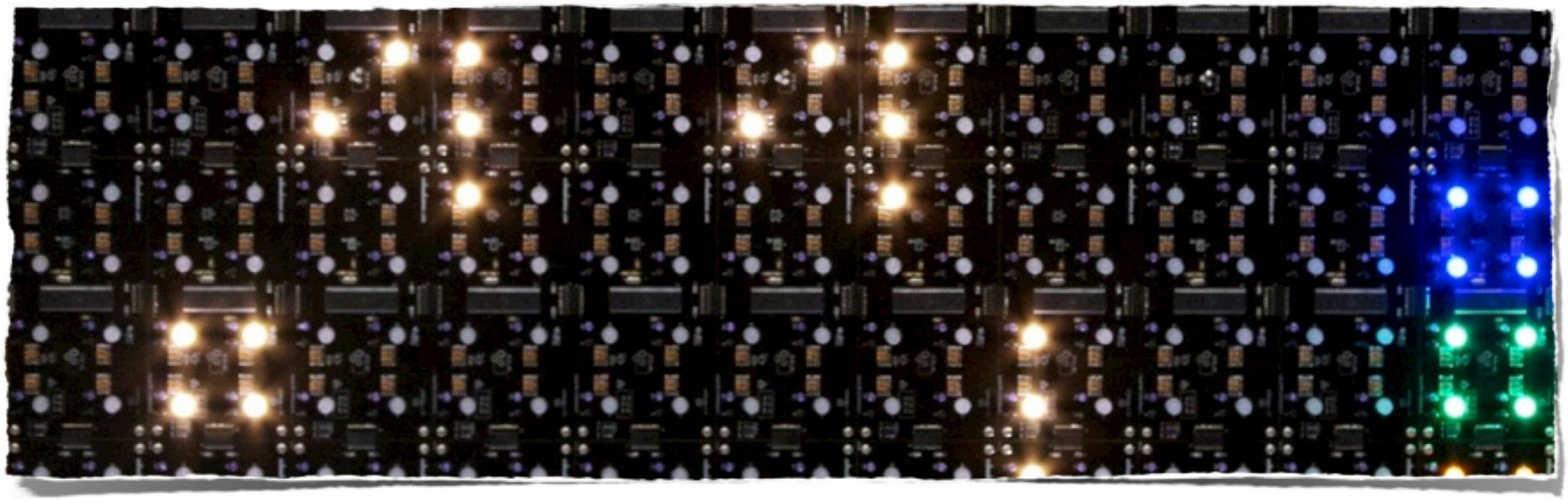
Interactive Game of Life Kits



Assembly & Usage Guide

This guide covers the assembly and usage of Interactive Game of Life Kits from Evil Mad Science.
Please exercise appropriate safety practice while soldering and installing these kits.

An open-source hardware+software project. For design files, source code, & additional documentation, please visit: http://wiki.evilmadscience.com/life

Support: http://www.evilmadscientist.com/forum/

Evil Mad Science LLC
http://evilmadscience.com/

Evil Mad Science

Kit version 1.0
Manual v. 1.0a

Introduction I:
Conway's Game of Life

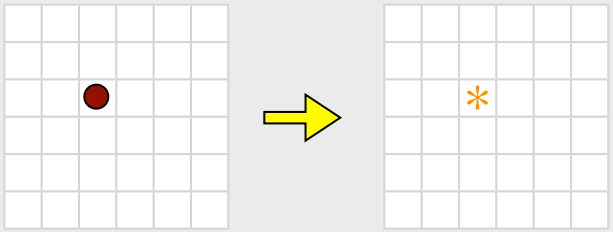
You're probably familiar with Conway's Game of Life, but let's review:

"Life" is a zero-player mathematical "toy" system created by John Conway in 1970. In it, we imagine an infinite plane filled with square cells that are each either living or dead. As time passes, one *generation* at a time, cells live or die, according to a fixed set of rules.

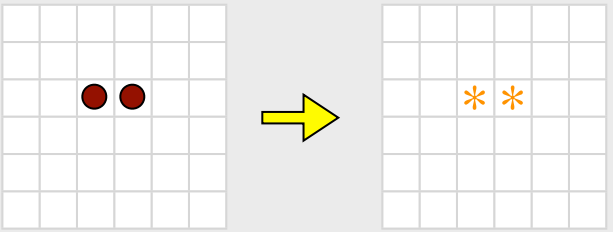
The rules:

1. A living cell with *zero or one* neighbors will die, as though from loneliness.

(The neighbors of a given cell are those *living cells* in the eight cells surrounding it.)

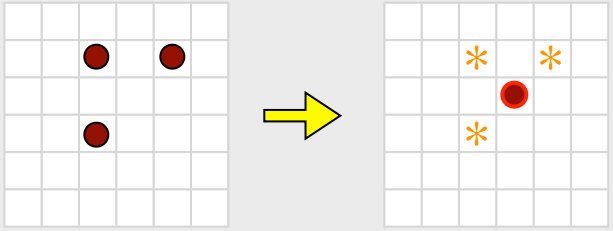


The one living cell has zero neighbors, and so it is no longer living in the next generation.

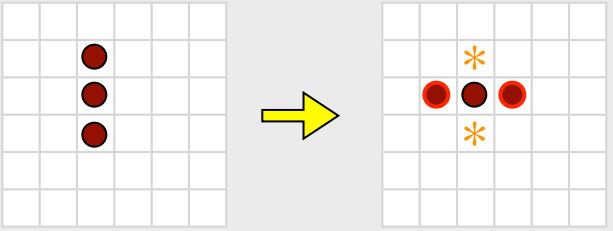


Each living cell only has one living neighbor, so both disappear in the next generation.

2. A non-living cell with *exactly three* neighbors will spring to life in the next generation.

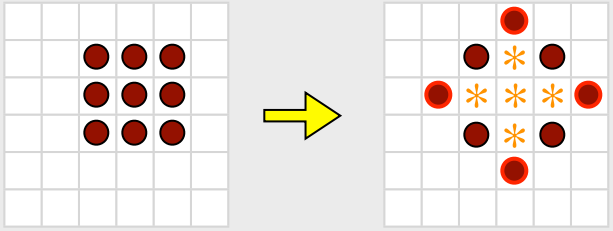


Each living cell has zero neighbors (and dies). But, the cell with three neighbors springs to life.

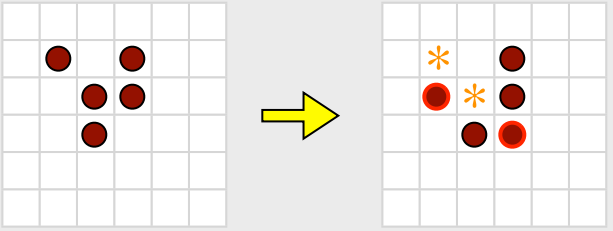


Two cells (with one neighbor each) die, and two cells (with three neighbors each) spring to life.

3. A living cell with *more than three* neighbors will die, as though from overcrowding.



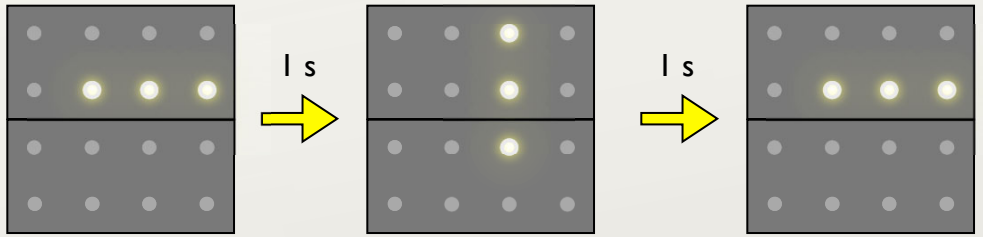
Five cells die from overcrowding (with 5 or 8 neighbors) and four are created.



Using all three rules, complex behavior can begin to emerge.

Introduction II:
Interactive Game of Life Kits

The big idea:
In Interactive Game of Life kits, living cells are represented by LEDs that are in the lit-up state. Non-living cells are represented by LEDs that are not lit. After a given interval of time, the display advances to display the next generation. The kits automatically communicate with one another, so that large installations can be constructed.



Default interval:
The set of living and non-living cells evolves to its next generation, initially at a default rate of one generation per second. This rate can be changed to 2 or 4 generations per second through a configuration menu.

Boundary conditions:
The "edge condition" is that all non-visible cells (i.e., those beyond the borders of the modules) are fixed, non-living cells. The edges do not wrap, unless you provide additional wiring to create this condition.

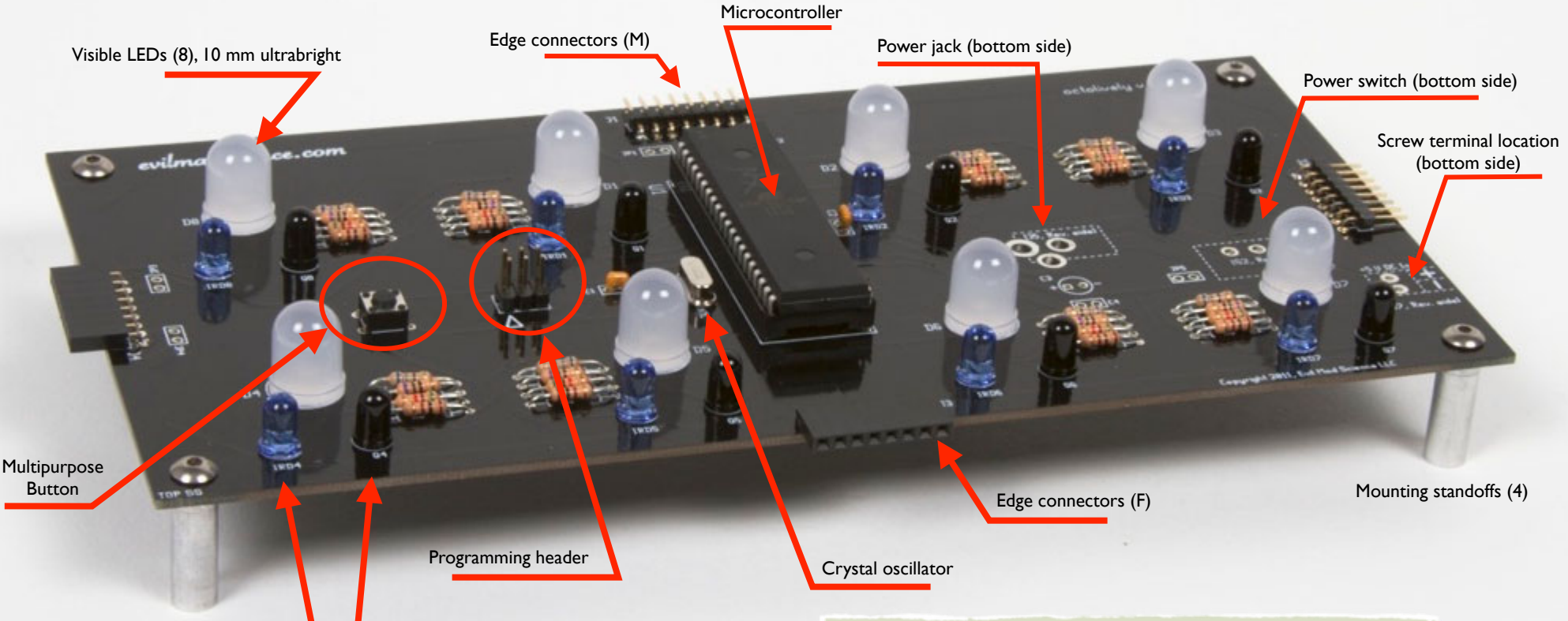
Interaction:
The state of any cell can be toggled at any time by moving your hand (or any similarly reflective object) close to one of the LEDs. (Technically, close to one of the sensor pairs adjacent to each LED.) When placed under a transparent surface (e.g., glass or acrylic), this creates a surface that acts similarly to an array of touch sensors.

Idle conditions and randomization:
The firmware contains an algorithm to detect simple "idle" conditions, either fully steady or oscillating back and forth between two fixed states. By default, the display will fill with random data about one minute after coming to an "idle" condition. This feature can be disabled in the configuration menu.

Introduction III:
Kit Anatomy

The Interactive Game of Life (IGoL) Kit is based on the "Octolively" circuit board. This circuit board allows us to build open source, tileable, digital interactive LED modules filled with ultrabright LEDs and sensors that detect stimulus provided by human interaction.

Each module is 4 X 8 inches in size, and features eight 10 mm ultrabright LEDs, spaced along a two-inch grid. Each module also has eight infrared proximity sensors— one for every LED —to detect nearby motion, even in total darkness. The modules can be tiled edge-to-edge, seamlessly, in many different shapes and sizes of rectangular arrays.



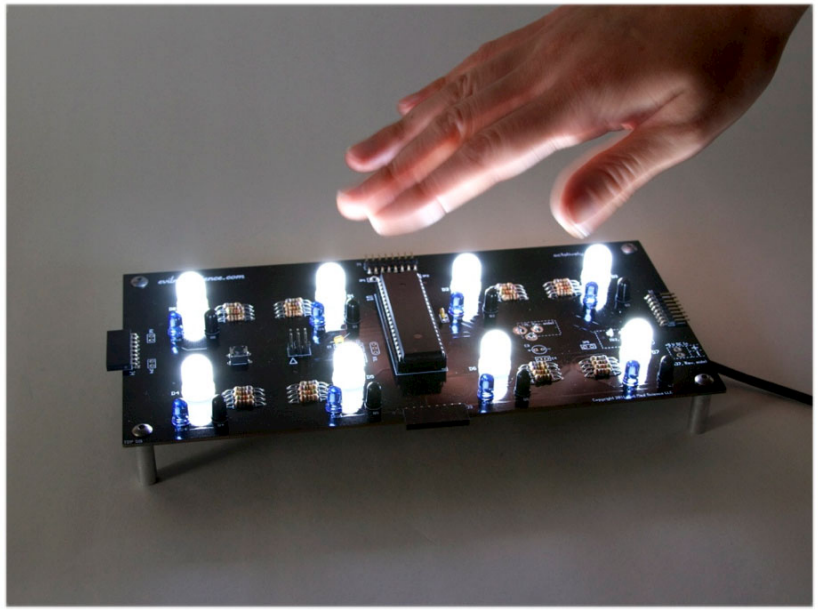
Each IGoL module is controlled by an on-board microcontroller and functions as a self-contained, stand-alone device. You do need to provide power (regulated 5 V DC), but no computer nor programming is required. The next few pages of the introduction will discuss power supplies and other considerations when planning your installation.

Introduction IV: Planning your installation

Part i: Powering IGoL Modules

IGoL modules require regulated 5V DC power to operate.

It is generally helpful to understand these power requirements, and to understand your options for providing that power before beginning assembly.



IGoL Power Supply Requirements

1. *The power supply should have regulated 5V DC output.*

Regulated power supplies keep their output within a few percent of 5 V DC.

(Unregulated 5 V power supplies may have voltage well in excess of 5 V, often approaching 10 V.)

2. *The power supply must have current capacity of at least 200 mA (i.e., 0.2 A) per module that it powers.*

For example, a single 5 V DC, 1 A power supply can power up to five modules.

(Extra current capacity is not a problem; you can power 1, 2, 3, 4, or 5 modules from one 5 V DC, 1 A power supply.)

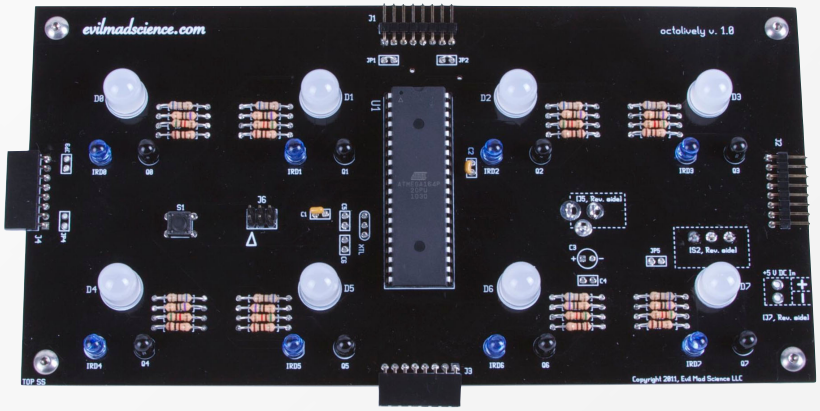
3. *Each module should be connected to only one power supply at a time.*

If you connect two different power supplies to one module at the same time, you are effectively connecting those two power supplies in parallel.

(That's usually a "no-no." Do so only when explicitly recommended by your power supply manufacturer.)

Introduction IV: Planning your installation
Part ii: Powering IGoL Modules, continued

Now that we've gone over the electrical requirements, how do you physically connect the modules to your power supply?



The next few pages discuss the edge connectors and give recommendations for powering small, medium and large arrays of modules.

Ways to connect to your power supply:

1. *Power jack (2.5 x 5.5 mm, center positive)*

IGoL kits are supplied with a high-current 2.5x5.5 mm barrel jack, that mounts on the bottom side of the circuit board. This can be used to connect directly to a suitable power supply: 5 V DC, regulated, Center positive 2.5 mm plug.

2. *Edge connectors*

IGoL modules can connect to each other side-to-side through their edge connectors. For small arrays (or small sections of large arrays), these edge connectors can be used to share power between neighboring boards.

3. *Screw terminals*

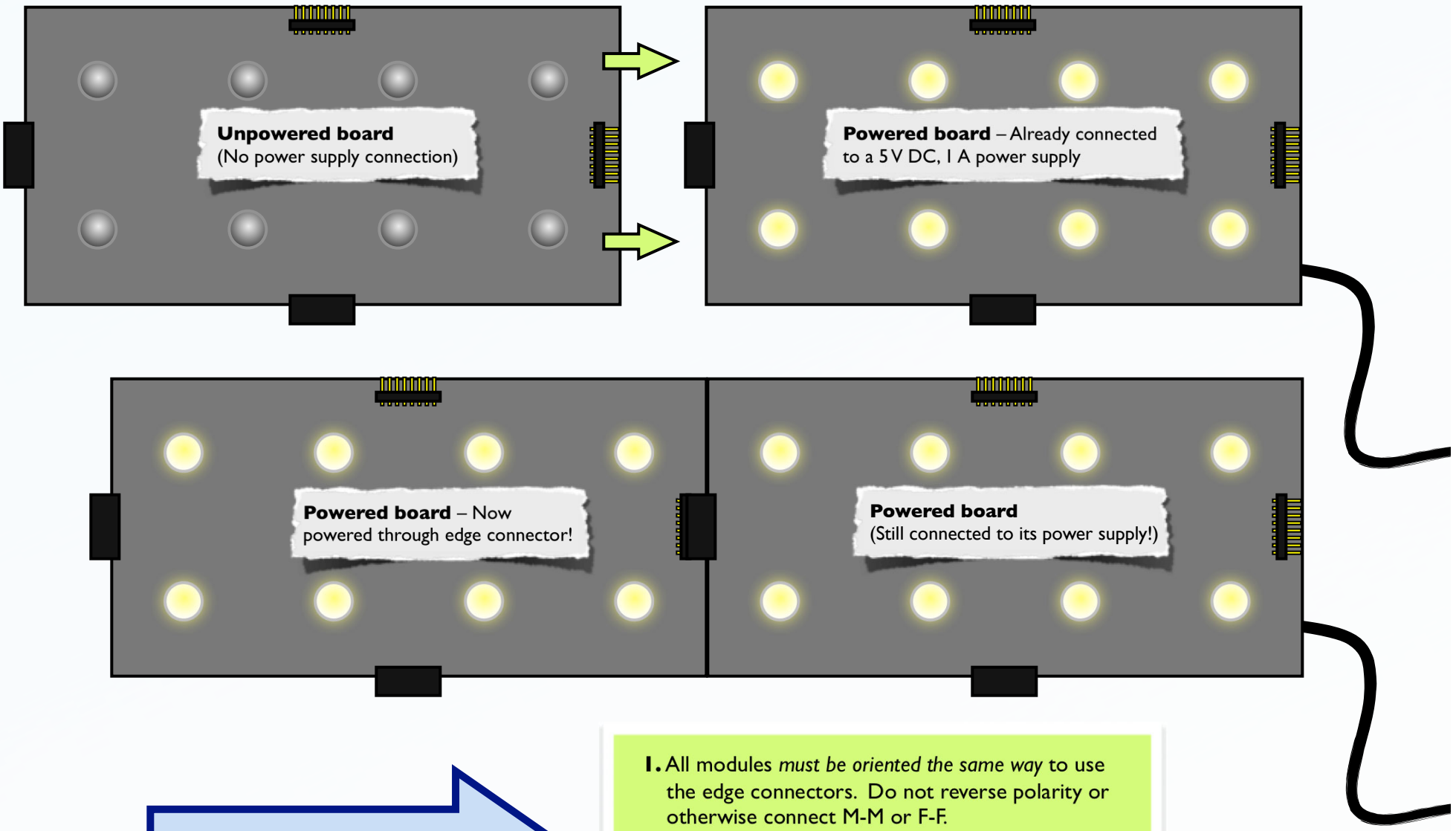
IGoL modules feature a location for an optional two-position screw terminal that can be mounted to the bottom of the circuit board. If installed, 5 V power can be connected to the modules through these screw terminals.

