Kit 25 - 4x4x8 RGB Tower

The heart of this blinkie is a 18F25K50 PIC produced by a company called Microchip. A PIC is a tiny, yet surprisingly powerful little computer. By itself, it can't do much – it needs some way to interact with the world – is done by giving it push buttons for "next pattern" and "previous pattern", and ways to communicate:

- To us – 128 RGB light emitting diodes (LEDs)
- From us – by push buttons to change the pattern up or down
- From us – by SD card
- To a computer – via USB

Each LED is individually addressable. Since each RGB LED is made up of three LEDs, there are 384 individual LEDs, each which can be displayed at 8 different brightness levels, allowing for 512 colors.

Right now (August, 2017) here is the latest on patterns:

- There are patterns built in to the PIC, both "interesting" ones, and a "one layer, one color" at-a-time test pattern.
- There can be patterns on an optional micro SD card.
- Eventually a (Windows?) program will be available allowing you to change the color and brightness of individual LEDs.
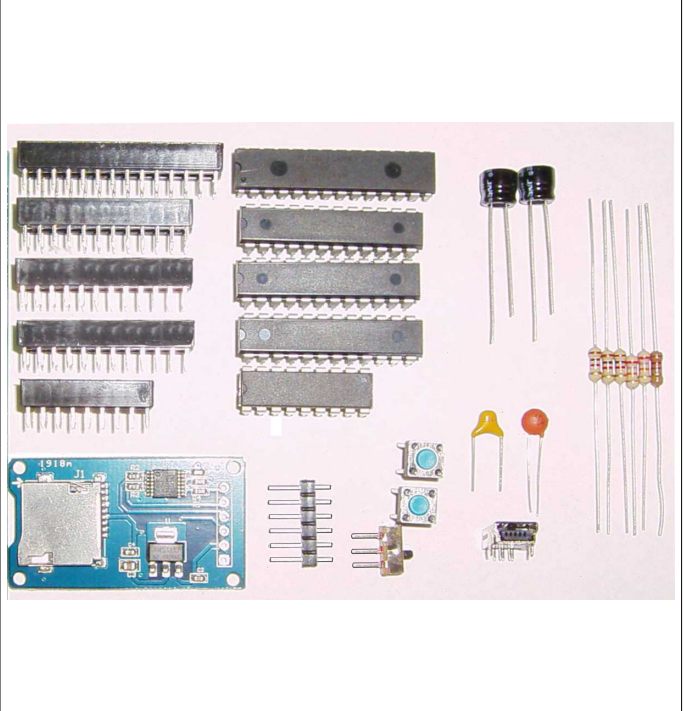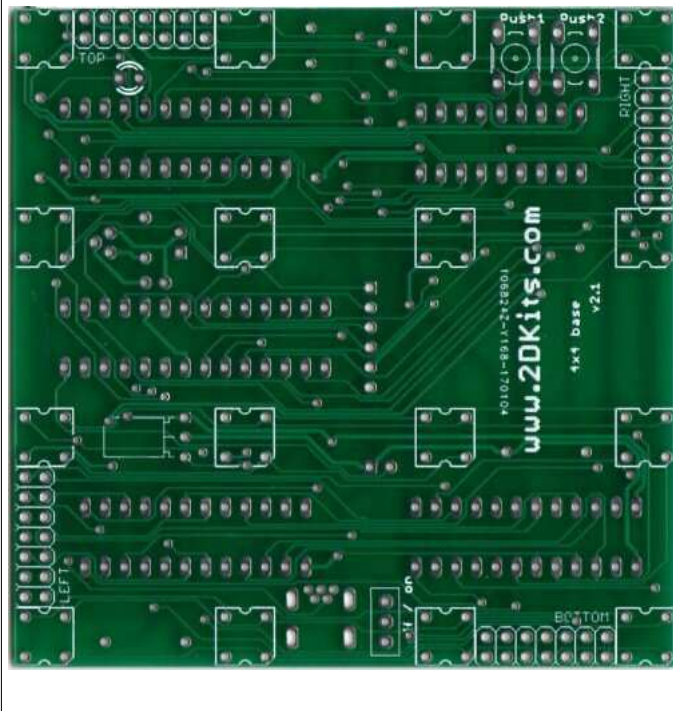
By building this blinkie, we hope you have a lot of fun!

Now, open up the kit and review the contents. There will be two packets.

