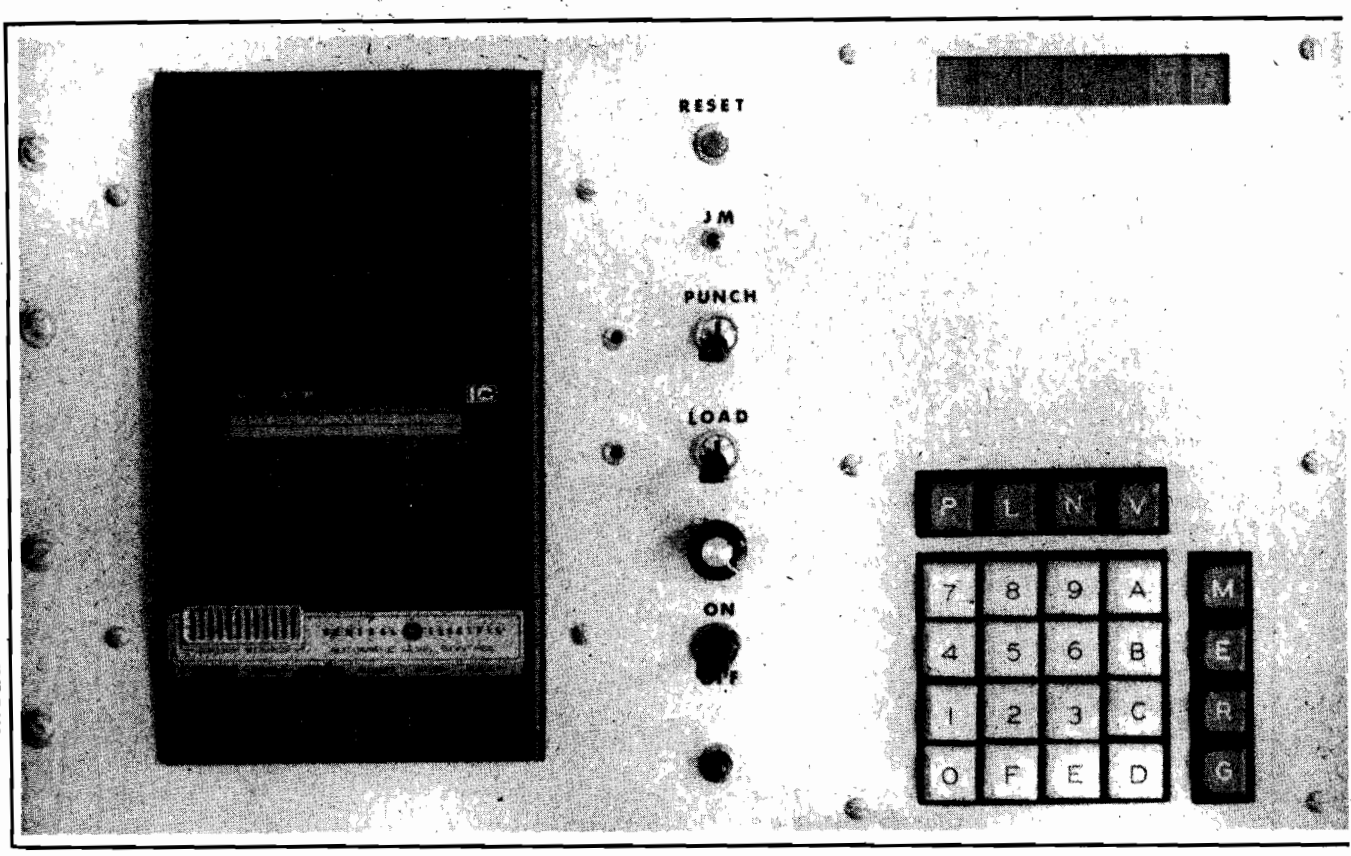



**Figure 2. Switches allowing permanent cassette recorder connections.**




module and cassette recorder mounted. (Photo by Don Cluck)

I would recommend the following minimum D2 power pply requirements:

| Description | Amps |
|---|---|
| 5v DC | |
| MEK 6800 D2 Kit | 1.5 |
| 24K bytes of memory | 6.6 |
| 12v DC | |
| RS-232C Interface | .03 |
| 2708 Eproms | .20 |
| 12v DC | |
| RS-232C Interface | .05 |

Physical distances between some components on e power supply are critical. This becomes increasing- important as more and more current is drawn. An sily overlooked area is the ground circuit. Do not let ur large filter capacitor negative connection get very from the supply ground. A few inches can be signifi- nt. If you have a problem here it will show up at the gulator outputs. The outputs will fall below 5 volts 0 times per second.

