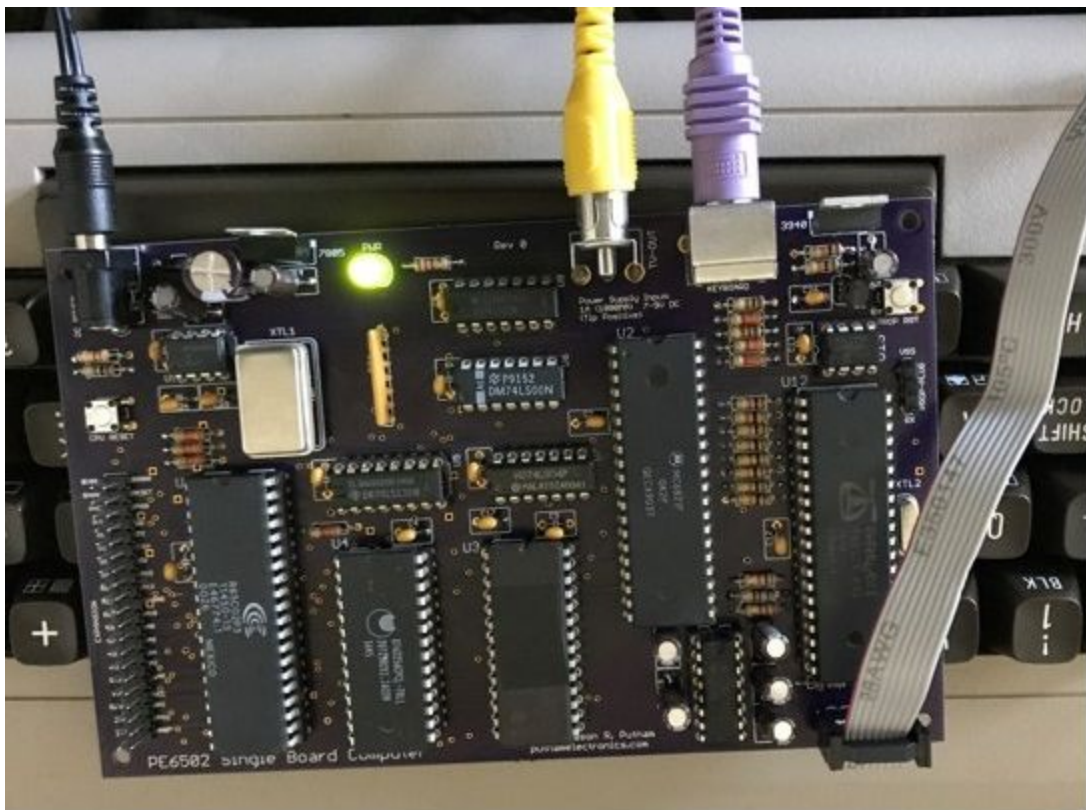


# PE6502 Single Board Computer Assembly Manual



2017-09-17 Putnam Electronics,  
[putnamelectronics.com](http://putnamelectronics.com)

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# I. Introduction - PLEASE READ (even if you don't usually read manuals!)

First off, **THANK YOU** for purchasing your PE6502 kit!

This computer was designed from a clean sheet of paper, and based on a 65C02 microprocessor. A design goal was to have this computer be very much like an Apple 1, but to have some more sophisticated capabilities (not unlike an Apple II/Atari 800/Commodore 64.) It was also a design goal to have these features without requiring any custom chips, and with a low parts count and small footprint. Ultimately, the computer must be useful, easy to assemble, and inexpensive to buy. I believe we've met the target requirements; The computer can be used as-is out of the box, can be expanded by customizing/evolving the onboard Parallax Propeller firmware, and also by adding plug-in expansion boards. I truly believe that, the more people that use this platform, the more that we'll discover it can do!

Before you move ahead with the construction, please consider this: You've paid good, hard-earned money for this kit. So prior to heating up your soldering iron, please do the following (I think this will pay big dividends with the final assembly!):

- A. Print this manual, or have it in your favorite e-Reader/tablet device.
- B. Grab a delicious beverage of choice (some folks like herbal tea, some like craft beer, others water..)
- C. Sit in a comfortable chair, with your distractions minimized, and...
- D. Read through this entire manual. Make sure you understand and can visualize the assembly steps, so by the time you're actually doing the soldering/assembly, you'll know what part goes where, which part is which, special considerations for each part, what step will be next, etc.
- E. Get excited! Your kit is supplied with the highest quality components, and when you're done, your PE6502 will be an AWESOME computer!

And now, let's get on to building your PE6502!

## II. Getting Ready

This section is comprised of four parts: Taking inventory of what parts you should have received in your kit, making sure you have other necessary items to use your PE6502, and what tools & supplies you'll need to assemble your PE6502. Finally, the last part will provide some information on how to install electronic components; how to determine resistor values, capacitor/LED/Diode/Resistor Pack polarity, and how to find pin one on a microchip.

A. **Take a parts inventory!** Let's make sure you've got what you're supposed to have! Simply print out the Bill of Materials in the appendix section in this manual (if you've not already printed the manual), and place a check mark on each part, once you have verified it's in your kit. Contact us if anything is missing (we triple-check, so nothing should be missing!) and we'll send the missing part out immediately.

B. **Other necessary items** (not included in this kit), so you can use your PE6502:

- "Wall-wart" power adaptor. You need one that is: AC to 9v DC, 300-1000ma, tip-positive, and outputs to a 2.1mm power jack.
- PS/2 keyboard. While some USB keyboard and PS/2 adaptors *\*might\** work, it's probably cheaper/easier to just get a PS/2 keyboard.
- composite video cable
- video monitor (or TV!) with a composite video input
- DB9 serial cable -or- DB9 to USB serial converter/adaptor.

**\*\*NOTE\*\*** If you have a 64bit Windows computer: We **STRONGLY** recommend you purchase a legitimate US Converters ([www.usconverters.com](http://www.usconverters.com)) USB serial adapter, like the model XS880.

I have tested with this exact model, and the serial communication has been bullet-proof! This is after I tried using a cheap/low quality/possibly counterfeit "prolific PL2303 clone" off ebay, and it would randomly reset the PE6502, would lock up my Windows computer if I unplugged it, and caused MUCH frustration.

I have no connection with US Converters, I am just a happy customer, and have verified that the PE6502 serial communications work as they should when using this serial interface. It is based off the FT232RL chip, and they have other (cheaper) models also based off this same chip, that will probably work just as well.

- a host computer, for loading from, saving to, or serial I/O use (instead of using a keyboard and monitor). I personally use a Windows 8.1 laptop.

**\*\*OPTIONAL\*\*** Items (not included in this kit):

- A power switch may be wired to the SW1 terminals located at the top-left of the PE6502 PC board, in the 5v power supply section. This would allow for a way to turn the PE6502 computer on and off without having to unplug the power supply.

**\*\*RECOMMENDED\*\*** Items (not included in this kit):

- some sort of enclosure and/or board standoffs, so you can safely use your PE6502 without risk of damaging it. Ideally this enclosure will feature a metal plate back, that can be screwed into the cooling tabs of the voltage regulators. Otherwise, you may want to add a screw-on heat-sink to the 5 volt voltage regulator.
- some way to capture a picture of your assembled and running PE6502, to send to us. We'll put you on our website, so others can see!

**C. Tools needed (for assembly):**

- PATIENCE!!! Just take your time, and enjoy the build! It will work, I promise! (If it doesn't work for some reason, check the Appendix section entitled "What to do if for some reason it doesn't work?" for help.)
- temperature regulated soldering iron
- soldering iron holder
- soldering iron tip cleaner
- good solder (60/40, thin! .032 inch diameter), rosin flux core

**\*\*NOTE\*\* Search for Kester, made in USA solder. It is "the good stuff"**

- desoldering braid, and/or desoldering pump
- digital multi meter - one that can test for continuity, measure voltage, measure resistance
- "nippy pliers" wire and lead cutters
- needle nose pliers - that can be used to neatly bend leads if needed for "pro" looking assembly of circuit board
- masking tape (to hold sockets in while you solder them)
- Rubbing alcohol, paper towels, Q-tips, and a clean (disposable) lint-free cloth
- a good bench!