In the first packet, looking from left to right, and top to bottom there should be the following parts:

1 - bottom driver circuit board for 16 LEDs	3 - 1K ohm resistors (**brown**, **black**, **red**)
1 - 28 pin socket	2 - 27K ohm resistors (**red**, **violet**, **orange**)
1 - 28 pin 18F2550 PIC chip (the "computer")	1 - 120 ohm resistors (**brown**, **red**, **brown**)
3 - 24 pin sockets	2 - 10V 220uF can capacitors (or "caps")
3 - 24 pin MBI5026 RGB column driver chips	1 - 0.33 uF capacitors (marked 334)
1 - 18 pin socket	1 - 0.1 uF capacitor (marked 10)
1 - 18 pin TD62783APG RGB row driver chip	2 - push buttons (4 pins)
1 - mini-USB socket	1 - 6-pin header
1 - small circuit board for micro SD card	1 - power switch (3 pins)
	1 - A/C USB power supply (not shown)

In the second packet, looking from left to right, and top to bottom there should be the following parts:

7 - Seven top circuit boards
    - we will refer to these as "waffle boards"
4 - long skinny leg circuit boards
	Bag, containing:
	   · 128 - RGB LEDs
	   · 4 - 14-pin angle header connectors
	   · 20 - 4-pin angle header connectors

Got everything to start? If you're building at a convention, the kit won't initially include the chips. Get the solder at the work table, and the chips from the staff after you solder your board.

Soldering Hints

Soldering is not like gluing; the solder forms an alloy with the metals to be connected that creates a stable electrical path and a certain amount of mechanical attachment. For the small connections on this project, a 25 or 30 watt soldering iron works well. Rosin core solder is used – the acid core solder sold for plumbing would eat your components in a short time.

Here's how to make a good connection:

- Prepare the connection. Bend the component lead slightly after it passes through the printed circuit board (this helps hold it in place while soldering).
- Prepare the tool. The soldering iron should be up to temperature. Clean the tip by quickly brushing it against a damp sponge or metal fiber pad. Melt a little solder (a 2mm length) onto the tip so it's shiny. This is called "tinning". The solder coating helps conduct heat from the tip to the connection.
- Place the tip in contact with the component lead and the printed circuit board pad.
- Place the solder against the connection directly opposite the tool. It should melt within 2 seconds, and flow around the connection. If it takes longer than that, you're not getting enough heat into the connection.

Any Questions? Contact us – dwayne@2dkits.com or drsulak@2dkits.com

- Keep the soldering iron in place until the solder flows freely and completely covers the connection. If the heat is removed too soon, the solder will tend to "ball up" and not stick well to the conductors. The solder connection should look "wetted", with concave shapes.

- Let the connection cool without movement at room temperature. This usually takes only a few seconds.

- If a connection is moved before it cools, it will take on a dull, satin look that is characteristic of a cold solder connection. A cold solder connection is fragile and conducts poorly – reheat the connection until the solder flows freely, and hold it still until it cools.

- Keep the tip of the soldering iron clean. Wipe off flux and excess solder regularly in the damp sponge or metal fiber pad, and re-tin if needed.

Assembly

You will notice these boards have a lot of holes.

There are two kinds of holes:
- those grouping pins together with a white outline, (called silk screening): the white outline shows the side on which to insert the part.
  - EXCEPTIONS: The base circuit board, the "waffle" boards, and the legs, all have white outlines on the OPPOSITE side – where the solder goes:

- Smaller holes with no outline around them are a special type of hole, called a **via.** It connects the electric circuit from one side of the board to the other side. You don't put anything in a **via**.
- Be careful not to make a solder bridge from some part's pin/lead to a via. Take your time and you shouldn't have any trouble.
- Please take special care when placing parts.
  - Is this the correct component?
  - Am I putting it on the correct side of the board -- inserted from the side with the white outline?
  - Is the orientation correct? (sockets, cylindrical capacitors, LEDs, and diodes have a "right way" and a "wrong way".   Resistors, the power switch, the push buttons, and the tiny capacitors do not.
  - Is it properly aligned? (Make sure a socket exactly matches the LENGTH (number of pins) as the holes in the board – it is easy to put one of say 18 pins, on a place meant for 24 or 28. However if you follow instructions we have you put the longest sockets in first, avoiding this.