### se and Front Panel

These represent important considerations in building omputer system. The case must satisfy the housing quirement. The front panel must provide the inter- e between man and machine.

Motorola has done a nice job in providing a hexa- cimal keyboard for input as part of the D2 kit. The xadecimal keyboard provides a much faster means inputting data and system commands than stomary toggle switches.

mounted my keyboard and display circuit board on aluminum front panel (photo 2) available at most ge electronic supply stores. The size I used is 10½ 19 inches.

On the left side I cut an opening for my tape recorder. To cut the hole I used a metal cutting blade and my hand held jig saw. The tape recorder is a General Electric model 3-5090A, used because it was the only recorder that would fit within the 10½-inch front panel dimension.

To get around the problem of no counter I use a verbal heading at the start of each record and a one-minute interrecord gap between each record on the tape. The verbal headings I use consist of:

1. Title
2. Brief description
3. Memory address references
4. Date recorded
5. Special instructions

| Verbal Heading | Record No. 1 | 1-Minute Inter-record Gap | Verbal Heading | Record No. 2 |
|---|---|---|---|---|

In addition to the tape recorder, I added two switches for isolation (figure 2). These switches allow me to leave the (ear) and (mic) lines permanently connected to both the recorder and the D2. Three additional switches on the front panel are a reset pushbutton, an on/off power switch, and a monitor select switch.

I removed the reset pushbutton from the MPU board. I then mounted a heavy-duty pushbutton on the front panel. The on/off switch, a single pole double throw, controls the AC line to the power supply. The monitor select switch allows switching between the J-bug and Minibug II monitors. When making off-board connections, it is a good idea to use connectors. I used molex connectors which simplify future modifications and repairs.

### Expansion

Motorola D2 kit expansion involves an alternate monitor, a card rack and a terminal. This expansion will

**Table 1. Monitor Comparison**

| Monitor Function | J Bug | MiniBug II | MiniBug III | SmartBug | |
|---|---|---|---|---|---|
| **Approximate Cost** | **(In Kit)** | **$50.00** | **$75.00** | **$20.00** | **$39.95** |
| 1. Display Internal Registers | R | R | R | R | R |
| 2. Load RAM from Tape | L | L | L | L | L |
| 3. Punch RAM to Tape | P | P | P | P | P |
| 4. Memory Examine/Change | M | M | M | M | M |
| 5. Go to Entered Address and Execute | G | G | G | G | G |
| 6. Set Terminal Baud Rate | — | S | S | — | |
| 7. Test Memory | — | W | — | — | |
| 8. Binary Punch RAM to Tape | — | Y | — | — | D |
| 9. Binary Load RAM from Tape | — | Z | — | — | |
| 10. Abort Program Execution | E | — | — | — | |
| 11. Trace One Instruction | N | — | N | — | |
| 12. Set a Break Point | V | — | V | — | K |
| 13. Reset a Break Point | V | — | U | — | |
| 14. Continue Execute from Break Point | E,G | — | C | — | |
| 15. Delete All Break Points | V | — | D | — | |
| 16. Print Address of All Break Points | — | — | B | — | |
| 17. Trace N Instructions | — | — | T | — | T |
| 18. Turn Echo On | — | — | — | — | E |
| 19. Turn Echo Off | — | — | — | — | N |
| 20. Display Contents of 'A' Reg | — | — | — | — | A |
| 21. Display Contents of 'B' Reg | — | — | — | — | B |
| 22. Display Contents of Condition Code Register | — | — | — | — | C |
| 23. Jumps to BFD-68 Disk Operating System | — | — | — | — | D |
| 24. Sets Hardcopy Flag | — | — | — | — | H |
| 25. Insert a Byte into Range of Memory | — | — | — | — | I |
| 26. Jump to Program After 'J' | — | — | — | — | J |
| 27. Quick Start Boots in BFD-68 Operating Sys. | — | — | — | — | Q |
| 28. Displays Contents of Index Register | — | — | — | — | X |
| 29. Jumps to E 400 User Defined Monitor Commands | — | — | — | — | 4 |

convert the D2 kit into a computer system. As a guide for the system expansion, I followed Motorola's application note AN-771, *MEK 6800 D2 Microcomputer Kit System Expansion Techniques.*

This document is a must for all D2 users. It is an excellent approach to expanding the MEK 6800 D2 kit. The application note covers 8K and 16K memory interfacing. In addition to the memory interface, the paper covers a data terminal interface using a monitor that co-resides with the J-bug monitor supplied with the kit.

