Digital Candle 1.0 Kit

Instruction Manual

Eastern Voltage Research, LLC
Introduction to the Digital Candle 1.0 Kit

Thank you for purchasing the Digital Candle 1.0 Kit. This kit is definitely a favorite of mine. I use the ones I’ve built all the time, especially when camping or when I want a little ambience around the house.

In the past several years, I’ve purchased many of those “inexpensive” LED candle lights and have been disappointed in the performance of most of them. Most of them were either not bright enough, or simple had a repeating pattern of illumination that was readily discernible to the eye or just simply did not look realistic at all. So that is why I decided to create my own LED candle.

The Digital Candle 1.0 kit utilizes a PIC microcontroller to produce a randomly varying pulse width modulated (PWM) output signal which drives a bank of four (4) yellow LEDs. The board is designed to accommodate both 1206 SMT and T-1 and T-1 ¾ thru-hole LEDs to provide the customer with the flexibility to use different LEDs of different intensities and colors. We also provided a standard serial programming interface on the board so that you can experiment with your own microcontroller code!

This kit is definitely one of my favorites and I hope you enjoy it too!
Notice to Beginners: If you are a first time kit builder, you may find this instruction manual easier to understand than expected. Each component in this kit has an individual check box, while a detailed description of each component is provided as well. If you follow each step in the instruction manual in order, and practice good soldering and kit building skills, the kit is next to fail-safe.

Please read this manual in its entirety before building, testing, or operating your kit!

Circuit Description

The Digital Candle 1.0 utilizes a PICF675 microcontroller, U1, which produces a randomized output pulse width modulation (PWM) signal which is used to drive a high current MOSFET transistor, Q1, to power an array of LEDs. There are two banks of LEDs which can be used. The first bank utilizes four (4) surface mount 1206 type LEDs, while the second bank utilizes four (4) T-1 or T-1 ¾ LEDs. Your kit will be supplied with four (4) surface mount 1206 type LEDs. However, you may wish to use your own LEDs instead and use either SMT or thru-hole. Any color LED can be used except white due to its high forward voltage characteristic. It is also important to note that you can only use one bank of LEDs at a time, as paralleling LEDs is not a good idea as the forward voltage characteristics of LEDs (even ones of the same part family) are not identical and will cause problems if those LEDs are paralleled. The output PWM signal of the PIC12F675 drives the gate of MOSFET transistor, Q1, which when turned ON, provides allows current to conduct through the LEDs (D1-D8) and causes them to illuminate.
Kit Building Tips

A good soldering technique is key! Let your soldering iron tip gently heat both the wires and pads simultaneously. Apply solder to the wire and the pad when the pad is hot enough to melt the solder. The finished joint should appear like a small shiny drop of water on paper, somewhat soaked in. If the pads have not heated up sufficiently, melted solder (heated only by the soldering iron itself) will form a cold solder joint and will not conduct properly. These cold joints appear as dull beads of solder, and can be easily fixed by applying additional heat to the pad and wire. All components, unless otherwise noted, should be mounted on the top side of the board. This is the side with the silkscreen printing.

When installing components, the component is placed flat to the board and the leads are bent on the backside of the board to prevent the part from falling out before soldering. The part is then soldered securely to the board, and the remaining lead length is clipped off. It is also extremely important to place the components as close to the board as possible. This is necessary for proper operation over the wide frequency range of the various kits we provide. Also be sure that component lead lengths are always as short as possible. This will avoid adding any stray capacitances or inductances that can be detrimental to circuit operation.

An alternative approach (which is actually the one I use) is to install the component into the board and then apply a piece of masking tape on the topside to hold the component in place temporarily. The leads on the backside of the board are then trimmed leaving about 0.10” lead protruding through the backside of the board, and then soldered from the backside. You can then remove the masking tape, and finally apply a small amount of solder on the top to complete the joint on both sides. This is shown in the figure below.
Surface Mount (SMT) Component Soldering Instructions

One of the first things you’ll notice with your electronics kit is that many of the included components are surface mount components. These components do not have conventional leads, as is the case with thru-hole components, and instead solder directly to pads located either on the top or bottom of the PCB board.

One of the first things to remember when soldering surface mount (SMT) components to the board is that patience is a must! The first step when soldering a SMT component to the board, after properly identifying both the component and the location where it will be installed on the PCB board, is to slightly “tin” one of the pads on the PCB board that will connect to the component. This is accomplished by simply applying a very small amount of solder directly to the pad with the soldering iron as shown below.

The next step is to pick up and hold the component in place on its tinned pad using tweezers. While holding the component in place with tweezers, briefly re-heat the solder with the soldering iron so that it flows onto the component solder tab and forms a nicely shaped solder fillet. For the remaining solder tabs on the same component, briefly heat up the component tab using the soldering iron and apply a small amount of solder directly to the pad, again creating a nicely shaped solder fillet. It is important to note that when reheating the solder, the soldering iron tip should contact the solder tab of the body of the component and not the solder directly. This will allow the solder to flow as efficiently as possible and form a proper solder fillet.
At first, surface mount soldering may seem a bit difficult, but its actually much easier than thru-hole soldering once you get the hang of it. Good luck and take your time!
Digital Candle 1.0 Kit Parts List

RESISTORS

- 1 47k Resistor, 0805, R1
- 4 33 ohm Resistor, 1206, R2,R3,R4,R5
- 1 10 ohm Resistor, 0805, R6

CAPACITORS

- 1 0.1uF Capacitor, 1206, C1
- 1 1uF Capacitor, 1206, C2

DIODES

- 4 LED, Yellow, 1206, D1,D3,D5,D7

SEMICONDUCTORS

- 1 DMG6968 MOSFET, SOT-23, Q1
- 1 PIC Microcontroller, U1

MISCELLANEOUS

- 1 Switch, Slide, SW1
- 4 AAA Battery Clips, BAT1,BAT2
- 1 PCB Board, Digital Candle 1.0
- 1 Schematic, Digital Candle 1.0

REQUIRED, NOT SUPPLIED

- 2 AAA Batteries, BAT1,BAT2
Digital Candle 1.0 - Component Layout Diagram
KIT Building Instructions

Now we will begin building the kit. There are just a few more important things to know before we install the first components.