**\*\*NOTE\*\* What makes a "good bench"?** A good bench is one that is somewhere out of the vicinity of "family space", nowhere near food, pet bedding, kids, other people, etc. You don't want this area "re-configured" while you're busy elsewhere, in the middle of your project. Also, this protects others from fumes, other hazards. The bench must also have good light! This makes a HUGE difference! The bench must have good ventilation! Take good care of yourself, human!

- protective eyewear. It is extremely rare, but solder can pop off what you're working on, and could potentially go in your eye. Your eyes are important to you! Protective eyewear = cheap insurance. Just do it!
- a place you can clean up after assembling/soldering.

**\*\*NOTE\*\* Do not eat while soldering! Do not drink while soldering! Do not touch your face, pick your nose, etc. while soldering.** Wash your hands and face well with soap and water after soldering. Again, take good care of yourself, human!

**\*\*OPTIONAL\*\* Tools** (If you're going "all-out", these items would be nice, but are certainly not required):

- desoldering station

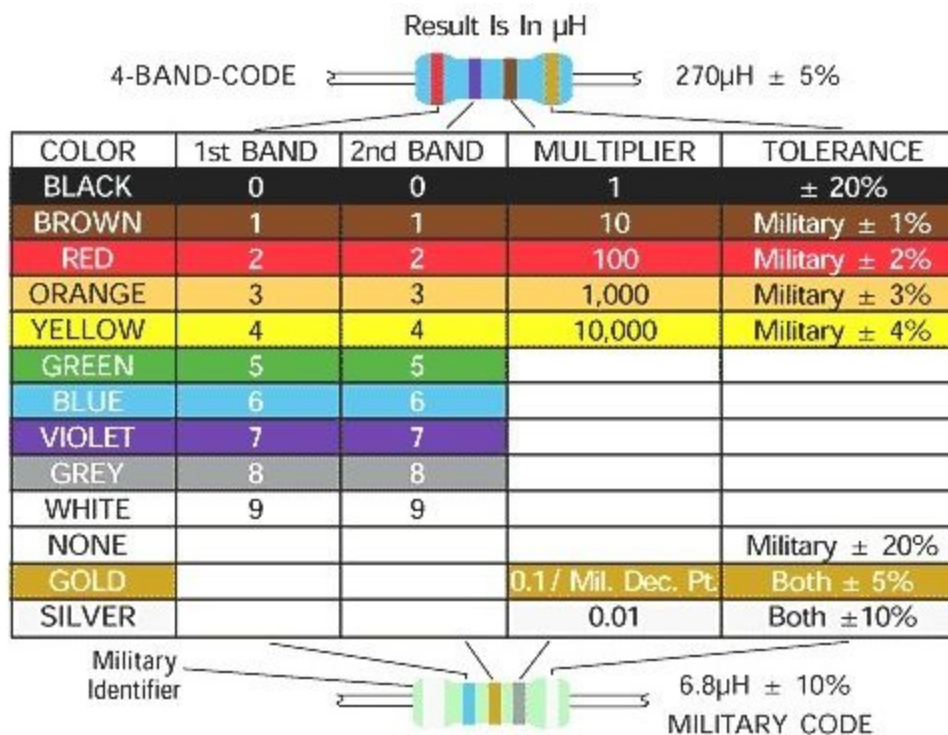
- logic probe
- magnification
- an empty egg container, for use with organizing/categorizing parts for your build. Alternatively, sandwich baggies work well too!
- music of some kind while you work

**\*\*RECOMMENDED\*\*** if you're new to this:

If you're new to soldering on boards, get some spare resistors, chip sockets, and some other parts, along with a solderable copper pad "perf-board" to practice with. These can be used, bought as a "grab bag" at an electronics parts store, etc. This way (along with reading the appendix section with soldering tips for newbs!) you can practice soldering before you put together your new computer.

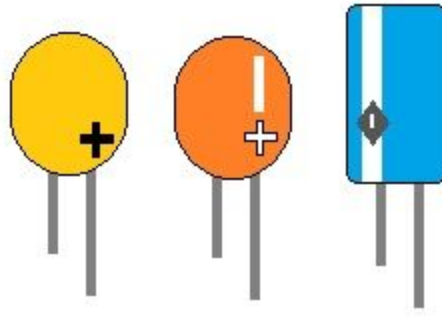
#### D. Miscellaneous notes on electronics components (to aid in installation):

- Resistors:
  - Resistor values are shown on the resistor body by colored bands. The following chart shows how to compute the value of a resistor based on the bands it has:



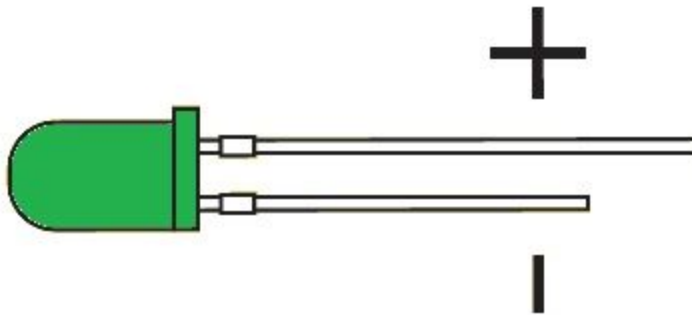
- For example, a resistor that shows Red, Red, Black, Gold, is a 220 Ohm, 5% tolerance.
- Resistors are NOT polarized- it doesn't matter what direction you install them in, however, it will look more professional if you install them all in the same orientation (for example, with the tolerance bands all on the right side.)

- Capacitors:
  - Capacitors that are polarity sensitive are often marked with a stripe, an arrow, and/or a plus sign to indicate polarity.



- The plus sign identifies the positive lead, while an arrow or stripe identifies the negative lead.
- Additionally, the positive lead is usually longer on a radial (both leads come out of the same side) capacitor.

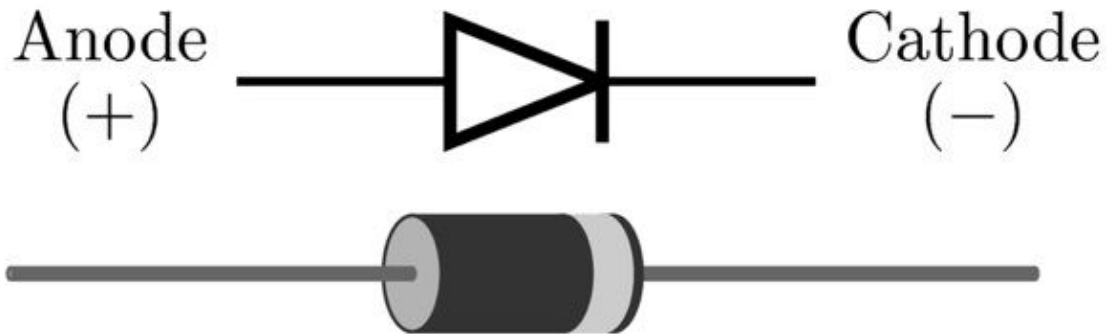
- LEDs:
  - Polarity for LEDs can usually be determined by looking at the lead length.



- The longer lead is the positive (anode) lead. The shorter lead is the negative (cathode) lead.
- Also, a machined flat spot on the edge of the LED indicates the negative side.

