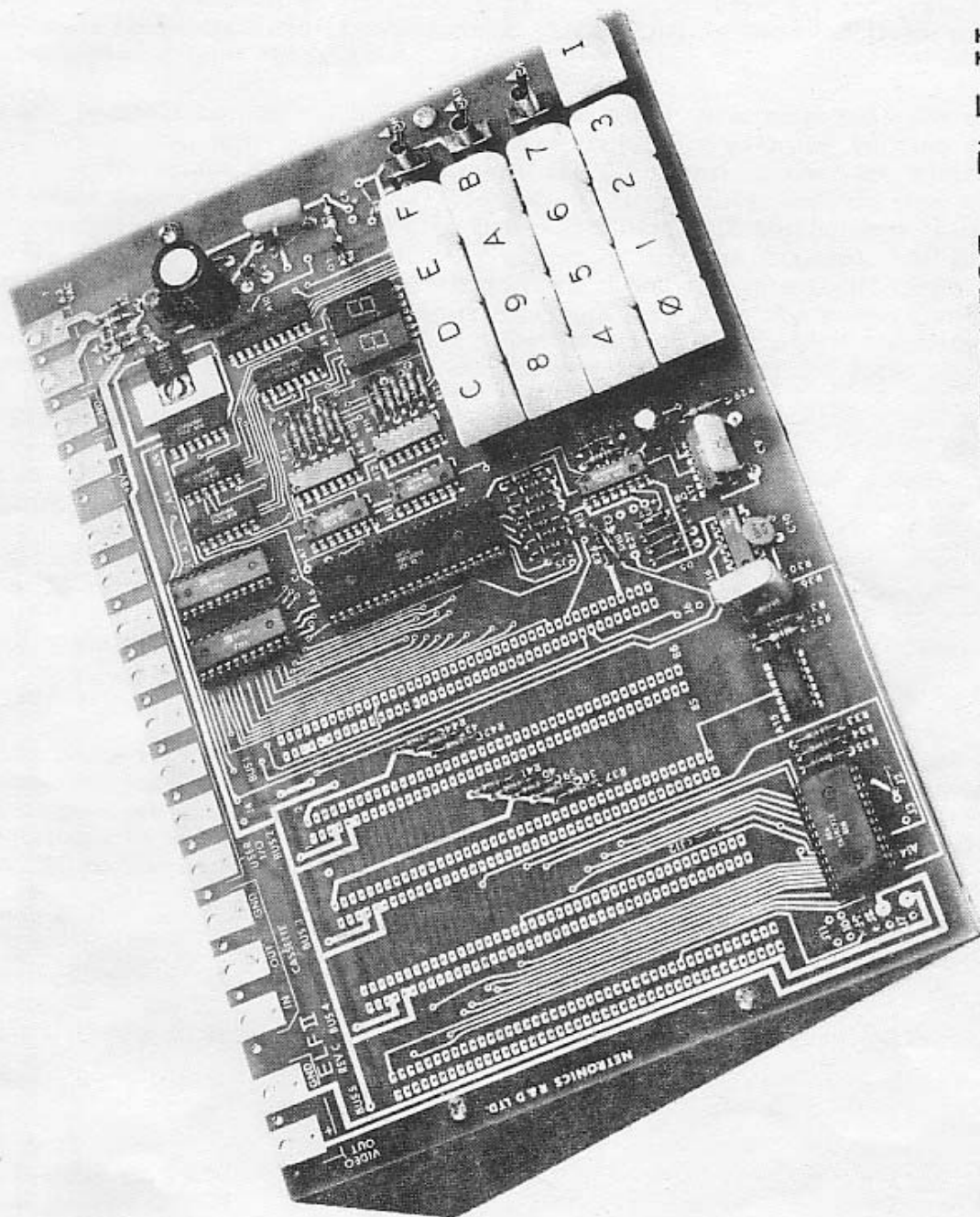


ASSEMBLY MANUAL



NETRONICS ELF II

REVISION C



NETRONICS RESEARCH AND DEVELOPMENT LIMITED
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W A R N I N G

Most of the integrated circuits supplied with this kit are of the MOS variety and are, therefore, subject to permanent damage when subjected to any static electricity charges. Static charges may be present on your body, work table, or clothing. Even the slightest static may destroy these parts. Do not unpack any of the integrated circuits until you are ready to use them. All MOS integrated circuits have been carefully tested at the factory prior to shipment. Any integrated circuits returned will be tested, and if evidence of mishandling is detected these parts cannot be replaced free of charge.