Take your time – you are building a work of art! If you accidentally drip solder into a via (a hole in the board that has no component), as long as it isn't bridged to another pad, it's OK. You can leave it filled.
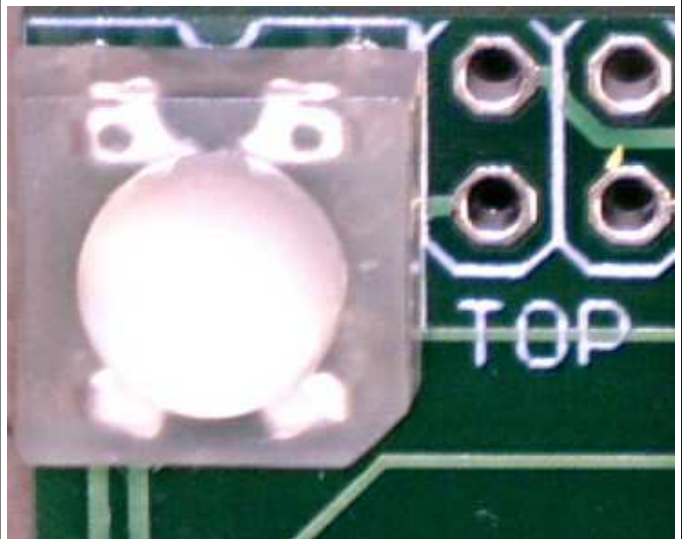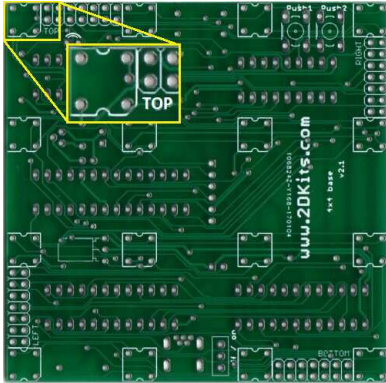
The steps you will be performing are:
- Build the base 4x4 LEDs
  - Test the base board
- Build the 7 additional layers of "waffle boards" and connect everything to the legs
  - Final testing of the completed tower.

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Now, on to the assembly!

Terminology: You will always be soldering a part or connector, to a solder pad on a circuit board.
We may refer to the part going through the hole to be soldered as a "pin", or "lead" – rhymes with "seed".

1. Orient the bottom driver board so the silk screening "TOP" is in the upper-left corner.
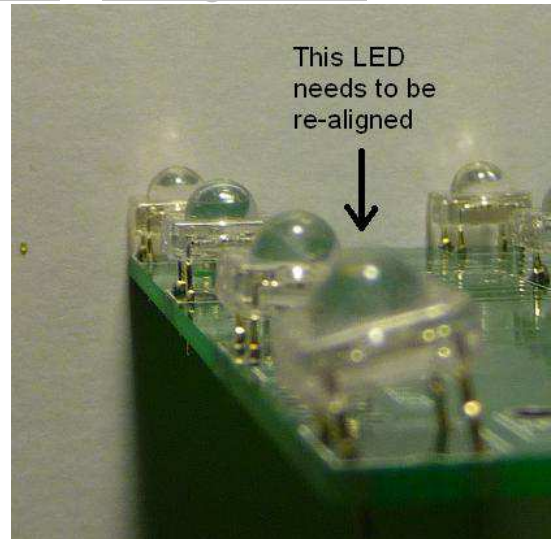

2. We will be inserting the LEDs.
    - The close-up photo shows one inserted with the all-important corner cut in the lower right.

In addition to checking the corner cut, you will see two "eyes" – holes – at the top of each LED.

3. Insert the 16 RGB LEDs. The LED corner cut **must** be in the lower right corner and **must** line up with the same cornercut printed in white on the circuit board!

4. Please recheck and make sure all 16 LEDs are oriented properly.

5. Place a piece of cardboard, or one of the "waffle board" circuit boards on top of the LEDs, hold them together, and flip it all over.
    - If you used a waffle board to hold the LEDS while flipping, slide the board with the LEDS diagonally a bit so the LEDs sit on the table, not the slippery waffle board.
    - You will be using this technique of flipping, later, when you insert LEDs into the waffle boards

6. Solder **one pin/pad** on each of the 16 LEDs. Flip it over and make sure they are all lined up correctly. . If they are not, re-melt the one solder connection and press it flat to the board.

7. If your LED looks like this, you will need to reheat the solder connection while gently pressing down on the LED to make it sit level on the board. Do this for any LEDs that are not level.

8. After inspection / straightening, solder the remaining 3 pins on each LED.
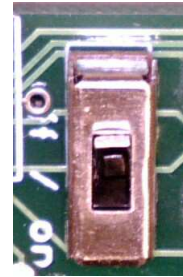

This LED needs to be re-aligned

9. Flip the board over to the LED side, and insert the power switch next to the "Off / on" notation. Inserting either direction is OK.

The switch falls out easily, so hold it in, flip the board over, and bend the pins to hold it to the board – the middle pin to one side, the end pins to the opposite side. Bend them about 30 degrees, not flat to the board.

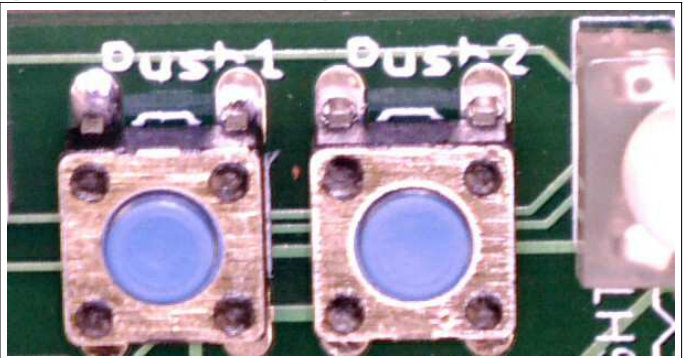Solder ONE pin, then make sure the switch is straight, re-melting the one connection if necessary.