4. *Hardwired power connections*

If the screw terminal is not installed, wires providing 5 V power can be soldered directly into the location normally used for the screw terminals.

Introduction IV: Planning your installation

Part iii: Using edge connectors



When can you power boards through the edge connectors?

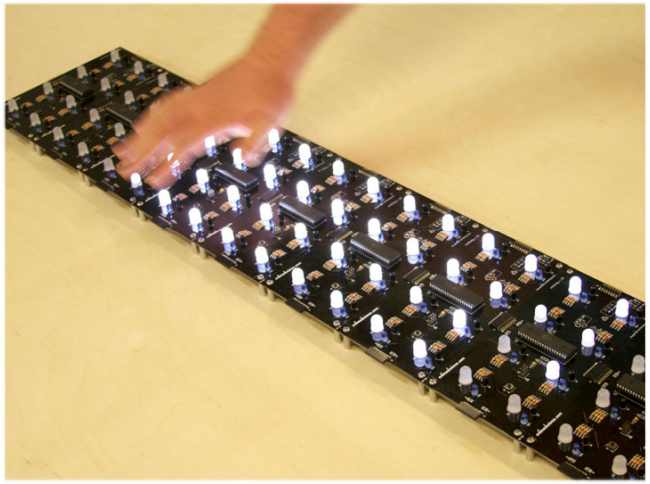
1. All modules *must be oriented the same way* to use the edge connectors. Do not reverse polarity or otherwise connect M-M or F-F.
2. The edge connectors and power jacks are rated for 4 A maximum. Even if your power supply is huge, you can only power a maximum group of 20 panels through one power supply connection.

Introduction IV: Planning your installation
Part iv: Powering small arrays of modules

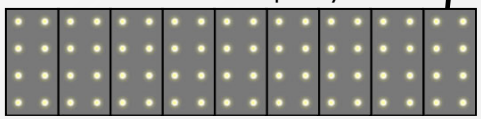
Small arrays– up to the capacity of a single power supply and consisting of 20 or fewer modules –can be powered with a single power supply connection and edge connectors.

4-inch wide strip array

(5 modules: Power supply capacity needed: 1 A or higher.)



8-inch wide strip array



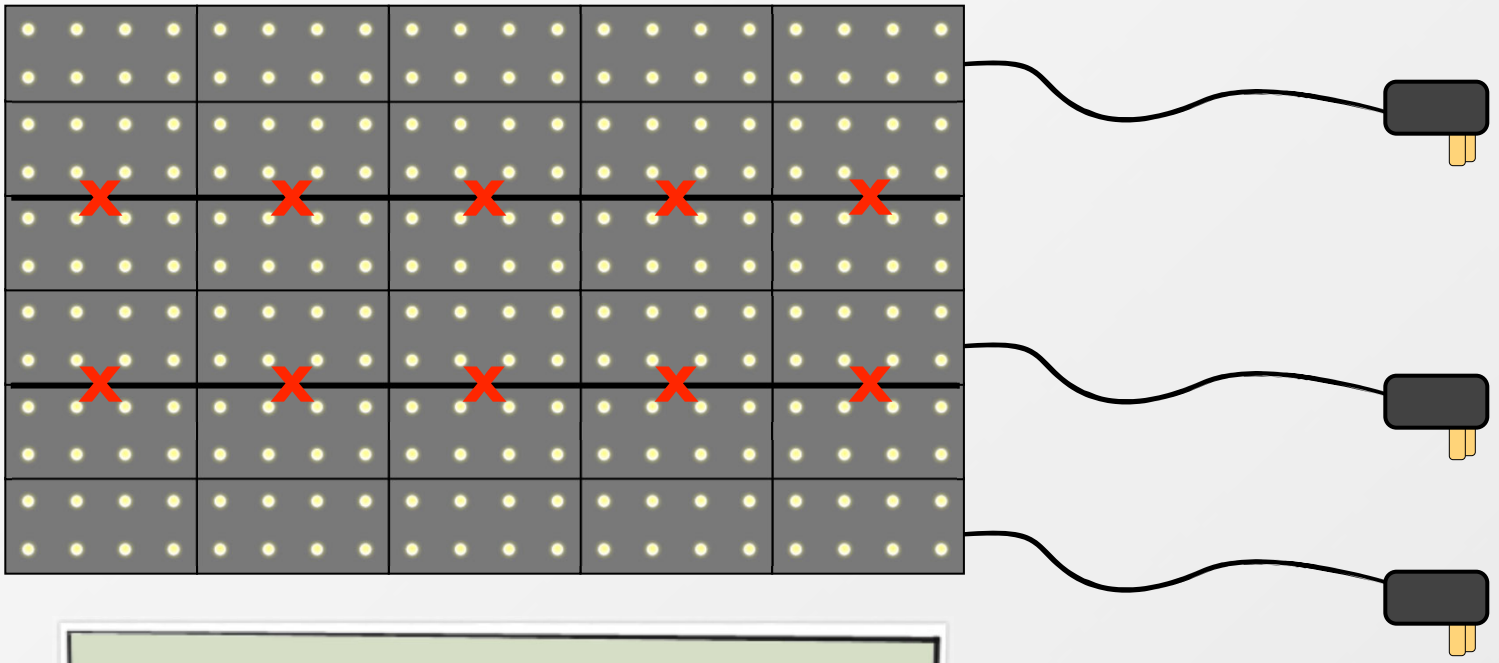
(9 modules: Power supply capacity needed: 1.8 A or higher.)

Larger-yet arrays can be constructed with 2D tiling

Introduction IV: Planning your installation
Part v: Powering mid-size arrays of IGoL modules

For arrays too large to be powered from a single power supply, you can selectively disable (or simply not install) the edge connectors, splitting it into independent small arrays.

Alternately, you may wish to follow the "Large array" methods from the next step (Introduction VII), entirely bypassing power from the edge connectors. In either case, note that all of the power supplies should be switched on at the same moment (within one second) to ensure proper behavior. This can normally be achieved by turning on a single switch or relay that controls multiple power outlets.



Example: This array of 30 modules is powered by three 5 V DC, 2 A plug-in power supplies. Each power supply drives 10 modules.

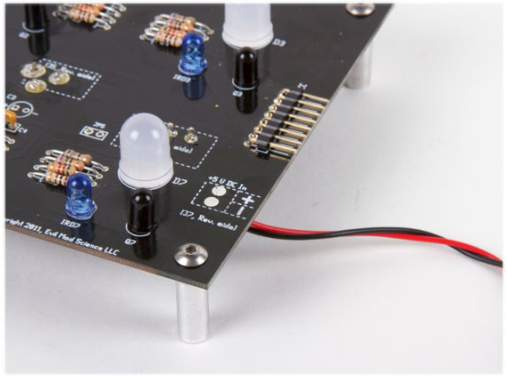
The modules are all connected together through their edge connectors, except where the connections have been disabled– the locations marked by with an "**X**." (In a later step, we'll show you how to disable those edge connectors.)

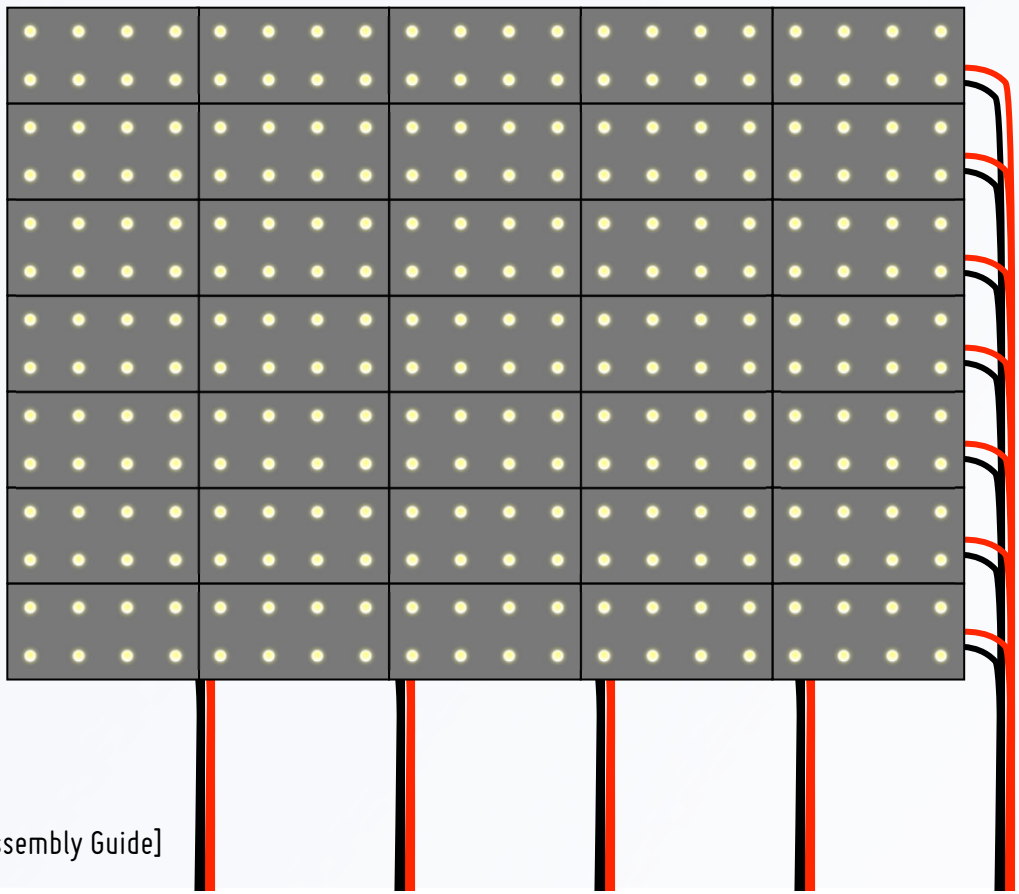
Introduction IV: Planning your installation
Part vi: Powering large arrays of modules

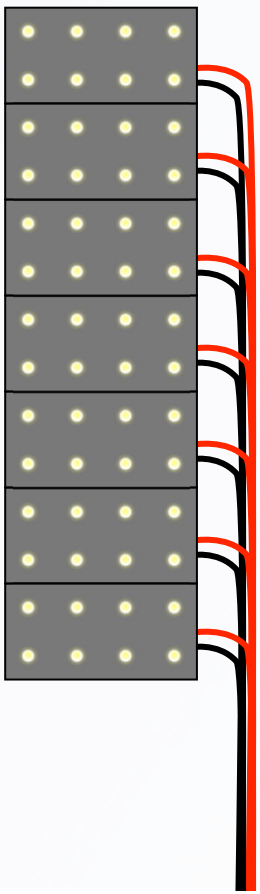
For large arrays and permanent installation, it may be preferable to run individual power wires to each module, attached either with screw terminals or directly soldered (hardwired) into place.

In this case, the edge connectors are disabled (or not installed), so that each module is only connected to power from a single source.

While the wiring in this case can become voluminous, it can be more straightforward, as an arbitrarily large array of modules can be powered, given a large enough 5 V power supply.

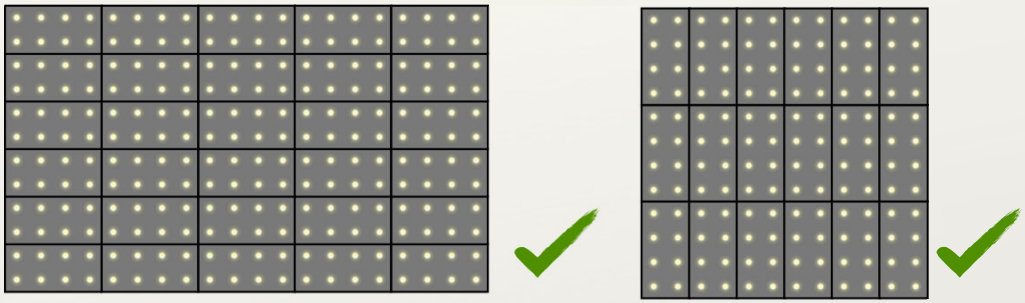


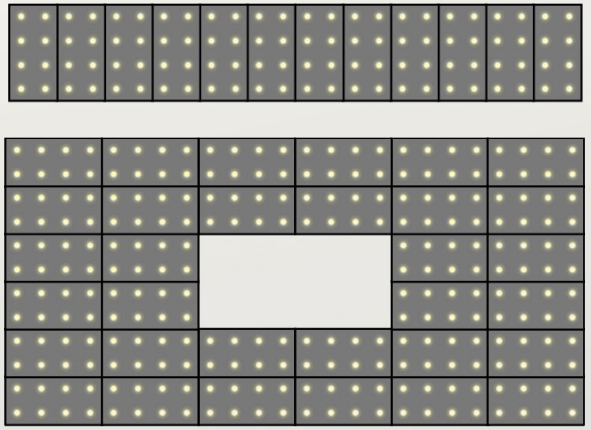




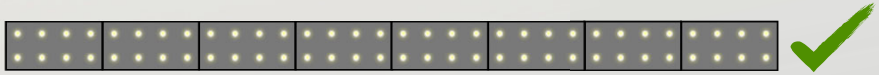
Introduction IV: Planning your installation
Part vii: Arranging IGoL Modules

With a few rare exceptions, Interactive Game of Life modules can be arranged in any array configuration that allows communication through the edge connectors. Any rectangular arrangement (i.e., any arrangement with exactly four corners) will always work well.



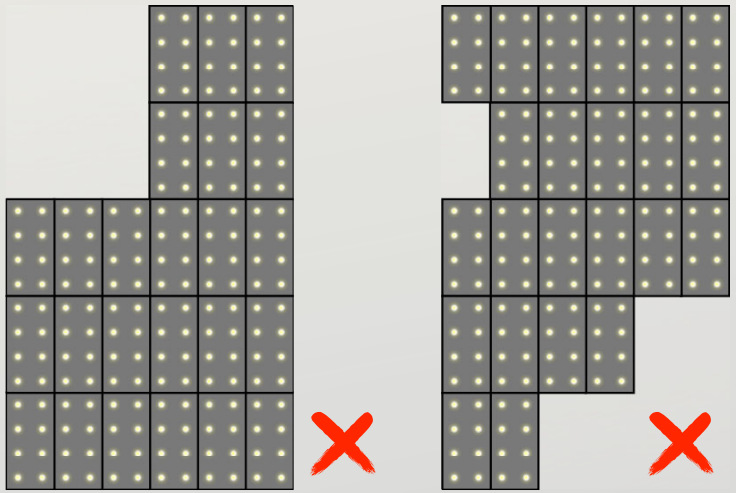


Any inside cutout should have exactly four corners.



While arrangements like these are technically valid, they are unlikely to be interesting. We recommend a bare minimum of 4 pixels of width and height, in all situations.

These arrangements <u>are</u> technically valid, but may not behave as expected: As there are no edge connections, each module will operate as an independent 2x4 pixel array.



For non-rectangular arrays– those with more than 4 outside corners– proceed with caution. Read the next section carefully, and consult with Evil Mad Science if you need additional assistance.

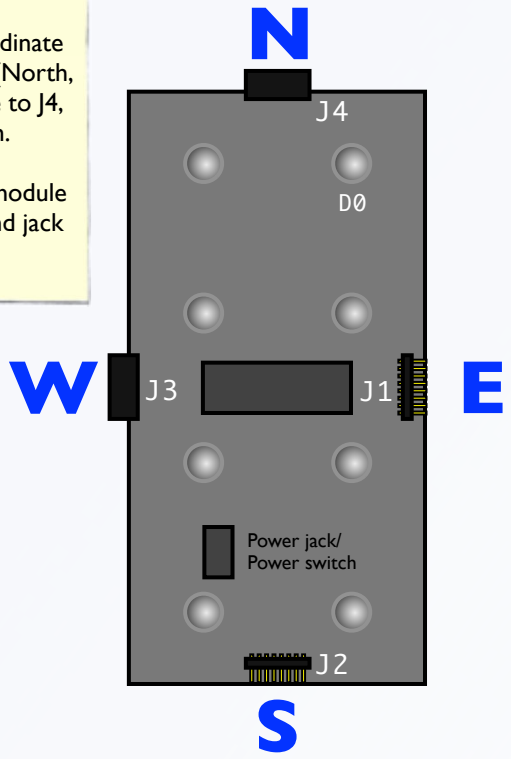
Introduction IV: Planning your installation
Part viii: Identifying the "Master" module

Within a grid of IGoL modules, every module communicates with its neighbors for synchronization and to learn the state of the neighboring LEDs. However, a single module, the "Master," is responsible for generating the timing signals that synchronize the array and for issuing commands that affect the entire array, such as advancing to the next generation.

You should identify the location of the Master module in your array. It's usually the one on the "southeast corner." (And yes, we'll explain what that means.)

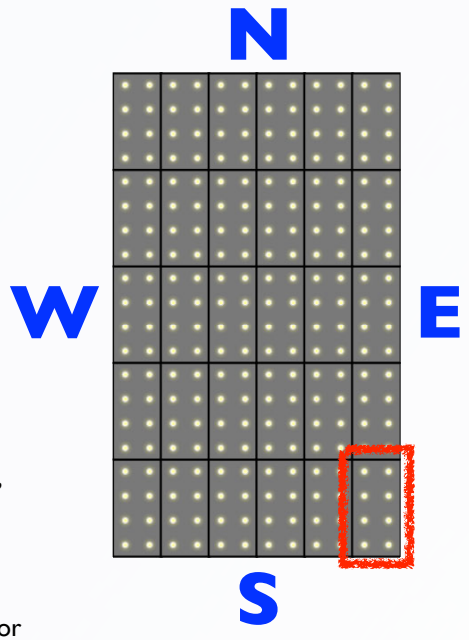
The coordinate system:
IGoL modules use an internal coordinate system, where the four directions (North, South, East, West) are given relative to J4, which is defined to be facing North.

Easier version: If you position the module vertically, with the power switch and jack at the bottom, "north" is "up."



Finding the Master (quick version):
The Master module is the module at the south-east corner of your array.

(If your IGoL array will be rectangular, you may skip the gory detail below, and advance directly to the next page.)

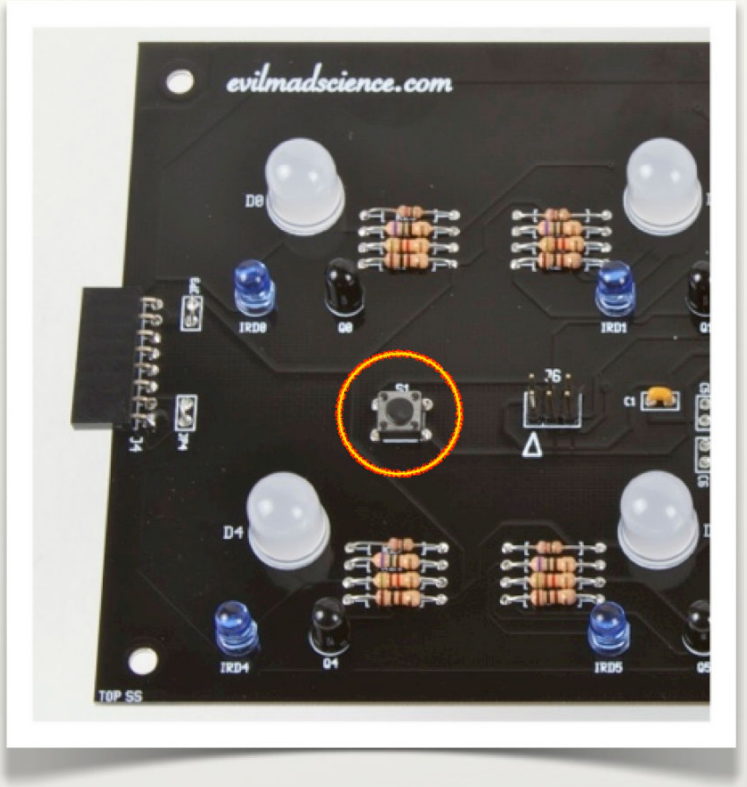


Finding the Master (gory detail):
Command signals (such as that to step to the next generation) always begin at the SE corner of the array, and travel north and west to reach every module.