The J-bug monitor provides control over the hexadecimal keyboard, 7-segment displays, and the cassette interface. In order for the system to be connected to an Ascii terminal, an additional monitor is required. Monitor options are Mikbug, Minibug II, Minibug III and the Smartbug ROMs. I used the Minibug II monitor in my system.

At the time I decided to go with the Minibug II monitor, Smartbug did not exist. Secondly, I was under the impression an ACIA interface would improve the system's data transfer rate. Actually this has only a small influence on the transfer rate. This interface transfers data slightly faster from the data bus to the terminal. Data moving at 300 baud through an ACIA is moving at approximately the same speed as data moving at 300 baud through a PIA. With the ACIA there are slightly faster throughput times, but nothing that is very significant. The serial and parallel port routines to move one Ascii character are:

Minibug OUTCH = 30 clock cycles
Mikbug OUTEEE = 130 clock cycles

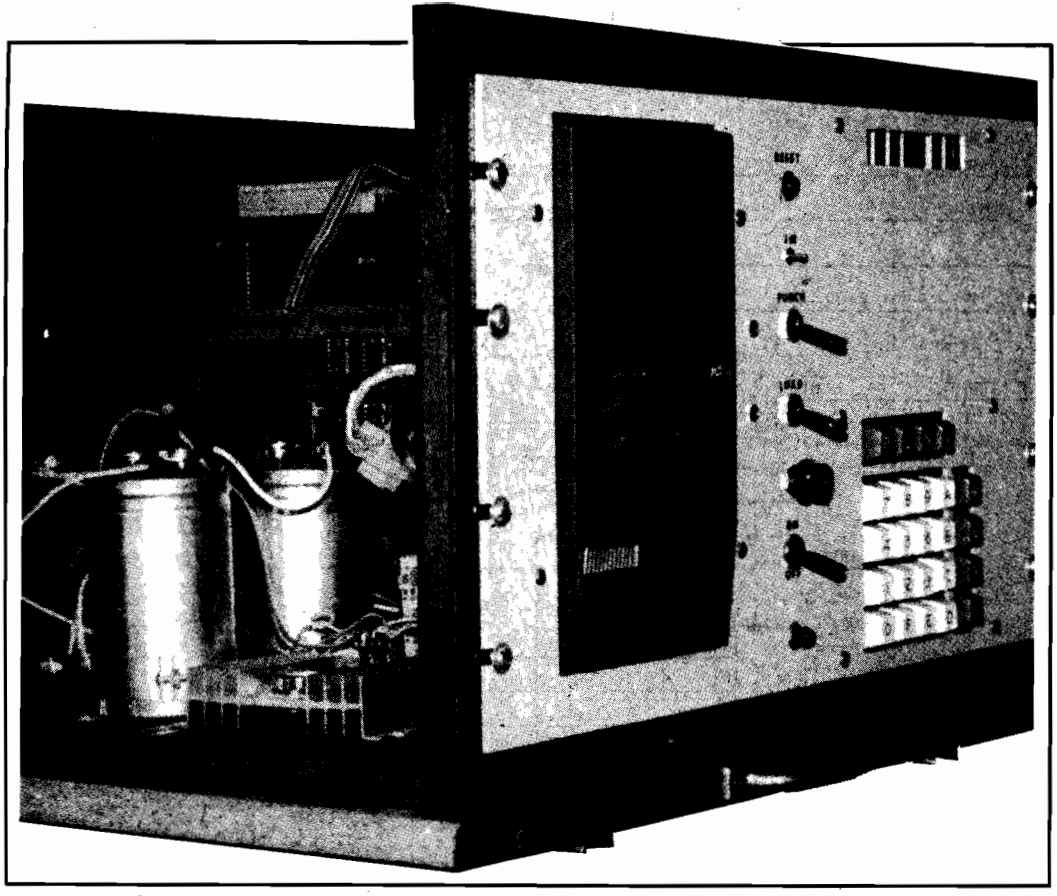
Based on a one megacycle clock, you would only a $1/10.000$ of a second per character transfer using a P and the Mikbug firmware.