When the switch is straight, solder the remaining two pins.

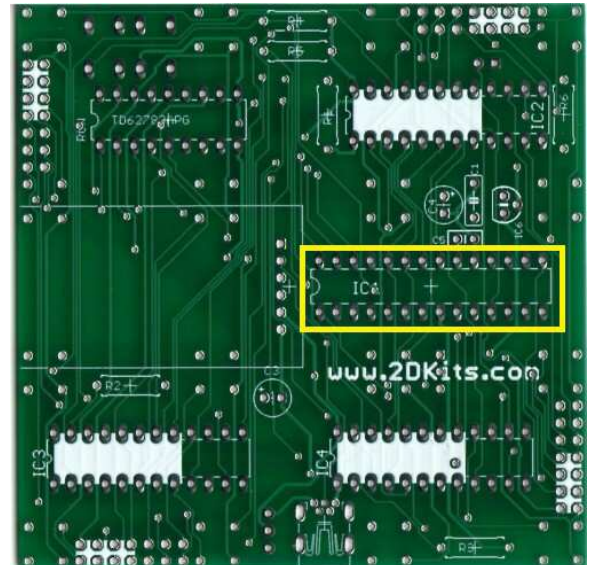10. Flip the board back over and insert the two push buttons.
    - They will "snap in" due to the bends already in the 4 leads – IF you push it in carefully.
    - Solder all 8 leads.

    This is a good time to note: ONLY the LEDS, power switch, and push buttons are inserted on the top side. Capacitors, resistors, sockets, and the angle-connectors for the legs, go on the bottom.

11. Flip the board to the bottom (match the photo at the right) and insert the 28-pin – the **biggest** of the five sockets, on the middle-right.
    - Make sure the **notch on one end** of the socket matches the notch on the printed outline on the board.
    - Hold the socket in and flip the board over, then bend one corner pin outward about 30 degrees, and the opposite corner pin outward the opposite way, to hold the socket from falling out.
    - Solder ONE corner pin, then make sure the socket is flat against the board, re-melting and pushing it tighter to the board if not.
    - Solder the opposite corner pin, again making sure the socket is flat against the circuit board.
    - Solder the rest of the socket pins – making sure you do NOT see the silk screen rectangular outline – that's on the socket side.

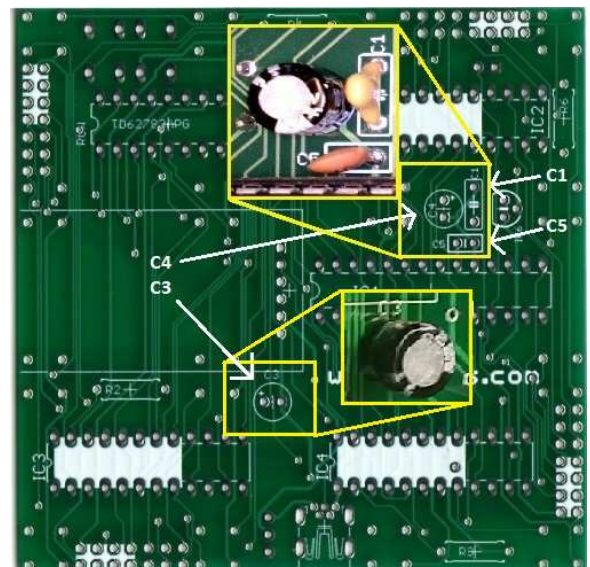12. Repeat above steps for the three 24-pin sockets then the 18-pin socket.

The large rectangular white painted parts show where the chips or angle connectors go if you were building the CUBE (4x4x4) base, which uses shorter chips and smaller legs to drive four layers.

13. Insert the can caps into C3 and C4. **Orientation is important.** Short lead, square pad, long lead, round pad. If these are soldered in backwards, they will dramatically self destruct when power is applied!
    - The stripe in C1 faces down
    - The stripe in C3 faces right

14. Flip the board back over. Insert the yellowish 0.33 uF capacitors (marked 334) into C1.   Insert the round brown 0.1 uF capacitor (marked 10) into C5.   Flip the board over and solder. Trim the leads.
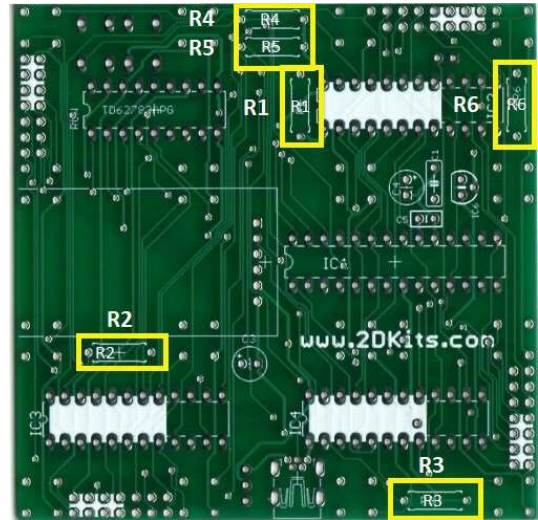
the sockets already inserted)

15. In the next few steps, resistors will be inserted. It is easier to insert them in you pre-bend the leads as shown. - if you have trouble reading them, use a magnifying glass – usually available at events 2Dkits participates in.