At turn-on time, each module automatically checks to see which of its four sides it has a neighbor on.
If a module does not have any neighbors on its south or east sides– meaning that it is the "most southeast" module –it will automatically configure itself as the Master.

If the planned arrangement of your modules is complex– such that more than one board is at a SE corner, or such that messages traveling north and west from the master board will not reach every module –please consult with Evil Mad Science to discuss possible issues and solutions.

Introduction IV: Planning your installation
Part ix: Button functions



There is a single tactile button switch located on each IGoL module, that serves a variety of functions.

• The button can be held at turn-on time to access the IGoL configuration menu. Normally, it is only necessary to actually change configuration on the Master module, and only to set initial user preferences. (More about this later.)

• During normal operation, the button has the following functions:

On the Master module:
– Press and release the button to pause the display or to resume.
– Hold the button for one second to clear the entire display.

On any other module:
– Press and release the button to resume (if paused) or (if not paused) to cycle through the different speeds (1,2,4 generations/s)
– Hold the button for one second to fill the entire display with random data.

• These functions can also be changed by reprogramming the modules.

Often, IGoL modules are installed under surfaces such that the buttons are not accessible.

If you are planning an installation with a surface but would like to still have access to the button functions, it is possible to relocate the switch off-board via wires, or to use any third-party normally-open switch, if you wire it in parallel with the switch on the module.

Most of these functions are also accessible in other ways, such as by designating modules as Control Pads, as discussed next.

Introduction IV: Planning your installation
Part x: Control Pads

Any IGoL module may be configured to act as a *Control Pad*.

(This is an entirely optional feature that is normally only useful for large installations.)

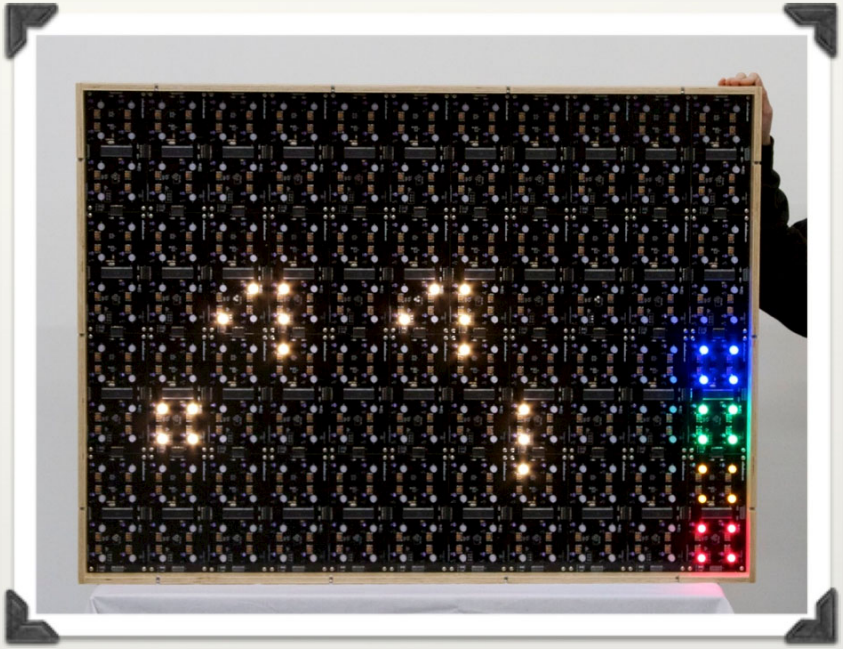
A module designated as a Control Pad does not actually display Conway's Game of Life, but instead acts just as a single pair of large buttons, to control the basic functions of the rest of the display. When configured as a Control Pad, all 8 of the visible LEDs on the module remain lit.

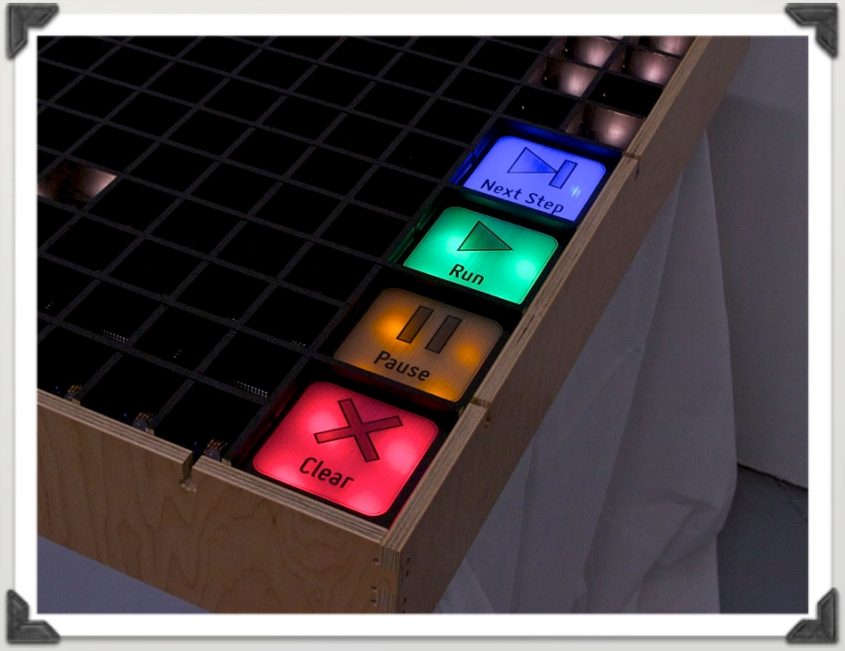
The large Game of Life display shown here has the two modules on the lower right (with colored LEDs), each configured to act as a pair of control pads, giving four effective "buttons." In this case, the "buttons" were covered with translucent overlays that do not interfere with operation.

Some important things about Control Pads:

• You do not, in any sense, need to have any Control Pads in your Game of Life installation. However, you may find them to be a useful option, especially for larger installations.

• *Any* IGoL module (whether colored or white) can be configured to act as a "regular" display module or as a Control Pad, by using its configuration menu.





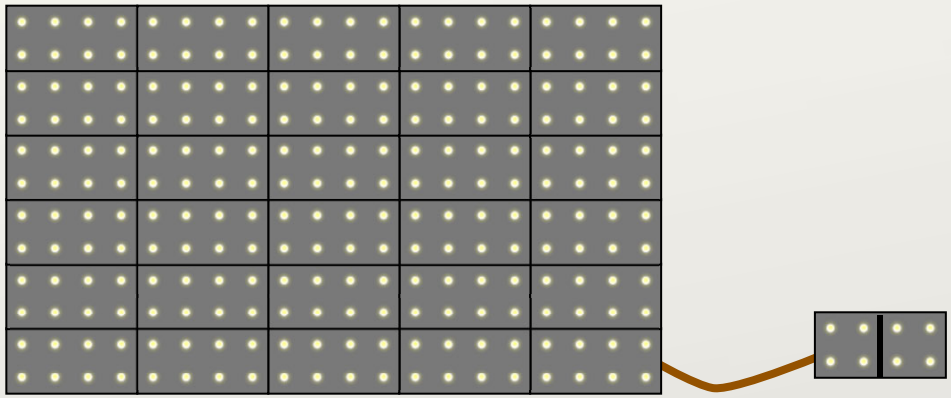
Introduction IV: Planning your installation
Part xi: Control Pads, continued

Additional notes about Control Pads:

• Control Pads can be placed *at any location* in the grid of modules, or even physically *outside of the grid*, in a separate control panel.

• From the standpoint of planning a grid of modules, modules designated as Control Pads must be considered as part of the array. A module designated as a Control Pad may still be the Master module (or not). This depends only on its location in the grid, not on whether or not it is designated as a Control Pad.

• The use of Control Pads does not conflict or otherwise interfere with the use of physical buttons (as described earlier) for controls.



Two standard Control Pad configurations are supported in the standard firmware, and can be selected in the configuration menu.

• The first type is the "Step/Play" Control Pad. This configures two virtual buttons, "Single Step" (in the north half of the module) and "Run" (in the south half of the module). Pressing "Run" will resume operation if paused, and will cycle through the available speeds (1, 2, 4 generations/second) if pressed repeatedly.

• The second type is the "Pause/Clear" Control pad. This configures two virtual buttons, "Pause" (in the north half of the module) and "Clear" (in the south half of the module).

• Additional functions may be possible if you care to reprogram the modules.

Assembly Step 1 – Tool checklist

The IGoL kit is a soldering kit. You'll need certain tools and supplies to build it.

Essential tools: Needed to build the kit:

1. Soldering iron

A basic soldering iron meant for electronics, with a reasonably fine point tip. We recommend one of this design-- a "pencil shape" soldering iron (not gun!) with a base that holds the iron and a wet sponge.

While you don't need an *expensive* one, the iron *can* make a big difference in the time needed to build the kit. (Seriously. If you use one that is old and busted, or an ultra-low-end $10 iron, expect to spend at least twice as long soldering!)

Our recommendation for a low-cost iron:
WLC100 by Weller, about $40.

2. Solder

Thin rosin core solder.

60/40 solder is easy to use; diameter of .025" or so is typical for work like this.

Either standard (lead-bearing) or newer "lead free" solder types will both work just fine.

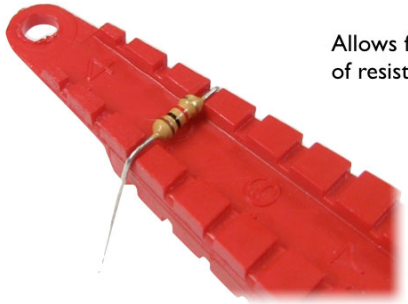
3. Angle Flush Cutters

For clipping loose wire ends.

e.g., Sears Craftsman

Possibly helpful accessories; not required

1. Resistor lead forming tool



Allows fast, neat bending of resistor leads.

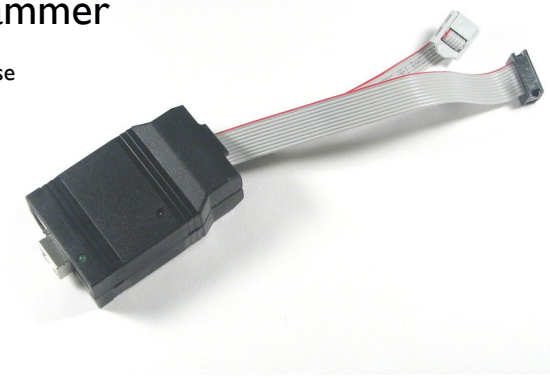
2. 5/64" Hex Driver

For attaching circuit boards to standoffs.

(Outside of the USA, a 2 mm hex driver will work nicely!)

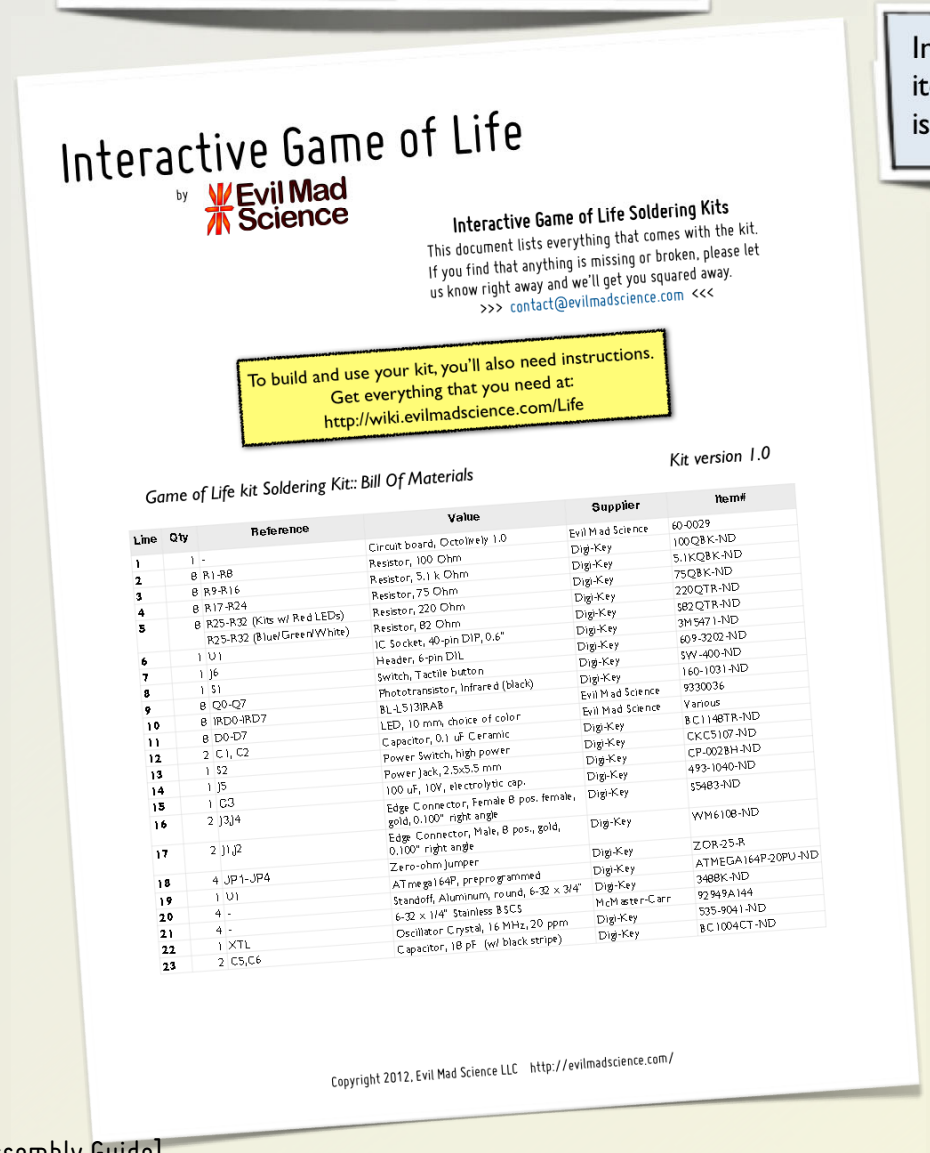
3. AVR ISP Programmer

Such as the USBtinyISP, in case you would like to reprogram your microcontrollers



Assembly Step 2 – Line numbers and the BOM

Your kit comes with a *bill of materials*, the authoritative list of what's in your kit.



Interactive Game of Life

by Evil Mad Science

Interactive Game of Life Soldering Kits

This document lists everything that comes with the kit. If you find that anything is missing or broken, please let us know right away and we'll get you squared away.

>>> contact@evilmadscience.com <<<

To build and use your kit, you'll also need instructions. Get everything that you need at: http://wiki.evilmadscience.com/Life

Game of Life kit Soldering Kit:: Bill Of Materials — *Kit version 1.0*

Line	Qty	Reference	Value	Supplier	Item#
1	1	-	Circuit board, Octolively 1.0	Evil Mad Science	60-0029
2	8	R1-R8	Resistor, 100 Ohm	Digi-Key	100QBK-ND
3	8	R9-R16	Resistor, 5.1 k Ohm	Digi-Key	5.1KQBK-ND
4	8	R17-R24	Resistor, 75 Ohm	Digi-Key	75QBK-ND
5	8	R25-R32 (Kits w/ Red LEDs) R25-R32 (Blue/Green/White)	Resistor, 220 Ohm Resistor, 82 Ohm	Digi-Key Digi-Key	220QTR-ND 82QTR-ND
6	1	U1	IC Socket, 40-pin DIP, 0.6"	Digi-Key	3M5471-ND
7	1	J6	Header, 6-pin DIL	Digi-Key	609-3202-ND
8	1	S1	Switch, Tactile button	Digi-Key	SW-400-ND
9	8	Q0-Q7	Phototransistor, Infrared (black)	Digi-Key	160-1031-ND
10	8	IRD0-IRD7	BL-L513IRAB	Evil Mad Science	9330036
11	8	D0-D7	LED, 10 mm, choice of color	Evil Mad Science	Various
12	2	C1, C2	Capacitor, 0.1 uF Ceramic	Digi-Key	BC114BTR-ND
13	1	S2	Power Switch, high power	Digi-Key	CKC5107-ND
14	1	J5	Power Jack, 2.5x5.5 mm	Digi-Key	CP-002BH-ND
15	1	C3	100 uF, 10V, electrolytic cap.	Digi-Key	493-1040-ND
16	2	J3J4	Edge Connector, Female 8 pos. female, gold, 0.100" right angle	Digi-Key	55483-ND
17	2	J1J2	Edge Connector, Male, 8 pos., gold, 0.100" right angle	Digi-Key	WM6108-ND
18	4	JP1-JP4	Zero-ohm jumper	Digi-Key	ZOR-25-R
19	1	U1	ATmega164P, preprogrammed	Digi-Key	ATMEGA164P-20PU-ND
20	4	-	Standoff, Aluminum, round, 6-32 x 3/4"	McMaster-Carr	34880K-ND
21	4	-	6-32 x 1/4" Stainless B5C5	Digi-Key	92949A144
22	1	XTL	Oscillator Crystal, 16 MHz, 20 ppm	Digi-Key	535-9041-ND
23	2	C5,C6	Capacitor, 18 pF (w/ black stripe)	Digi-Key	BC1004CT-ND

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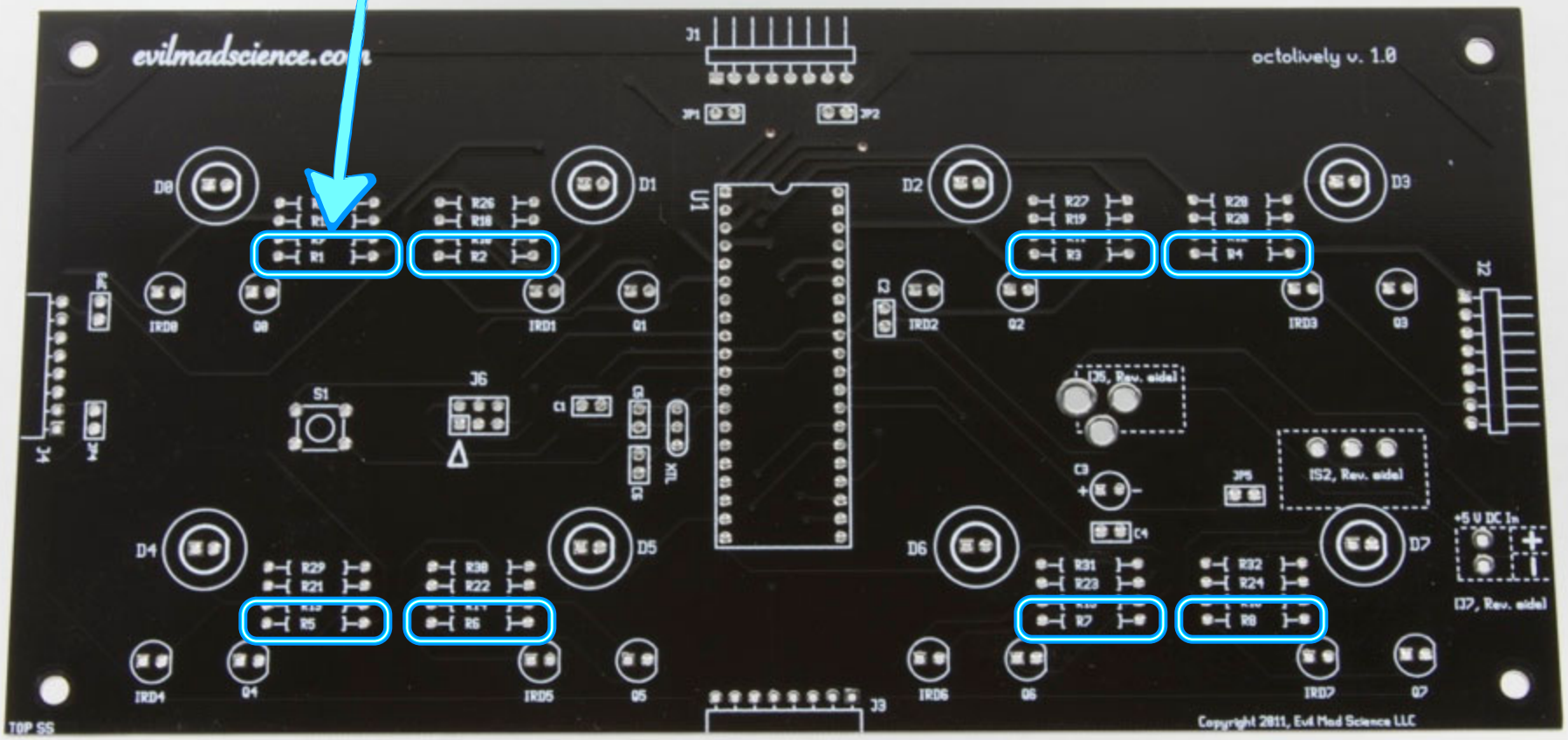
In the instructions, we refer to components by their line item number on the bill of materials. For example, **#19** is the (big) microcontroller chip.