For each component, the word “install” always means the following:

1. Pick the correct value to start with.
2. Insert the component into the correct printed circuit board (PCB) location.
3. Orient the component correctly – especially when there is a right and a wrong way to solder it in. (i.e. Electrolytic capacitors, diodes, ICs, transistors, etc…)
4. Solder all connections unless directed otherwise. Ensure enough heat is used to allow solder to flow for clean, shiny, and completed connections.

Also, please be sure to take us seriously when we say that good soldering is the key to the proper operation of your circuit!

- Use a 25W soldering pencil with a clean, sharp tip. DO NOT USE a high power soldering gun such as those trigger activated units.
- Use only rosin core solder intended for electronics use
- Ensure your work area is clean, and has plenty of bright lighting
- Build your kit in stages, taking breaks to check your work. Be sure to clean the board periodically with a brush or compressed air to remove any excess wire cuttings, etc…

Okay, so lets begin!

☐ 1. Install R1, 47k, 0805 resistor (marking 473 or similar)
☐ 2. Install R2, 33 ohm, 1206 resistor (marking 33R or similar)
☐ 3. Install R3, 33 ohm, 1206 resistor (marking 33R or similar)
☐ 4. Install R4, 33 ohm, 1206 resistor (marking 33R or similar)
☐ 5. Install R5, 33 ohm, 1206 resistor (marking 33R or similar)
☐ 6. Install R6, 33 ohm, 0805 resistor (marking 10R or similar)
☐ 7. Install C1, 0.1uF 1206 capacitor (no marking)
8. Install D1, LED. The green end of the 1206 LED is the cathode and will install on the board so that the cathode ends all point towards the center of the “cross” array as shown in the figure below.

9. Install U1, PIC12F675 Microcontroller. Note that one end of the IC is marked by a dot, notch, or band; this end MUST be oriented as shown on the PCB layout.

10. Install Q1, DMG6968 MOSFET. This component has three leads and can only be installed one way on the board so no confusion there.

11. Install SW1, switch. Note that there is no incorrect way to install this switch. The switch may be inserted in any orientation.

12. Install the (4) AAA battery clips to the underside of the board.

Congratulations! You have just completed your Digital Candle 1.0 kit. Please take a few moments to look over the board and ensure that all the components are installed properly with the correct orientation. Since some of the parts may be unfamiliar to you, you may want to be extra sure that they have been inserted correctly. After you are sure that everything seems to be properly installed, move on to the set-up and testing section.
PIC Microcontroller Code Modification

One of the cool options of this kit is that we have made it easy for you to experiment with your own PIC microcontroller code. We have supplied the kit with both an unprotected PIC microcontroller as well as provided pads so that you can connect a suitable flash programmer to the device to upload your own code. All that is required is an appropriate FLASH programmer and external 5VDC power source which can be connected to the board as shown below. A 1uF, capacitor is also required.

To connect a FLASH programmer to the LED sequencer board, simply connect the appropriate programmer to the board as shown below. Pads for each of the necessary signals are provided on the underside of the Digital Candle board.

1. Install 1uF, 1206 (or similar) ceramic capacitor to the 1206 pads as shown in the figure below. Any value capacitor from 1uF to 10uF (rated for at least 10VDC) will work. The capacitor can be a ceramic or electrolytic type. If using a electrolytic capacitor, the top pad on the capacitor pads is the positive pad.

2. Connect a 5VDC power source to the pads as shown below.

3. Connect the FLASH programmer to the pads as shown below.

Note: When programming the Digital Candle board, please remove all AAA batteries and connect your own 5VDC power source. The board must be powered via 5VDC for the programmer to work correctly.
Set-up and Testing

Okay, so let's begin!

1. Install (2) AAA batteries into the battery clips. Make sure the batteries are installed with the correct polarity.

2. Turn the switch to the ON position if the LEDs are not already illuminated. If everything was built and installed correctly, the LEDs should be illuminates and randomly flashing simulating the flaming characteristic of a candle.

Congratulations! Your Digital Candle 1.0 is now completed and operational.

Troubleshooting

PROBLEM: The LEDs do not illuminate when I turn the switch ON.
SOLUTION: Verify that the LEDs and U1 are installed correctly, the battery is installed correctly, and the battery is not completely drained.

PROBLEM: One or more LEDs is not illuminating, but others are working.
SOLUTION: Check the soldering joints of the resistors and LEDs on each string and ensure they are properly soldered with nice clean solder joints. Also, double check that the LED is installed in the correct orientation.
Conclusion

We sincerely hope that you have enjoyed the construction of this Eastern Voltage Research Kit. As always, we have tried to write this instruction manual in the easiest, most “user friendly” format that is possible. As our customers, we value your opinions, comments, and additions that you would like to see in future publications. Please submit comments or ideas to:

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Thanks again from the people here at Eastern Voltage Research.

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