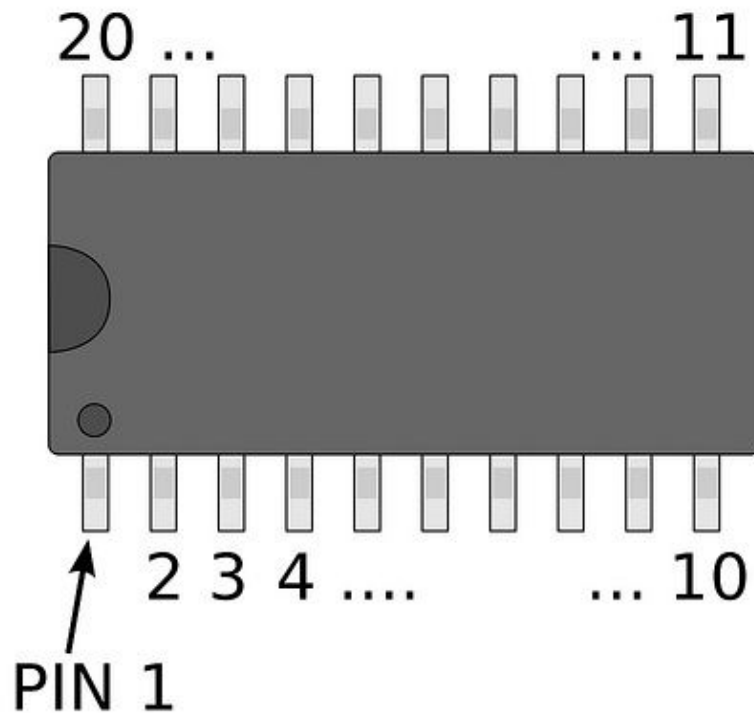
- Diodes:

- Polarity for a diode can be determined by looking for a band marking on the diode close to one side. This marks the negative (cathode) lead.



- Microchips (also called Integrated Circuits, or ICs for short):

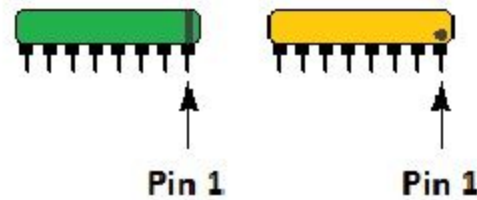
- Pin 1 on an IC will typically be marked in one or both of two ways;
  - with a dot on the top of the case at that pin.
  - with a half-moon shape on the top edge, so when you orient the chip with this shape at the top, pin one is located at the top-left pin.



- The pins on an IC are numbered counterclockwise starting at pin 1, and moving around the chip until the last pin, across from pin one on the other side.



- Resistor Packs:
  - Pin 1 on a resistor pack will be marked with either a band, or a dot.



- Ultimately, it is this pin 1 that connects the common lead of the resistors in the pack. All the other leads are the other side of each on-board resistor.

**\*\*NOTE\*\*** In the assembly section of this manual, there will be directions for how to place a polarized part. The convention used in this manual will be in the following format:

- C25 (10uF) - Top-left of MAX232 (- lead to bottom pad)

In the example above, we are told that Capacitor 25 (located at top-left of the MAX232 chip), is oriented so that the negative marked lead is placed in the bottom pad through-hole.

### III. Assembly Steps

During assembly, we will refer to the orientation of the PE6502 circuit board as follows: We will call the component side the side that has the white silkscreened labels (and the name “PE6502 Single Board Computer”) on it. As you view the PE6502 circuit board from top-down, viewing the component side, make sure the name “PE6502 Single Board Computer” is right-side up, in your normal reading perspective. With the board in this configuration, we’ll refer to the bottom-left of the PC board the area where this name is. The left side is where the expansion header is. The top-left is where the DC Power jack is. The top is where the PWR LED is, and the TV Out jack is at the top as well. The top-right is where the 3940 voltage regulator is. The right-side has the propeller plug (and the Propeller chip itself is in this area.) Finally, the bottom-right is where the serial header section is located.

#### A. Organize all kit parts, test and categorize resistors.

- Group together resistors of like value, and place a label identifying each value group with these resistors. This will greatly simplify assembly later! Use the color chart in part D of the Getting Ready section of this manual to help you identify values, and double check values with a multimeter to be sure you’ve properly identified and categorized all resistors.
- Group together all capacitors of the same type. For example, there will be 15 .1uF capacitors; 11 for decoupling capacitors, and 4 for other purposes.
- The Bill of Materials lists the detailed part information for each PC Board identifier.

For example, R1 on the PC Board is a 220 ohm resistor. U1 is the 65C02 CPU (and 40 pin socket)

#### B. Clean the cpu board prior to assembly.

Before you start soldering, ensure the PC Board is clean and free of contaminants. Use a paper towel soaked with some rubbing alcohol, to wipe-off both sides of the PE6502 PC board, and then let it dry.

#### C. Assemble the power supply, and test voltages.

The power supply is split across the PE6502 circuit board into two locations:

- The main 5 volt section is at the top-left of the circuit board, and consists of these components:
  - JP1 (DC Power Connector)
  - SW1 (no parts here, this is where you can install an optional power switch. If you don’t want to use this, simply short the bottom two SW1 pads to the top two SW1 pads with leftover component leads and solder.)
  - D1 diode (this is a polarized part! Please be sure the stripe on the diode matches the stripe on the PC board (i.e., it is installed on the right side)
  - C21 (100uF) - capacitor (- lead to bottom pad) left of the 7805
  - C14 (10uF) - capacitor (- lead to left pad) below of 7805

- 7805 (VR1 in BOM) 5v voltage regulator (tab oriented as shown on the PC board)
    - PWR LED (this is a polarized part! Be sure to match the flat as shown on the PC board) This part is located at the top-center of the board, just to the right of the 7805 voltage regulator.
    - R1 (220) - top-center of the PC board, to the right of the PWR LED.
  - The 3.3 volt section used for the Parallax Propeller is located at the top-right of the circuit board, and consists of these components:
    - 3940 (VR2 in BOM) 3.3v voltage regulator (tab oriented as shown on PC board)
    - C15 (10uF) - capacitor (- lead bottom pad)
  - **TESTING:** Visually inspect the board for shorts caused from falling balls of solder. Observe safety precautions, and then plug power supply into JP1 jack, and plug power supply into a wall outlet. (If you installed an optional power switch, be sure to turn this switch ON!) Observe PWR LED should be lit. Using a voltmeter, observe 5v DC by touching the positive (red) lead of the voltmeter to a VCC pad in the expansion header location, and the negative (black) lead of the voltmeter to a GND pad in the same expansion header location. Observe 3.3v DC by touching the positive lead of the voltmeter to lead of C15 that is closest to the 3940 voltage regulator, and touching the negative lead of the voltmeter to a GND pad in the expansion header section.
- D. Solder in the chip sockets, being careful to install the sockets with their pin one notch in the correct orientation. All vertical oriented chip sockets will have the pin one notch pointing to the top. All horizontal oriented chip sockets will have the pin one notch pointing to the left. There are 12 chip sockets in total, and there is no U11! Use masking tape to hold each chip socket fully seated in the PC board, and then solder in the socket from the solder side. Remove the tape when you are done.
- Vertical oriented chip sockets (pin one notch points to the top):
    - U1 65C02 CPU socket, 40-pin
    - U2 6821 (65C21) PIA socket, 40-pin
    - U3 27C256 ROM socket, 28-pin
    - U4 62256 SRAM socket, 28-pin
    - U10 MAX232 RS232 Transceiver socket, 16-pin
    - U12 P8X32A-D40 Propeller socket, 40-pin
  - Horizontal oriented chip sockets (pin one notch points to the left):
    - U5 74HCT138N 3:8 DECODER socket, 16-pin
    - U6 74HCT00N QUAD NAND socket, 14-pin
    - U7 74HCT04N HEX INVERTER socket, 14-pin
    - U8 74HCT32N QUAD OR socket, 14-pin
    - U9 LM555N Timer socket, 8-pin
    - U13 24LC256P EEPROM socket, 8-pin
  - **TESTING:** Visually ensure all sockets have been installed with the pin one notch in the proper direction. If desired, check for proper voltage and ground at each

chip socket, using the schematic and/or datasheets for each chip to obtain proper pin locations.