In some places, the assembly procedure may differ between kit versions.

In particular, note that some resistor values are different for kits with white LEDs versus the "control pad" versions with colored LEDs.

Assembly Step 3 – First component locations

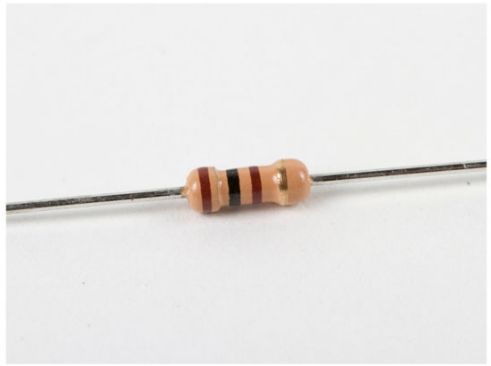
Our first assembly step will be to add components in locations R1 through R8 on the circuit board. Locate these 8 locations on your circuit board, as shown highlighted here.



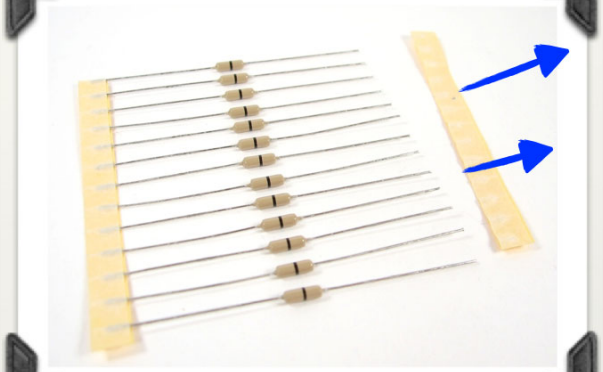
The Octolively circuit board, **#1** on the bill of materials.

Assembly Step 4 – Find the first component

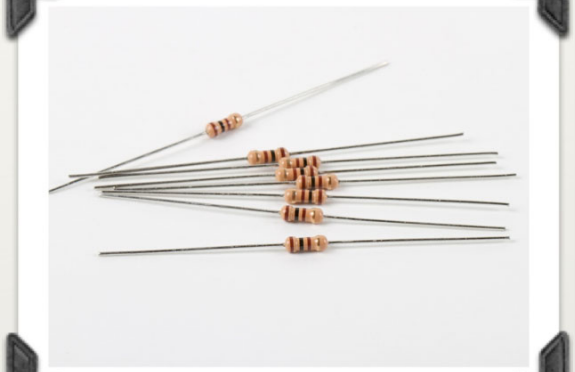
Our first component type is a 100 ohm resistor, **#2**. For this first one, we'll take it slowly.



Our first components are 100 Ohm resistors, **#2**. Identify them by their color code: Brown-Black-Brown-Gold



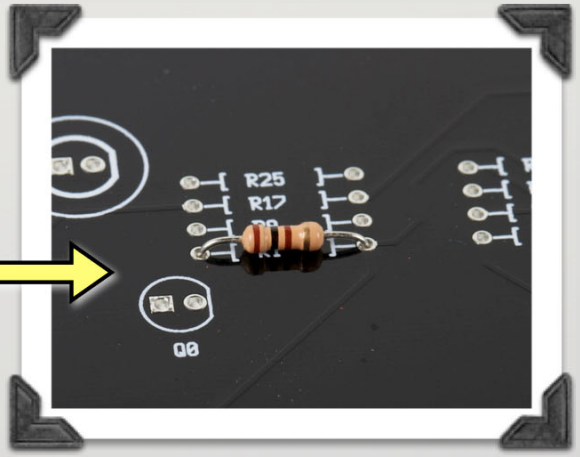
The resistors are normally taped together like the ones shown here. Pull the tape straight off to remove it.



With the tape removed, you should now have 8 of these resistors.

Take one and bend it like so.

Insert it at location R1
(the orientation does not matter)



And press it flush to the board

(Next up... Soldering tips!)

Assembly Step 5 – Some hints on soldering

As the old Heathkit manuals say, "it is interesting to note" that the vast majority of problems reported with soldering kits turn out to be due to unreliable solder connections.

Before we go further, here's a quick refresher, with our suggested procedures for adding components to the circuit board. These procedures apply to most components in the kit.

Adding components to the circuit board

(0). Pre-form the leads of components if needed.
(For example, like the resistor in step 4.)

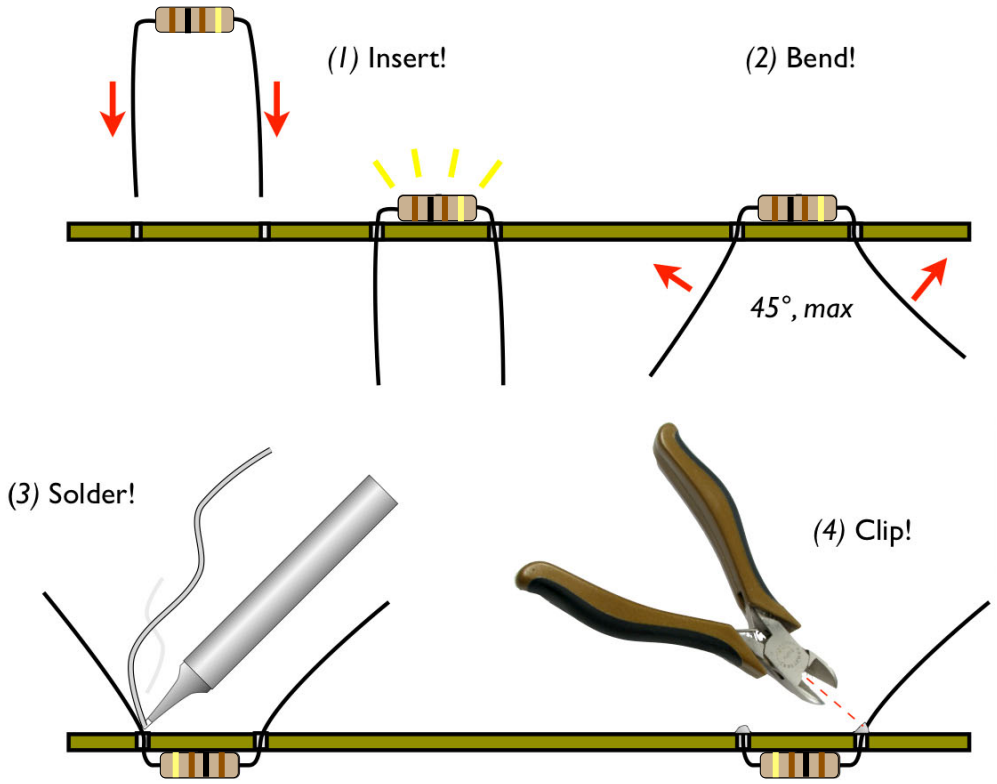
(1). Insert each component into the circuit board, from the top, at its given location. Push it flush to the board (Note that some components, like the chip and LEDs, need to be inserted with a particular orientation.)

(2). If your component has flexible leads, *gently* bend the leads out, up to 45°, to hold it in place while you solder.

(3). One at a time, from the back side, solder the leads of the component to the circuit board.

- Your tip *needs* to be *shiny* (tinned). If not, melt some fresh solder against it and *quickly* swipe clean on a wet sponge.
- Place the solder against the joint that you wish to connect.
- Touch the iron to the solder and joint for about one second. Count it out: "one thousand one."
- The solder should melt to the joint and leave a shiny wet-looking joint. If not, let it cool and try again.

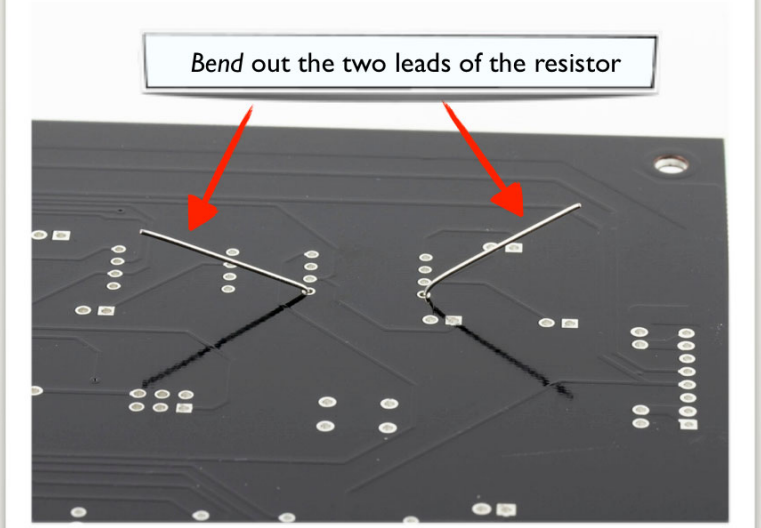
(4). If the component has long and/or or flexible leads, clip off the extra length, close to the board. (But not so close that you're clipping the board itself.)

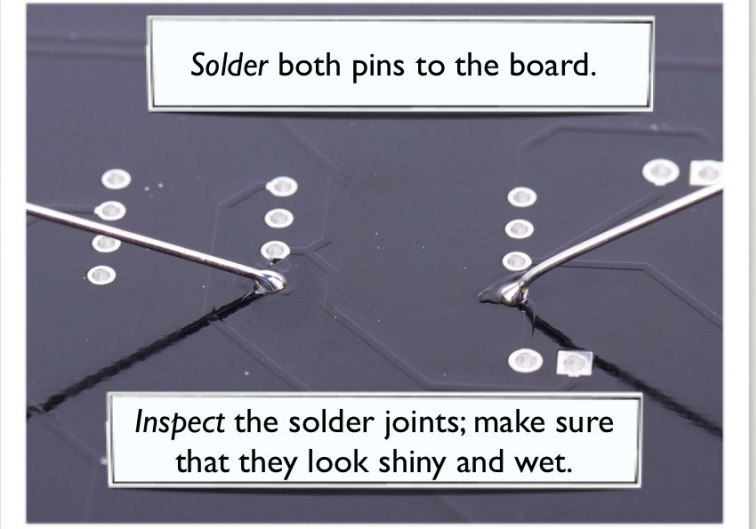


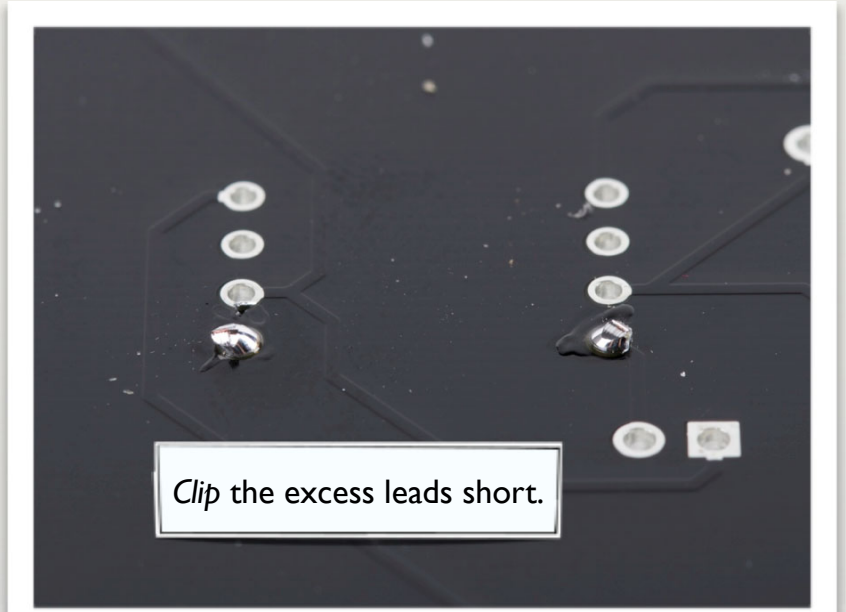
To be continued...

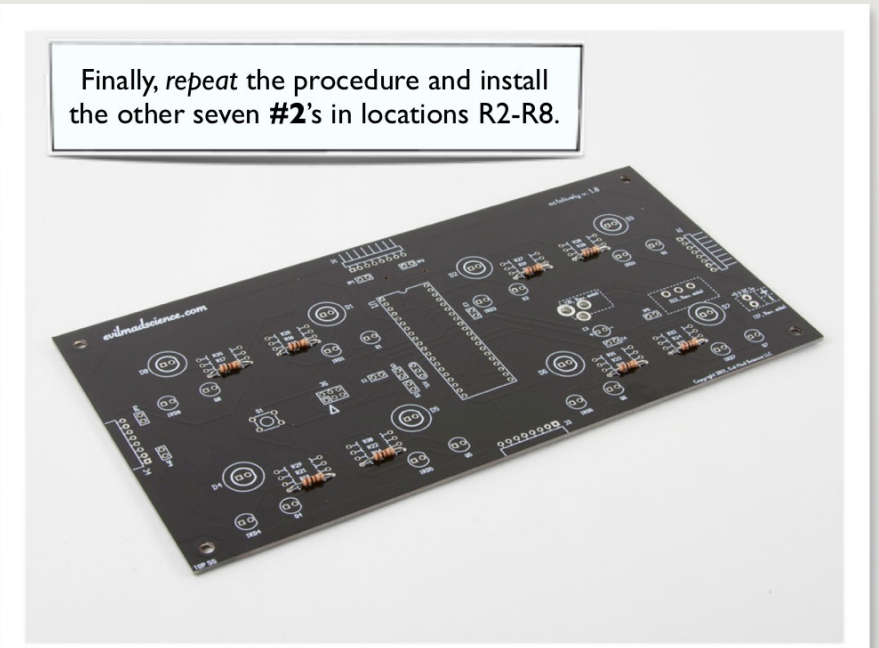
Assembly Step 6 – Solder that first resistor

(Where we perform those steps that we just described!)





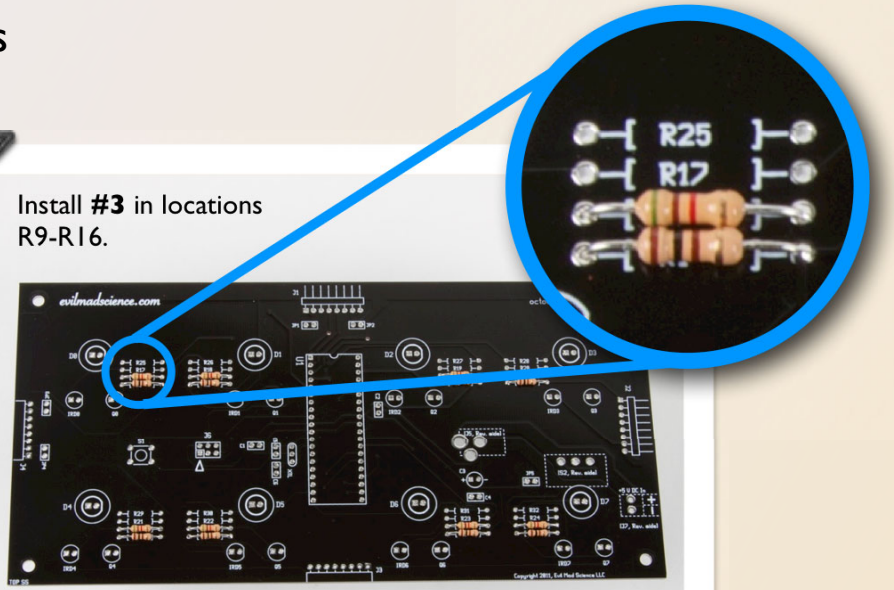




Assembly Step 7 – Add the next two resistors

#3. 5.1 k resistors. Green-Brown-Red-Gold, 8 pieces.

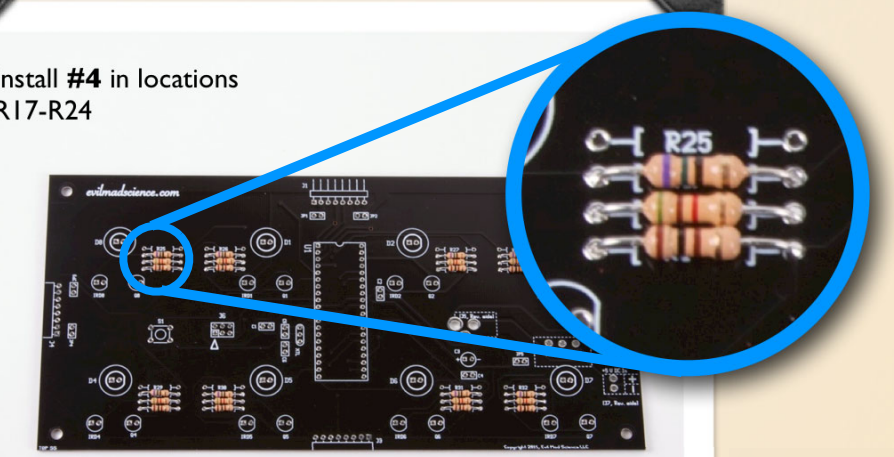
Install **#3** in locations
R9-R16.



(Locations R9-R16 are "right above"
the last resistors that you installed.)

#4. 75 Ohm Resistors. Violet-Green-Black-Gold, 8 pieces.

Install **#4** in locations
R17-R24



(As before, these locations are "right above"
the last resistors that you installed.)

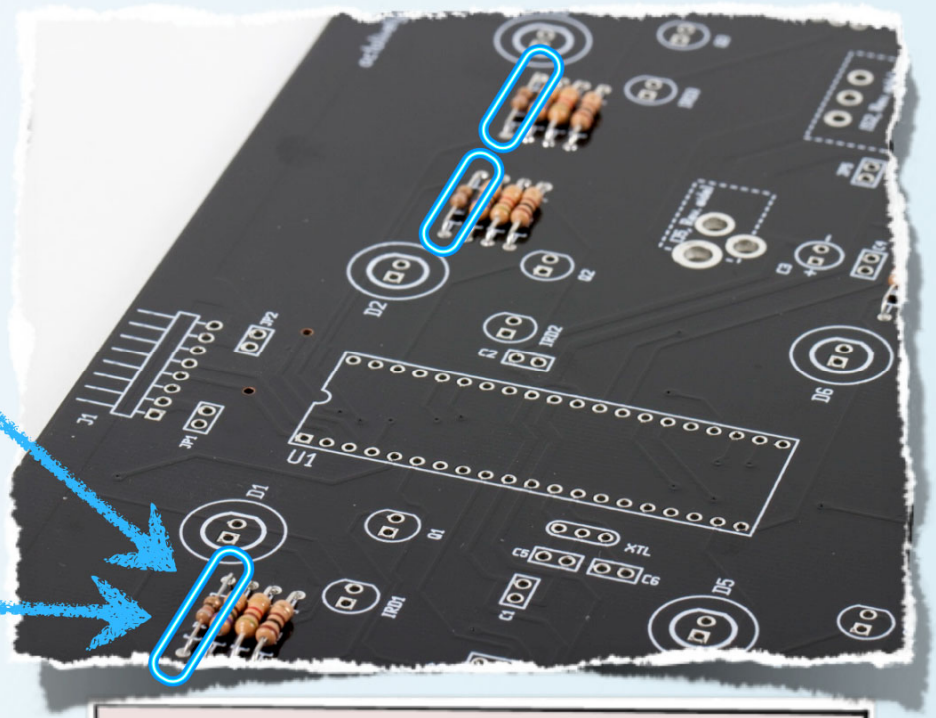
Assembly Step 8 – Last resistors

Part **#5** is a "load" resistor that sets the current through the visible LEDs. Its value depends on the LED color.