To prepare yourself to install MOS integrated circuits we suggest that the following steps be taken. (1) Wrap a piece of bare wire (bell wire with the varnish coating removed will do) around your wrist. Connect the other end of the wire to ground (a cold water pipe or radiator). (2) Use a sheet of aluminum foil on your work surface, approximately 12"x15" and ground the aluminum foil to the same cold water pipe. (3) Make sure that the tip of your soldering iron is grounded. If in doubt re-ground it. (4) Place the printed circuit board and the integrated circuits in their protective carrier on the aluminum foil work surface. The protective carrier is a conductive foam which electrically connects all of the pins of the integrated circuits together, thereby preventing any voltage drop between the pins.

TOOLS REQUIRED

Low power soldering iron no larger than 35 watts. Preferably lower power with a small pointy grounded tip.

60/40 solder. DO NOT USE additional flux or acid core solder. Use of acid core solder will automatically void all warranties.

Assorted small hand tools, screw driver, small cutter and needle nose pliers.

PARTS LIST

Check all parts received against the following parts list. This kit includes all parts required except solder and an AC power transformer. The 86 pin expansion bus connectors are available separately with the accessory boards and are shown in the picture to illustrate the ease of expanding memory, adding a cassette interface, ASCII keyboard or other I/O devices.

DESCRIPTION

QUANTITY

| | |
|--|---|
| 1802 Microprocessor IC A-6 | 1 |
| 1861 Video Graphics IC A-14 (may be marked TA10171) | 1 |
| 2101 256 4 Memory IC A-1, A-2 or 87556 (CMOS equiv.) | 2 |
| 4050 IC A-7, A-11 | 2 |
| 4016 IC A-3, A-4 | 2 |
| 4023 IC A-5 | 1 |
| 4049 IC A-13 | 1 |
| 74C922 IC A-10 or 74C923 | 1 |
| 74C173 IC A-9 or CD4076 | 1 |
| 74L00 IC A-15 | 1 |
| 7474 IC A-16 | 1 |
| 9368 IC A-8, A-12 | 2 |
| 4013 IC A-17 | 1 |

PARTS LIST

| <u>DESCRIPTION</u> | <u>QUANTITY</u> |
|---|-----------------|
| NSN373 Dual 7 Segment Display or (2) HP 5082-7740 Displays | 1 |
| 340T-5 5V Regulator (may be marked 7805) | 1 |
| IN4148 Diode D-5, 6, 7, 8, 9, 10 | 6 |
| Resistor 470 ohm $\frac{1}{4}$ watt 10% (yellow, violet, brown) | 2 |
| IN4001 Diode D-1, 2, 3, 4 (last digit may vary) | 4 |
| 5082 Red Light Emitting Diode | 1 |
| Resistor 1K $\frac{1}{4}$ watt 10% (brown, black, red) | 1 |
| Resistor 120 ohm $\frac{1}{4}$ watt 10% (brown, red, brown) | 14 |
| Resistor 200 ohm $\frac{1}{4}$ watt 10% (red, black, brown) | 1 |
| Resistor 47,000 ohm $\frac{1}{4}$ watt 10% (yellow, violet, orange) | 9 |
| Resistor 10,000 ohm $\frac{1}{4}$ watt 10% (brown, black, orange) | 3 |
| Resistor 2.2K $\frac{1}{4}$ watt 10% (red, red, red) | 2 |
| Resistor 22 K $\frac{1}{4}$ watt 10% (red, red, orange) | 8 |
| Capacitor Disc, 330pf (may be marked 331) | 1 |
| Capacitor Electrolytic 1000uf | 1 |
| Capacitor Electrolytic 10uf | 1 |
| Capacitor Electrolytic 22uf | 1 |
| Capacitor Tantalum 1.0uf | 1 |
| Capacitor Mylar .15uf | 2 |
| Switch Momentary | 17 |
| Switch Toggle | 3 |
| Switch Caps (\emptyset 1 2 3 4 5 6 7 8 9 A B C D E F I) | 1 ea. |
| Printed Circuit Board | 1 |
| Crystal 3.579545 MHz | 1 |
| IC Socket 40 pin | 1 |
| IC Socket 22 pin | 2 |
| IC Socket 24 pin | 1 |
| Heatsink Aluminum 1"x1" | 1 |
| Wood Side Rails | 2 |
| Screw 6/32 x 3/8 | 7 |
| Nut 6/32 x $\frac{1}{4}$ " AF | 7 |
| Screw #6 Type A x 3/8 | 4 |
| Specification Sheet 1802 | 1 |
| Instruction Book | 1 |