E. Solder in the decoupling capacitors, **and C17 (to the left of C3.)**

- The decoupling capacitors are NOT polarized.
- All decoupling capacitors, if marked on one side with label from the manufacturer, should all be installed in the same orientation (all installed so that the label is on the same side for all installations) for a most professional look.
- The decoupling capacitors should have their leads all bent the same way, with one lead straight, and one lead bent out a little bit and then angled down (kind of like a capital letter “R”) so that they all fit in their mounting holes in the PC board in the same exact way. The straight leg should always be closest to the chip the decoupling capacitor is filtering, so that the shortest lead between capacitor and chip exists.
- All but 1 chip will have a decoupling capacitor (the MAX232 chip does not have a decoupling capacitor.) For all other chips, the decoupling capacitor is installed in the section marked on the PC board with a C number that matches that chips U number. For example, U1 (CPU) decoupling capacitor is installed in blank C1, U2 capacitor in C2, etc. Install a decoupling capacitor in locations C1, C2, C3, C4, C5, C6, C7, C8, C9, C12, and C13) Remember, there is no chip U11!

F. Solder in the resistors and resistor pack.

- Resistors are not polarized- but should all be installed in the same orientation (all installed so that the tolerance band is on the right-side for example.)
- All resistors should have the same exact bend placed into the leads, so that they all align on the PC board when installed, for a most professional look.
- The resistor pack pin 1 goes to the top of the board- and is marked with a small “1” on the PC board at the pin 1 location. Install this component fully seated into the board.
- There are 26 resistors to install in this step:
  - R27 (10K) - Top right of board, near 3.3v power supply section
  - R26 (10K) - Top right of board, near 3.3v power supply section
  - R25 (1K) - Bottom right of board, just under Propeller chip
  - R22 (100) - Group of 5 resistors together, just below PS/2 connector
  - R20 (3.3K) - Group of 5 resistors together, just below PS/2 connector
  - R21 (100) - Group of 5 resistors together, just below PS/2 connector
  - R19 (3.3K) - Group of 5 resistors together, just below PS/2 connector
  - R10 (3.3K) - Group of 5 resistors together, just below PS/2 connector
  - R2 (1K) - Group of 8, upper left side of Propeller
  - R3 (1K) - Group of 8, upper left side of Propeller
  - R4 (1K) - Group of 8, upper left side of Propeller
  - R5 (1K) - Group of 8, upper left side of Propeller
  - R6 (1K) - Group of 8, upper left side of Propeller
  - R7 (1K) - Group of 8, upper left side of Propeller
  - R8 (1K) - Group of 8, upper left side of Propeller

- R9 (1K) - Group of 8, upper left side of Propeller
- R18 (1K) - Group of 3, bottom right side of PIA
- R14 (560) - Group of 3, bottom right side of PIA
- R17 (220) - Group of 3, bottom right side of PIA
- R1 (220) - Top Center of board \*\*Already installed with Power supply!\*\*
- R23 (3.3K) - Upper right side of 65C02 CPU
- R16 (220K) - Group of 2, just below Power jack, upper left side
- R15 (1M) - Group of 2, just below Power jack, upper left side
- R11 (3.3K) - Group of 3, top left of 65C02 CPU
- R12 (3.3K) - Group of 3, top left of 65C02 CPU
- R13 (3.3K) - Group of 3, top left of 65C02 CPU

G. Solder in the ps/2, and the composite connector.

- The composite connector *may* require some fitting. If so, you may have to either bend in the leads slightly so they align with the holes on the PC board
- In some rare cases, the leads of the composite connector might be too fat to slide fully into the mounting holes on the PC board. If this is the case, some GENTLE adjustment of the leads using an emery board or sandpaper will allow for a perfect fit before you solder the connector in place.
- Be sure to seat both connectors fully onto the PC board before soldering. Use masking tape to hold them in place if necessary until they are soldered.

H. Solder in the serial parts.

- The PE6502 serial interface is comprised of 5 polarized capacitors, 1 non-polarized capacitor, a transistor, a serial connector header, and a MAX232 (for which you've already installed the socket for in a previous step.)
  - Install the 5 capacitors (these are polarized parts!) as follows:
    - C25 (10uF) - Top-left of MAX232 (- lead to bottom pad)
    - C19 (10uF) - Bottom-left of MAX232 (- lead to bottom pad)
    - C18 (10uF) - Top-right of MAX232 (- **lead to TOP pad**)
    - C22 (10uF) - Middle-right of MAX232 (-lead to bottom pad)
    - C20 (10uF) - Bottom-right of MAX232 (-lead to bottom pad)
  - Install the Q1 transistor - at the top-right of the PC board, to the left of the Prop RST tac switch location. You will have to bend the legs of the transistor slightly so that it will fit in the mounting holes. Seat it in the PC board enough so that the leads are not in danger of shorting to anything (and the transistor package is close to the PC board) but not so close that there is great pressure on the leads. Be sure to align the flat on the transistor package to the flat mark on the PC board, and solder it into place.
  - Install the non-polarized capacitor, C26 (.1uF), to the left of the Q1 transistor.
  - Install the serial connector header, into its location at the bottom-right of the PC board. Just as you did with the chip sockets, use tape to hold this part fully seated into the PC board until you finish soldering it in place.

- I. Solder in the reset circuit, and tac switches.
- The reset circuit is comprised of 3 capacitors, the LM555 timer chip (for which you've already installed the socket and decoupling capacitor for in previous steps), and two tac switches.
    - Install the 3 capacitors (these are polarized parts!) as follows:
      - C16 (10uF) - above of LM555 (- lead to left pad)
      - C24 (.1uF) - bottom-left of LM555 (not polarized!)
      - C23 (.1uF) - bottom-right of LM555 (not polarized!)
    - Install the 2 reset tac switches into their locations. The tac switches are wider than they are tall, and therefore will only fit with the widest part of the switch oriented horizontally on the board. Insure these are installed fully seated into the PC board.
      - CPU Reset switch - on the left side of PC board just above the expansion header.
      - Prop RST switch - on the top-right side of the PC board just above the Propeller plug header.
- J. Solder in the CPU oscillator, and the Propeller crystal.
- OPTIONAL: If you would like the option of changing your PE6502 clock speed between 1MHz, 2MHz, and 4MHz (not recommended) obtain a 16-pin chip socket, and remove all inside pin legs so only the perimeter pins remain. This will allow the socket to be installed where the oscillator needs to go on the PE6502 PC board, and the oscillator can be plugged into that socket.
  - Install both oscillator and crystal parts so that they are flat against the PC board.
  - The oscillator MUST be installed with the right-angle corner (pin 1) installed in the top-left oscillator pad (the other 3 corners are rounded.)
  - The crystal is not polarized and can be installed in either direction.
- K. Solder in the expansion header, and the prop-plug header.
- Install the expansion header into its location along the left-side of the PC board. Just as you did with the chip sockets, use tape to hold this part fully seated into the PC board until you finish soldering it in place.
  - Install the Propeller plug programming header into its place at the top-right of the PC board. This is a right-angle header, so be sure to orient the header so that the base sits fully seated into the PC board with its legs into the mounting holes straight. On top of the base, the pins should make a right-angle, and then protrude off the right-side of the PC board to facilitate connection to a Propeller plug interface.
- L. Check for cold solder joints, solder bridges, etc.
- Check in the appendix section for soldering newbs for more information. Essentially you're looking for a not-completely-formed solder joint (no meniscus, not fully penetrating joint, cracked looking, not shiny)
  - If you find any bad/cold solder joints, touch them up now until they meet your approval.