For kits *with yellow/red LEDs*, **#5** is 220 Ohm resistor, color code: Red-Red-Brown-Gold.

With *other colors of LEDs*, **#5** is an 82 Ohm resistor. Color code: Gray-Red-Black-Gold. (This is typically a *smaller* resistor, too.)

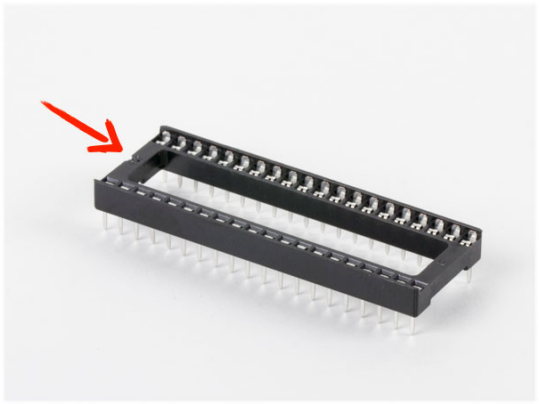
Depends on kit type!



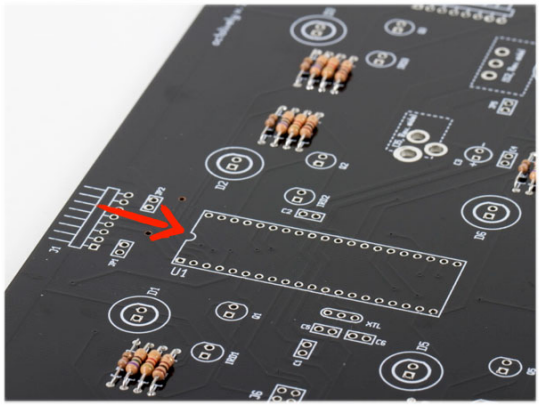
There are 8 resistors **#5**. Install them in locations R25-R32. This is the last resistor in each little block of four resistors.

Advanced tip: If you are using multiple LED colors on a single board, make sure that the resistor by each LED is the correct type: 220 ohm for red/orange/yellow/yellow-green, 82 ohm for blue/green/white.

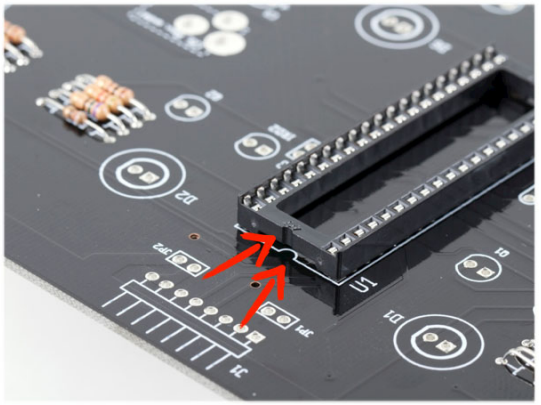
Assembly Step 9 – The IC Socket



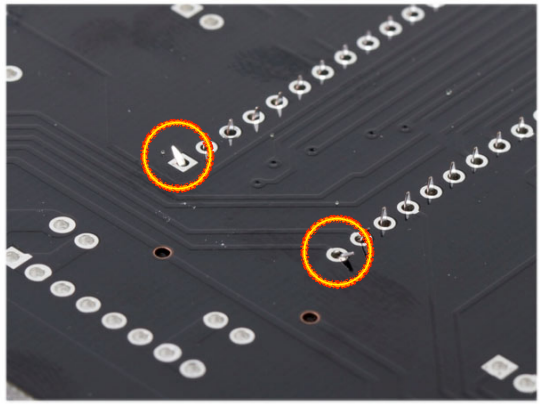
This is **#6**, the 40-position socket for the microcontroller. Locate the polarity marking notch at one end of the socket.



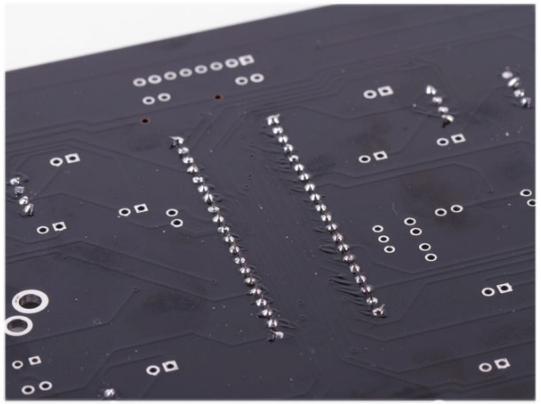
There is a corresponding footprint for the socket, at location U1 on the circuit board. It has a corresponding notch at one end.



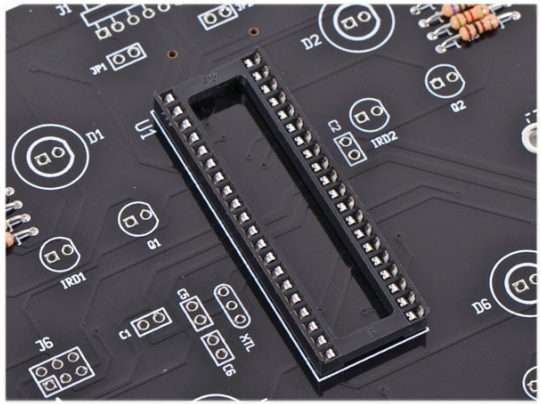
Insert the socket into the circuit board, matching the two ends with the notches.



On the bottom side of the circuit board, bend out the four corner pins of the socket, to hold it in place while you solder.



Solder all 40 pins of the socket into place. You can rest the circuit board flat on the socket while you solder.

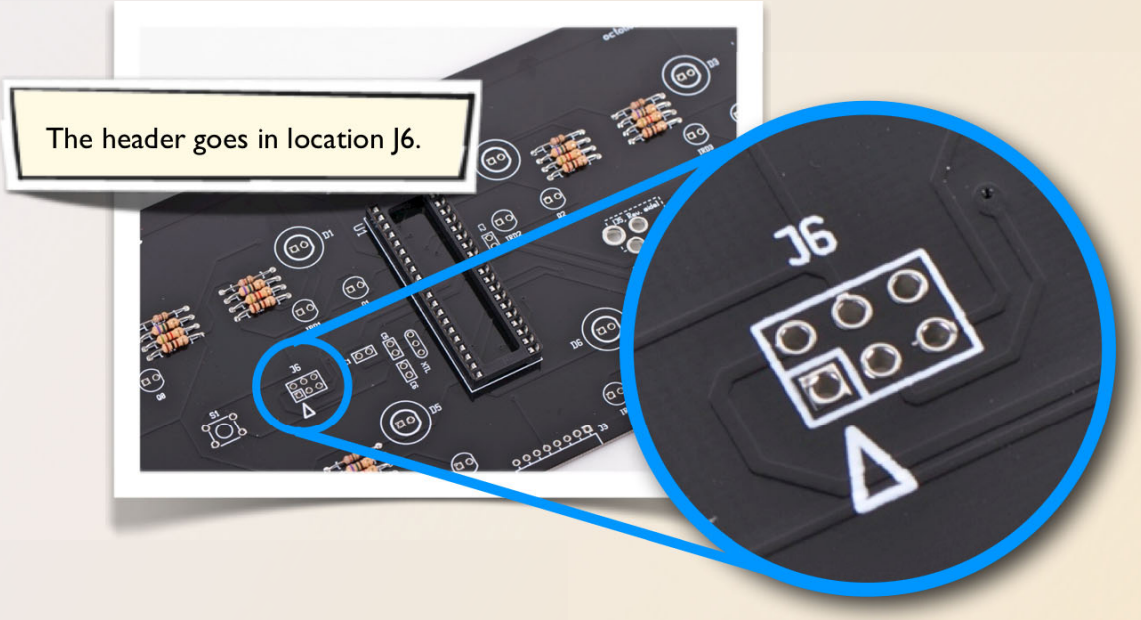


Don't insert the chip just yet– we'll do that later.

Assembly Step 10 – The programming header (optional)

Part **#7** is a 6-pin DIL ("dual inline") Header.

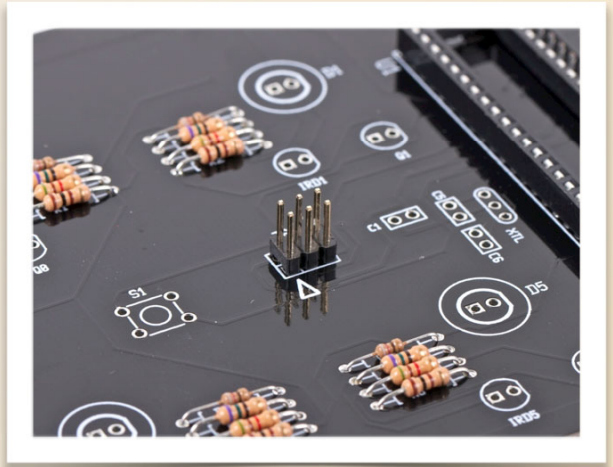
This is an *optional* part, used for connecting to an AVR ISP Programmer. We recommend installing it, in case you wish to reprogram your modules at some point in the future.



The header goes in location J6.

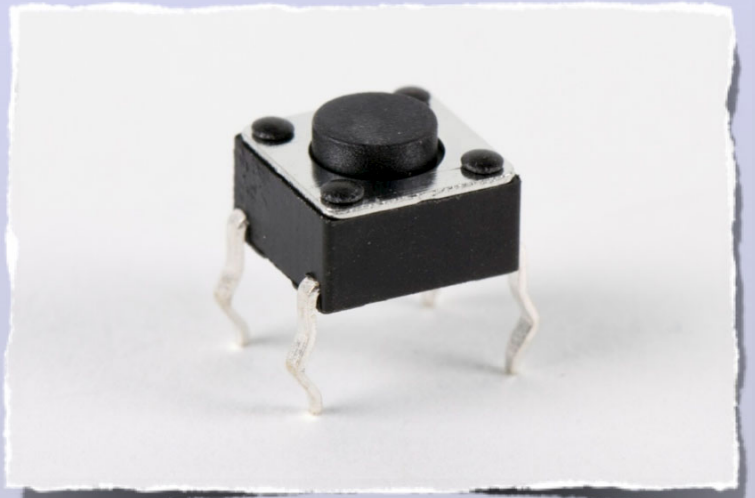
Header pins are short, and cannot be bent to them it in place. However, you *can* rest the whole board on the header to keep it in place while you solder; it's the tallest thing.

Pro-tip: To get the header straight, solder *one pin only* at first. Then check for straightness, before soldering the other pins.

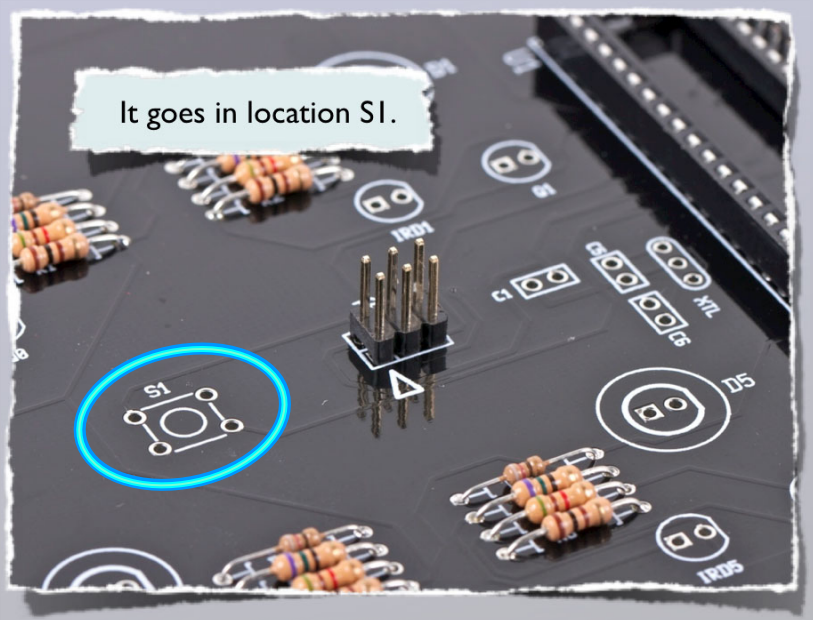


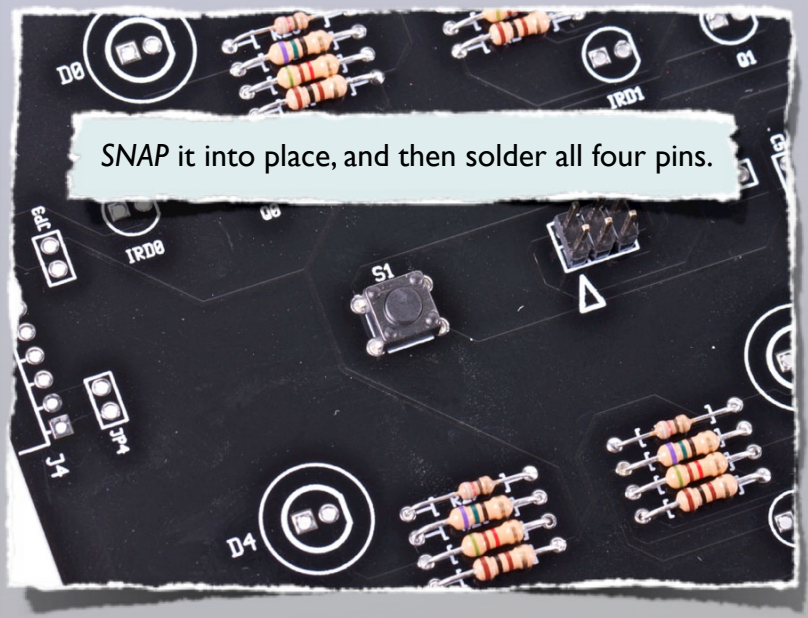
Here's how it should look with all six pins soldered.

Assembly Step 11 – Tactile button switch



Part **#8** is a tactile button switch.





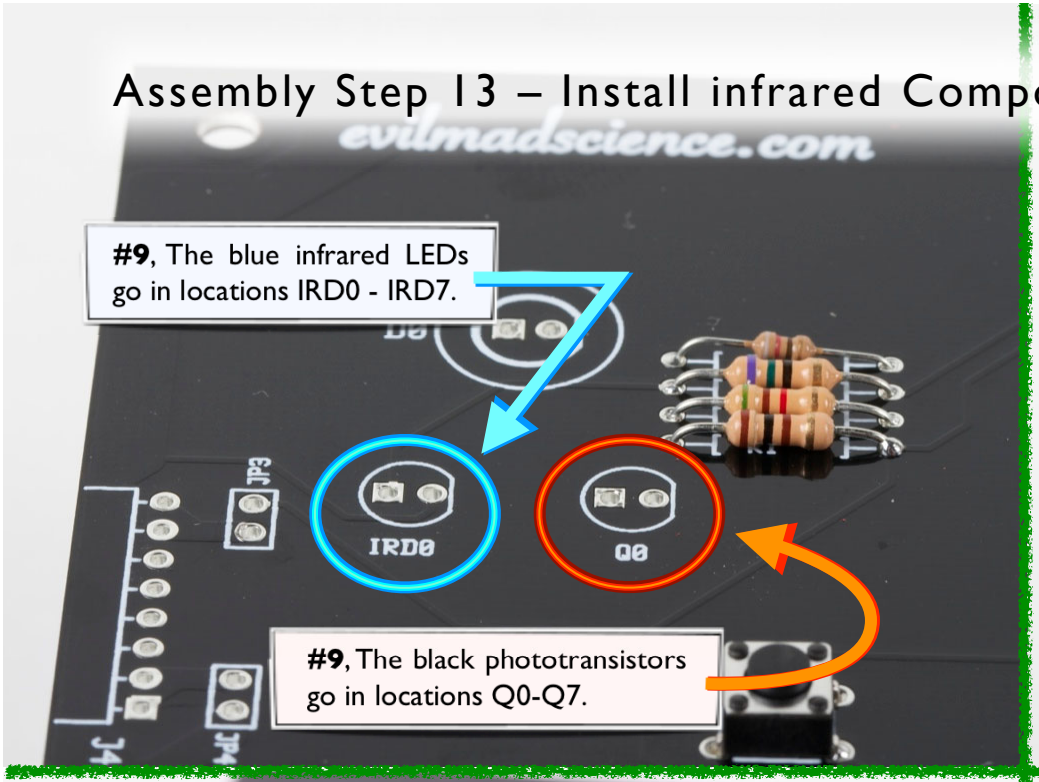
Assembly Step 12 – Identify infrared components

Parts **#9** are infrared phototransistors. It looks like an LED with a black lens. There are 8 of these in total.

Parts **#10** are infrared LEDs with a transparent blue lens. There are 8 of these in total.

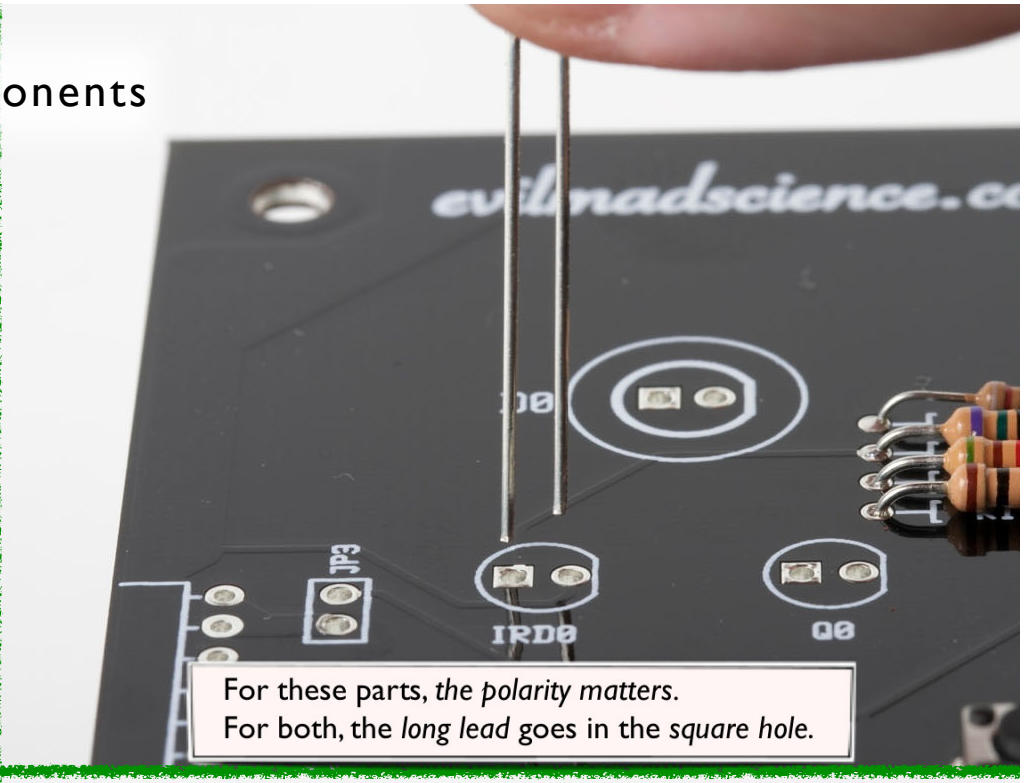
On both, notice that there is one *long lead* and one *short lead*.

Assembly Step 13 – Install infrared Components



#9, The blue infrared LEDs go in locations IRD0 - IRD7.

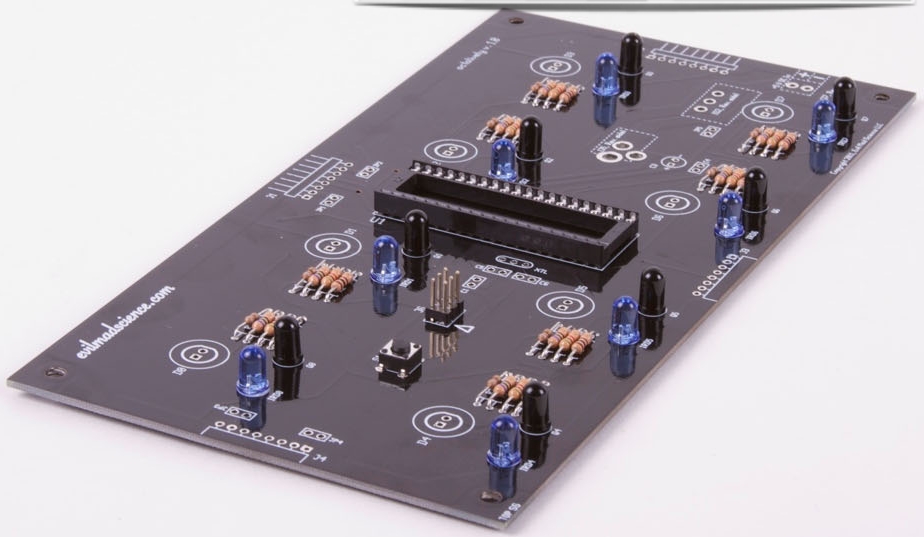
#9, The black phototransistors go in locations Q0-Q7.