Most of the 6800 software was written to use w the Mikbug monitor and a PIA interface. If one choos to go with any other monitor, all of this software has be modified, patched to make it work. Patching sour code listings is time consuming but not difficu However, trying to patch a Basic interpreter witho the source listing is a mind boggler.

I would suggest for anyone using a monitor other th Mikbug to get the disassembler up and running first.

**Table 2. Common MikBug and MiniBug II Patch**

| | MikBug | | MiniBug III | |
|---|---|---|---|---|
| **Description** | **Label** | **Address** | **Label** | **Addre** |
| Output 2 Hex Char | OUT2H | E0BF | OUT2H | E173 |
| Output 4 Hex Char | OUT4HS | E0C8 | OUT4HS | E17C |
| Output ASCII Char | OUTEEE | E1D1 | OUTCH | E108 |
| Input ASCII Char | INEEE | E1AC | INCH | E11F |
| Output ASCII String | PDATA1 | E07E | PDATA1 | E130 |
| Output Left Hex | OUTHL | E067 | OUTHL | E0FA |
| Output Right Hex | OUTHR | E06B | OUTHR | E0FE |
| Output Space | OUTS | E0CC | OUTS | E180 |
| Monitor Control | CONTROL | E0E3 | CONTRL | E040 |



(Photo by Don Cluck)

**Photo 3 Microprocessor system pulled out, illustrating advantage of rack mount.**

**rd Rack**

This is required to connect all the components of the stem. It provides the common tie to all of the system cir- it boards. There are no commercially available card cks that combine both the Exorcisor and S-100 bus. It is a distinct advantage to be able to use S-100 ards in your system. For example, you can purchase K static RAM memory boards for about $130, com- red to Motorola's 16K board for $395. The saving is vious, and for the cost of a couple of ICs you can nstruct an S-100 interface.

To construct my card rack I used wire wrap connec- rs and mounted them on 1/16-inch thick masonite. I am ing two Exorcisor connectors and three S-100 con- ctors. The two Exorcisor connectors are used for e MPU board and an expansion board. The three 100 connectors house three 8K memory boards.

I used small screws and solder lugs to provide for the wer connections, soldering the wire wrap wire from the s to the solder lugs. Then the power supply lines were nnected to the small screws using wire terminals. e peripheral ports use 25-pin RS-232 connectors d I mounted them on the expansion circuit board.

**e S-100 Interface**

There are two reasons why a hardware interface is quired between the two buses. First, there is a slight ference in the control signals. The Exorcisor bus ntrol signals are R/W, 02 and VMA, while the S-100 nals are MWRITE and SMEMR. Secondly, the S-100 s is uni-directional. Data flows only one direction on ch data line. This means there are two data lines for ch data bit. Of course, the Exorcisor is bi-directional d uses only one line for each data bit.

I constructed my interface (figures 3 and 4) from a concept provided by Jade Electronics. I made only one slight modification, adding a buffer to the VMA signal.

The S-100 bus requires an 8v DC unregulated supply to drive the on-board 5-volt regulators. Don't be too generous with this voltage. I have seen specifications ranging from 8-11v DC. At one time I tried to use 9 volts. This worked the 7805s too hard, forcing them to run hot. My present supply delivers just over 7½ volts. This keeps everything nice and cool.

**Terminal Selection**

I am using Southwest Technical Products' CTC-64. This system comes complete with a 9-inch Motorola monitor. The kit is easy to assemble and it comes with all the documentation necessary. An excellent feature of this kit is the provision for programming. Using appropriate jumpers during assembly you can control with software such features as paging, scrolling, control key assignments, cursor control, bell control and highlighting.

The highlighting function is desirable, but not that easy to use. Highlighting is when the character and background are reversed. SWTP uses the 7 bit to control the highlighting function. The CTC-64 by itself highlights fine.