- Remove any solder bridges you find with desoldering braid. Ensure the previously bridged joints are now un-bridged, but good solder joints.
- M. Clean off the PE6502 of flux.
- Using rubbing alcohol and Q-tips, clean off the flux that inevitably splattered all over the PE6502 board while you were soldering.
    - Dip a fresh Q-tip into the alcohol, then use it to scrub away the flux splatters.
    - Use a fresh, non-dipped Q-tip to go back and dry off any remaining alcohol on the board.
    - Repeat the alcohol dipped Q-tip scrub, then dry Q-tip scrub until no flux, oily-looking swirls/smudges remain.
    - This process also helps to remove tiny splatters of solder from the board, removing them as a possible source of a short later.
    - An old, clean but about to be thrown-away t-shirt, or other lint-free cloth can then be used to help remove any remaining lint from the Q-tips.
    - Ensure the board is clean and dry before you continue to the next step!
- N. Last second checks before the chips are plugged in.
- All polarized components installed in proper orientation.
  - No un-trimmed component leads still exist.
  - All parts are installed.
  - Power switch option is either installed, or leads were installed and soldered (and trimmed!) to keep the PE6502 in the “ON” position.
- O. Plug in the chips.
- Be sure to plug all chips into the proper location, with the correct orientation (chip notch or pin 1 indicator matches socket and board pin 1 indicators.)
  - Before you attempt to plug in a chip, you might have to bend all legs on each side to bring them closer to a 90 degree angle with the chip body (i.e., the pins might be too spread out, and need to be brought closer together so they’ll easily align with the socket).
    - This is most easily accomplished by holding a chip by its body, and one whole side at a time, use a table surface (or piece of wood) to GENTLY bend all pins closer to the opposite side pins.
    - Only do this a little bit at a time- switching sides to obtain an even bend of both sides towards each other, and stopping when you’ve got a good alignment to plug the chip into its socket.
    - Too much bending (admittedly to a sharp angle) and back will weaken the pin, possibly causing it to break off, rendering the chip useless.
  - CAREFULLY insert the chip into its socket, ensuring that all legs are entering the socket in their individual place, centered into the socket opening.
    - If any individual lead is not aligned so that it will go into its socket, stop, adjust it with needlenose pliers GENTLY, and then try again.
    - Once you are certain that all pins are aligned with their individual socket, apply pressure to the top of the chip to seat it fully in its socket.

- After the chip is fully seated, verify that all chip leads went fully into their socket and are not bent, etc. (bent pins have caused LOTS of issues!)
- P. The smoke test!** The assembly steps are essentially done. All that remains is that first, super-cautious power-on, watching closely to ensure nothing goes “POP!” when you power it on!

In the old days, a smoke test was just that- to ensure that nothing caught on fire during the first power up! While it's unlikely your PE6502 will catch fire, be ready to cut the power immediately if you see something that appears to be drastically going wrong.

If your PE6502 passes this smoke test, power it back off, connect your keyboard, composite monitor/TV, and your serial harness. Your PE6502 is ready for use!

**\*\*NOTE\*\*** When connecting the serial harness to the serial header, be mindful of the ribbon cable- which has a red stripe on one side of it. This red stripe indicates pin 1, and should be facing the left side (aligned with the pin 1 marking on the PC board for the serial header.)

**\*\*NOTE\*\*** Other serial terminal programs, such as Terminate, and PuTTY will work, but we've used Tera Term (see Appendix section “Where to Get More Information”/ web links for download information) with great success. Here are the Tera Term settings known to work well with the PE6502 computer:

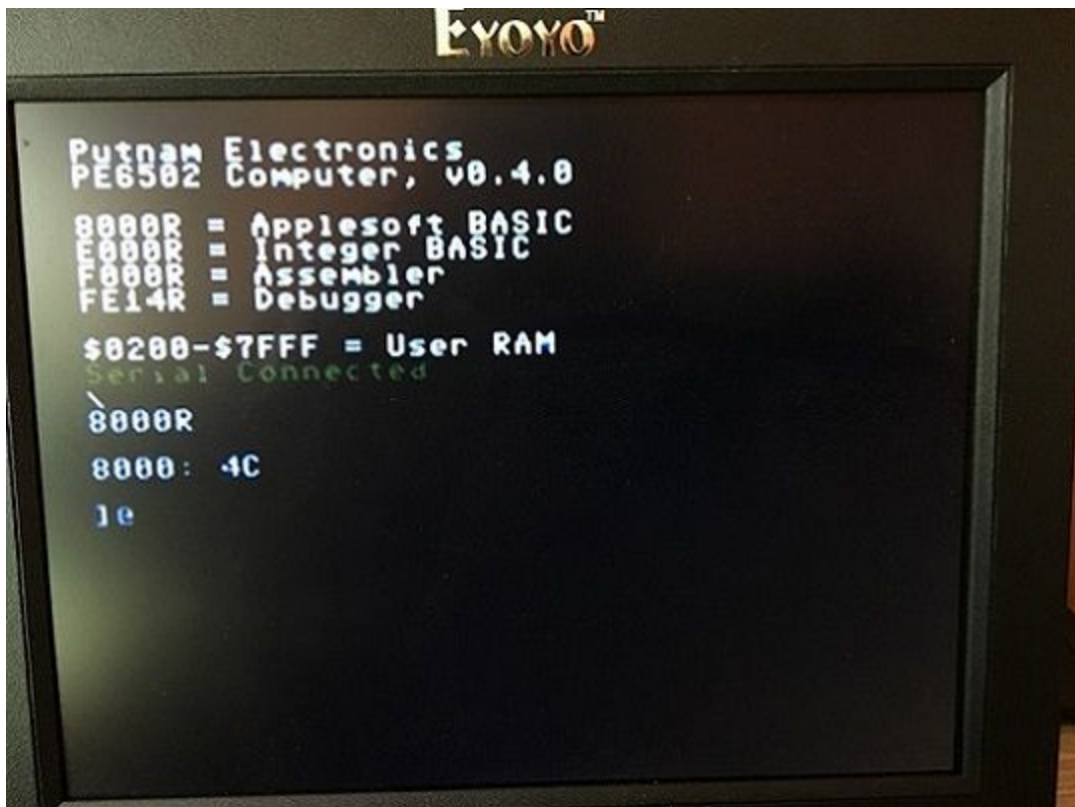
The screenshot shows the 'Tera Term: Terminal setup' dialog box. It contains several settings: 'Terminal size' is set to 40 x 24 with 'Term size = win size' checked; 'New-line' settings show 'Receive' as CR+LF and 'Transmit' as CR; 'Terminal ID' is set to VT100; 'Answerback' is empty; 'Coding (receive)' and 'Coding (transmit)' are both set to UTF-8; 'locale' is set to american; and 'CodePage' is set to 65001. There are checkboxes for 'Local echo' and 'Auto switch [VT<->TEK]' which are unchecked. Buttons for 'OK', 'Cancel', and 'Help' are on the right.

The screenshot shows the 'Tera Term: Serial port setup' dialog box. It contains settings for the serial port: 'Port' is COM4; 'Baud rate' is 115200; 'Data' is 8 bit; 'Parity' is none; 'Stop' is 1 bit; and 'Flow control' is hardware. There is a 'Transmit delay' section with '1 msec/char' and '1 msec/line'. Buttons for 'OK', 'Cancel', and 'Help' are on the right.



## IV. You're done! ENJOY!

Hey, you did it! You've now got a working computer, that you've built yourself! Now, have fun with it! Go to the [putnamelectronics.com](http://putnamelectronics.com) forum, and talk with the rest of us users/enjoyers of the PE6502! Tell us about what hardware you're using your computer with, software you're using, and what software you'd like to make. Talk about the hardware expansions you would like to see. And, if you can, show young people/old people/kindred spirits this computer- use it to teach, use it to learn.



# A1. Appendix I - Now that I've built this thing, how do I actually use it?

This really is a simple computer. Upon power on, it starts in the monitor program (also known as "Woz Mon".) This program allows you to view and modify the contents of RAM, and view the contents of ROM. The power up system header gives you an abbreviated memory map, showing you where the main programs are in ROM, and where user RAM is located.

To view a memory address (ROM or RAM), simply type that address at the monitor prompt (a backspace, with a blinking at sign cursor), and hit enter. To view a range, type the start address, a period, and the stop address and hit enter. To modify the contents of an address in RAM, type that address, a colon, and the contents in two-hexadecimal byte code, and then hit enter. Multiple follow on bytecodes in incrementing address locations can be entered after the initial entry, by separating them with a space, and hitting enter when you are done.

To run a program in RAM or ROM, enter the start address, followed by an R, and then hit enter. For example, to start Integer BASIC, type E000R (and then hit enter.) Notice the prompt changes to a greater-than sign. You're now in Integer BASIC! Type CALL-256 (and then hit enter) to exit. Typing 8000R (and then hitting enter) will start Applesoft Lite BASIC (notice the right bracket prompt.) Again, type CALL-256 (and then hit enter) to exit back to the monitor. The Krusader Assembler (and also debugger) both start in the same way, but both exit by typing a dollar sign, and then hitting enter.