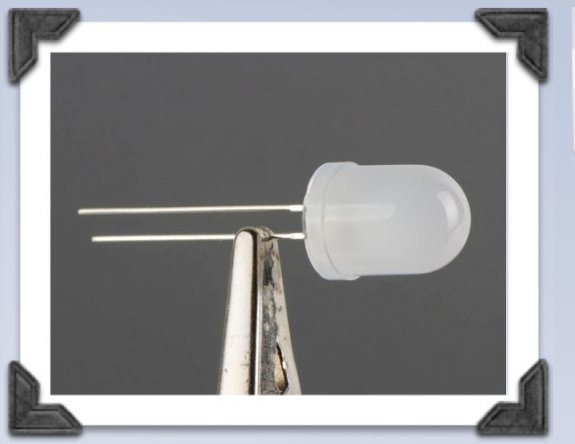
For these parts, *the polarity matters*.
For both, the *long lead* goes in the *square hole*.

Install all 8 infrared LEDs and all 8 phototransistors flush to the board. Solder them in place and clip the leads.

Here's how everything should look so far, with the infrared components now in place.



Assembly Step 14 – Visible LEDs



Next are **#11**, the 8 visible LEDs.
As with the IR components, each LED has one long lead and one short lead.

If you have a "regular" kit with 8 LEDs of the same color, install those LEDs in locations D0-D7. As before, insert the *long lead* into the *square hole*.

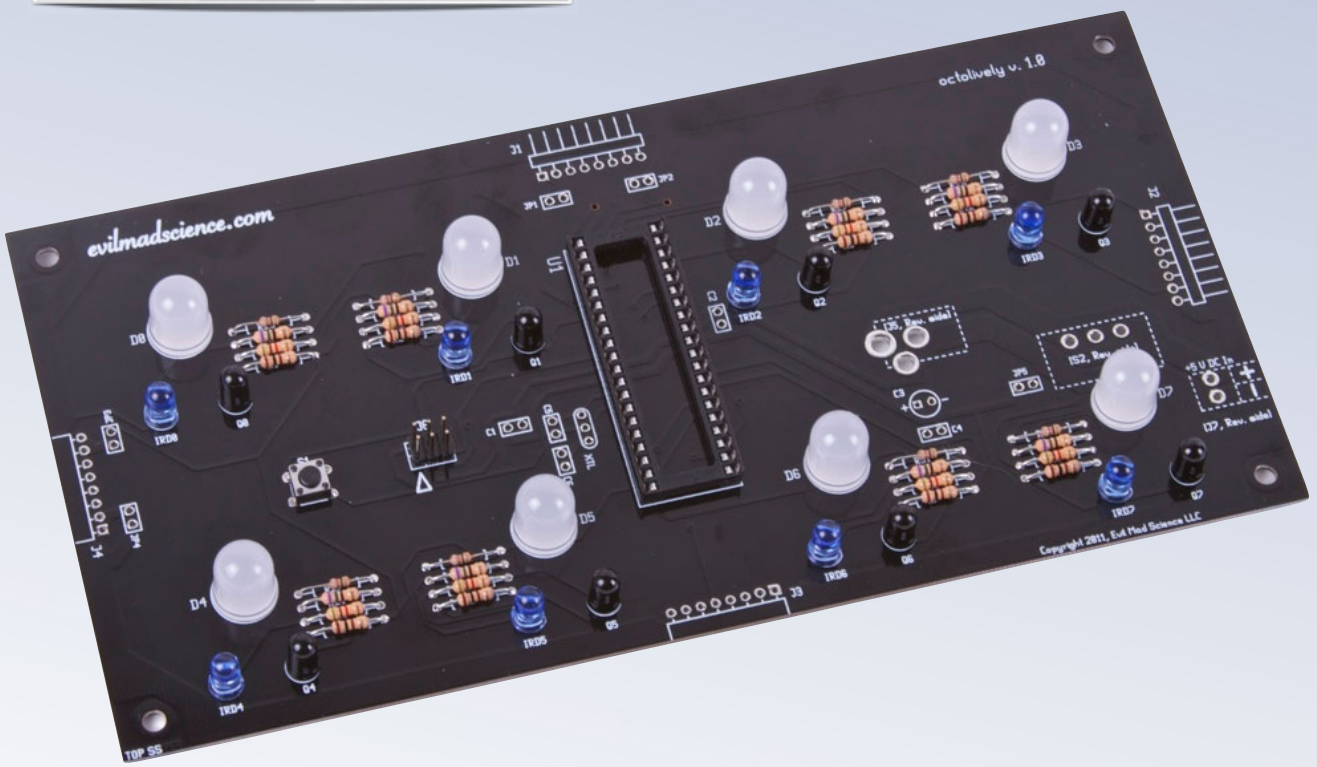
If you have one of the "control pad" kits-- with two colors of LEDs, install the LEDs as follows, in each case with the *long lead* into the *square hole*.

For Red/Yellow kit:
Install yellow LEDs in D0,D1,D4, and D5.
Install red LEDs in D2, D3, D6, and D7.

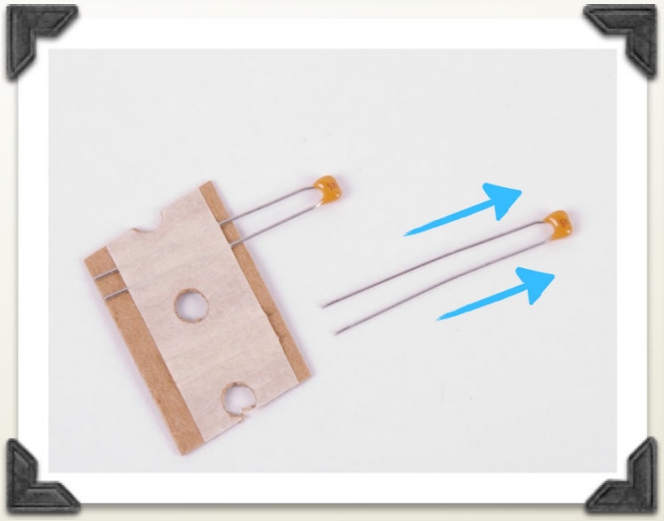
These will become the "pause" and "stop" buttons, color-coded yellow and red.

Blue/Green kit:
Install blue LEDs in D0,D1,D4, and D5.
Install green LEDs in D2, D3, D6, and D7.

These will become the "step" and "play" buttons, color-coded blue and green.

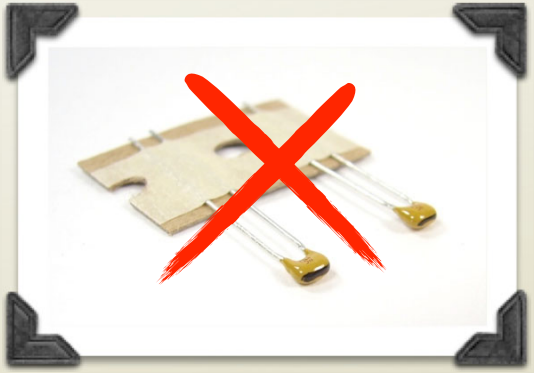


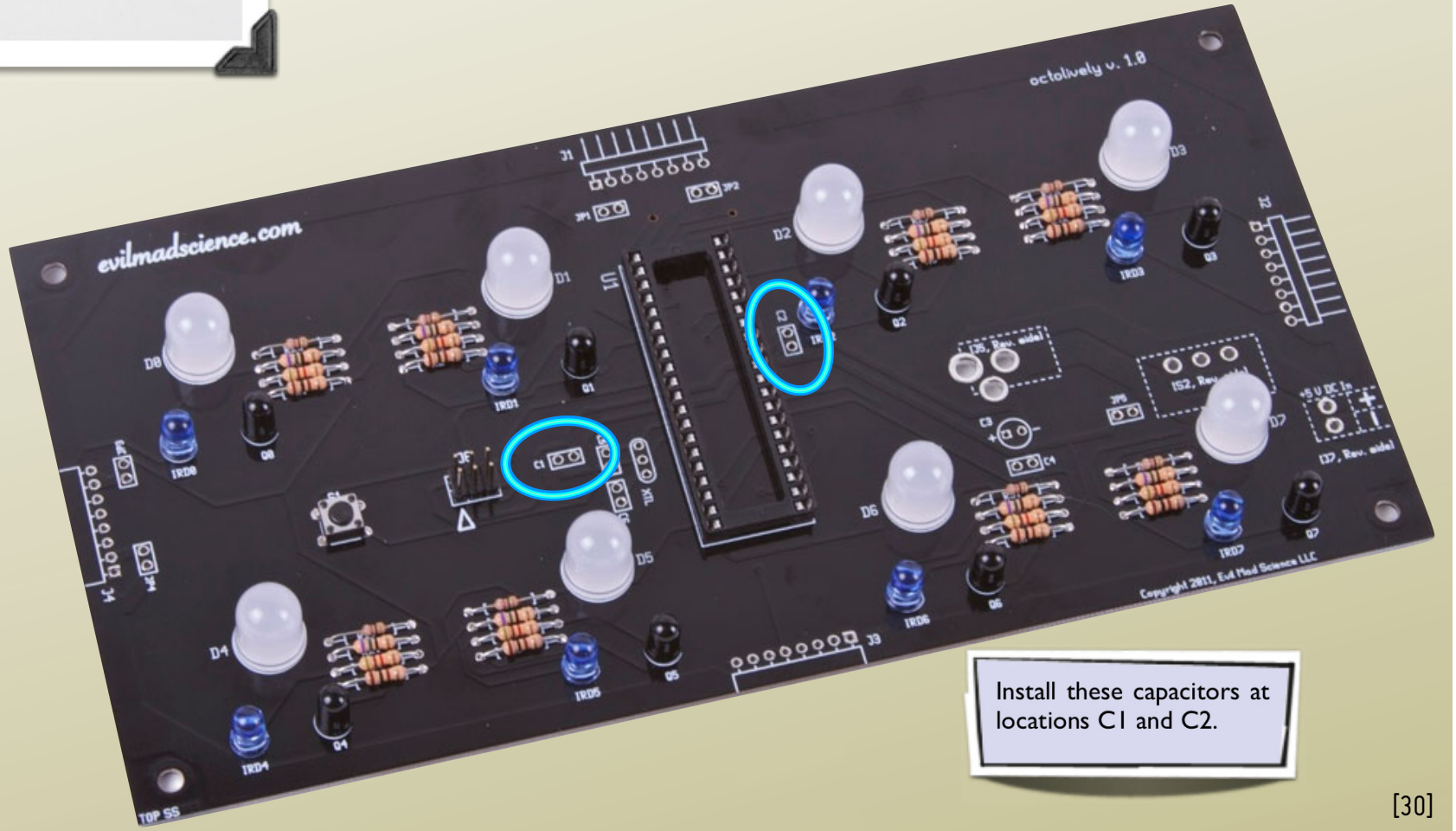
Assembly Step 15 – Little capacitors



Parts **#12** are 0.1 µF ceramic capacitors– two little yellow blobs on leads. They usually come on tape, so pull them out.

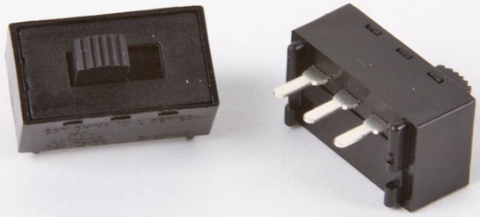
Important: You actually have two sets of similar little capacitors in your kit. The *other set* is marked with black stripes on the top to distinguish them. For this step, *use the set without black stripes*.



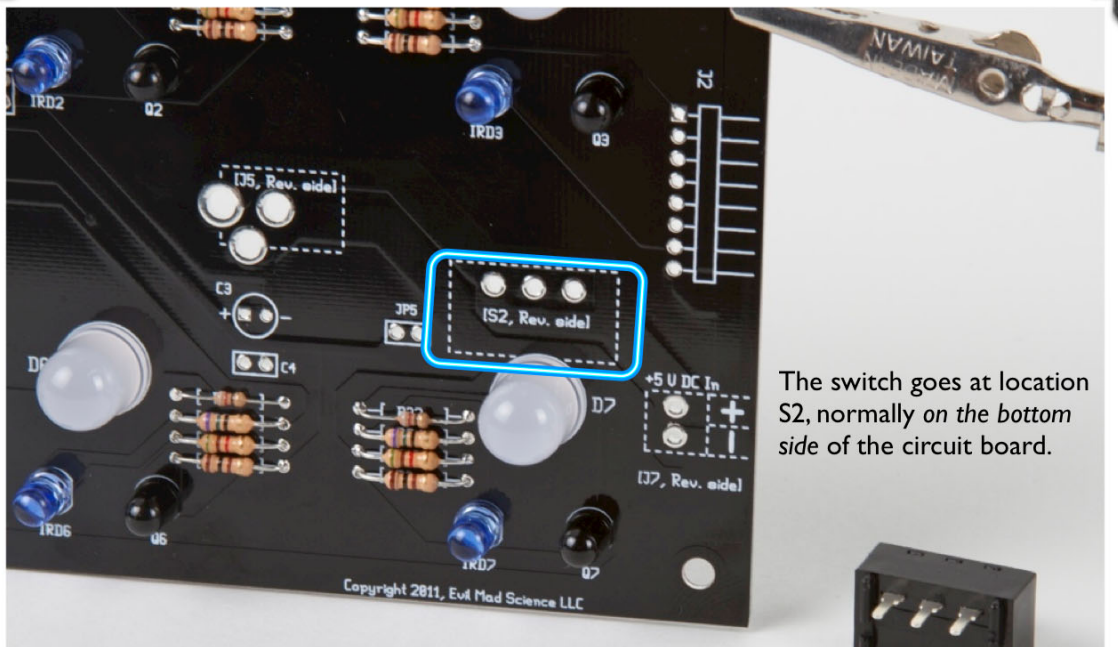


Install these capacitors at locations C1 and C2.

Assembly Step 16 – Power switch, part 1



(There's just one power switch per kit; two are shown here for clarity.)



The switch goes at location S2, normally *on the bottom side* of the circuit board.

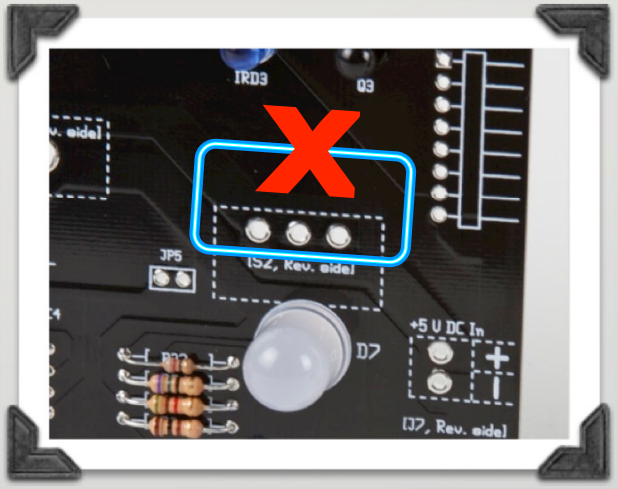
Orientation: Make sure that the switch sits under the dotted outline as shown above, not offset as shown below.

Part **#13** is a high-current slider switch.

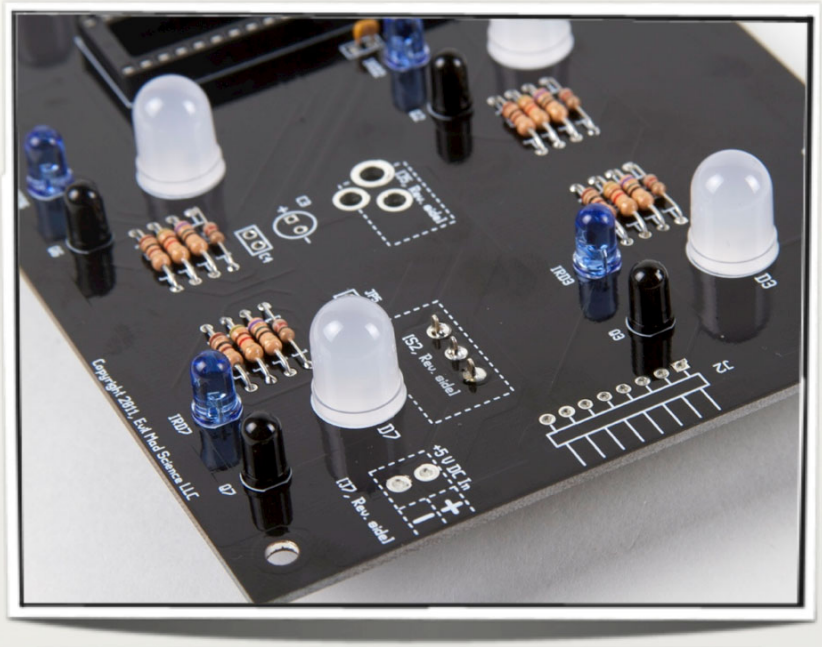
In an array, you may not need to install this on every module.
– In the circuit, the switch sits between the power jack and the rest of the board.
– If you are powering an array, only the modules that will be connected to power actually need power jacks and power switches.

Like this!

Not like this!



Assembly Step 17 – Power switch, part II

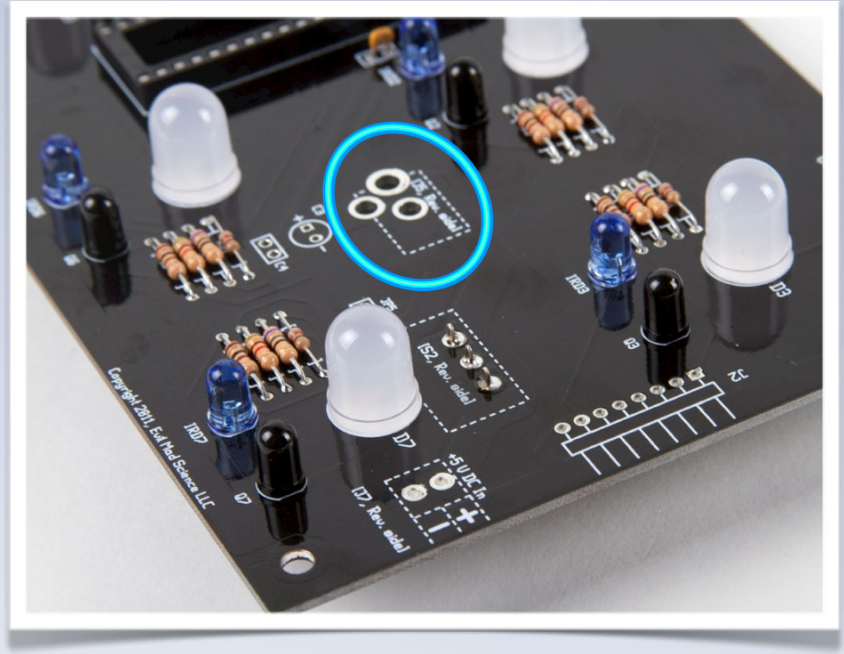


With the switch on the bottom side, solder the three pins of the power switch into place as shown.

If desired, you can instead install the power switch on the top side. If so, rotate it 180 degrees, so that it's *not* in the dotted line area.

You can also install this (or a different) power switch off-board, by running wires to the switch location. (Make sure that your wires and switch are rated for the current that you will be putting through them.)

Assembly Step 18 – Power jack



#14, The power jack goes in location J5, on the bottom side of the circuit board.

