

Four Letter Word Step-Wise Easy Assembly Manual

If you have limited experience with constructing electronic kits and building things with electronic parts, this manual is for you. It will assist you by guiding you through the steps with ample diagrams to help reduce confusion to manageable levels. Writing a manual like this is difficult because “beginner” can mean many different things. The most basic place to start is to assume that the person has difficulty identifying the components and has only a little experience in soldering.

Identification is fairly easy to overcome with illustrations and explanations, but soldering experience is more difficult to teach with words on paper because it involves hands-on techniques, knowing how much heat is required to make solder flow properly, and how much heat or solder is too much, to the point of potentially damaging the circuit board or component being soldered.

Due to this consideration, we advise a total beginner, who has no experience with soldering, to take a community college or vocational class in soldering, or seek a friend who can give firsthand advice and observe the results. If you are confident that your soldering skills are good, then we encourage you to proceed and gain the experience and satisfaction of building something that you can proudly say that you made with your own hands. And what better object to make than this totally unique nixie four-letter word generator!

This manual is divided into sequences, each with a complete drawing highlighting the parts to be added in a number of described steps, and showing those parts already added in earlier steps being dimmed out (in gray), so that the degree of completeness of the assembly each step of the way is clearly visible.

The parts for the kit are supplied in small plastic bags, each with a list of the parts in that bag. The first step in identifying the parts is to remove the contents of each bag and sort the parts out into groups of similar items, such as those resistors which have the same color code bands. The totals of these groups should agree with the list for each bag. This is often enough to properly identify each part. Many parts, such as resistors and capacitors, can be placed on a metal tray with a bit of masking tape

to hold their leads in place, or even inserted into the styrofoam that is part of the packing material. Integrated circuits and transistors should be placed into styrofoam with some aluminum foil taped to the surface to protect against static electricity that may damage them. The parts that are most vulnerable to such damage are already packaged in the kit inserted into aluminum foil.

If you have original, vintage sockets for your nixie tubes, you should clean all original wires off with a soldering iron and remove excess solder. A solder vacuum pump, or “solder sucker” is useful for this, or rap the socket onto a table while the solder is still molten. The wires may be difficult to remove, but as you see from looking at the printed circuit for this kit, there are two small holes and one larger hole for each pin of the nixie tube. The small pair of holes are intended to be used with the vintage sockets, so the tips of each socket solder “tag” must be clipped off to leave two tangs or prongs. These have to be slightly bent outward to meet the holes in the board.

Individual socket pins can also be used (as shown in the parts list in the full User Manual). We recommend the Mill-Max ones, available from Mouser Electronics or Digi-Key. These can only fit into the larger holes for each pin. The individual socket pins are best mounted first, before anything else, but vintage sockets can be left off until a much later step. If you use the socket pins, review the notes in the User Manual about reverse nixie tube mounting and notice that there are two parts lists, one for CUTU (components up, tubes up) and another for CDTU (components down, tubes up). The difference between these two options affect some parts (look ahead to Sequence H. in this manual).

NOTE: This revision is specific to Revision B Printed Circuit Boards that began shipping in May 2004. It can not be used with Revision A boards that were supplied with kits prior to May 2004. Look carefully at the markings on the PCB.

RESISTOR COLOR CODE: Resistors are traditionally marked with color code bands. These are read starting on the end where the bands are closest to the wire. There are three colors and then a fourth one, which is always gold. The gold band signifies that the value of the part is within a tolerance band of plus or minus 5%. Going back to the outside band, and reading in sequence, the first two colors represent the digits, and the third band represents the number of zeros added, using the same number as the color represents for the digits. We'll call these bands a, b, c and d in the following table, instead of 1, 2, 3 and 4.



color bands:

color of band	digit band a & b	zeros added band c	shortcut for band c (used in specifying the value)
black	0	none	abohms
brown	1	0	ab0 ohms
red	2	00	ab00 ohms or a.b k
orange	3	000	ab k ohms or k (kilo)
yellow	4	0000	ab0 k
green	5	00000	a.b Megohm or a.bM (mega)
blue	6	000000	ab Megohm or M
violet	7	(rarely used)	
gray	8	(rarely used)	
white	9	(rarely used)	
silver	(not used)	divide by 10	a.b ohms
gold	(not used)	divide by 100	0.ab ohms

To use the table, the colors for bands a and b are read first. For example orange and orange mean 33, and if the band c color is also orange it indicates to add three zeros, to make it 33000 ohms, which is usually written as "33 k ohms" or simply "33 k". Band c is often referred to as the multiplier, since it multiplies (or divides) the first two digits by some power of ten.

A few more examples:

red-violet-red, means 2700 ohms or 2.7 k.

orange-white-brown, means 390 ohms.

green-blue-yellow, means 560000, which is 560 k.

brown-green-green, means 1500000, which is 1.5 M.

red-red-blue, means 22000000, or 22 M (22 million)

orange-orange-gold, means 33/100 or 0.33 ohms (one in the kit)

DIODES. Diodes are cylindrical, like resistors, but have a single band, black or white (depending on the body color) to mark the cathode. In all cases the markings on the circuit board will also have this band to show the correct orientation.

CAPACITORS. Large aluminum-case electrolytic capacitors, such as C40, C42, C43, etc. also have a correct polarity that must be observed. The negative side is identified by a clear band along the side with a minus sign. The positive wire is longer and the circuit board shows this with a plus sign and a circle around the hole. Be sure that these are correct. They can explode like small firecrackers if they are reversed.

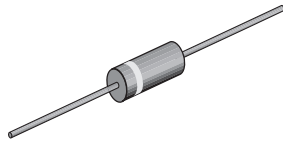
TRANSISTORS. The transistors all look the same (with the exception of the power FET, Q27). Some are marked MPSA92 and others are MPSA42. They must not be mixed up. The flat on one side corresponds to a similar marking on the board.

INTEGRATED CIRCUITS (CHIPS). The IC chips are all of the same form, with pin one marked by a dot and/or the gap between pin one and the highest pin number marked with a semicircular notch on one end. The dot and notch are clearly marked on the board and on the drawings.

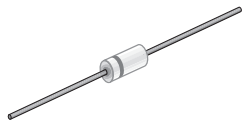
Caution, not all if the IC chips are facing the same way on the board. Please pay close attention to the orientation as shown in this document and on the printed circuit board.

Some of the ICs may be used with sockets, while others may not use sockets at all. This is explained clearly in the sequences and parts lists.

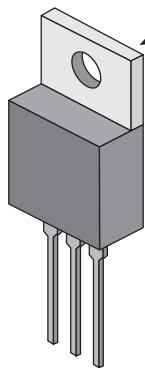
Physical identification of selected parts



Diode, plastic body
• D5, D6, D7, D8 marked 1N4002
1N4003, 1N4004 or 1N4005
• D1 marked MUR1100E or UF1005



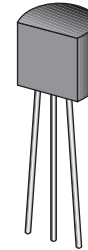
Diode, glass body
• D90-D99 marked 1N4148



Metal Tab for heat dissipation (not bolted to any heat sink because it only gets warm, not hot enough to require additional cooling)

Integrated Circuit (IC) Voltage Regulator
• U1, marked 7805 (other letters may precede or follow the 7805)

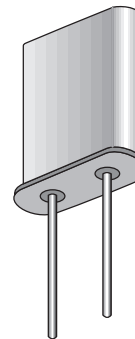
Transistor, Power FET or MOSFET
• Q27, marked IRF730, or IRF830 or IRF840



Transistor
• Q15, Q16, Q17, Q18, Q19, Q20
and optional Q94 marked
MPS A42 or KSP42

• Q21, Q22, Q23, Q24, Q25 marked
MPS A92 or KSP92

Be careful not to mix them, resulting
in the wrong parts installed.