You can always reset the CPU, and also the Propeller terminal, by pressing their respective reset buttons.

Using the "Tera Term" terminal program (see Appendix section with useful links), you can load a program into memory, by using the File menu -> "Send File". Then browse to the text file you wish to send (if it is in machine code, make sure your PE6502 is in the monitor program first! Likewise, if the program you are sending is in BASIC, make sure your PE6502 is in the proper BASIC before sending the file- otherwise you'll get lots of errors and have to reset!) You can save too, for example, if you're in BASIC, type LIST and hit enter (while you're connected to serial and have the teraterm terminal window echoing your screen output.) Next, after the listing completes, simply highlight in teraterm the program, copy and paste it to a text file, and save that file.

For in-depth instructions for the individual PE6502 applications in ROM, please see the links section elsewhere in this document for more in-depth, dedicated guides.

**\*\*NOTE\*\*** For full-size schematics, please refer to the dedicated schematics file, located on the putnamelectronics website PE6502 product page.





## A3. Appendix III - Bill of Materials

**\*\*NOTE\*\*** for an .xls version of the Bill of Materials, please download from the PE6502 page in the Products section of the putnamelectronics.com website.

**\*\*NOTE\*\*** all prices listed are from the vendor at the time of design, and are ABSOLUTELY not guaranteed- these are subject to change. Please contact Putnam Electronics if a part is missing from your kit- we will send you this missing part free of charge. Please purchase replacement parts directly from the vendor, linked in the Appendix section "Where to Get More Information"/ web links.

1	Part #	Value	Description	Mouser Part Number	Price Quantity of 1
2	C1	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
3	C2	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
4	C3	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
5	C4	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
6	C5	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
7	C6	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
8	C7	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
9	C8	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
10	C9	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
11	C12	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
12	C13	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
13	C14	10uF	CAPACITOR	<a href="#">647-UPW1H100MDD1TD</a>	\$0.25
14	C15	10uF	CAPACITOR	<a href="#">647-UPW1H100MDD1TD</a>	\$0.25
15	C16	10uF	CAPACITOR	<a href="#">647-UPW1H100MDD1TD</a>	\$0.25
16	C17	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
17	C18	10uF	CAPACITOR	<a href="#">647-UPW1H100MDD1TD</a>	\$0.25
18	C19	10uF	CAPACITOR	<a href="#">647-UPW1H100MDD1TD</a>	\$0.25
19	C20	10uF	CAPACITOR	<a href="#">647-UPW1H100MDD1TD</a>	\$0.25
20	C21	100uF	CAPACITOR	647-UPW1J101MPD	\$0.31
21	C22	10uF	CAPACITOR	<a href="#">647-UPW1H100MDD1TD</a>	\$0.25
22	C23	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
23	C24	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
24	C25	10uF	CAPACITOR	<a href="#">647-UPW1H100MDD1TD</a>	\$0.25
25	C26	.1uF	CAPACITOR	594-K104M15X7RF53L2	\$0.10
26	D1	1N4001	DIODE	625-1N4001E-E3/54	\$0.34
27	EXPANSION	6502_EXPANSION_HEADER	40 pin (2x20) male hdr (buy 80pin & mod)	<a href="#">571-41037770</a>	\$2.60
28	JP1	DC POWER	2.1mm DC male - Power Jack	992-CON-SOCJ-2155	\$1.00
29	PROP-PLUG	PROP-PLUG	1x4 male PIN HEADER	517-929648-01-04-I	\$0.47
30	PS2	KEYBOARD	PS2 Connector	eBay	\$0.45
31	PWR	PWR LED	LED (green, rectangle)	667-LNG351GKG	\$0.48
32	Q1	2N3904	NPN Transistor	512-2N4401BU	\$0.21
33	R1	220	RESISTOR, American symbol	660-CF1/4CT52R221J	\$0.15
34	R2	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
35	R3	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
36	R4	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
37	R5	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
38	R6	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
39	R7	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
40	R8	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
41	R9	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
42	R10	3.3K	RESISTOR, American symbol	660-CF1/4CT52R332J	\$0.15

	Part #	Value	Description	Mouser Part Number	Price Quant
43	R11	3.3K	RESISTOR, American symbol	660-CF1/4CT52R332J	\$0.15
44	R12	3.3K	RESISTOR, American symbol	660-CF1/4CT52R332J	\$0.15
45	R13	3.3K	RESISTOR, American symbol	660-CF1/4CT52R332J	\$0.15
46	R14	560	RESISTOR, American symbol	660-CF1/4CT52R561J	\$0.15
47	R15	1M	RESISTOR, American symbol	660-CF1/4CT52R105J	\$0.15
48	R16	220K	RESISTOR, American symbol	660-CF1/4CT52R224J	\$0.15
49	R17	220	RESISTOR, American symbol	660-CF1/4CT52R221J	\$0.15
50	R18	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
51	R19	3.3K	RESISTOR, American symbol	660-CF1/4CT52R332J	\$0.15
52	R20	3.3K	RESISTOR, American symbol	660-CF1/4CT52R332J	\$0.15
53	R21	100	RESISTOR, American symbol	660-CF1/4CT52R101J	\$0.15
54	R22	100	RESISTOR, American symbol	660-CF1/4CT52R101J	\$0.15
55	R23	3.3K	RESISTOR, American symbol	660-CF1/4CT52R332J	\$0.15
56	R25	1K	RESISTOR, American symbol	660-CF1/4CT52R102J	\$0.15
57	R26	10K	RESISTOR, American symbol	660-CF1/4CT52R103J	\$0.15
58	R27	10K	RESISTOR, American symbol	660-CF1/4CT52R103J	\$0.15
59	RP1	3.3K	SIL RESISTOR	652-4607X-1LF-3.3K	\$0.33
60	S1	CPU RESET	OMRON SWITCH	<a href="#">653-B3F-1000</a>	\$0.25
61	S2	PROP RST	OMRON SWITCH	<a href="#">653-B3F-1000</a>	\$0.25
62	SERIAL	2x5 pin header	10 pin (2x5) male PIN HEADER	(source from 80 pin header)	\$0.00
63	SW1	Power Switch	n/a (solder switch wires to)	n/a	\$0.00
64	SW2	Power Switch	n/a (solder switch wires to)	n/a	\$0.00
65	TV	RCA_PHONO	Yellow PHONO RCA Jack	534-589	\$1.39
66		40 pin chip socket	40 pin DIP socket	575-199640	\$1.37
67	U1	65C02 CPU	WDC 65C02	955-W65C02S6TPG-14	\$6.95
68		40 pin chip socket	40 pin DIP socket	575-199640	\$1.37
69	U2	6821 PIA (65C21)	MICROCONTROLLER/MEMORY DEVICE	eBay (Mouser 65C21S=\$5.95)	\$5.99
70		28 pin chip socket	28 pin DIP socket	575-199628	\$0.96
71	U3	27C256 ROM	MEMORY	556-AT27C256R70PU	\$1.79
72		28 pin chip socket	28 pin DIP socket	575-199628	\$0.96
73	U4	62256 SRAM	256K (32K x 8) CMOS-Static RAM	913-AS6C62256A-70PCN	\$2.10
74		16 pin chip socket	16 pin DIP socket	575-199316	\$0.55
75	U5	74HCT138N	3-line to 8-line DECODER/DEMULTIPLEXER	<a href="#">595-SN74HCT138N</a>	\$0.58
76		14 pin chip socket	14 pin DIP socket	<a href="#">575-199314</a>	\$0.48
77	U6	74HCT00N	Quad 2-input NAND gate	<a href="#">595-SN74HCT00N</a>	\$0.46
78		14 pin chip socket	14 pin DIP socket	<a href="#">575-199314</a>	\$0.48
79	U7	74HCT04N	Hex INVERTER	<a href="#">595-SN74HCT04N</a>	\$0.46
80		14 pin chip socket	14 pin DIP socket	<a href="#">575-199314</a>	\$0.48
81	U8	74HCT32N	Quad 2-input OR gate	<a href="#">595-SN74HC32N</a>	\$0.46
82		8 pin chip socket	8 pin DIP socket	<a href="#">575-199308</a>	\$0.27
83	U9	LM555N	555 TIMER	<a href="#">512-LM555CN</a>	\$0.41
84		16 pin chip socket	16 pin DIP socket	575-199316	\$0.55
85	U10	MAX232	RS232 TRANSCEIVER	595-MAX232N	\$1.08
86		40 pin chip socket	40 pin DIP socket	575-199640	\$1.37
87	U12	P8X32A-D40	Parallax Propeller	619-P8X32A-D40	\$7.99
88		8 pin chip socket	8 pin DIP socket	575-199308	\$0.27
89	U13	24LC256P	Serial EEPROM	579-24LC256-I/P	\$0.99
90	VR1	7805	Positive VOLTAGE REGULATOR	512-LM7805CT	\$0.61
91	VR2	3940	Positive VOLTAGE REGULATOR	926-LM3940IT-3.3NOPB	\$1.65
92	XTL1	1.0MHz	CRYSTAL RESONATOR	774-MXO45-3C-1.0	\$2.07
93	XTL2	5.0MHz	CRYSTAL	520-HCU500-20X	\$0.53
94	(XTL1 Skt)	4 pin OSC socket	Socket 14pin size 4 pin	535-1107741	\$1.14
95	(N/A)	(Serial Connector/Harness)	Connects to serial header on PE6502, ends in DB9	(jameco part # 355688)	