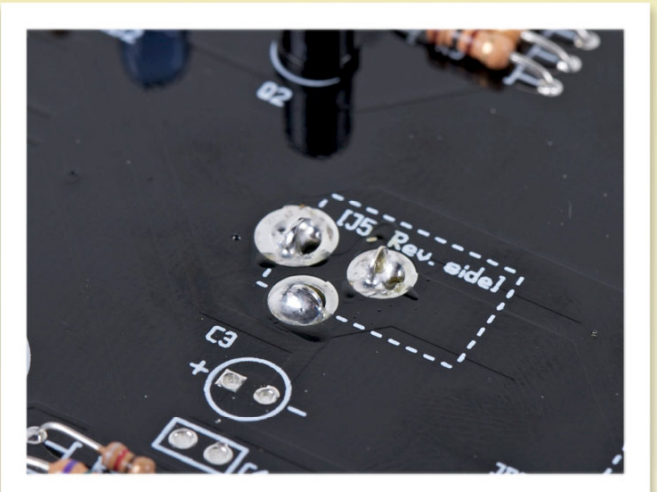
(As with the power switch, you may not need a power jack on every module.)

The power jack is located very close to the power switch.

– To prevent the end of the power cord from potentially bumping into the switch, it is helpful to rotate the power jack several degrees in the direction indicated by the arrows.

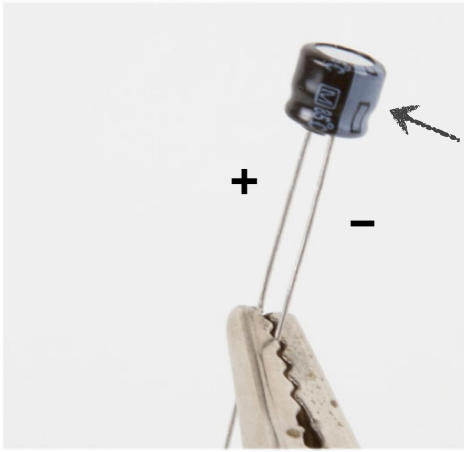
– To do this, you may want to solder the jack with the power connector plugged in (but not connected to power).

Assembly Step 19 – Electrolytic Capacitor



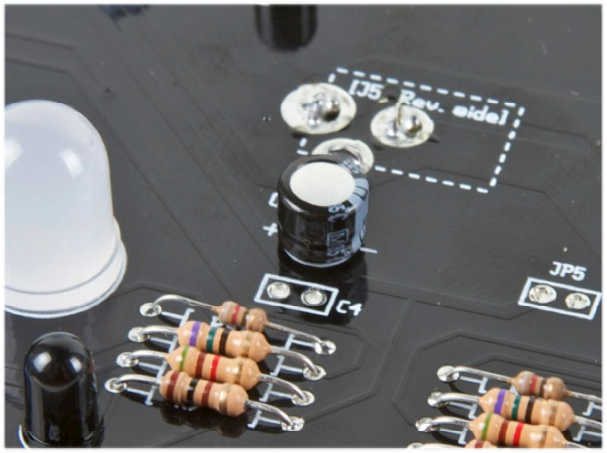
Solder the three pins of the power jack. It should make a solid connection, but it is not important to completely fill the holes with solder.

Our next component will go nearby in C3. Note that location C3 has its polarity marked on the board.



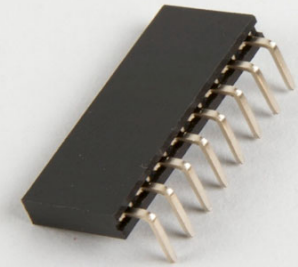
Our next part is **#15**, a 100 µF electrolytic capacitor, which goes in location C3.

This capacitor has a polarity: The "–" side is marked with a broad white stripe.



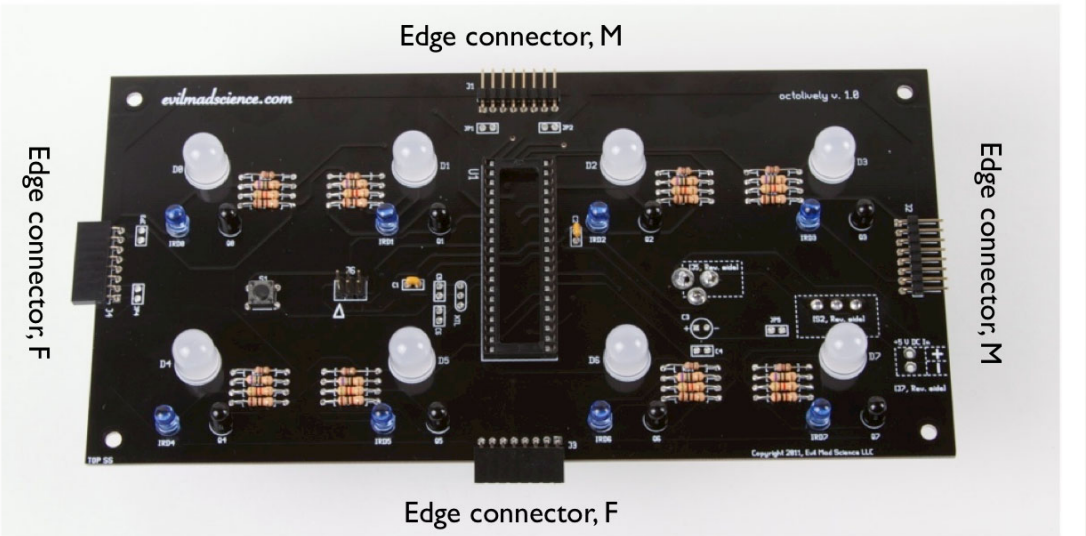
Install the capacitor at C3, matching the polarity to that indicated on the board, negative side to negative side.

Assembly Step 20 – Edge connectors, part 1

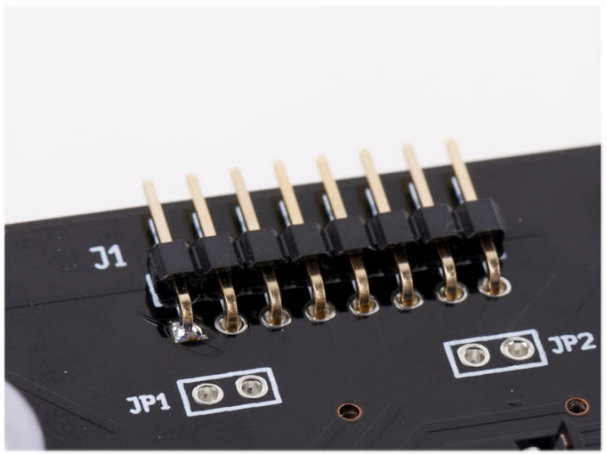


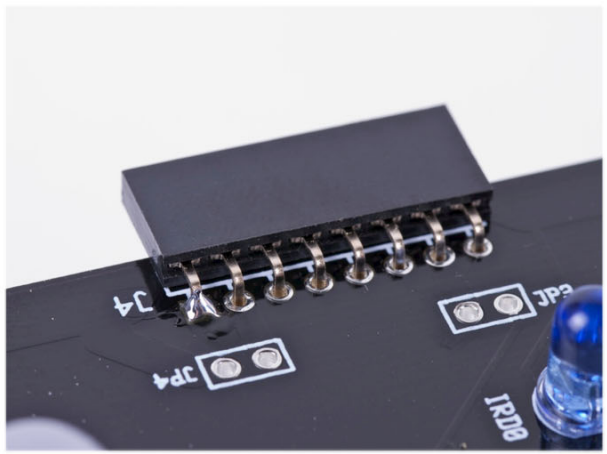
#16 Edge connector, F
Install at J3, J4

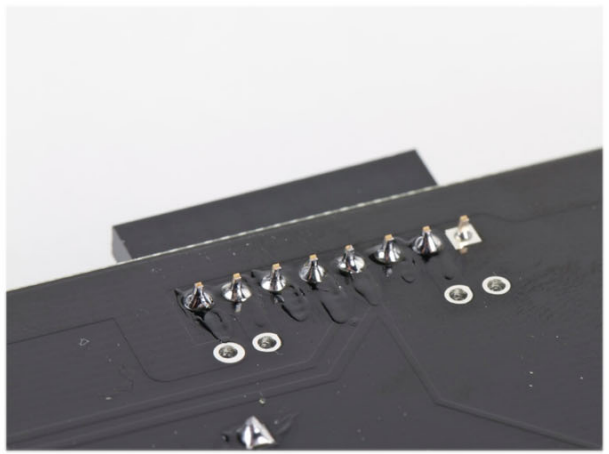
#17 Edge connector, M
Install at J1, J2



Note: It is often preferable *to not install* the edge connectors along the outer edges of larger installations, where nothing will be connected. You can save this step for later (or skip it entirely) if you prefer.



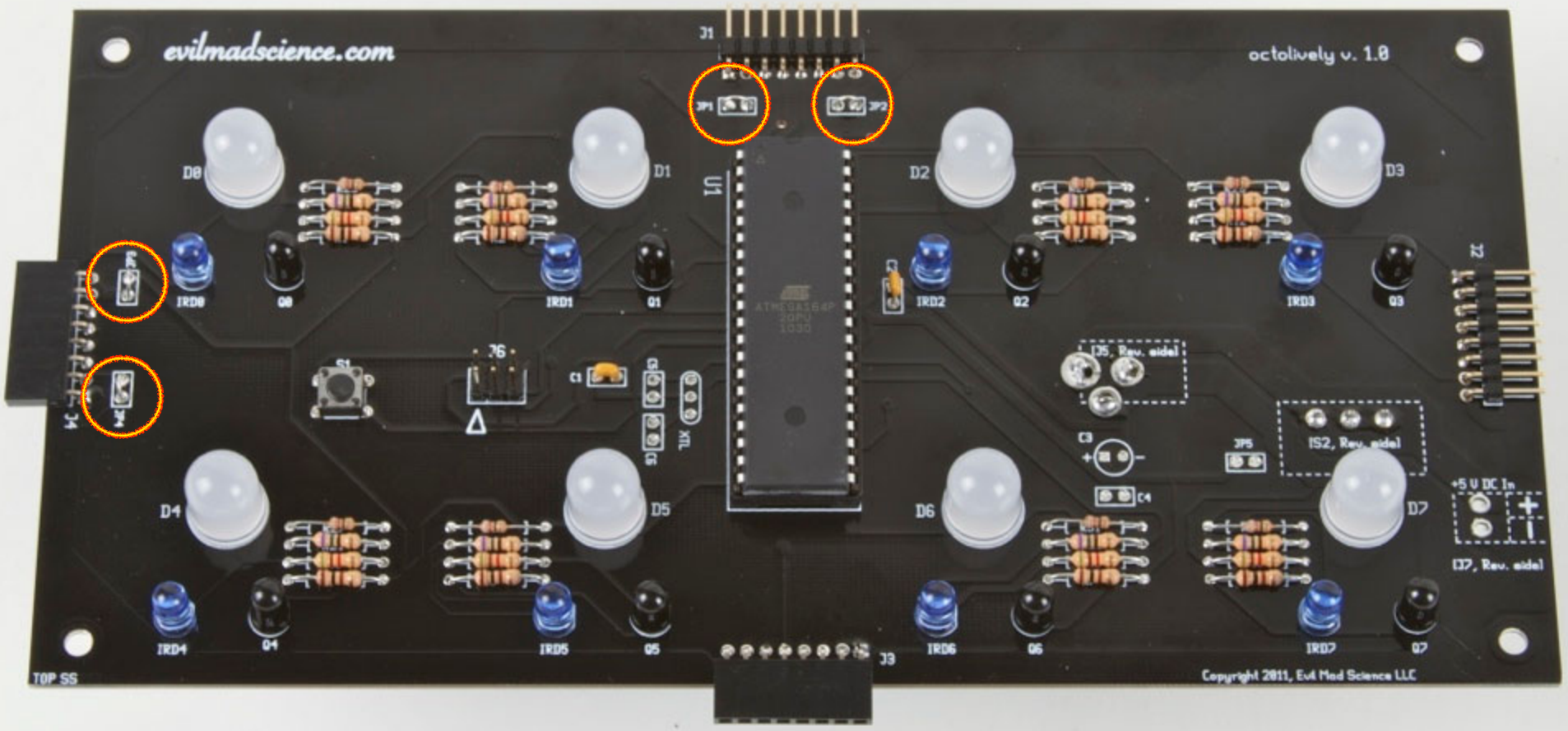




To get each edge connector straight and level: First solder one pin from the top to "tack" the connector in place.
Check for straightness. Then, solder the other 7 pins from the back side.

Assembly Step 21 – Edge connectors, part II: About power jumpers

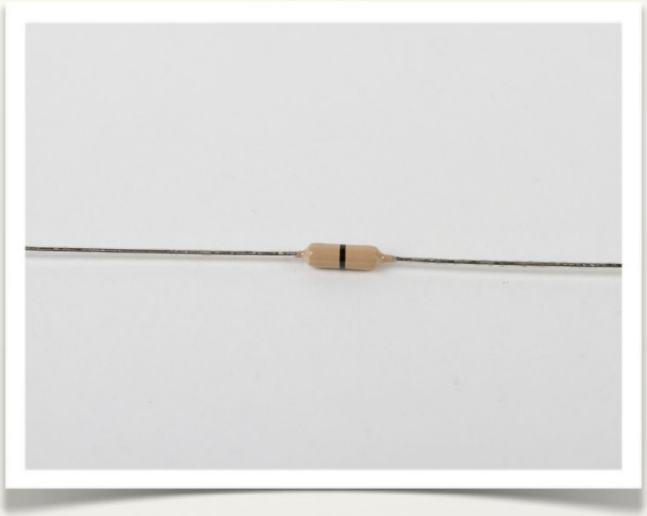
The four locations highlighted are power jumpers JP1-JP4. These jumpers control whether the module's power supply is or is not connected to the edge connectors.



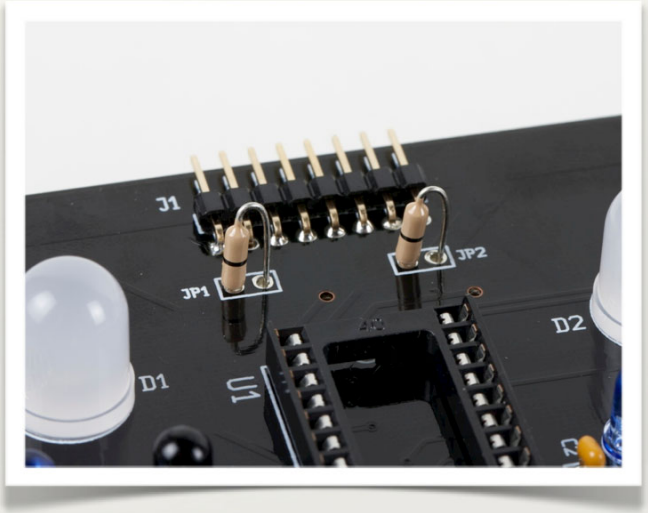
JP1 and JP2, by edge connector J1, (if installed) connect +5 V and GND to the module above this one. JP3 and JP4, (if installed) connect +5 V and GND to the module to the left this one.

In the next step, we'll install these power jumpers.

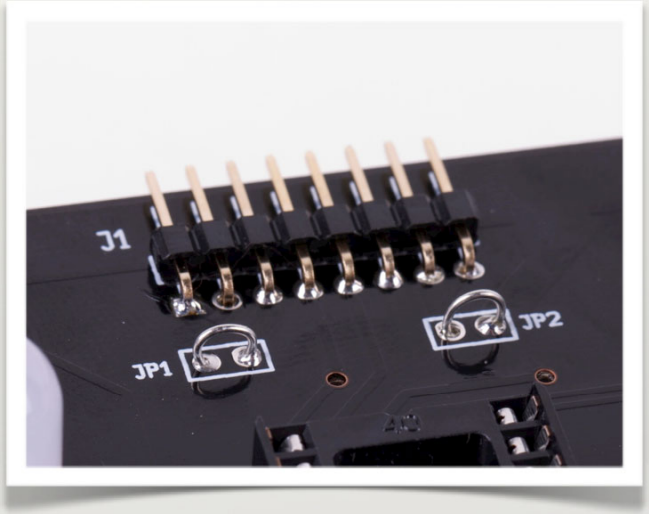
Assembly Step 22 – Edge connectors, part III: Installing power jumpers



Four wire jumpers, **#18**, are included with the kit. These look like resistors with a single black stripe.



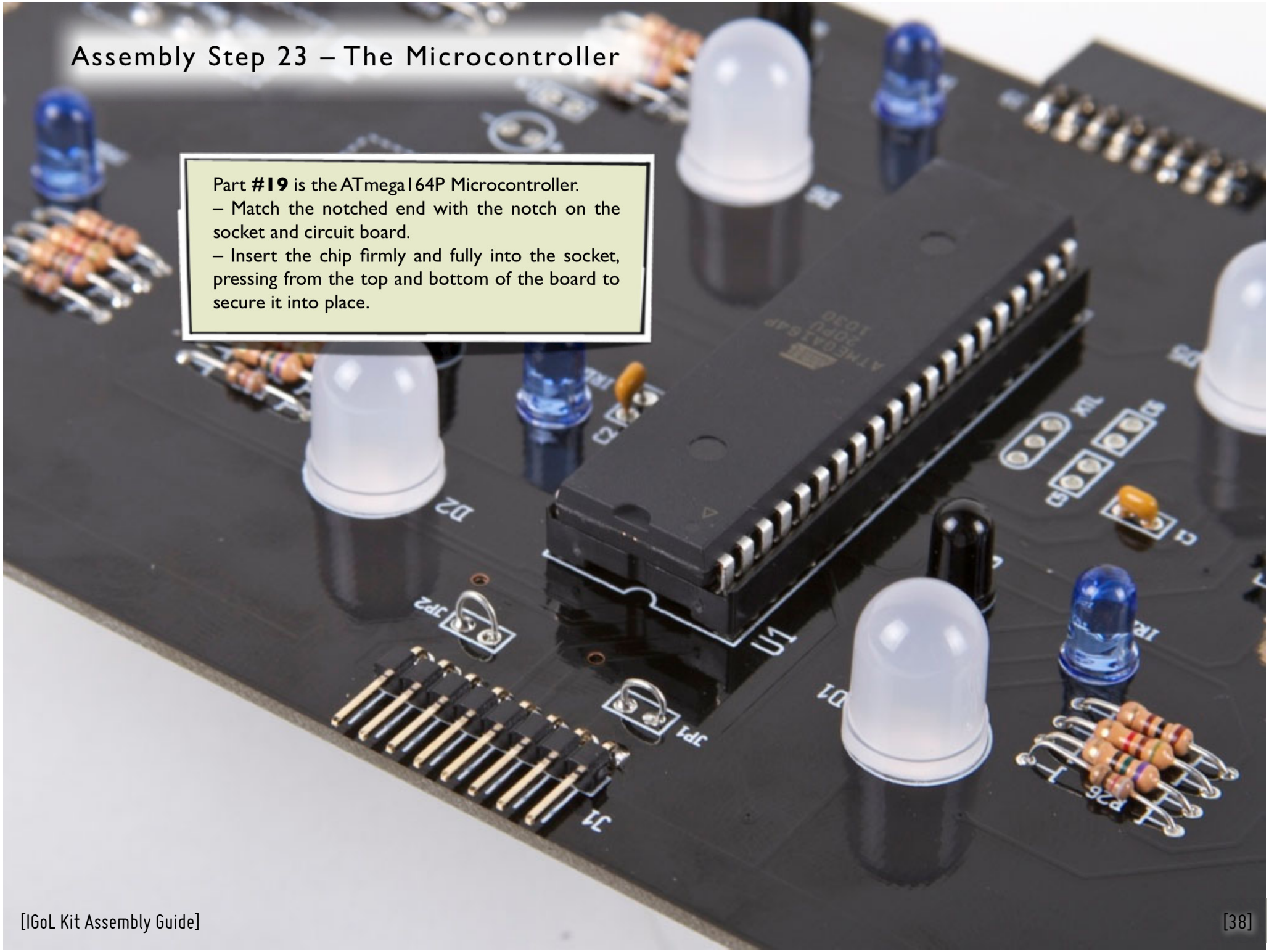
To enable the edge connectors for power distribution, you can solder these jumpers into JP1-JP4.



For a slightly more elegant appearance, *just use the wire* from the jumpers, to form little wire loops that you can solder in place.