PRINTED CIRCUIT BOARD ASSEMBLY

The P.C. board supplied is the highest grade, double sided with plated thru holes, available. Extreme care should be taken when soldering to avoid excessive heat which will damage components as well as the printed circuit board. Note that there is foil pattern on both sides. All components are inserted from the side with the component designation lettering and the lettering "ELF II" on the upper left hand corner, and are soldered on the other side. All instructions which include a direction, i.e. right, top, bottom, presume that the board is held with the component side facing you and the lettering ELF II are in the upper left hand corner of the board.

Referring to figure detailing component location install components as follows. Check box on the left when completing each step. (Trim excess lead length before soldering).

- (✓) 1. Install R-4 thru R-17, 120 ohm (brown, red, brown). SOLDER. Do not discard excess lead lengths.
- (~) 2. Install the dual display NSN373. Note the letter "1" printed on the foil side of the display P.C. board next to #1 pin. This pin must be positioned as per Figure 1. If your kit is supplied with HP displays, simply plug them into the board. Note that the decimal points face toward the key board. When soldering the display, apply heat for a maximum of two seconds to avoid damaging the display.
- (✓) 3. Install diodes D-1 thru D-4 IN4001. Note: Band on the diode must face the direction of the arrow symbol on the P.C. board. SOLDER.
- (✓) 4. Install diodes D-5 thru D-10 IN4148. Note: Band on the diode faces the direction of the arrow symbol on the P.C. board. SOLDER.
- () 5. Install the 340T 5V regulator (may be labeled 7805). The aluminum heatsink is placed directly on the P.C. board. Secure the regulator to the heatsink and P.C. board using 6-32 screw and nut. Make sure that the heatsink does not touch any adjacent foil pattern. SOLDER.
- (✓) 6. Install resistors R-2,32 470 ohm (yellow, violet, brown). SOLDER.
- (✓) 7. Install resistor R-28 200 ohm (red, black, brown). SOLDER.
- (✓) 8. Install resistors R-19 thru 26,29 47,000 ohm (yellow, violet, orange). SOLDER.
- (✓) 9. Install resistors R-30,34,36 10,000 ohm (brown, black, orange). SOLDER.
- (✓) 10. Install resistor R-33 1000 ohm (brown, black, red). SOLDER.
- (✓) 11. Install resistor R-31,35 2200 ohm (red, red, red). SOLDER.
- (✓) 12. Install resistors R-37-44 22,000 ohm (red, red, orange). SOLDER.
- (✓) 13. Install C-1 10uf capacitor. Note polarity. SOLDER.
- (✓) 14. Install C-2 1000uf capacitor. Note polarity. SOLDER.
- (✓) 15. Install C-3 1.0uf capacitor. Note polarity. SOLDER.
- (✓) 16. Install C-4,9 .15uf capacitor. SOLDER.
- (✓) 17. Install C-8 22uf capacitor. Note polarity. SOLDER.
- (✓) 18. Install C-10 330pf capacitor (may be marked 331). SOLDER.
- (✓) 19. Install Q-1 red light emitting diode. Note the long lead (+) goes into the hole next to symbol Q-1 on the P.C. board. SOLDER.
- (✓) 20. Install 40 pin socket in location A-6. SOLDER.
- () 21. Install 22 pin socket in location A-1,2. SOLDER.
- (✓) 22. Install 24 pin socket in location A-14. SOLDER.
- (✓) 23. Install 3579.545 crystal. SOLDER.