96. (N/A)

(N/A)

PE6502 2-layer PC board

(N/A)

## A4. Appendix IV - Soldering Tips for Newbs

Soldering is the mechanical and electrical connection of two (or more) electronics devices.. To be done properly, good thermal control is a must! Thermal control involves both the soldering iron being regulated to the proper temperature, and the heat only being applied for just long enough for a solid connection to be made (but not too short, or else a faulty solder joint can be created!) Two things are needed here: A temperature regulated soldering iron (and not one of those el-cheapo soldering irons you get at Walmart, with just a plug and no controls!) and also the skill to use the soldering iron properly without burning the board or components. Plus, a clean iron which will prevent contaminated joints, and the proper solder (again, get 60/40 - that's 60% tin, 40% lead, with rosin flux core, in .032 inch diameter.) Get GOOD solder!

Too long on a PC board/connection with a soldering iron will melt the phenolic resin (plastic) the PC board is made of, causing the copper trace and/or pad beneath the connection to delaminate, ruining the board. Too short on the PC board/connection with a soldering iron, and a "cold" solder joint will be created- it's signature is a milky, dull appearance, that will have a high resistance and a poor mechanical connection. A proper soldering joint will not burn the PC board or components, yet will be shiny in appearance.

The main idea: Assemble the joint to be soldered mechanically. You then want to "tin" (lightly coat) the clean soldering iron tip, (once it is up-to-temperature- around 675 degrees F) with some fresh solder. Then, apply the tip of the soldering iron to the joint, so that it is simultaneously heating the solder pad on the PC board, and the component lead to be soldered. While you are heating the joint, touch the joint with a strand of solder from your solder reel, and a perfect soldering joint should happen as the tinned iron "pulls" the fresh solder into the headed joint. Then remove the iron from the joint, and continue holding the joint for a few seconds while it cools long enough for the solder to solidify in a shiny joint. Don't blow on it to cool- let it cool on its own! REMEMBER: not too long, or else you will melt the PC Board and delaminate the pad or a trace. Also, try not to push too much solder into the joint (you want the solder to flow from the solder reel into the joint), as pushing it can put too much solder on the other side of the PC board. However, you do want solder going all the way through the joint.

It is a good idea to trim leads that are sticking through a soldered PC board joint. This prevents the long leads from touching other items/leads, and causing a short circuit. HOWEVER, never cut a lead too short (cutting into the solder "meniscus", that bit of a solder cone that surrounds the wire or lead coming through the joint.) Doing so will weaken the joint, and cause a reliability problem later.

**\*\*It makes sense for someone new to soldering to PRACTICE, on an inexpensive piece of copper pad "perf board", available online from many parts suppliers, Radio Shack (if you can**

still find one!), Microcenter, Amazon, etc. Don't risk your fancy new PE6502 PC Board if you're not feeling confident. Everyone has to learn somehow, and the perf board is the perfect way. Buy some cheap resistors, sockets, and other parts (or re-use parts clipped off dead electronics) to practice soldering components into a board.

Also, an inexpensive solder kit, from an electronics vendor (like Adafruit) can provide good practice. Try this one:

<https://www.adafruit.com/product/184>

Excellent advice/tutelage is available at the following website (specifically section 1b-2c, but the whole page is very good!): <http://www.pinrepair.com/begin/index.htm#intro2>

Finally, search on YouTube to find good tutorials/examples of soldering.



## A5. Appendix V - What to do if for some reason it doesn't work?

Ok, if you're here, you might be having an issue. Take a deep breath, and relax. It's no indication of doom if your project doesn't work at first power on, I promise you! It's not uncommon for the issue to be something simple (a forgotten part, an un-soldered joint, etc.) You'll get your computer working!

First, let's start with a thorough visual inspection of the PC Board, under good light, with magnification. You're looking for missing parts, an un-soldered joint, a long, untrimmed lead shorting on something, a bridged solder joint (too much solder on a joint, so that it is connecting to the adjacent joint where no connection should be made). Also look for a little ball of solder that perhaps has splattered off your iron, and is shorting something. Verify all chips and polarized components are installed in the proper orientation. Verify that all components are installed in the correct place (especially resistors- the correct value resistors are installed in the correct place). Verify that with the chips- that all legs are properly installed in their sockets. Sometimes chip pins can bend upon installation into the socket, so that they are not making connection with the socket.

Second, if your visual inspection turned up nothing (and if the board is doing nothing, or part of the board is doing nothing) re-verify the power supply is getting the right voltages to each component. During assembly you should have already verified your 5 volt rail, and 3.3 volt rail, and all chip power supplies. But, if you're having trouble, this step never hurts.

If you're still having trouble, go to our website ([putnamelectronics.com](http://putnamelectronics.com)) and shoot us an email. We'll contact you and help you troubleshoot from there. We'll get you going!

## A6. Appendix VI - Interesting Tidbits About The Chips

There are 12 micro-chips (not counting the 2 different voltage regulator packages!) in the PE6502.

65c02 microprocessor - A very popular, general-purpose 8-bit microprocessor. It is the currently produced (and backwards compatible) variant of the MOS 6502 processor. It has an 8-bit data bus and registers, and a 16-bit address bus and program counter. First produced (in 6502 form) in 1975, it (or a variant of) has been used in the following devices/computers: Atari 2600, Atari 400/800, Apple 1/Apple II, Commodore PET/Vic-20/C-64, Nintendo Entertainment System to name a few.

6821 Peripheral Interface Adapter - First designed in the 1970s to be a glueless connection to a Motorola 6800 (a competing microprocessor of the same era as the 6502) style bus, it provides 20 Input/Output lines. These lines are organized into 2, 8-bit, bi-directional ports (or 16 individual, general-purpose Input/Output lines), and 4 control-lines (for hardware handshaking, or just high/low output signals.)

62256 Static Random Access Memory (RAM) - a 262,144-bit device, organized as 32,768 (32K) words by 8-bit, asynchronous Static RAM. Fabricated with highly reliable CMOS technology, this memory is designed for low-power applications. SRAM is easier to implement, as it holds its values (while powered) without additional circuitry. This is unlike Dynamic RAM (DRAM), which was used in many 8-bit computers of the past, and required additional circuitry to be "refreshed" repeatedly to hold its contents.

27C256 Read Only Memory (ROM) - a 262,144-bit device, organized as 32,768 (32K) words by 8-bit, parallel interface Read Only Memory. This device is a "One Time Programmable" (OTP), so once it is burned, it's programmed. This device holds the PE6502 ROM programs: The WOZ monitor (this is the program that is running when you first power the PE6502 system on), Integer BASIC, Applesoft Lite BASIC, Krusader Assembler and debugger.