16. Orient the board as shown in the photo, and insert the resistors.
    - R1, R2, R3 – 1K ohm (**brown black red**)
    - R4, R5 – 27K ohm (**red purple orange**)
    - R6 – 120 ohm (**brown red brown**)
       - It does not matter which direction they are inserted, as long as the correct resistor is inserted into the correct board location.
       - Form the leads into a "V" after inserting, to hold them in place and make them easier to solder.
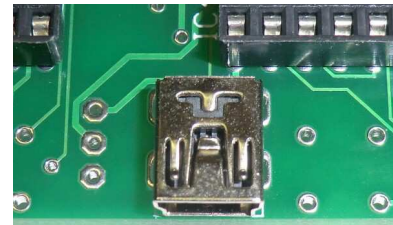
17. Flip the board
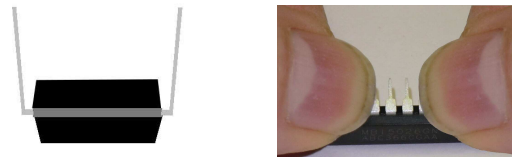   - solder the leads.
     - Trim the leads.

18. Flip the board over to the side with all the sockets, and insert the USB socket. Flip the board over.
      - solder the 4 larger legs of the USB connector case.
      - carefully solder the 5 tiny data pins of the connector.

We are now going to insert the five chips.

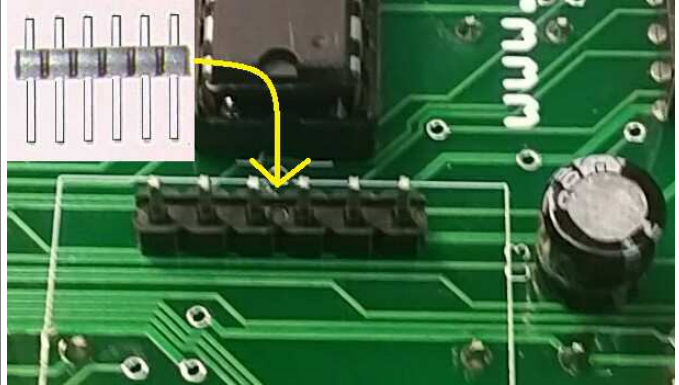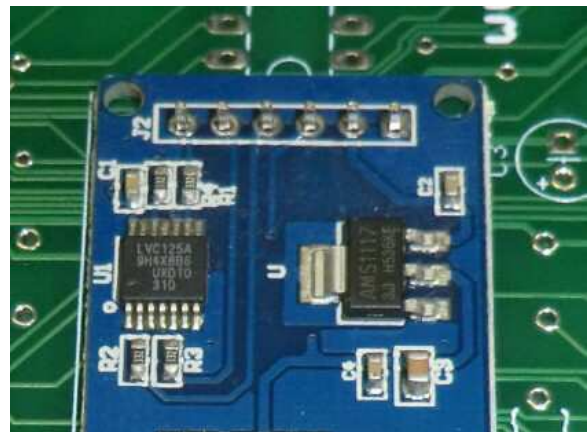|	
19. The chips come with the leads spread (left drawing), so place chip on the table as shown (right drawing), and push down and away from you a little to make the leads perpendicular. - Then do this with the other side's leads.	
20. Flip the board back to the socket side, and insert the chips in the sockets. There are 4 chips, but only 3 <u>different</u> chips, each with a unique number of pins. Just match the chip size to the socket size. For each chip: - Align the notch on one end with the notch in the white socket outline on the board. - This should match the notch in the socket, but if not, just match the chip with the white socket outline on the board. - make sure all pins are in a socket hole, and press down to seat the chip – Watch carefully to avoid bent pins. - repeat above until all chips are in sockets. 21. With the USB socket on the bottom, verify all five chips were inserted with the notch on the LEFT.	

22. Insert the 6-pin SD card board connector's LONG pins into the 6 holes in the SD board's outline.
 - Flip the board over and solder 1 end pin, then make sure the connector is flush with the circuit board. The pins should be perpendicular to the board.
 - repeat for the other end pin
 - then solder the 4 middle pins.
 - then trim the 6 leads on the LED side – **make sure you catch them as they will fly when snipped off.**

23. Insert the SD card board over the 6 pins, as shown (chips on top side)

24. Solder ONE pin, making sure the two circuit boards (main and SD card) are parallel – not angled up or down. Reheat the pin's solder and adjust as necessary
 - then solder the other 5 pins.