- (✓) 22. Install key pad switches. Note that 17 switches are the momentary type. Install these in spaces Ø thru F and I. Make sure that the switch is flush on the P.C. board before soldering to insure that the key buttons will be in a straight line after soldering. SOLDER.
 - (✓) 23. Install the 3 toggle type switches as shown. Note precautions above. SOLDER.
 - (✓) 24. The 17 momentary switches require key buttons. Install the key buttons Ø thru F and I, as shown.
 - (✓) 25. Install jumpers J-1,2,5,8,9,12. SOLDER from top of board and trim excess on bottom.
 - (✓) 25a. Install an insulated wire jumper in holes designated for R-1. SOLDER.
- STOP. Recheck all steps. Do not install IC's until the following preliminary test is made.
- (✓) 26. Connect 6.3 -8V AC power source to terminals, as shown, and apply power. Measure voltage at + terminal of C-1 and ground. It should measure $5 \pm 10\%$. If 5V reading is not obtained do not proceed. Check and correct before proceeding. The LED Q-1 and the display should not light at this time.
 - (✓) 27. Remove AC power and discharge C-1 and C-2.
 - (✓) 28. Install IC's 8,12,15,16. SOLDER. (Do not overheat). Note position of #1 pin, a dot, half-moon cutout, or 1 designation on the IC must agree.
 - (✓) 29. The remaining IC's are MOS types and must be handled using precaution outlined on page 1. Make sure that the bench, soldering iron tip and you are grounded.
 - (✓) 30. Install IC A-3,4,5,7,9,10,11,13,17. Note position of #1 pin as in Step 28. SOLDER. (Do not overheat).
 - (✓) 31. Install IC A-1,2,6, and 14 into their sockets. Take care to observe the #1 pin, as above, and that all leads are securely seated into socket.
 - (✓) 32. Recheck all your work. Check for solder bridges between adjacent foil patterns.
 - () 33. Mount the P.C. board onto the two walnut finished side rails. Note left and right side. Make a starter hole with a nail or awl and secure with 4 #6 type A pointy tip screws.
 - () 34. Place the self-stick rubber bumper foot on the bottom edge of the underside of the P.C. board, under capacitor C-9. This is used to prevent the P.C. board from bending when depressing the input switches.
 - () 35. Reconnect the AC power source.
 - () 36. A resistor (not supplied) may be substituted for the jumper if a supply other than the recommended AC source is used. Adjust the value of R-1 for a maximum of 8.5V DC at C-2. See Step 37.

- () 37. Measure voltage at C-2. If higher than 8.5V DC remove jumper and add resistor (not supplied).
- () 38. The toggle switches should be arranged as follows: Run off, Load (L) off. Memory Protect off. Now set (Load) L switch on
- () 39. Depress the "8" button twice.
- () 40. Depress and release the Input (I) button. The display should indicate the letters 8 8.
- () 41. Repeat Steps 39 and 40 for all input switches 0 thru F in order. The corresponding display outputs should be 00 thru FF. Note that B and D will produce lower case b and d on the display.
- () 42. Now set the Memory Protect M/P switch on. Place Load (L) switch off and then reset to on. This will protect the memory and restart the micro-processor at memory location (0000).
- () 43. Now depress and release the Input (I) button. 88 should appear on the display. Repeated actuation of the (I) button should produce 00,11,22,33, etc. to FF indicating that the memory has recorded the keys depressed during Steps 38 and 41.

If any of the above tests do not function locate difficulty before proceeding. Two additional tests are included, the first will check the Q-1 LED lamp and the second will test the video output circuit.

INTRODUCTION TO PROGRAMMING

Once you have built your ELF II, you must learn how to load a sequence of bytes into memory and then go back and display the sequence. Let us write a simple program that can be loaded into the memory and run.

Suppose you want to program the computer to turn on the Q LED whenever the Input switch is set to on. First, you must draw a flow chart that shows the required sequence of steps (Fig. A). Locate the correct instructions in the Instruction Subset Table (blue card). A 7A instruction will perform Step 1. Load this instruction into M(0000). Note that when the Input switch is not depressed, EF4=1. A two byte 3F00 instruction will jump (branch) back to the 7A instruction at M(0000) as long as the Input switch is not operated (EF4=1). This condition is known as a loop, and the program will stay in this loop while it is waiting for the Input switch to be depressed. Load 3F 00 into memory locations M(0001) and M(0002) to perform the second step in the flow chart. All GO TO MM instructions shown in the Table put MM into the lower order byte of the program counter if a GO TO condition exists. Otherwise, the next instruction in sequence is fetched by the 1802.