However, when combined with the Minibug II monitor, the 7 bit is lost during the input algorithm. This is because this algorithm ANDs the incoming data byte with a 7F, dropping the seventh bit. It is still possible to generate highlighted characters. It requires you to generate your own special character set with the 7 bit high. □

**Figures 3 and 4 follow**

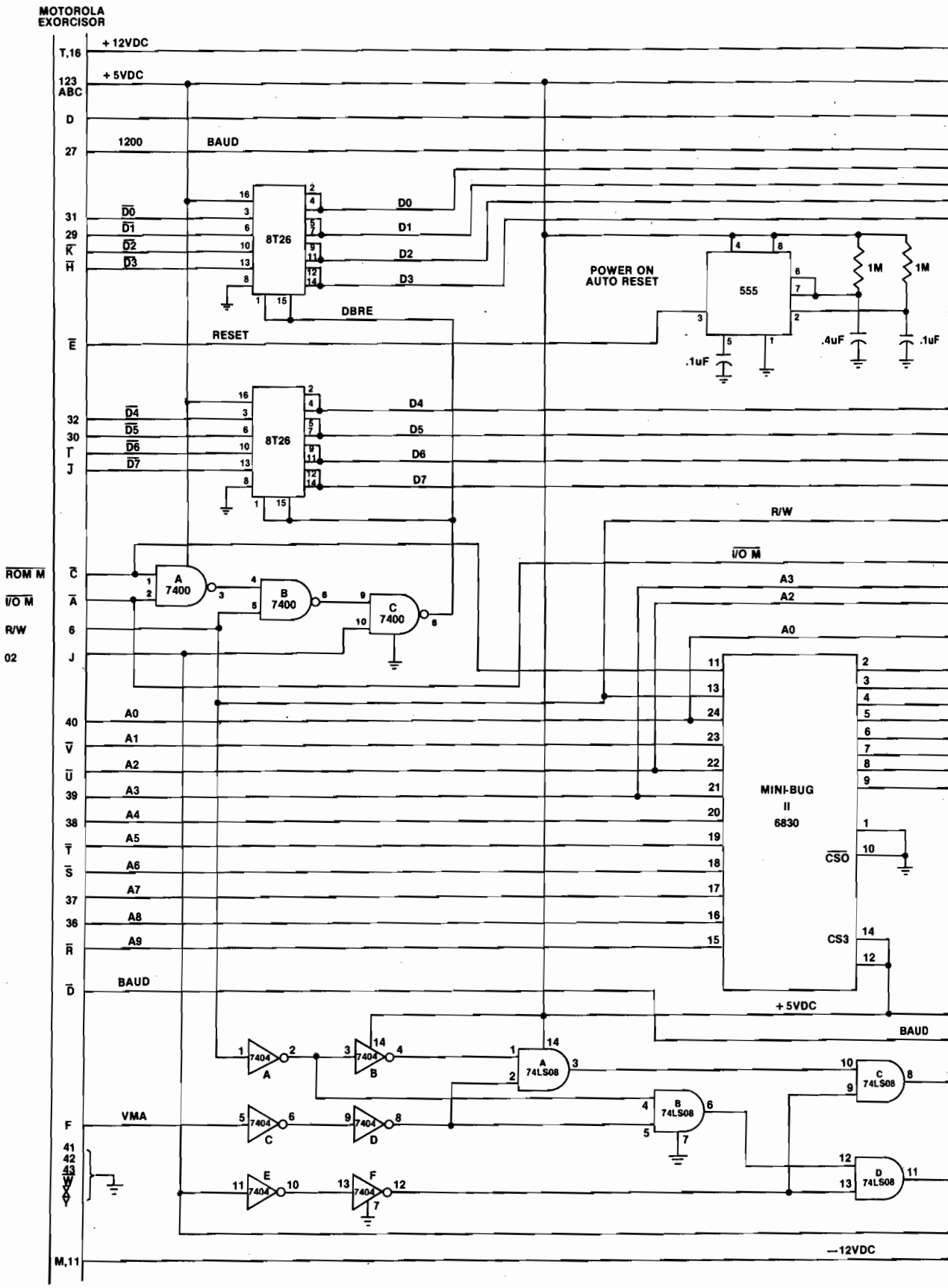
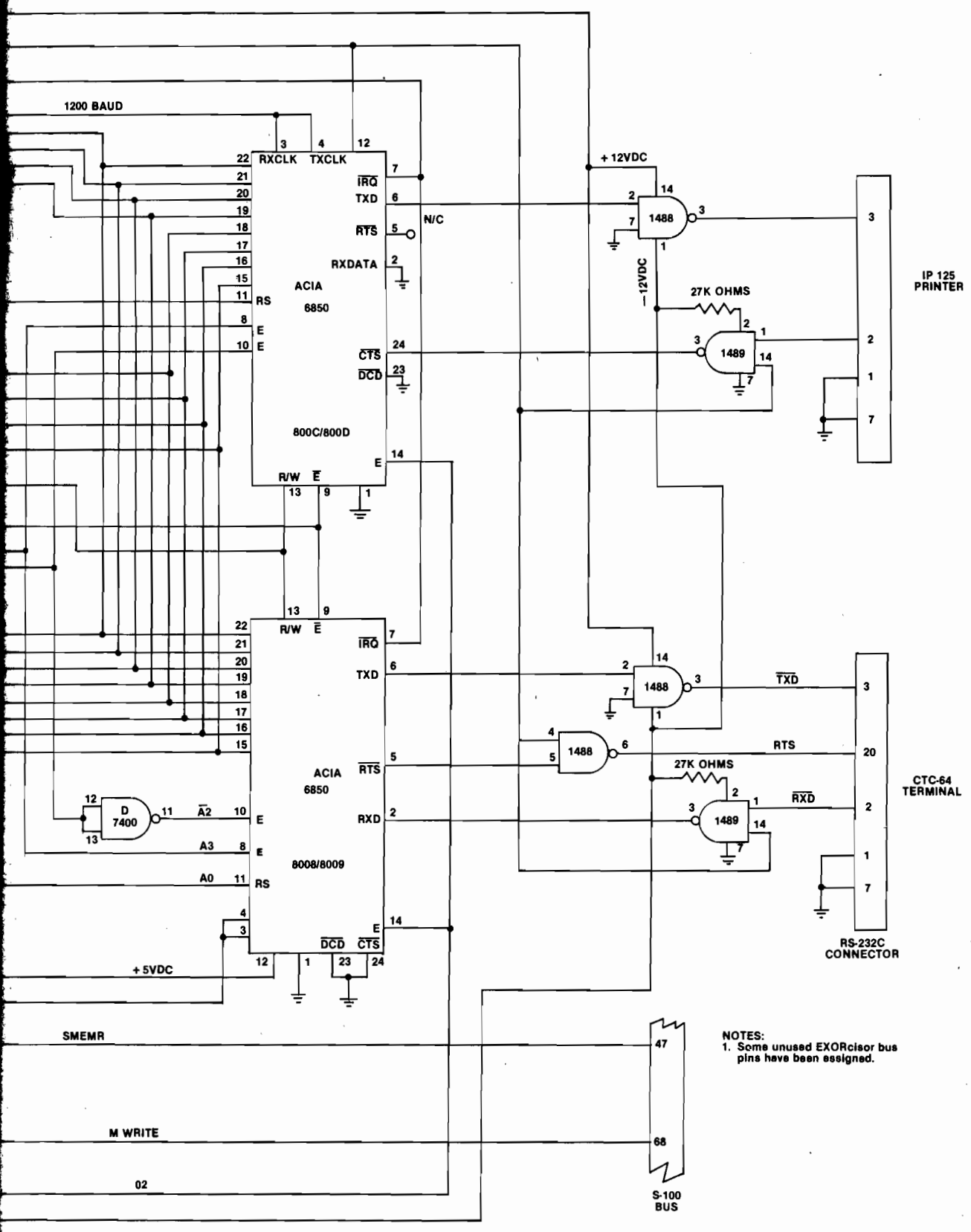
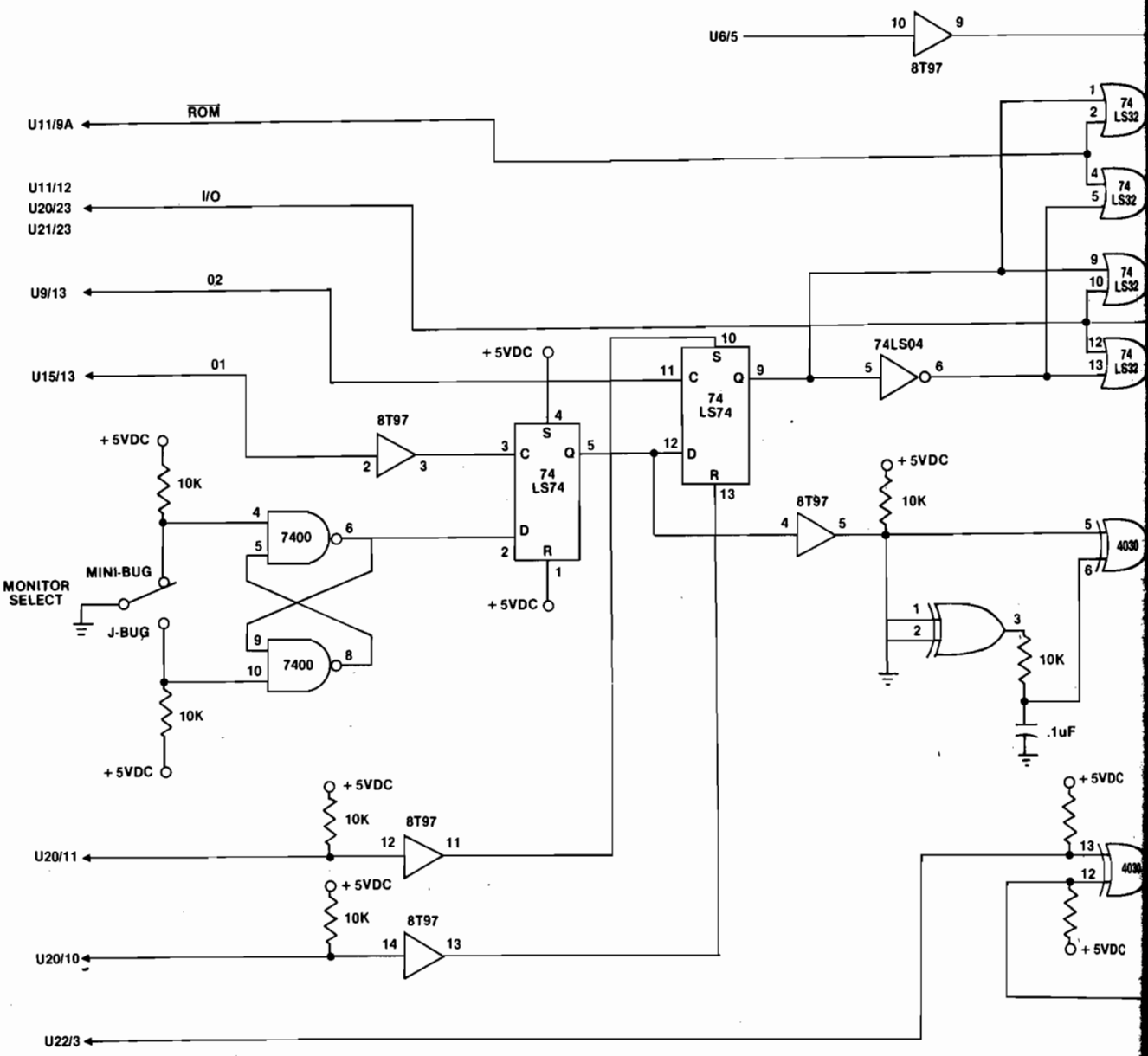