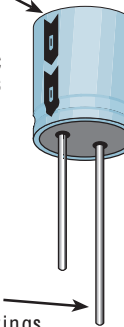
Crystal
• Y81, marked 4.000



Inductor (coil)
• L71. This is heavier and somewhat
thinner around the middle. There
are no polarity markings and only
a number printed on top (224 or 104).

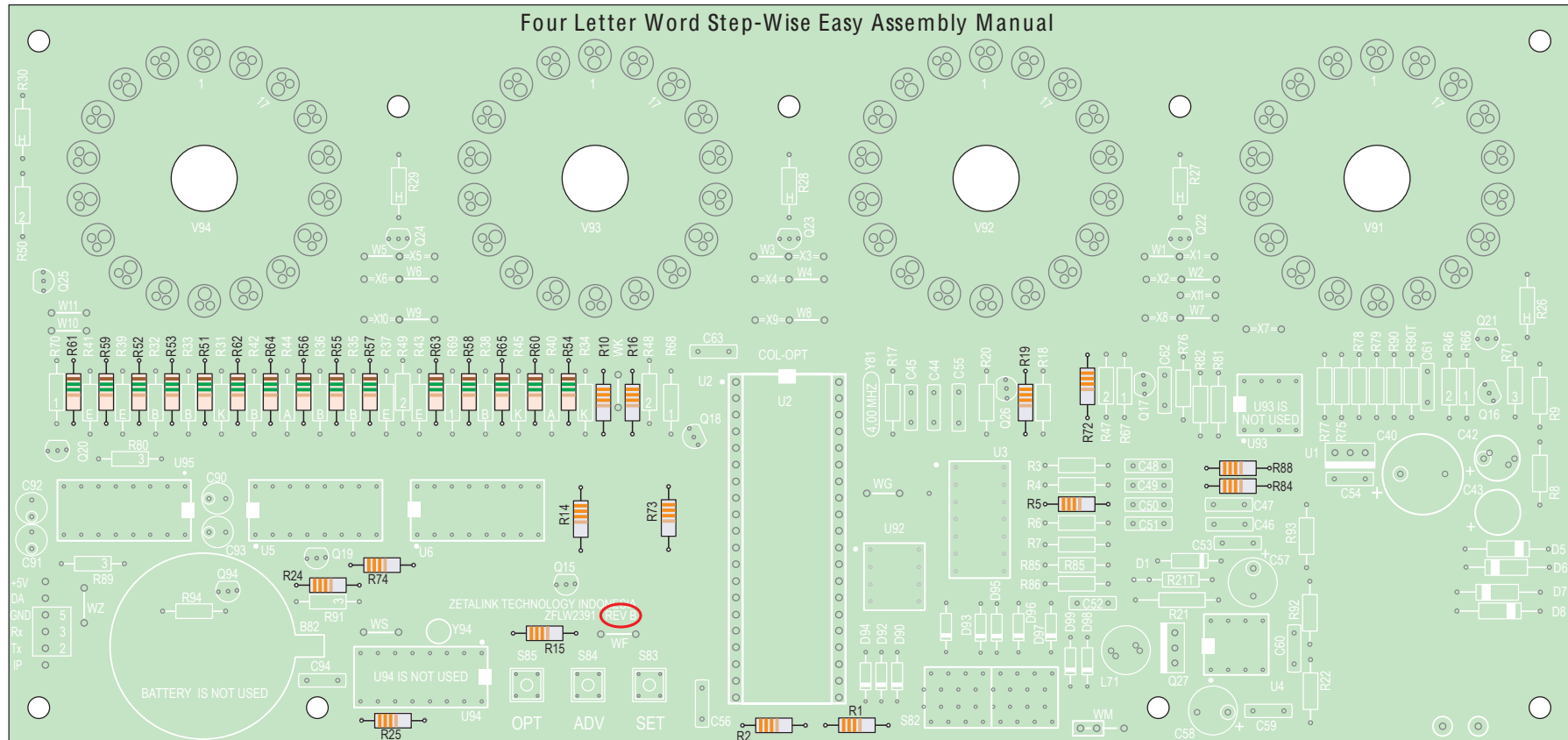
Negative polarity marked on side

Capacitor, aluminum electrolytic
• C40, C42, C43, C57, C58 (different sizes
and values, similar form)



Positive lead wire is longer,
goes into hole marked with
a white circle or with + sign.
Note the polarity on all drawings.

A



A

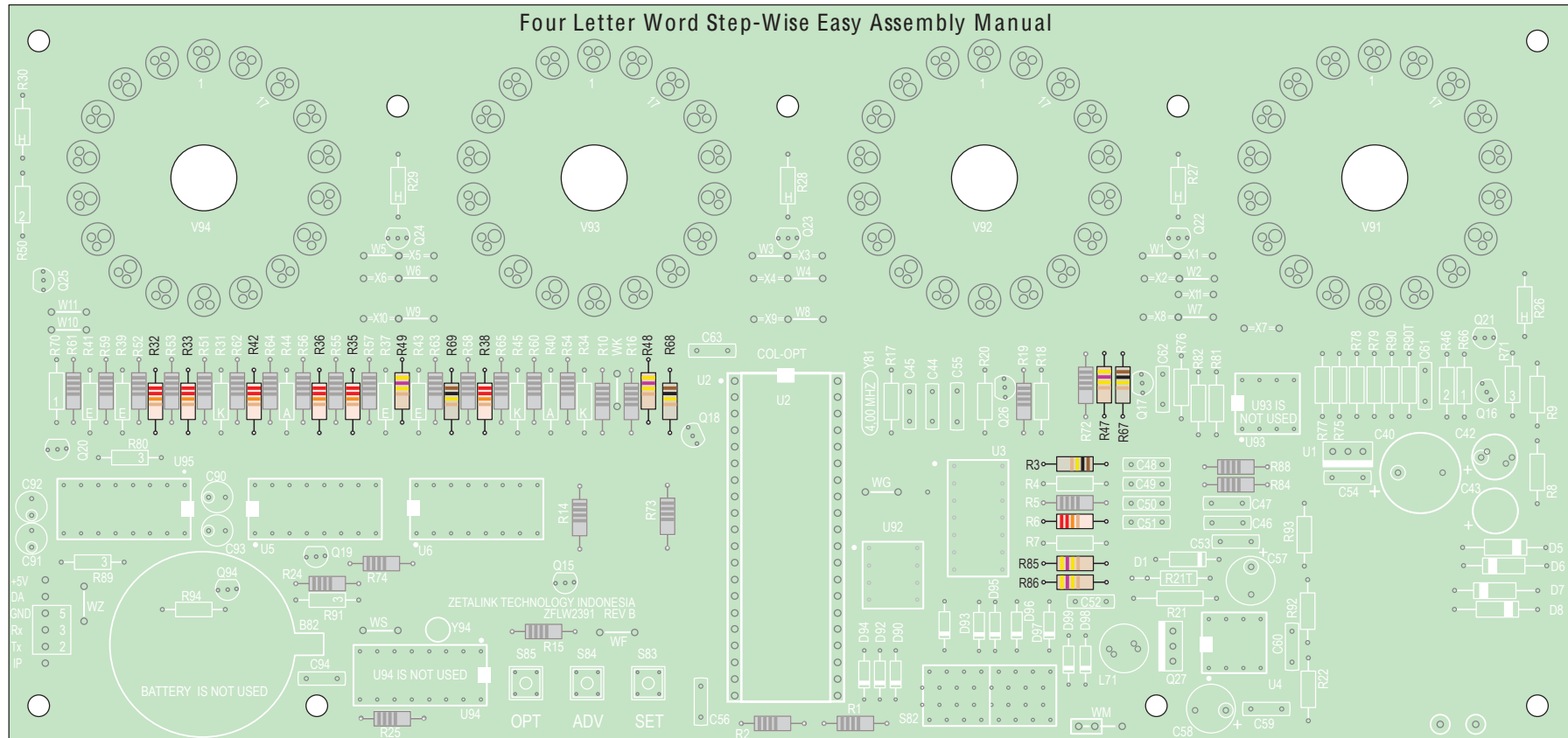
Sequence A — install 30 resistors.