Loading a one-byte 7B instruction into M(0003) takes care of Step 3, while a 30 01 instruction will jump back to the 3F 00 instruction at M(0001). Load the 30 01 instruction into M(0004) and M(0005) to complete the program.

You load this 6-byte program by placing the Load switch on the on position, with Run and MP set to off. Input the hex number 7A and depress the Input switch. Release the Input switch, insert 3F and operate the Input switch again. Then load 00 and so on until the last byte, 01, has been stored at M(0005). If you blow the program, set MP to on and Load to off. Then set Load to on and operate the Input switch until you get to the byte immediately preceding the wrong entry. Set MP to off, set up the correct byte, and operate Input. Flip MP back to on to protect what you have stored in memory.

To start the program running, set Load switch to the off position and set the Run switch to on. Nothing should happen until you depress the Input switch, at which time the Q LED should come on. Releasing the Input switch should cause the LED to extinguish. If you like, you can now observe the timing signals of the 1802 on an oscilloscope while the program is running. (Refer to 1802 specification sheet).

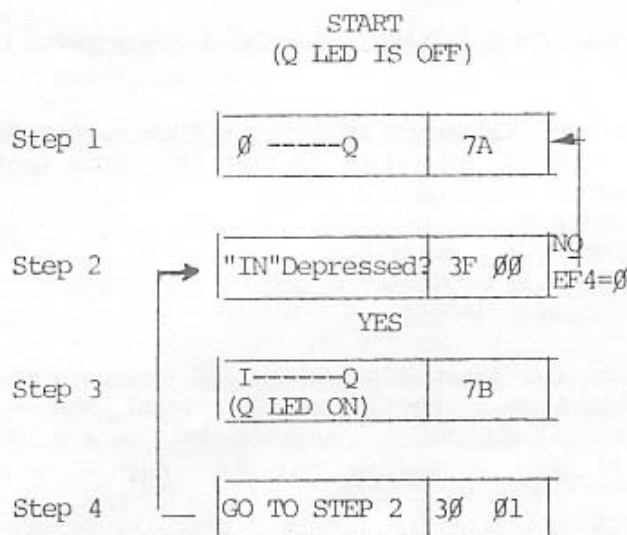


Fig. A. Program turns on Q-LED when Input switch is operated.

GRAPHICS TEST PROGRAM

To use the graphics we must connect the composite video output to a television monitor or receiver. If a monitor is being used simply plug the video output directly into the monitor input terminals. If a television set is to be used, it must be modified to the extent of adding an external video input jack or a separate modulator must be purchased (usual cost between \$8-\$15), which would allow direct connection to a standard television receiver antenna terminals. The unique Pixie Graphic system employs the (DMA) capability built into the 1802 Microprocessor to work in conjunction with the graphics IC. This allows you to display any 256 byte segment of memory on a CRT screen. The following program will set the system up to display the contents of the remaining 256 bytes on the television screen. If this program is entered into the computer and run the first eight lines will represent the memory through 003A. The remaining lines will represent the random memory contents for the balance of the 256 byte memory. Zeros in memory represent a dark square on the screen where a 1 represents a white square. Entering the following space ship program from memory 0040 to memory 00FF will cause a display representing the space ship Enterprise and the words Cosmac Elf on your screen. A quick test of all of the memory would be to load zeros from memory 0040 to memory 00FF which should give a dark screen below the first eight rows. Subsequently, entering 1's into memory location 0040 to memory 00FF should produce a total white area beneath the first eight rows.

Figure B shows the memory addresses of bytes mapped into a television screen in sample program.