Parallax P8X32A Propeller - a modern, 8-core microcontroller. Each core (called a Cog) is a 32-bit, reduced instruction set computer (RISC) CPU, designed to share common shared memory. In 2014, Parallax released the Propeller hardware and software tools as open-source under GNU public license. This incredibly versatile chip serves as an onboard terminal, and display on the PE6502. It can do MUCH more! Parallax Propellers have been the basis of entire hobbyist computers, and can even emulate other computers and devices, such as the Commodore SID sound chip.

24LC256P Serial Electrically Erasable Programmable Read Only Memory - This device serves as onboard, electrically erasable and reprogrammable ROM memory for the Parallax Propeller. This is a standard ROM device frequently paired with the Parallax Propeller.

MAX232 RS232 Transceiver - created in 1987, this device converts signals from a RS-232 standard serial port, to Transistor-Transistor Logic (TTL) signals that can be used to interface directly with other microchips in the PE6502 computer. Part of this package converts the TTL signals used onboard the computer to the 7.5 volt signals needed for serial communications off the board (part of the RS-232 standard.)

LM555N Timer - created in 1972, this classic integrated circuit has been used in literally thousands of applications. It can serve as a timer, a pulse generator, an oscillator, a flip-flop, you name it! It is used in the PE6502 computer to hold the 65c02 CPU in reset mode when the power is first switched on, long enough for the Propeller chip to download and start executing its terminal emulator code. Then the 555 timer allows the 65c02 to boot. The 65c02 would otherwise boot before the terminal, and would require a manual CPU reset before the PE6502 computer was ready to use.

7400 Quad 2-input NAND gate - the 7400 Transistor-Transistor Logic (TTL) chip package contains 4, 2-input NAND gates. This is used as part of the PE6502 "GLUE" logic, so that when a specific address is selected in ROM, the ROM chip is selected and put on the PE6502 data bus. It is also used in the RAM Read/Write control circuit.

7404 Hex Inverter - the 7404 Transistor-Transistor Logic (TTL) chip package contains 6, single input, single output inverter gates. This is used as part of the PE6502 "GLUE" logic, so that when a specific address is selected in ROM, the ROM chip is selected and put on the PE6502 data bus. It is also used in the CPU reset circuit, and the PIA circuit.

7432 Quad 2-input OR gate - Transistor-Transistor Logic (TTL) chip package contains 4, 2-input OR gates. This is used as part of the PE6502 "GLUE" logic, so that when a specific address is selected in ROM, the ROM chip is selected and put on the PE6502 data bus.

74138 3-line to 8-line Decoder/Demultiplexer - Transistor-Transistor Logic (TTL) chip package contains 4, 2-input NAND gates. This is used as part of the PE6502 "GLUE" logic, so that when a specific address is selected in ROM, the ROM chip is selected and put on the PE6502 data bus.

## A7. Appendix VII - How to "flash" the Propeller SW

This section will walk you through how to "flash" (or reprogram) the Parallax Propeller ROM, so that you can save customizations to the Parallax Propeller terminal firmware, and also so that you will know how to upgrade the PR6502 terminal firmware should a newer version of the firmware be released.

- a) Ensure you've installed "Propeller Tools" on your host computer that you use to connect to your PE6502 via serial interface. To download Propeller Tools, navigate to the Parallax website, P8X32A-D40 Propeller support page (<https://www.parallax.com/product/p8x32a-d40>), and download Propeller Tool Software (for Windows), and also the Parallax Serial Terminal. Install these on your Windows machine (Use this link to download the MacOS version if you use Mac: <https://www.parallax.com/downloads/propelleride-software-mac>; Use this link to download the Linux version if you use Linux: <https://www.parallax.com/downloads/propelleride-software-linux>)
- b) Ensure your serial port is connecting your PE6502 to your host computer where you've installed Propeller Tools. Verify that the Propeller Tools is able to talk to the PE6502's Propeller (the PE6502 must be powered on!) using the Propeller Tools Run menu -> "Identify Hardware..." menu setting. This should confirm the Propeller device found/available. If not, double check that your PE6502 is powered on, and that your serial interface is connected and properly installed.
- c) Ensure you have all required ".spin" files (the "Top" spin is the main Propeller program, and any Object .spin files that the top spin references) in the same directory. Open the Top spin file, using the Propeller Tools File menu -> "Open..." Browse to your Top .spin file, select it, and click "Open"
- d) Confirm the Top .spin file you've selected is open in the Propeller Tools editor, and then select from the Run menu -> Compile Current -> "Load EEPROM" You should see status as the Propeller .spin code is compiled, loaded to the Propeller RAM, and finally programmed into the Propeller's 24LC256P ROM chip.
- e) Verify a success message is received. Your Propeller has now been "flashed"!

## A8. Appendix VII - Where To Get More Info/Important Links

Putnam Electronics website:  
[putnamelectronics.com](http://putnamelectronics.com)

Suggested Serial adaptor, Tera Term serial terminal software, power supply, etc.:  
<http://www.usconverters.com/usb-serial-rs232-adapters>  
<https://ttssh2.osdn.jp/>  
<http://www.mouser.com/ProductDetail/Gravitech/9V1A-21-POS-WALL/?qs=sGAEpiMZZMvq007EO%252bXAYafurk4XukHd>

electronics supplies:  
<http://www.mouser.com/>  
<https://www.digikey.com/>  
<http://www.jameco.com/>  
<https://www.adafruit.com/>

Programming Guides/Websites:  
<https://skilldrick.github.io/easy6502/>  
[https://en.wikibooks.org/wiki/6502\\_Assembly](https://en.wikibooks.org/wiki/6502_Assembly)  
<http://www.sbprojects.com/projects/apple1/develop.php>  
<http://www.willegal.net/appleii/apple1-software.htm>

Krusader Specific:  
<http://manualzz.com/doc/6691677/replica-1-krusader---user-manual>

Integer BASIC Specific:  
<http://www.woz.org/letters/apple-basic>

Applesoft Lite Specific:  
<https://cowgod.org/replica1/applesoft/>

Apple 1 Manuals (helpful for monitor, and integer BASIC:  
<http://www.sbprojects.com/projects/apple1/download.php>

6502 Specific: (Go to documents section for datasheets!)  
<http://6502.org/>

Parallax Propeller Specific:  
<http://forums.parallax.com/categories/65>  
<http://obex.parallax.com/>  
<https://www.parallax.com/downloads/p8x32a-propeller-datasheet>

## A9. Appendix VIV - Acknowledgements

I'd like to thank some people, (listed in no particular order,) without whom this project would not have been possible:

You- the customer for the PE6502 computer.

Ben Heckendorn - who's show (available on Element 14 and also YouTube) first inspired the idea that it would be possible to build a simple 6502 based computer.

Vince Briel - Vince's work has inspired me to no end. The original purveyor of high-quality kits, blending vintage-inspired computers with modern tech, into low cost and easy to assemble products.

Steve "Woz" Wozniak - Woz's write-up in the forward section of Tom Owad's "Apple 1 Replica Creation - Back to the Garage" made me realize that a single person really can understand a computer, and design their own. His simple monitor program, and Integer BASIC are marvels of functionality, simplicity, and space efficiency.

Jeff Tranter - Jeff's YouTube channel first made me aware of electronics kits, both Heathkit and also Briel Computers. His awesome presentation of the subject matter showed what was possible with these kits once they were built. They are usable machines with a huge library of vintage software!

Costas Skordis - Con's interest in the PE6502 inspired me to pull the project off the shelf and finish it/make it available to others. Con was a fearless test-pilot, the first person to actually assemble the PE6502 PC board (all that existed previously was the breadboard prototype!) Con also contributed heavily to the Propeller firmware used in the PE6502, adding fast serial connection with handshake, and helpful serial connection indicators to the software, adding colors, etc.

Ken Wessen - Ken's Krusader assembler and debugger are featured in the PE6502 system ROM, gave us permission to include this software. Ken's software is efficient, and adds great functionality to this computer.

Tom Greene - Tom's "AppleSoft Lite" BASIC works well with the PE6502 computer, is originally from dis-assembled Apple II code. Tom then removed the Apple II specific code removed, and added his own code.