Step A1. Locate the 15 resistors with the value 1.5 Megohms (brown-green-green-gold). Install as shown in the long row. All of them have a “9” marked inside their rectangle. The 1.5M resistors are R61, R59, R52, R53, R51, R62, R64, R56, R55, R57, R63, R58, R65, R60 and R54.

Step A2. Locate 15 of the 16 resistors supplied with the value 33k ohms (orange-orange-orange-gold). Install as shown. Most have a “3” marked inside their rectangle. The extra 33k resistor will be installed later, and its placement depends on CUTU or CDTU mounting. The 33k resistors are R24, R74, R14, R25, R15, R10, R16, R73, R1, R2, R5, R19, R72, R84 and R88.

Step A3. Double check the parts placement, and make any corrections required. Then hold the parts in place with foam or masking tape (lightly applied), reverse the board and solder these parts. Clip the excess wire, saving the scraps for use as jumper wires later on.

Step A4. Remove the foam or tape.

B**B**

Sequence B — install 16 more resistors.

Step B1. Locate four of the five 100k resistors (brown-black-yellow-gold). The extra one should be set aside for later. Install as shown. Some of these have a “1” marked inside their rectangle. They are R69, R68, R67 and R3.

Step B2. Locate all seven of the 22k resistors (red-red-orange-gold). Install as shown. Some of these have a “B” marked inside of their rectangle. They are R32, R33, R42, R36, R35, R38 and R6.

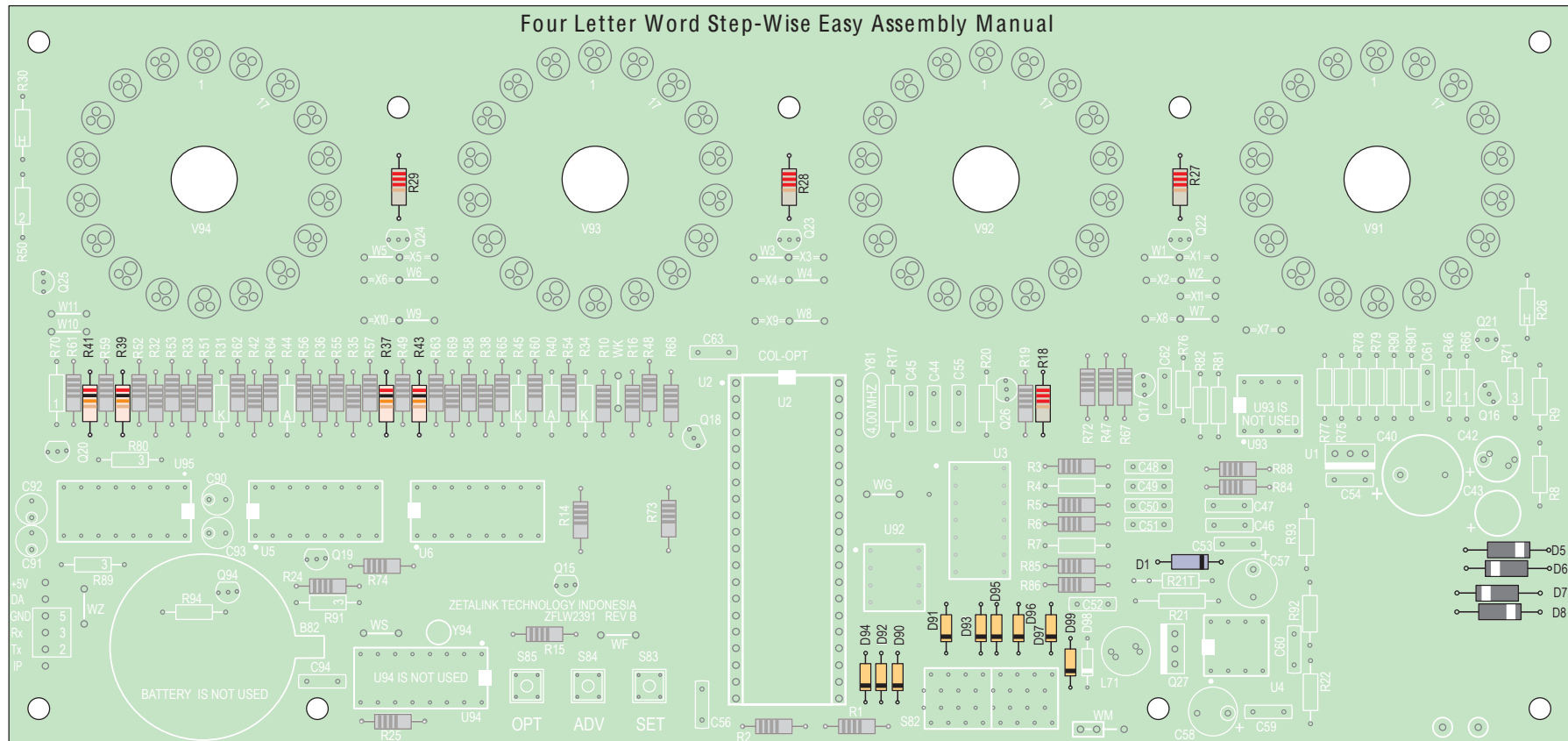
Step B3. Locate five of the six 470k resistors (yellow-violet-yellow-gold). The extra one should be set aside for later. Install as shown in the

illustration. Some of these values have a “2” marked inside their rectangle. These are R49, R48, R47, R85 and R86.

Step B4. Double check the parts placement, and make any corrections required. Then hold the parts in place with foam or masking tape (lightly applied), reverse the board and solder these parts. Clip the excess wire, saving the scraps for use as jumper wires later on.

Step B5. Remove the foam or tape.

C



C

Sequence C — install all diodes and additional resistors.

Step C1. Locate four of five 2.2k resistors (red-red-red-gold). Set aside the fifth one for later. Most of these are marked with “H” inside their rectangle. Install these as shown. These are R29, R28, R27 and R18.