GRAPHICS TEST PROGRAM

| LABEL | M | BYTES | COMMENTS |
|-----------|------|--------|------------------------------|
| Start | 0000 | 90B1B2 | R1.1,R2.1=00 |
| | 0003 | B3B4 | R3.0,R4.0=00 |
| | 0005 | F82DA3 | R3.0=(main) |
| | 0008 | F83FA2 | R2.0=(stack) |
| | 000B | F811A1 | R1.0=(interrupt) |
| | 000E | D3 | P=3(go to main) |
| Return | 000F | 72 | restore D,R2+1 |
| | 0010 | 70 | restore XP,R2+1 |
| Interrupt | 0011 | 2278 | R2-1,save XP @ M2 |
| | 0013 | 2252 | R2-1, save D @ M2 |
| | 0015 | C4C4C4 | no-op (9 cycles) |
| | 0018 | F800B0 | |
| Refresh | 001B | F800A0 | R0=0000 (refresh ptr) |
| | 001E | 80E2 | D=R0.0 |
| | ---- | ---- | 8 DMA cycles (R0+8) |
| | 0020 | E220A0 | R0-1,R0.0=D |
| | ---- | ---- | 8 DMA cycles (R0+8) |
| | 0023 | E220A0 | R0-1,R0.0=D |
| | ---- | ---- | 8 DMA cycles (R0+8) |
| | 0026 | E220A0 | R0-1,R0.0=D |
| | ---- | ---- | 8 DMA cycles (R0+8) |
| | 0029 | 3C1E | go to refresh (EF1=0) |
| Main | 002B | 300F | go to return (EF1=1) |
| | 002D | E269 | X=2, turn TV on |
| | 002F | 3F2F | wait for IN pressed |
| | 0031 | 6CA4 | set MX,D,R4.0=input switches |
| | 0033 | 3733 | wait for IN released |
| | 0035 | 3F35 | wait for IN pressed |
| | 0037 | 6C | set MX, D=input switches |
| | 0038 | 5414 | set M4=D,R4+1 |
| | 003A | 3033 | go to M33 |
| | 003C | 0000 | |
| | 003E | 0000 | |

| | | | | | | | |
|------|------|------|------|------|------|------|------|
| 0000 | 0001 | 0002 | 0003 | 0004 | 0005 | 0006 | 0007 |
| 0008 | 0009 | 000A | | | | 000E | 000F |
| 0010 | 0011 | 0012 | | | | 0016 | 0017 |
| | | | | | | | |
| 00F0 | 00F1 | 00F2 | | | | 00F6 | 00F7 |
| 00F8 | 00F9 | 00FA | 00FB | 00FC | 00FD | 00FE | 00FF |

FIGURE B Memory addresses of bytes mapped onto TV screen in sample program.

Load in the Spaceship Program after loading the Graphics Test Program.

SPACESHIP PROGRAM

| M | BYTE SEQUENCE | | | | | | | |
|------|---------------|----|----|----|----|----|----|----|
| 0040 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 0048 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 0050 | 7B | DE | DB | DE | 00 | 00 | 00 | 00 |
| 0058 | 4A | 50 | DA | 52 | 00 | 00 | 00 | 00 |
| 0060 | 42 | 5E | AB | D0 | 00 | 00 | 00 | 00 |
| 0068 | 4A | 42 | 8A | 52 | 00 | 00 | 00 | 00 |
| 0070 | 7B | DE | 8A | 5E | 00 | 00 | 00 | 00 |
| 0078 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 0080 | 00 | 00 | 00 | 00 | 00 | 00 | 07 | E0 |
| 0088 | 00 | 00 | 00 | 00 | FF | FF | FF | FF |
| 0090 | 00 | 06 | 00 | 01 | 00 | 00 | 00 | 01 |
| 0098 | 00 | 7F | E0 | 01 | 00 | 00 | 00 | 02 |
| 00A0 | 7F | C0 | 3F | E0 | FC | FF | FF | FE |
| 00A8 | 40 | 0F | 00 | 10 | 04 | 80 | 00 | 00 |
| 00B0 | 7F | C0 | 3F | E0 | 04 | 80 | 00 | 00 |
| 00B8 | 00 | 3F | D0 | 40 | 04 | 80 | 00 | 00 |
| 00C0 | 00 | 0F | 08 | 20 | 04 | 80 | 7A | 1E |
| 00C8 | 00 | 00 | 07 | 90 | 04 | 80 | 42 | 10 |
| 00D0 | 00 | 00 | 18 | 7F | FC | F0 | 72 | 1C |
| 00D8 | 00 | 00 | 30 | 00 | 00 | 10 | 42 | 10 |
| 00E0 | 00 | 00 | 73 | FC | 00 | 10 | 7B | D0 |
| 00E8 | 00 | 00 | 30 | 00 | 3F | F0 | 00 | 00 |
| 00F0 | 00 | 00 | 18 | 0F | C0 | 00 | 00 | 00 |
| 00F8 | 00 | 00 | 07 | F0 | 00 | 00 | 00 | 00 |

WARRANTY

All of the components supplied in this kit are under warranty for six months from date of purchase. Any parts suspected to be defective should be returned to Netronics with \$1.00 for postage and handling. They will be tested and returned postpaid.