25. Insert one small jumper which you will make:
 - Take one of your scrap trimmed off leads, and bend it into a U the width of the 2 holes shows labeled "IC6"
 - Insert it into the holes as shown, and spread out the leads on the other side of the board so it won't fall out when you solder it
 - Solder the 2 leads and trim them

This picture is also a good one to check three of the four capacitors. Note the color and shape, and the silver stripe on the big one facing C5.
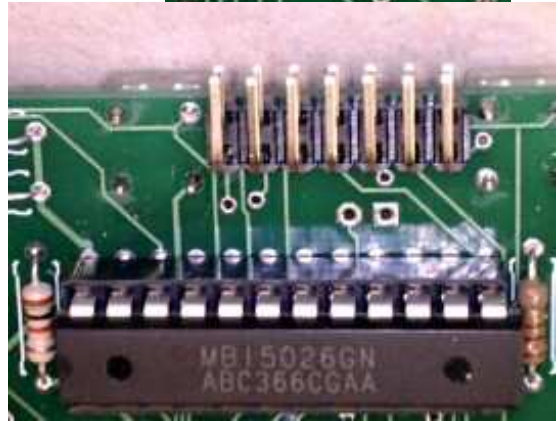
Step 22.'s picture can help confirm the placement of the remaining capacitor.
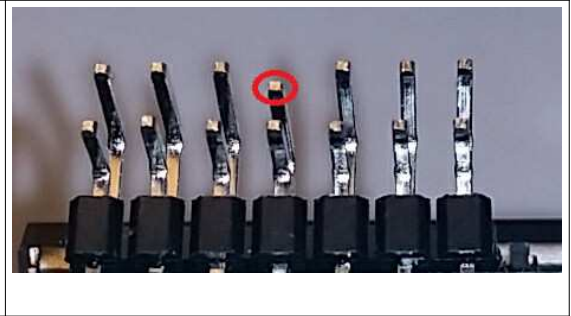
26. Flip the board to the chip side. Insert the 14-pin angle headers. Verify they are inserted the correct way and on the correct side of the board! Flip the board over and observe the pins coming up through holes surrounded by white silk screening. As mentioned, this is correct.

27. Solder **one pin/pad** on each of the 8-pin angle headers. Flip it over and **make sure they are flat with the board**. If they are not, reheat and adjust. It is easy to overheat the angle headers, melting the plastic. Alternate soldering one pin at a time on each of the angle headers. Top, right, bottom, left. Repeat until soldering is complete. The opposite (top / LED) side of the board will look like the picture to the right.

28. Caution: Overheating while soldering can cause the pins to slide – correct any such by re-melting the solder and sliding them back into position.
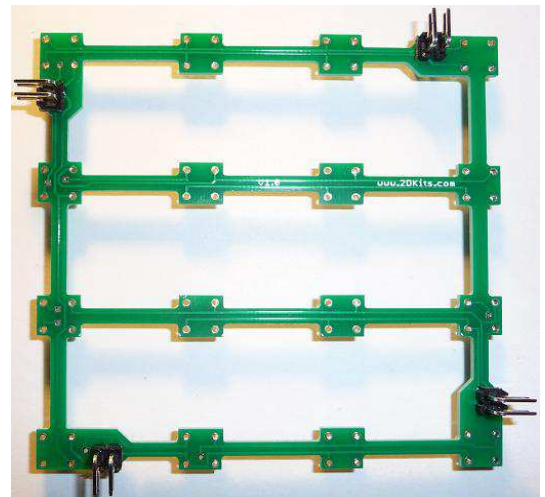   - You CAN NOT just bend them so the ends line up – they won't plug-in to the leg far enough.

At this point, the base board – 4 by 4 LEDs – is done and should be **tested.** To enable test mode, remove the SD card. Then plug the tower into a mini (not micro!) USB connector power source: PC, USB hub, or transformer. Turn it on and verify that all LEDs light as it cycles through the colors. If not, see "troubleshooting" near the end of these instructions.

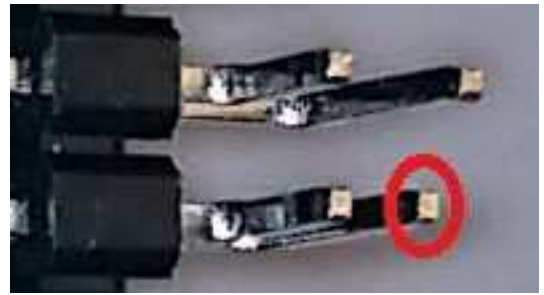**Now proceed making the 7 additional "waffle board" layers of your tower:**

29. Take a waffle board and find the side with TOP, RIGHT, LEFT and BOTTOM. FLIP IT OVER.

30. Insert the 4-pin angle headers. **Verify they are inserted the correct way and on the correct side of the board!** Flip the board over and observe the pins coming up through holes surrounded by white silk screening. As mentioned, this is correct.