Step C2. Locate all four 20k resistors (red-black-orange-gold). Install in the locations indicated. All of these have a “E” inside their rectangle. These are R41, R39, R37 and R43

Step C3. Locate nine of the ten small 1N4148 signal diodes. These have a glass body and are smaller than resistors. Install these in the locations nearby to S82. The polarity band must match the marking. The diodes installed are D94, D92, D90, D91, D93, D96, D97 and D99. D98 may or may not be mounted later in step H.

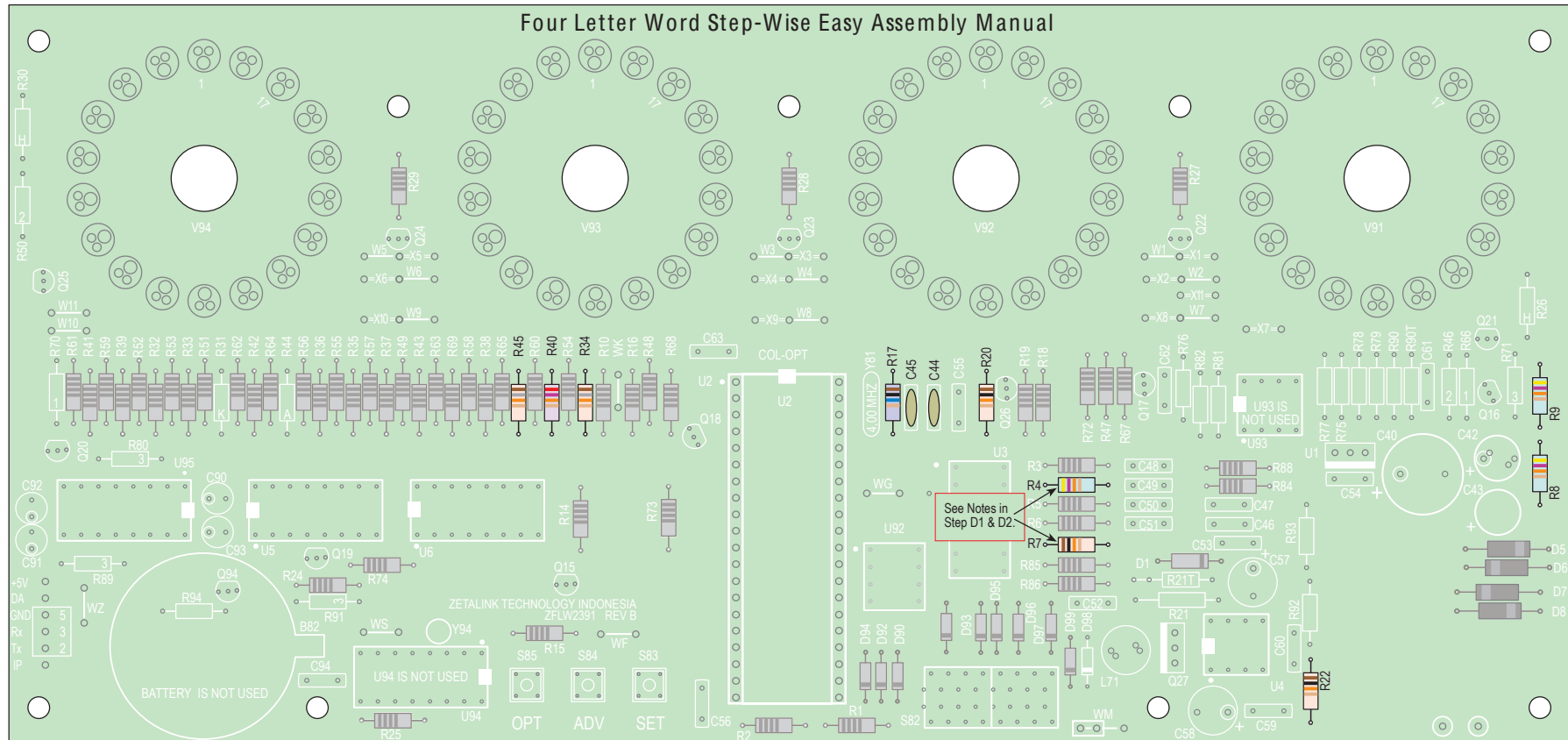
Step C4. Locate four larger plastic diodes, marked 1N4002 (may also be 1N4003, 4004, through 4007, inclusive). Install at D5 to D8, noting that the cathode mark reverses direction—adjacent diode pairs are reversed

Step C5. Locate the last remaining diode (it is different from the others). This is installed at D1, also observing the cathode band to be sure that the polarity is correct

Step C6. Double check the parts placement, and make any corrections required. Then hold the parts in place with foam or masking tape (lightly applied), reverse the board and solder these parts. Clip the excess wire, saving the scraps for use as jumper wires later on.

Step C7. Remove the foam or tape.

D



D

Sequence D — install additional resistors.

Step D1. Locate all three 10k resistors (brown-black-orange-gold). Install as shown at R20, R22, and R7. *Note: If you live where the mains power is 50 Hz (almost everywhere except North America), install the 10k resistor in R4 instead.* The diagram shows R7.

Step D2. Locate all three 47k resistors (yellow-violet-orange-gold). These are placed at R8, R9 and R4. *Note: If you live where the mains power is 50 Hz, install the 47k resistor in R7 instead.* The diagram shows R4.

Step D3. Locate two of three 18k resistors (brown-gray-orange-gold). Install as shown at R34 and R45. These have a “K” mark on the PCB.

Step D4. Locate one of two 27k resistors (red-violet-orange-gold). Install as shown at R40. The extra resistors from step D3 and D4 will be

installed later.