IN CASE OF DIFFICULTY

In the event of difficulty check all wiring against the instructions. Check for solder bridges and all component values. If you still cannot determine the problem, return the defective printed circuit board ONLY. Please enclose a check or money order for \$12.00 and pack the board securely, and insure the parcel. Your unit will be tested and returned insured and postpaid.

If you suspect a defective component, return the component with \$1.00 to cover postage and handling and we will test and return the component prepaid and insured. Mailing address: NETRONICS RESEARCH & DEVELOPMENT LIMITED, 333 Litchfield Road, Route 202, New Milford, Connecticut 06776, Attention: Service Department.

A NOTE ON PROGRAMMING

The Elf II Kit can be programmed to operate as a micro or mini computer or as a infinite number of variable circuit configurations, i.e. counter, alarm system, lock, controller, thermostat, timer, telephone dialer, etc. There is no limit in design application because the microprocessor can control, compute, compare and look like almost any circuit configuration on a clock by clock pulse basis. All we have to do is learn to program it. Programming the microprocessor for either computer use or to design circuits will require a working understanding of the microprocessor and general programming techniques. This kit includes all the hardware to get "Hands On" experience. We recommend to the beginner that he purchase the RCA Users Manual for the 1802 microprocessor. It will explain the architecture and notations, instruction format, timing, utilization, programming techniques, interfacing and and system operations, application and sample programs, etc. The cost is \$5.00. If programming is really new to you we would also recommend An Introduction to Microcomputers, Volume I Basic Concepts by Adam Osborne. A few hundred pages of easy to understand information ranging from the history of microcomputers, Binary Arithmetic, logic, and most importantly details on programming which will be useful in understanding all microprocessors. The cost is \$7.50. If you are really into the Binary Arithmetic, RCA also offers a manual on Binary Sub-Routines for the Cosmac Microprocessor. The cost is \$5.00. Netronics has recently introduced a short course on programming the 1802. It is written in simple, easy to understand language, and explains each of the 1802 instructions with an example of what actually happens with each of them. It is loaded with examples and ideal for "Hands On" experience for the novice. The cost is \$5.00.

We encourage all Elf users to share their programs with us. If you have found an exciting use for the Elf, we would be happy to know about it and would forward the information to our other users.

The Elf can easily be expanded into a full blown computer. We suggest, however, that you first learn the machine language programming techniques, and then add all of the options as you begin to understand your needs and how this system will fulfill them. Happy Computing!

ORDER FORM

PLEASE SEND:

| | | | | |
|--|------|--------|-------|-----|
| _____ RCA 1802 Users Manual | | \$5.00 | +.50 | P&H |
| _____ RCA Binary Sub-Routines for 1802 Microprocessor | | 5.00 | +.50 | P&H |
| _____ Introduction to Microcomputers/Osborne Vol. I | | 7.50 | +.50 | P&H |
| _____ Short Course In Programming the 1802/With examples on each instruction | | 5.00 | +.50 | P&H |
| _____ Wall Mounted AC Power Transformer/Suitable for powering the Basic Elf II | | | | |
| _____ plus Giant (cassette I/O board) | | 4.95 | +.85 | P&H |
| _____ Prototyping (Kluge) Board/Provisions for 36 IC's plus regulator | | 17.00 | +1.00 | P&H |
| _____ Giant Board™ including cassette I/O Prom with system editor monitor | | | | |
| _____ 8 bit P I/O, TTY/RS232-C interface, 2n line decoders for 14 separate I/O lines | Kit | 39.95 | +2.00 | P&H |
| _____ 4K low power static RAM memory board | Kit | 89.95 | +3.00 | P&H |
| _____ 5 Amp +8V accessory power supply | Kit | 34.95 | +2.00 | P&H |
| _____ RF modulator used to connect your Elf II directly to TV antenna terminals | Kit | 8.95 | | PP |
| _____ 86 pin gold plated expansion card connectors | each | 5.70 | | PP |

Connecticut residents add 7% tax

NAME _____

Total Enclosed _____

ADDRESS _____

ZIP CODE _____

NETRONICS RESEARCH & DEVELOPMENT LIMITED, 333 Litchfield Road, New Milford, CT 06776