31. Solder one pad on each of the 4-pin angle headers. Flip it over and **make sure they are flat with the board**. If they are not, reheat and adjust. It is easy to overheat the angle headers, melting the plastic. Alternate soldering one pin at a time on each of the angle headers. Top, right, bottom, left. Repeat until soldering is complete.
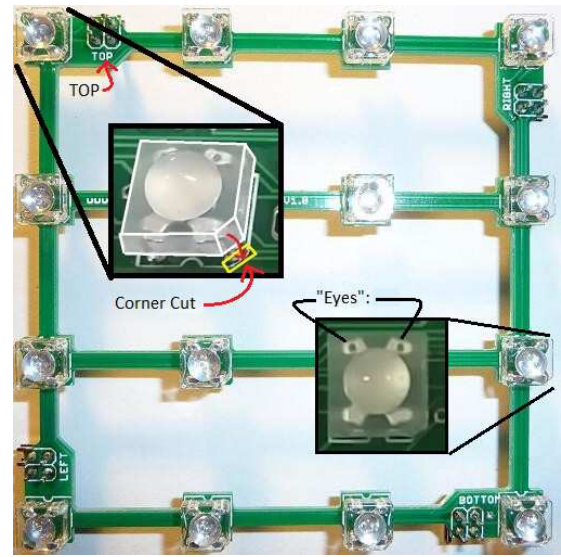
32. Again, overheating while soldering can cause the pins to slide – correct any such by re-melting the solder and sliding them.

33. Insert the 16 RGB LEDs. **Orientation is important** for LEDs. With the board showing "TOP" in the upper left:
   - There is a beveled corner. This should be in the lower right corner. "Eyes" on each LED should be toward "TOP". See inset in picture.

34. Please recheck and make sure all 16 LEDs are oriented properly.
   - As you did with the base board, flip the board over and solder one pad on each of the 16 LEDs. Flip it over and make sure they are flat with the board. If they are not, reheat and adjust the LEDs.
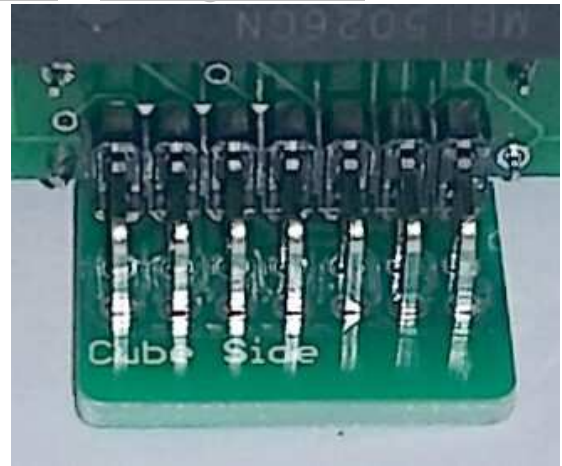   - Then solder the remaining 3 leads on each LED.

35. Repeat steps 33 and 34 for the remaining waffle boards.

The next steps will connect the legs and the seven additional 4x4 LED "waffle" boards to the base:

36. Regarding the legs:
    - ALL legs are the SAME
    - One leg will connect all the TOP connectors together. All of the TOP, RIGHT, LEFT, and BOTTOM silk screening will align.
    - On the legs, one side is labeled "cube side". This faces in toward the tower! All legs must have the label facing inward to the bottom driver circuit board.
    - Connect ONE leg to the "BOTTOM" corner of the main circuit board.
      -- Cube Side facing toward board
      -- Long part of leg sticking up on the LED side

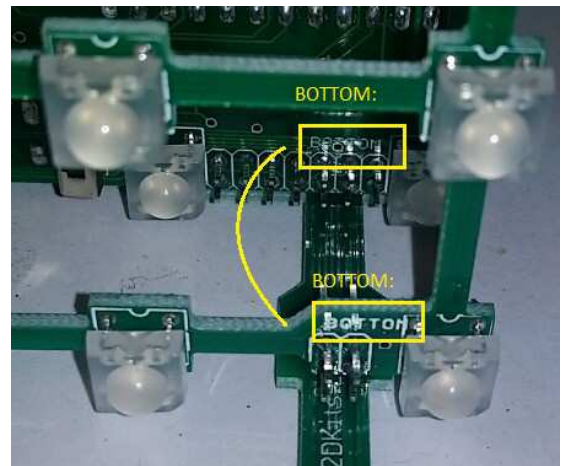37. Solder 2 LEGs in place at positions "TOP" and "BOTTOM".
    - Solder one pin/pad to the main circuit board "BOTTOM" corner.
    - repeat – using a 2nd leg connecting to the OPPOSITE corner, labeled "TOP".