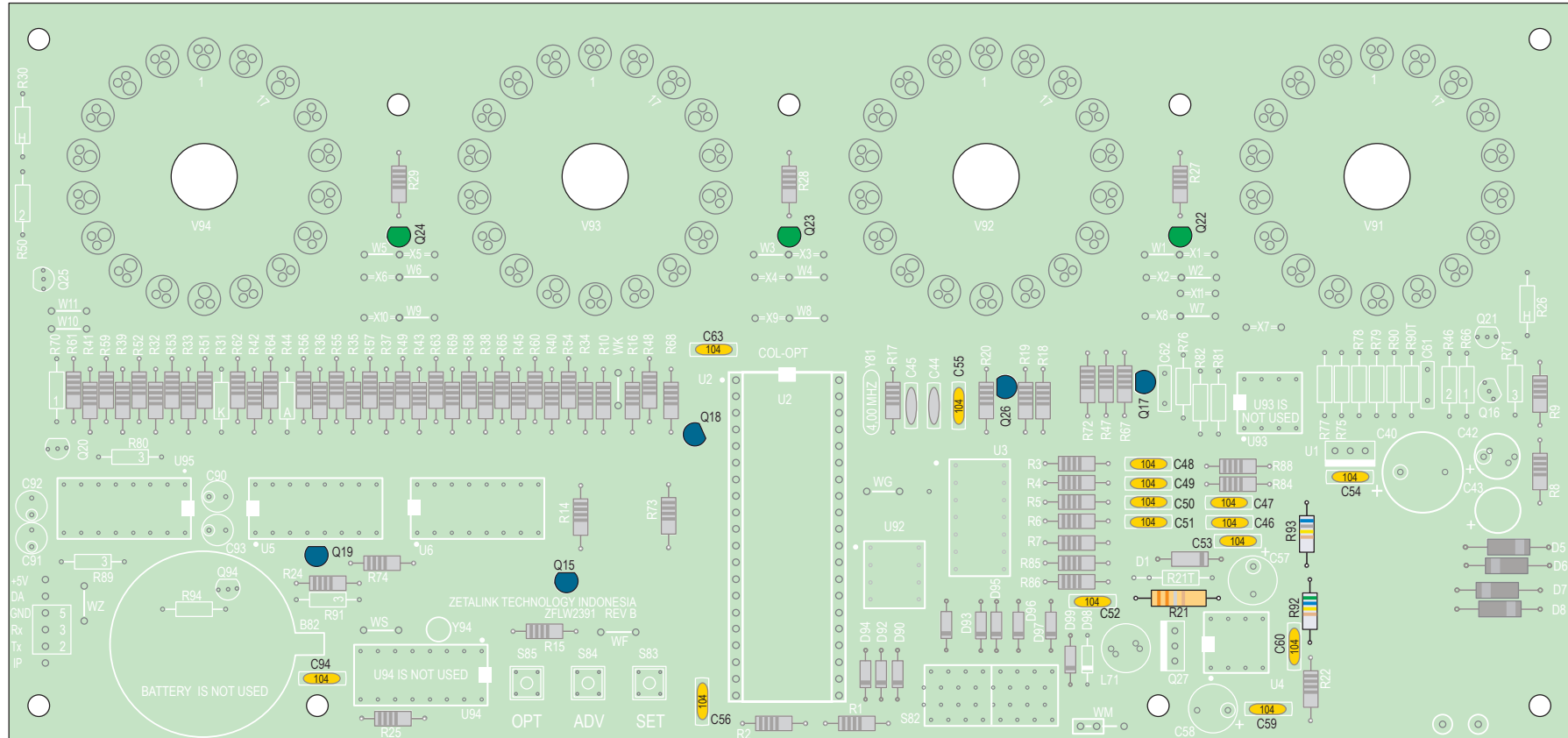
Step D5. Install the single 10M resistor (brown-black-blue-gold), R17.

Step D6. Locate two small disc ceramic capacitors, marked 20 or 22. These go alongside R17, at C44 and C45.

Step D7. As with all earlier steps, double check your work. This is getting easier now as the board is filling up, and if you made any errors before, this is when you might discover them, unless you were very thorough in checking everything.

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E



E

Sequence E — install bypass capacitors and other parts.

Step E1. Locate all fifteen 100 nanofarad (0.1uf) monolithic bypass capacitors. These are marked “104”. Install these at C46, C47, etc. as shown.

Step E2. Locate five of the six transistors marked MPSA42. Double check their marking (with a magnifier, if necessary). Install these at Q15, Q17, Q18, Q19 and Q26, noting the position of the flat side, and fanning out the lead wires so that they do not cross.

Step E3. Locate three of the four transistors marked MPSA92, and install these at Q22, Q23 and Q24. The extra MPSA92 and MPSA42 will be installed later.

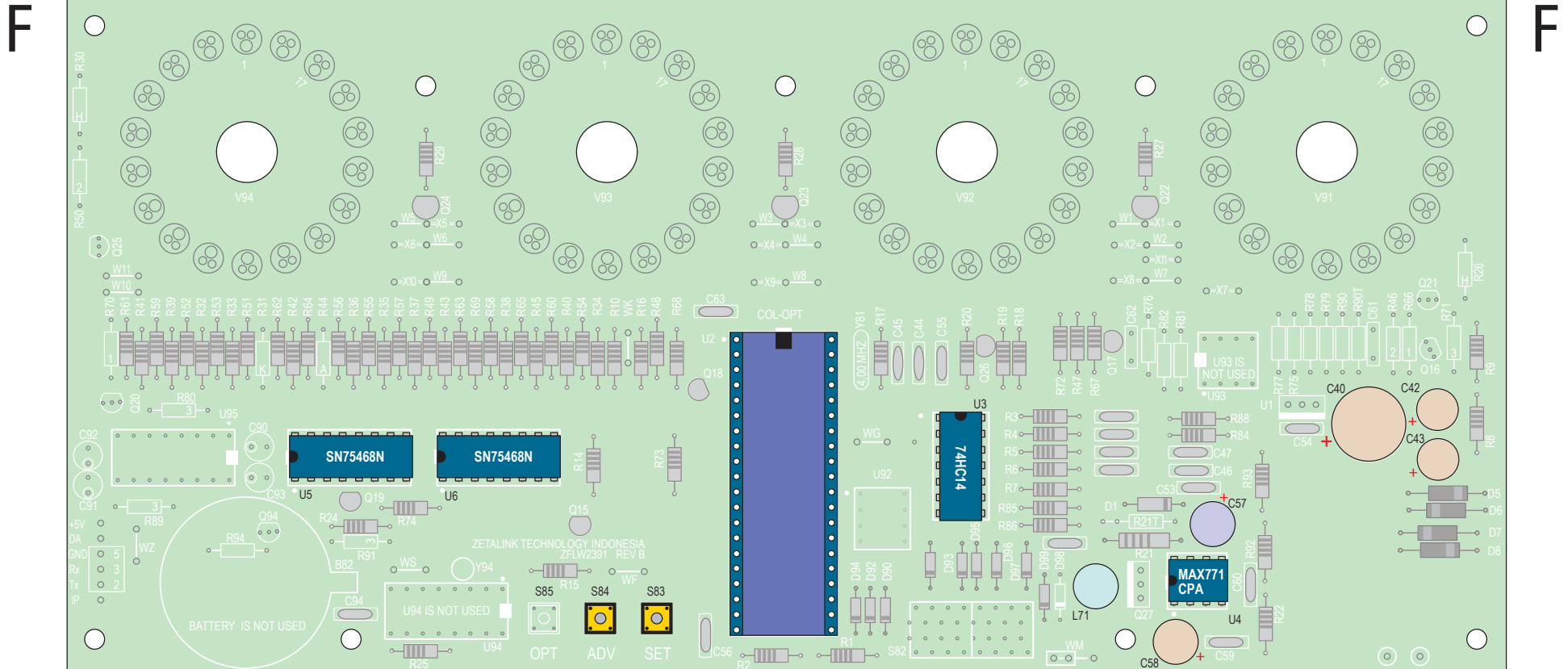
Step E4. Locate the 560k resistor (green-blue-yellow-gold) and install it at R92.

Step E5. Locate the 680k resistor (blue-grey-yellow-gold) and install this at R93.

Step E6. Locate the larger 0.33 ohm resistor (orange-orange-silver-gold) and install at R21. There is an alternate hole on the left side for longer parts.

Step E7. As with all earlier steps, double check your work.

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Sequence F — Add integrated circuits, switches, electrolytic capacitors, etc.

Step F1. Install IC chips U5 and U6. These are marked SN75468N. No socket is supplied, but if you wish to add your own socket there is no problem in doing so. Failure and replacement of these is considered very unlikely.

Step F2. Install IC chip U4. This is marked MAX771CPA. IMPORTANT: This must be soldered directly to the PCB. A socket can not be used.

Step F3. Install the IC socket for U2.

Step F4. Install IC chip U3, marked 74HC14 (14 pins). No socket is supplied, but if you wish to add your own socket there is no problem in doing so.

Step F5. Install the two small tactile switches, S83 and S84. If your case plans so dictate, you may put these on the opposite side.