**Figure 3. Expansion Boa**




NOTES:
1. Some unused EXORcisor bus pins have been assigned.

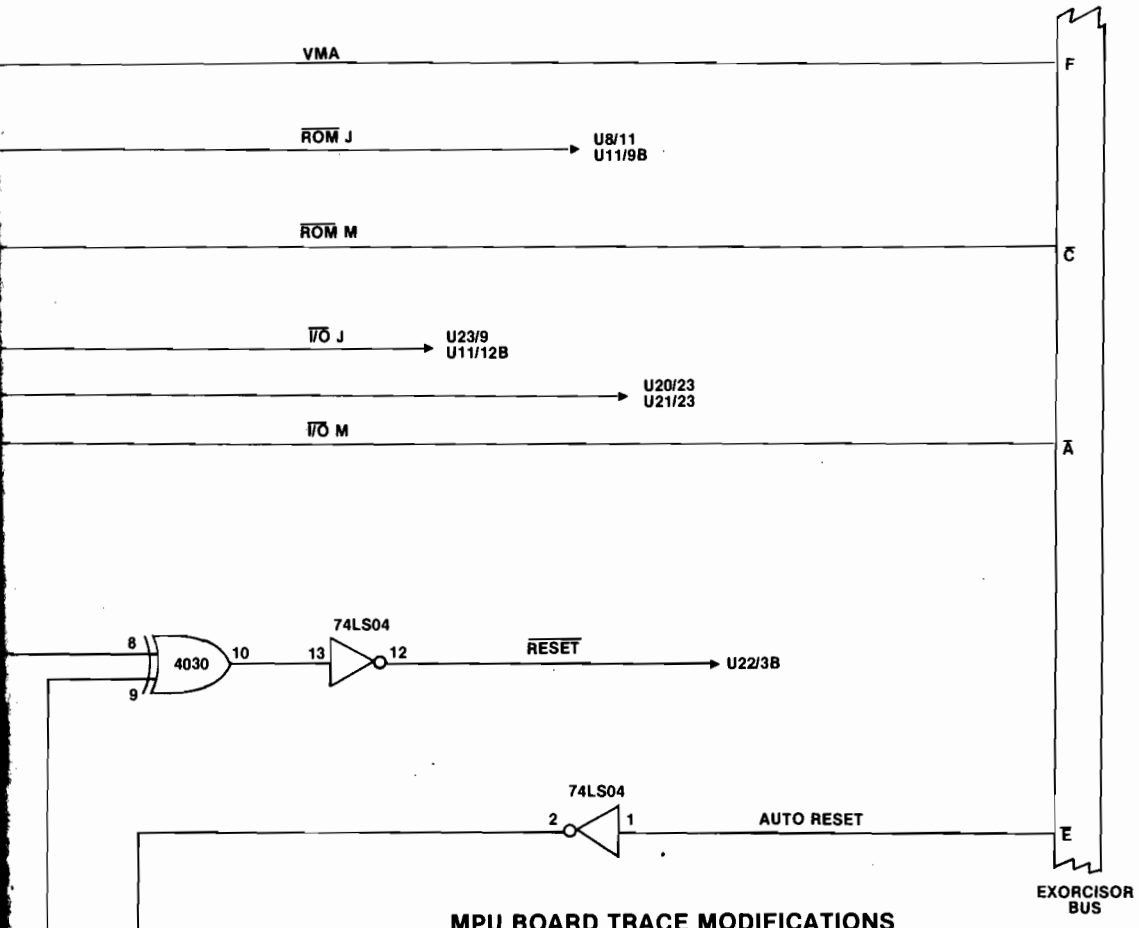
ripheral I/O and MINIBUG II).




**NOTES:**

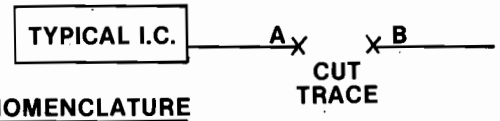
1. **Some unused EXORcisor pins are assigned.**
2. **Modifications are for a 24.5K system with the on board 512bytes at address $6000_{16}$.**
3. **See Motorola Application Note AN-771.**
4. **IC designations refer to D2 kit nomenclature.**

**Figure 4. Wire Wrap Area MPU Board**

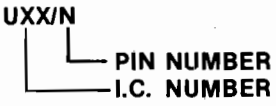



## MPU BOARD TRACE MODIFICATIONS

| CUT TRACE AT | COMMENTS | TERM |
|---|---|---|
| U11/9 | See Schematic | $\overline{ROM}$ |
| U11 12 | See Schematic | $\overline{I/O}$ |
| U22/3,4 | See Schematic | $\overline{RESET}$ |
| U20/23 | 'A' Side to U11/12 | I/O USER PIA |
| U21/23 | 'A' Side to U11/12 | I/O KEYBOARD PIA |
| U11/4 | 'A' SIDE N/C | $\overline{RAM}$ |
| U11 7 | 'A' SIDE TO U11 4B<br>'B' SIDE N/C | $\overline{PROM}$ 1 $6000_{16}$ |




## NOMENCLATURE




ual Monitor Switching Logic w/Auto Reset)