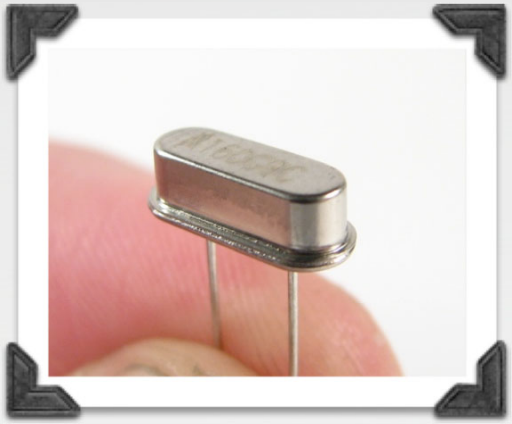
(Once the edge connectors are enabled with the power jumpers, you can disable them by clipping the little loops, or re-enable them by soldering them back together.)

Assembly Step 23 – The Microcontroller

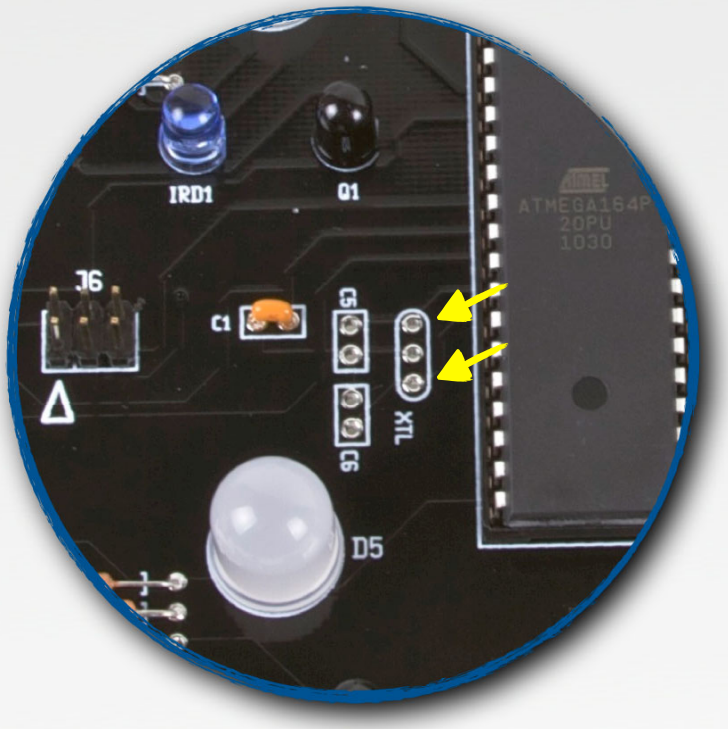


Part **#19** is the ATmega164P Microcontroller.
– Match the notched end with the notch on the socket and circuit board.
– Insert the chip firmly and fully into the socket, pressing from the top and bottom of the board to secure it into place.

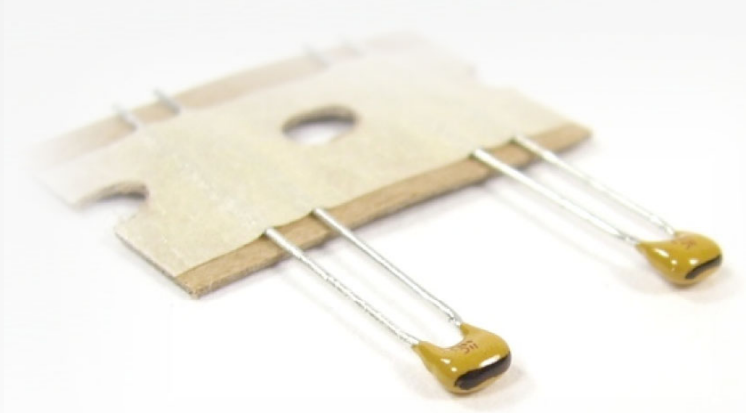
Assembly Step 24 – Quartz Crystal and Helper Caps



Install part **#22**, a 16 MHz quartz crystal. Its two pins go in the *outer two holes* of the location marked "XTL." Solder both pins in place, much like a resistor.



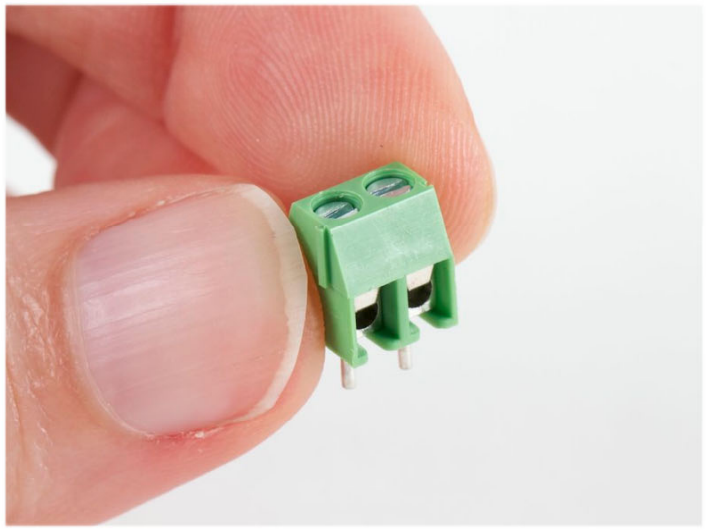
Parts **#23** are 18 pF ceramic capacitors-- little yellow beads with two pins. Again, there are two similar types of ceramic capacitors in the kit, and these ones are marked with a *black stripe*.)

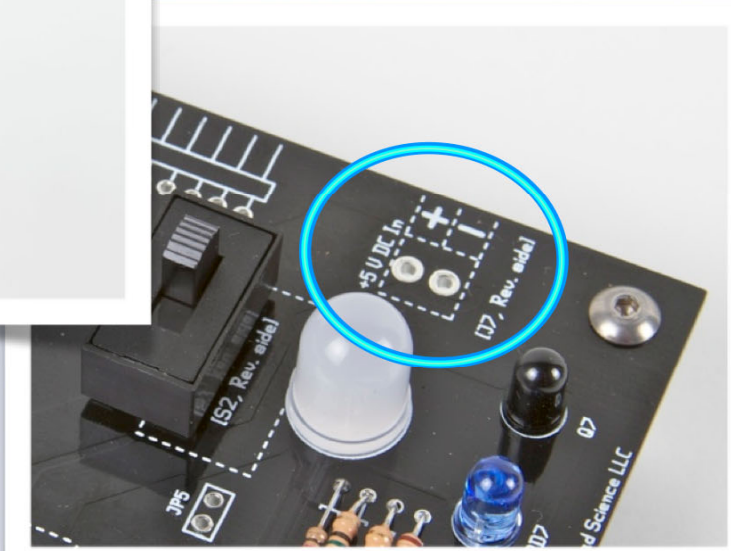


Solder these two capacitors on the board at locations C5 and C6, next to the quartz crystal.

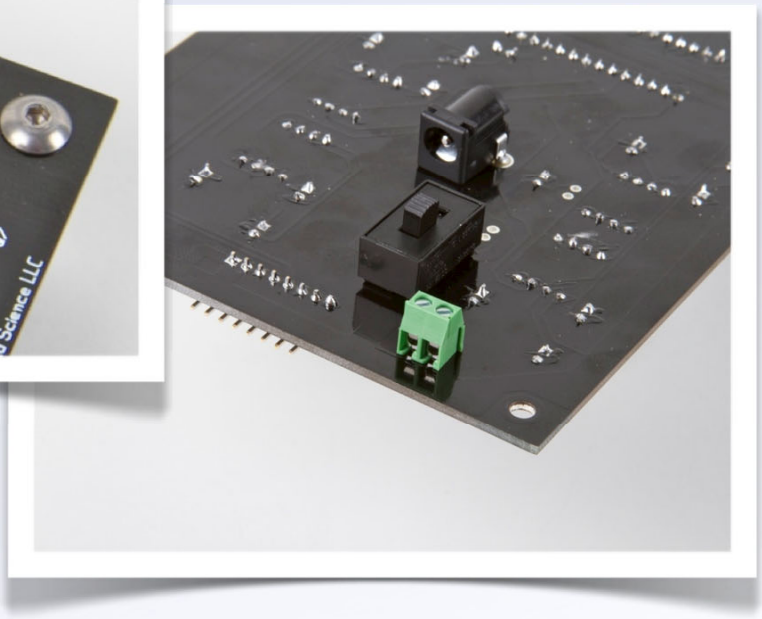
If they are taped together, pull them straight out of the tape.

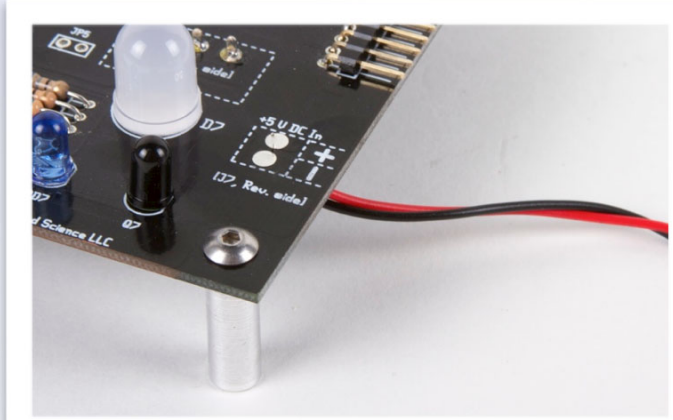
Assembly Step 25 – Optional screw terminals / hardwiring point





Location J7 on the bottom side of the circuit board is for an optional 2-position screw terminal for connecting 5 V power (+ 5V DC/GND) to the module.

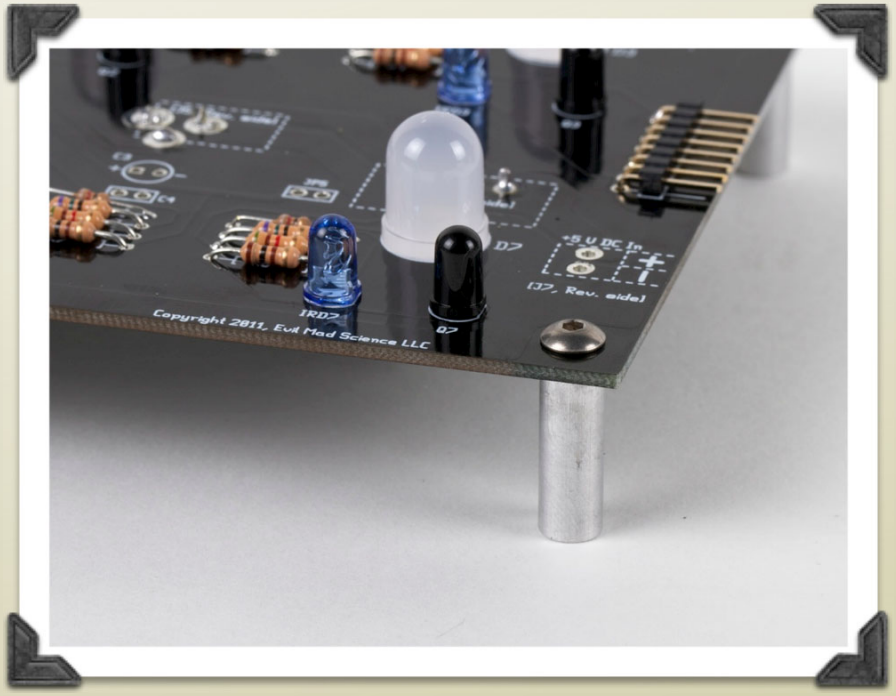




If not installing the screw terminal, J7 can be used as a port for hardwiring the power connections (+5 V DC /GND).

Assembly Step 26 – Mounting hardware

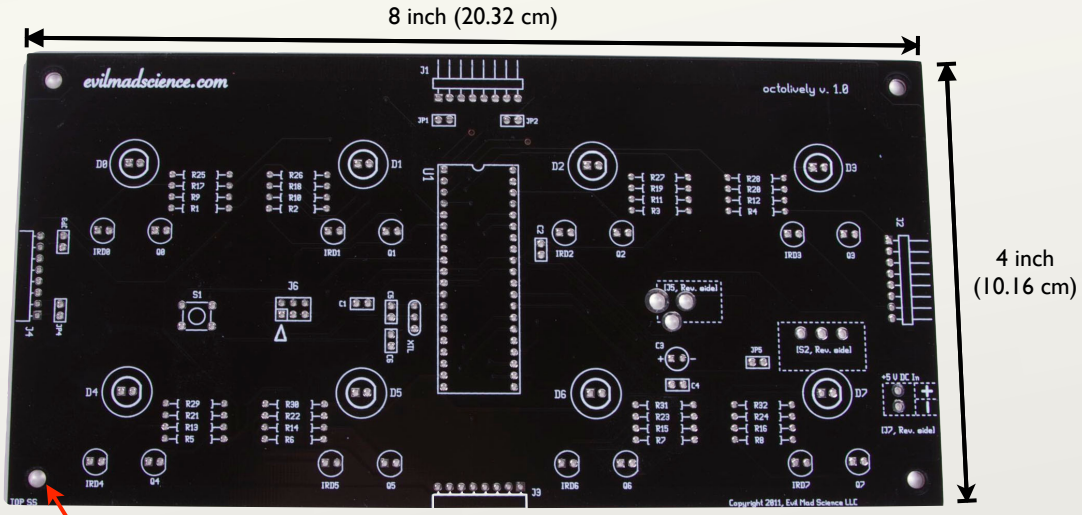
Parts **#20** are the 6-32 x 3/4" aluminum standoffs (4 pieces).
Parts **#21** are the 6-32 by 1/4" button socket cap head screws.

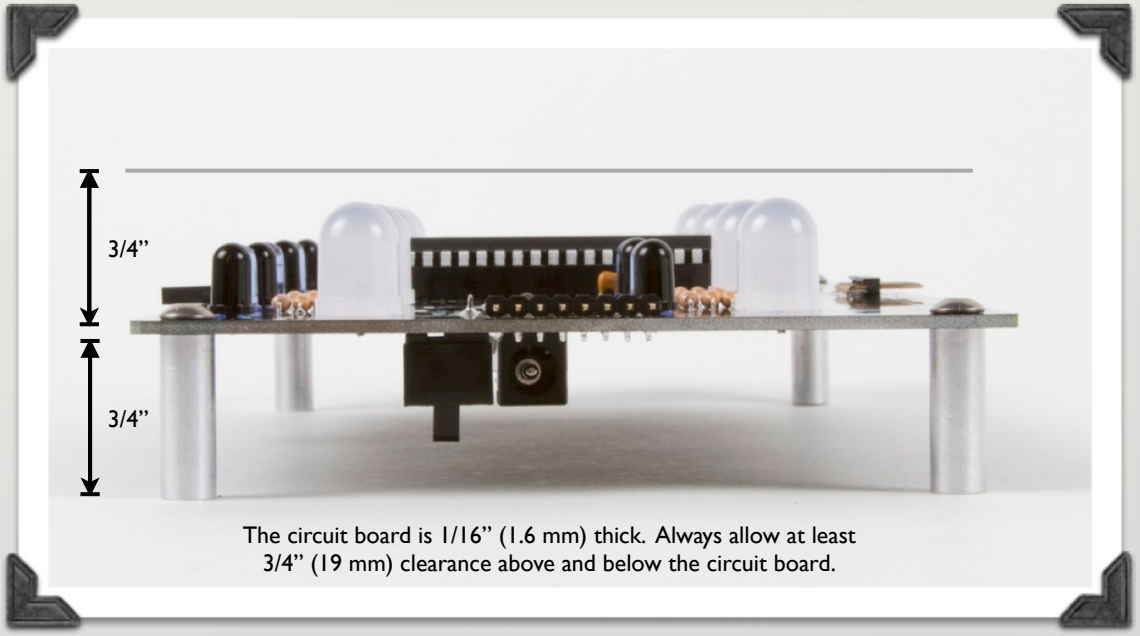


Mount the standoffs at each corner of module.

You can tighten the screws with a 5/64" (2 mm) hex wrench. If you do not have such a wrench, that's okay too! Drop the screw through one of the holes, put your finger over the screw to hold it still, and thread the standoff fully onto it. (If you press firmly on the screw head while doing so, you can get the standoff very tight this way.)

IGoL Kit Usage:
Mounting dimensions





IGoL Kit Usage:
Turn-on calibration

• The sensors in the IGoL kit are reflective infrared sensors pairs. Each pair consists of an infrared LED that illuminates nearby surfaces, and an infrared phototransistors that light reflected off of those surfaces. The IR is pulsed, in order to reduce sensitivity to external infrared sources. If you photograph the modules with a digital camera, the IR pulses may be visible.

• After turn on, you may find that the sensors are "jumpy," triggering without interaction. If so, slowly wave your hand once past the sensors, to calibrate them as to how much reflection they should expect to "see." This procedure allows the sensor readout to adapt to a number of different lighting conditions and mounting styles.

IGoL Kit Usage:
The configuration menu

The configuration menu on a given IGoL module is accessed by holding down the button (S1) at the moment when the module is switched on.

You may want to use the configuration menu in the following cases:

(A) You wish to designate a given module as a Control Pad, either the Step/Play type or the Pause/Clear type.

(B) You wish to change the default settings *on the Master module* (changing these on other modules will have no effect):

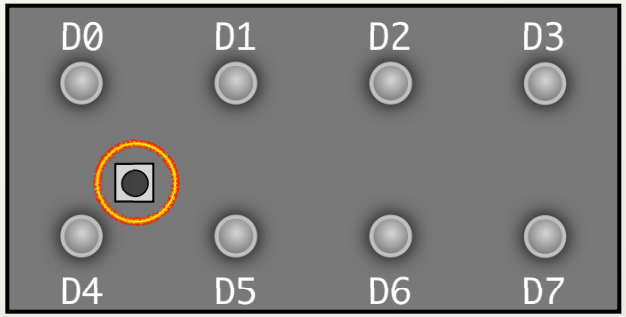
- Idle detection mode (and random fill):
  - Default behavior: The display will fill with random data after 60 seconds of idle time.
  - Alternate behavior 1: The display will fill with random data after 15 seconds of idle time.
  - Alternate behavior 2: Disabled; no idle detection.

- Time interval between generations (at turn on):
  - Default: 1 generation/second at turn on
  - Alternate behavior 1: 2 gen/s at turn on.
  - Alternate behavior 2: 4 gen/s at turn on.

(C) You wish to *force* a module to always act as Master or "Caboose" (most NW module). These options are *normally not needed.* They are provided for possible utility in the case of unusual array topography, such as arrays that wrap around continuously.

Once the configuration is saved, it is permanently stored in nonvolatile memory (EEPROM), and will stay in that configuration until you decide to change it.

Upper row (D0 - D3):
Menu name (hold button to cycle)



Lower row (D4 - D7)
Menu item (press button to cycle)

While in the configuration menu, the particular menu "name" is given by LED (or LEDs) lit in the "upper" row (D0-D3). The menu options are given by the LED lit in the "lower" row (D4-D7). A detailed map of these options is given on the following page.

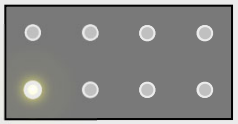
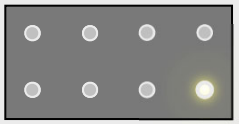
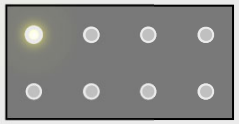
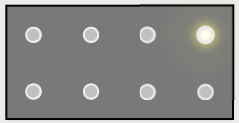
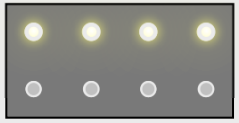
Hold down the button for one second to cycle between the different menu "names," or just press the button to cycle between the different options. When you are done with the configuration, get to the fifth menu (where D0-D3 are lit), and select the rightmost option (D7), and hold the button to save and exit.

IGoL Kit Configuration Menu

HOLD Button at turn-on to access menu

Lower row (D4 - D7):
"Menu item" (Press button to cycle between options)

Upper row (D0-D3):
"Menu name"
HOLD button to
cycle between options

	D4 	D5 	D6 	D7 
 D0: Board Type	Normal (Default)	Step/Play Buttons	Pause/Clear Buttons	—
 D1: Board "rank"	Auto-Detect (Default)	Force Master	Force "Caboose"	—
 D2: Random Fill Config	Idle 60 s (Default)	After Idle 15 s	Disabled	—
 D3: Default speed	1 Hz steps at turn-on	2 Hz steps at turn-on	4 Hz steps at turn-on	—
 D0-D3: Continue/Save	Go to top menu (D0)	—	—	SAVE AND EXIT

Interactive Game of Life Kits

Evil Mad Science

evilmadscience.com

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or contact us by e-mail: contact@evilmadscience.com