Step F6. Install capacitors C42 and C43 (2.2 uf, 160 VDC). Note that the longer

wire is the positive lead and goes into the hole that has a white ring around it. There are two alternate holes for these parts in case the lead spacing is smaller (rotate the part about 45°).

Step F7. Install capacitor C40 (470 uf, 25 VDC min.). As with all such parts, the longer lead is positive and must go into the hole with a white ring. (Capacitors of this type can explode if reversed.)

Step F8. Install capacitor C57 (4.7 uf, 250 VDC), observing polarity.

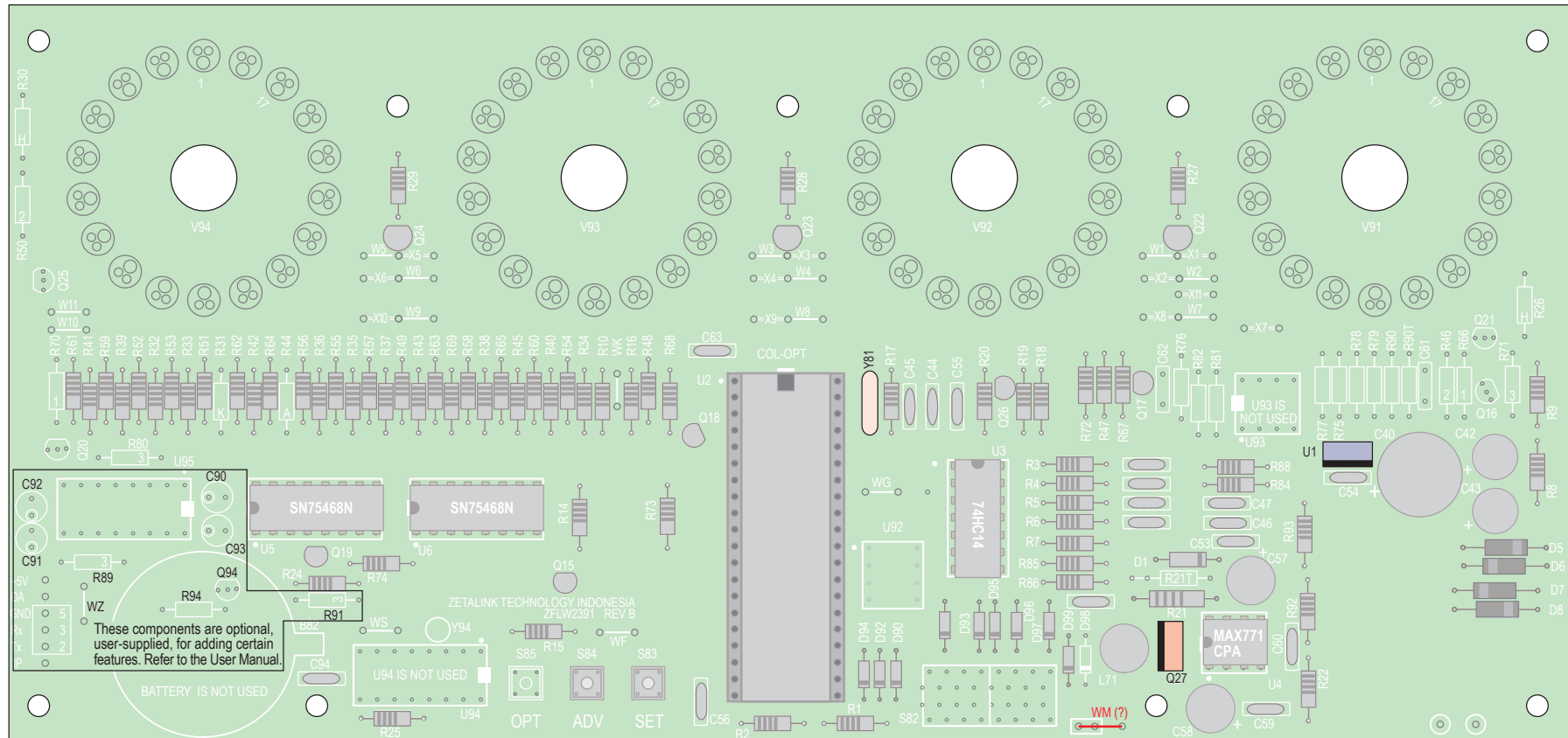
Step F9. Install capacitor C58 (220 uf, 25VDC), observing polarity.

Step F10. Install inductor L71 (marked 224). There is no polarity to be concerned with.

Step F11. As with all earlier steps, double check your work.

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G



G

Sequence G — install other taller parts.

Step G1. Locate the voltage regulator, U1 (marked 7805). Install standing up on the three pins, with the metal side facing toward C54.

Step G2. Locate the FET (field-effect transistor), Q27 (marked IRF830 or IRF730). Install standing up on the three pins, with the metal side facing toward L71 (left).

Step G3. Locate the 4.000 Megahertz crystal, Y81 (in a tall, oblong metal can, marked 4.000). Install standing on end, flush to the board.

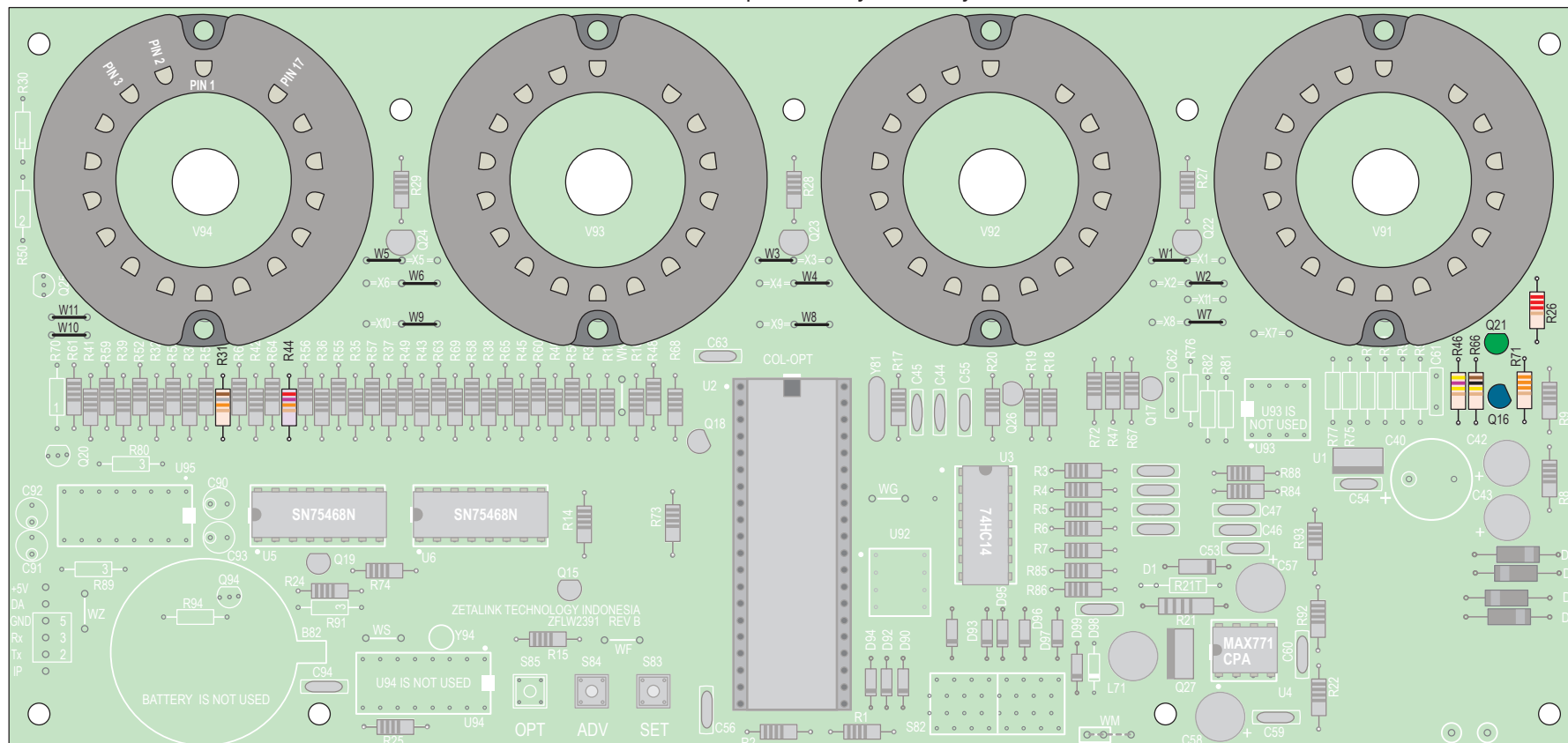
Step G4. If you wish to have a 24-hour time display (common in Europe, and many other countries), then install jumper WM. For a 12-hour display, leave WM open. Holes are provided for a 2-pin jumper header so this feature can be changed with ease, or connected to a switch at another location.

