LED cube building instructions

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Prepare LEDs

1) On 18 of the LEDs,
   a) If building 0.9" spacing cube, bend top of longer (anode) lead 90 deg in direction of other lead so that straight part is same length and bent part bridges gap between leads
   b) If building 0.X" spacing cube, bend over top of longer lead 90 deg in direction of other lead so straight part is 0.X+0.1" long.
2) On other 9 LEDs leave longer pin straight
3) On all LEDs, With anode lead on top and (shorter) cathode lead at bottom, bend cathode lead 90 deg to the right, flush with the base of the LED.

Build LED rows

4) Start with 9 LEDs that have straight anode leads.
5) Starting at the right-most hole in top row, insert LEDs (all with 90 deg bend at end of anode lead) into fixture hole with lens down and bent cathode lead pointing horizontally to the right. The anode lead should be directly above cathode lead (two leads vertical with cathode at bottom pointing right.)
6) Put second LED in middle hole oriented the same way. Lay bent cathode lead between two leads of rightmost LED.
7) Put third LED in left hole oriented the same way. Lay bent cathode lead between leads of middle LED.
8) Working from right to left, solder cathode lead from LED at left where it touches LED cathode lead right at base of LED.
   a) Hardly any solder is needed, just brush iron tip parallel to leads where they overlap.
   b) Be careful not to bridge solder between cathode and anode leads at base of LED.
9) Repeat for middle and bottom rows of three LEDs.

Attach cross wires to make first LED plane

10) Strip >2" piece of 22-24 gauge solid wire and straighten length at end.
11) Bend end of wire 180 deg into smallest possible hook on end.
12) hook wire on top row of horizontal LED cathode wires at right side of left-most LED/
13) Lay wire vertically across top of bottom two rows of cathode wires (perpendicular to them) and cut so that 1/4" sticks out beyond bottom row
   a) Adjust wire position to be perpendicular to cathode leads and close to LEDs.
14) Solder cross wire to LED cathodes
   a) Solder hooked end of wire to LED cathode lead at top.
      i) If wire moves, melt solder and reposition wire by holding bottom end with pliers, then let solder freeze while holding in place
   b) Solder vertical cross wire to middle cathode row where they cross.
      i) just put a small blob of solder between the wires
   c) solder cross wire to bottom cathode row the same way.
15) Then repeat steps for second cross wire at right side of LED plane, to the right of the LEDs.
16) Test electrical contacts between cathode wires and vertical anode lead of each LED.

a) Fix any shorts or opens.

17) Remove LED plane from fixture.

Build second and third LED planes using 18 LEDs with bent anode leads

18) Make LED rows and attach cross wires as above
19) Before removing LED plane from fixture, adjust anode lead of each LED as follows:
    a) grab bent section at end of anode lead with needle-nose pliers
    b) pull lead toward top of fixture so that tip of bent lead is aligned with lead where it enters LED at other end
    c) entire anode lead should stay in vertical plane made by two leads in original position
    d) bent tip of anode lead will made contact with anode lead in LED plane above right where lead enters LED
20) Remove second LED plane after tips of anode leads are aligned.
21) Build third LED plane and align tips of anode leads as above.
    a) Do not remove plane from fixture.
    b) This will be top layer of LEDs in cube.

Attach middle LED plane to top plane

22) Orient second plane with bent anode wires to same direction as plane in fixture.
    a) This will make sure LED columns line up even if holes spacing varies slightly.
23) Prepare the first LED by applying a small blob of solder to tip of anode lead of LED in upper right corner of fixture.
24) Align second LED plane directly above plane in fixture. Set vertical distance so that spacing between planes is the same as spacing between LEDs in a plane.
25) Align LED anode lead with solder so that its end abuts the anode lead on the LED in the plane above it.
26) Use the soldering iron to melt the solder blob and bridge the solder between the two leads.
    a) Add some more solder if needed to attach the leads together.
    b) If needed, use the iron to melt the solder joint and carefully reposition the upper LED plane to get correct spacing and alignment of LEDs between the two planes.
    c) Avoid having the bent end of the anode lead extend past the vertical anode lead of the upper LED and short with the cathode lead.
    d) If this happens, remelt the solder joint and pull the bent end back with pliers.
27) Repeat these steps with LEDs in the other three corners of the planes. Carefully adjust the spacing and alignment of each corner before soldering the next.
28) Once the corner LEDs are attached and aligned, the middle LEDs may be soldered more easily without additional alignment steps.
    a) If necessary, use pliers to bend the anode lead from the LED below into position in contact with the upper LED anode lead. Soldering will be easier if the leads are already touching.
    b) Make sure all 9 of the LED anodes are soldered together.

Attach third LED plane to middle plane

29) Before attaching the third plane, check the position of the ends of the anode leads from the second LED plane.
    a) Gently bend them so their tips line up with the anode lead where it enters the LED back as before.
    b) The LED cube is fragile so adjustments must be done very gently!
30) Find the third LED plane (with straight anode leads) and rotate it to its original orientation.

31) Follow the above steps to attach and align the corner LEDs first, followed by the middle LEDs.
32) Remove the top plane of LEDs from the fixture and invert the cube so the straight anode leads are pointing down
33) Put LED cube somewhere safe while board is prepared.

Prepare Protoboard and Mount LED Cube

34) Unpack Arduino Diecimilla and place it on table with USB port side away from you.
35) Install 6-pin single row header in "ANALOG IN" socket strip on left side.
36) Install 8-pin single row header in "DIGITAL 0-7" socket strip on right side.
37) Put protoboard with **copper side up** onto header pins.
    a) Orient board with broken side away from you.
    b) Center board from left to right on pins.
    c) Align bottom edge of pins on second row of holes from bottom of board.
38) Solder one pin on each header onto copper pad for now while cube is positioned
    a) This makes it easier to move them if a mistake is made
39) Roughly position cube in center of board.
    a) Orient cathode leads sticking out from each plane pointing away from you (to top of board).
    b) Try to avoid power jack and USB port with cube leads.
    c) If possible, leave space between tops of headers and first row of cube pins. This will make wiring a little easier.
    d) Make sure there are a couple rows of holes beyond cube wires
40) Mark position of center LED lead and remove LED cube again
41) Using known spacing of LED cube leads, measure 0.X" in each direction from center lead and place a dot on corresponding hole.
    a) This will make it easier to get cube installed in correct holes.
42) Replace LED cube and put leads through marked holes
    a) Start on one edge, tilt cube toward that edge and get all leads in holes
    b) Push cube in a bit and align middle row of pins into holes while cube remains tilted.
    c) Get last row of pins in holes and straighten out cube.
43) Adjust height of cube so that 0.1" of LED anode lead is visible under board
    a) Resistors will be soldered to these leads so make sure all can be seen.
44) Solder one corner LED lead onto copper pad at the top of the board
    a) Can reflow the solder and adjust spacing if necessary.
45) For each of the remaining corners:
    a) Adjust tilt of cube so that planes are parallel to protoboard.
    b) Solder corner to pad on top of board
    c) Double check alignment
    d) Reflow solder and adjust position if needed
46) Once corners are soldered, solder interior leads to pads on top of protoboard
    a) No adjustment possible once corners are fixed
47) Solder rest of pins on headers to pads on top of protoboard.

Wire connections to common cathodes

48) Strip insulation from wire to above height of cube layer

Wire LED lines to cube anodes using resistors

49) Resistor wiring is done on bottom of protoboard but connection to header pins is made on top