    You now have 2 opposite legs soldered into place

38. One by one, plug in the "waffle" boards being very careful to match "TOP" on waffle to "TOP" on base board, then topo on the next waffle board to the other "TOPs".
    - Again solder just ONE Pin of each of the 4 waffle connectors
    - Go back and solder the additional angle-connector pins on the base and on the legs. Alternating soldering one pin at a time on each of the angle headers prevents the plastic from overheating. Repeat until soldering is complete.
    - continue until all 7 waffle boards are connected to 2 legs.

39. Attach the two remaining legs, one of which lines up with every boards "LEFT", the other with all "RIGHT", to the base and 7 waffle boards. 40. Solder all the pins, holding the leg tightly onto the pins as you solder the first pin of each group of 4 or 14, to hold it in place.	

You have finished the assembly of your blinkie tower! Now it is time to test it.

The tower is powered via a mini USB connector.

Remove the SD card if you'd put it back after testing the base circuit board, as this puts the tower into test mode.

Connect the tower to a transformer with mini-USB connector, or via a mini-USB cable to a computer.

You should see all 16 LEDs in a layer light up with one color, move from the bottom up, and repeat twice more with the remaining two colors. If not, see "Troubleshooting" below.

<div align="center"><u>Use</u></div>

Once built, the use of this blinkie is fairly straightforward. Don't get it wet.

This blinkie has additional patterns stored in the PIC, and even more can be placed on the micro SD card.

To change patterns, press either push button and **hold** for at least one second. The LEDs will display the current pattern number, and then the number displayed on the in binary will count up (or down). This is displayed on the left-most bottom row in blue. Each number represents a stored pattern. If the push button is released, the pattern associated with that particular number will then be displayed on your blinkie.

There are two modes, normal and demonstration. Normal mode will stay at the selected pattern. Demonstration mode will cycle through all patterns. If you are in demonstration mode, the top left LED on the second level will show red when either of the buttons are pressed. To toggle between the modes, press both switches at the same time.

<div align="center">**FUTURE:** As of September 2017.</div>

- There is a problem in the SD card reader software in the PIC chip – some may read OK, some not.
    - This will require swapping the chip.
- The patterns in the SD card currently are from the 8x16 matrix kit.
    - They produce interesting, but not tower-specific patterns.
    - We will be developing more patterns, and putting them up on http://www.2dkits.com on a to-be-added "Tower" blinkie page. You will be able to download them, and write them to your SD card.
- The USB port is more than a power port. It supports full USB communication. Using your computer to control the tower is being worked on.

2dkits.com will create a mailing list for tower owners. Please contact us using the emails shown at the top of each page, and copy the documentation author whose email is at the end of this document.

Troubleshooting

If all the LEDs don't flash, then you'll need to do a little troubleshooting to finish your project. The following steps should isolate most problems.

TOWER-specific troubleshooting:

- If one whole waffle board seems wrong:
  - do the legs line up? "Top" with "Top"

- If one row or column within a waffle board isn't lighting up:
  - the angle connector has an unsoldered pin – either on the leg, or on the circuit board.

- If one LED doesn't light up:
  - Is the corner-cut in the right place, i.e. was the LED installed in the right rotation?
  - Check each pin's solder connection
  - The LED could be defective and needs replacing

Generic troubleshooting:

- Recheck your solder connections. 80% of all problems are traced to this.
  - Missed soldering a pin
  - Soldered only "the pad" or only "the pin" but didn't connect the pin and the PAD with solder.
  - Cold solder connections (which look dull, not shiny) and broken connections will cause erratic performance or failure. Reheat all such solder connections until they flow and look shiny and secure.

- Check for bits of solder, lead ends, or other foreign matter which may be lodged in the wiring.

- Check for shorts or "bridging" where the solder incorrectly joined two pins. All solder connections should look like they are connecting just ONE pin
  - between pins of a socket
  - between the tiny pins on the USB socket
  - between a part's pin and a small **via** hole

- The chips are reversed *or* one leg of a chip was folded when inserted.

- One of the metal socket leads is folded or missing.

- A resistor is in the incorrect location. This may cause the switches not to work, or LEDs to not light up properly.

- A bad part – it does happen. In the hundreds of boards assembled, we've seen two or three parts fail. Let us know.

- A part was missing or wrong. Sorry about that, we sort and bag the parts by hand – no outsourcing here! Let us know.

- A part was lost/melted/damaged/destroyed while building the kit. It happens – you're not the first (or second, or fiftieth). Let us know.

If it is still not working correctly, drop us a note and explain the problem.

Cube doc by **Dale Sulak**, modified for Tower by **Ward Christensen –** WardC@2dkits.com