Step G5. As with all earlier steps, double check your work.

The next step requires making a decision: Mount the nixie tubes on the same side as the other parts (abbreviated to CUTU = components up, tubes up), or on the opposite side (abbreviated to CDTU = components down, tubes up). This depends on what type of case you plan to use. If you are not sure, think it through carefully. You can't change your mind later.

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H1



H1

Sequence H: **FOR CUTU (components up, tubes up) option.** If you wish to have the components facing down, with the nixie tubes on the opposite side from the other components, skip to Sequence H2, **FOR CDTU.**

Step H1. Locate all of the extra parts that were set aside in earlier steps, except the glassbody diode, D98. These include resistors (one each of 2.2k, 470k, 100k, 33k, 18k and 27k), and transistors (one each of MPSA42 and MPSA92).

Step H2. Mount the 2.2k resistor (red-red-red-gold) at R26.

Step H3. Mount the 470k resistor (yellow-violet-yellow-gold) at R46.

Step H4. Mount the 100k resistor (brown-black-yellow-gold) at R66.

Step H5. Mount the 33k resistor (orange-orange-orange-gold) at R71.

Step H6. Mount the 18k resistor (brown-gray-orange-gold) at R31.

Step H7. Mount the 27k resistor (red-violet-orange-gold) at R44.

Step H8. Mount the MPSA42 transistor at Q16.

Step H9. Mount the MPSA92 transistor at Q21. Be sure that these are not reversed (look carefully at the markings one more time).

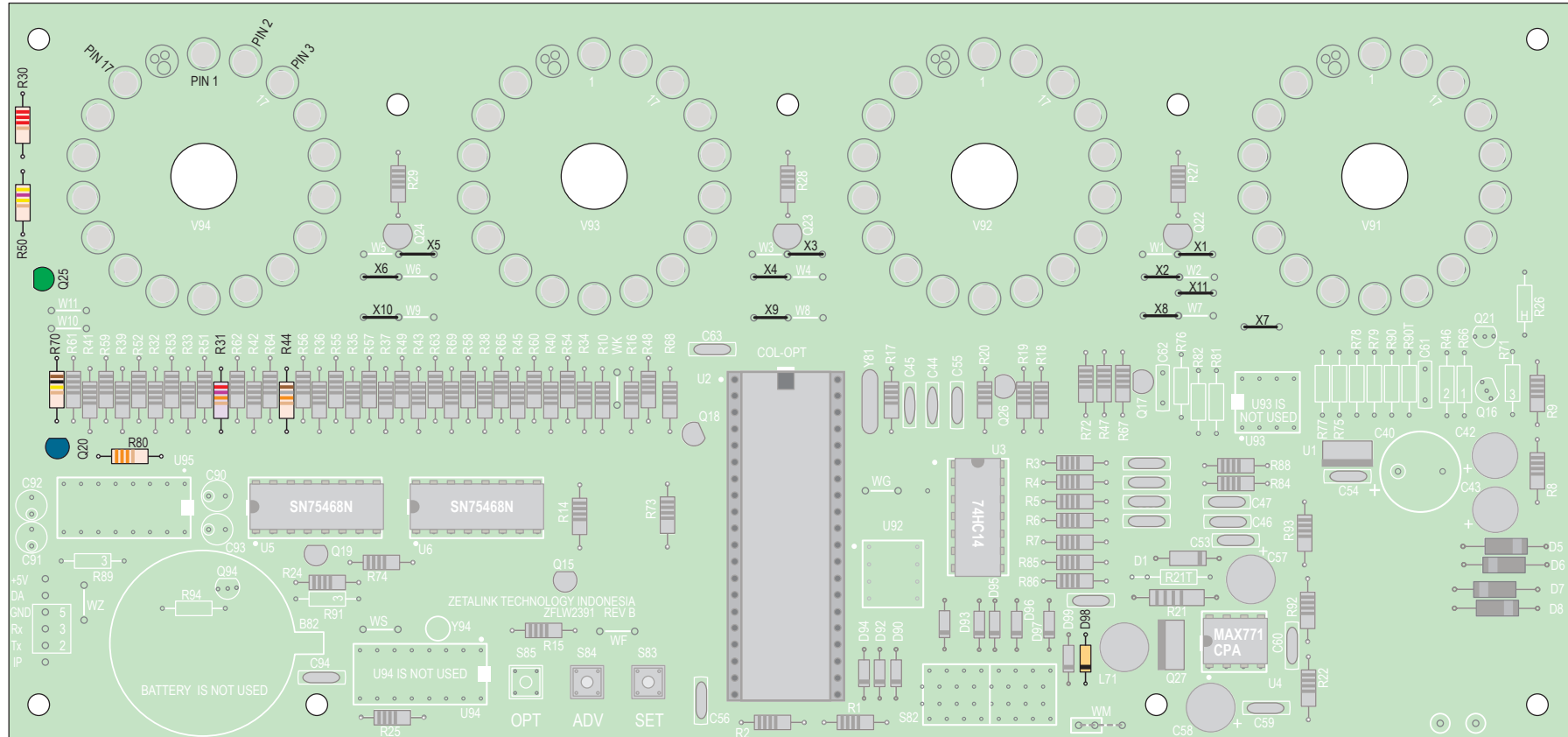
Step H10. Prepare eleven wire scraps from resistors as jumpers. Mount these in all jumpers marked with W plus a number (W1, W2, to W11). Do not put any jumpers into the X-jumper positions. See hint at Step E8.

Step H11. Mount the sockets. See the additional explanation on use of the vintage sockets, or on substituting modern socket pins. CAREFULLY note the position of the key gap (missing pin) between pin 1 and pin 17. Double check this before soldering. A socket incorrectly mounted is extremely difficult to remove and reposition.

Step H12. As with all earlier steps, double check your work.

H2

H2



Sequence H: **FOR CDTU (components down, tubes up) option.** If you wish to have the components facing up, with the nixie tubes on the same side as the components, return to Sequence H1, **FOR CUTU**, then skip this sequence page.

Step H21. Locate all of the extra parts that were set aside in earlier steps. These include resistors (one each of 2.2k, 470k, 100k, 33k, 18k and 27k), transistors (one each of MPSA42 and MPSA92), and a glass-body diode.

Step H22. Mount the 2.2k resistor (red-red-red-gold) at R30.

Step H23. Mount the 470k resistor (yellow-violet-yellow-gold) at R50.

Step H24. Mount the 100k resistor (brown-black-yellow-gold) at R70.

Step H25. Mount the 18k resistor (brown-gray-orange-gold) at R44.

Step H26. Mount the 27k resistor (red-violet-orange-gold) at R31.

Step H27. Mount the 33k resistor (orange-orange-orange-gold) at R80.

Step H28. Mount the MPSA42 transistor at Q20.

Step H29. Mount the MPSA92 transistor at Q25. Be sure that these are not reversed (look carefully at the markings one more time).

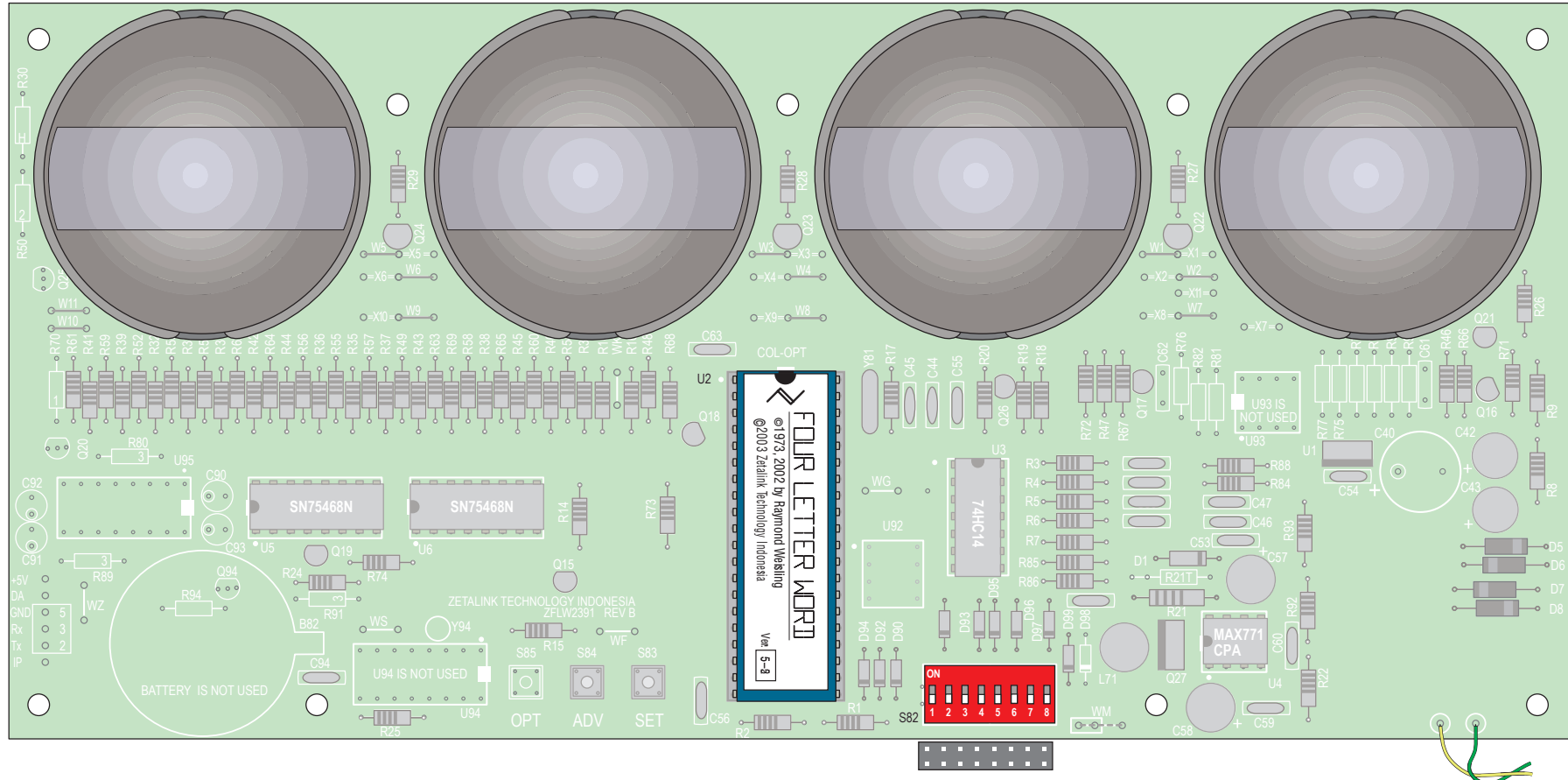
Step H30. Locate the glass-body diode that is like D99, D90, etc. Install at D98. This selects the reversed character formation for CDTU.

Step H31. Prepare 11 wire scraps from resistors as jumpers. Mount 11 of these in all jumpers marked with X plus a number (X1, X2, to X11). Do not put any jumpers into the W+number jumper positions, which are nearby to the X-jumpers. See hint at Step E8.

Step H32. Mount the sockets. See the additional explanation on use of the vintage sockets, or on substituting modern socket pins. CAREFULLY note the position of the key gap (missing pin) between pin 1 and pin 17. Double check this before soldering. A socket ubcorrectly mounted is extremely difficult to remove and reposition.

Step H31. As with all earlier steps, double check your work.

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Sequence J: (This image assumes that CUTU mounting was selected in Sequence H.) Complete the installation of components.

Step J1. Locate the large 40-pin integrated circuit. This is the microcontroller or microcomputer chip, which is the heart of the Four Letter Word. Note that the top end is where the notch is located. Insert it into the socket. You may have to straighten the pins by pushing the chip down on the table while gently applying a little bending pressure, first on one side and then the other, so that the two rows are parallel to each other, rather than spread outward slightly. (This may already have been done since the chip is functionally tested before shipment.)

Step J2. If you wish to use the DIP switch on the main circuit board, locate this switch (8 small actuators are on the one piece, with 16 pins on the bottom). If instead you want to use the bonus remote switch board, then locate the 16-pin plug header. These may be installed on the opposite side of the board if that makes more sense for the case that you intend to use. The 16-pin header is also shown above, slightly outside of the

board perimeter. Both may be installed of desired, on opposite sides, if the header is soldered first, then the soldered points covered over with the DIP switch and its pins soldered from the opposite side. Set all sections of the switch to OFF so that the start-up does not involve any unfamiliar settings.

Step J3. Solder two wires to the holes marked "12 VAC" as shown and run these to a source of AC power no more than 15 volts AC. If you are unsure about whether the power is AC or DC, check with a multimeter or ask someone who knows. No harm will occur if the power is DC, but the unit will not operate correctly.

Step J4. Carefully insert the nixie tubes and apply power. The unit should work and display a start-up message, ending in PLAY and then a stream of words should appear.

End of assembly sequences. Please refer to the User Manual for more information.