Surface Mount Mini Clock Assembly Manual

Document version 1.0 for use with PC board version 2

Table of Contents

Purpose

Thanks for buying this kit. This kit was designed primarily to compare with the transistor clock. I hope you have fun with it and you may learn a thing or two about surface mount parts.

Since you are an experienced kit builder the soldering section may be superfluous, you be the judge, but keep in mind;

You need to make 193 good solder joints to have the clock work.

You will need the following tools to build your clock.

- Soldering iron meant for electrical work with an extremely sharp point meant for surface mount part assembly.
- Tweezers for handling the SMT parts
- Magnifying glass to check parts and solder joints
- A multimeter may come in handy to check for shorts and power supply operation

Unpacking/Parts List

Familiarize yourself with the components by reading the parts identification chapter while you unpack the kit. Please do not open more than one bag of 1206 sized component at a time, some are not labeled on the part, only the bag.

Present	Qty	Item
X	1	Assembly Manual
	2	Res. Zero ohm 1206
	7	Res, 1K, SMT 1206
	1	Res, 100K, SMT 1206
	21	Res, 330, SMT 1206
	1	Cap, 0.1uF, Cer., SMT 1206
	1	Cap, 10uF, Cer., SMT 1206
	2	Cap, 27pF, Cer., SMT 1206
	1	Xtal, 32.768K, SMT
	1	Tran, NPN, 2N3904, SMT
	2	Tran, PNP, 2N3906, SMT
	1	IC,uProc PIC18F2321, SOIC-2
	6	LED, 7-segment, RED, smt
	4	LED, Red, SMT, 12mcd
	1	Socket, USB-A, rt angl
	3	Switch, N.O. Push, SMT
	1	Supply, 5Volt 0.5Amp
	1	Cable, USB, AB, 6ft
	1	PCB
	1	3x5 Wood Plaque
	4	Nylon stand-off
	4	#8 1" screw
	1	Solder and Wick

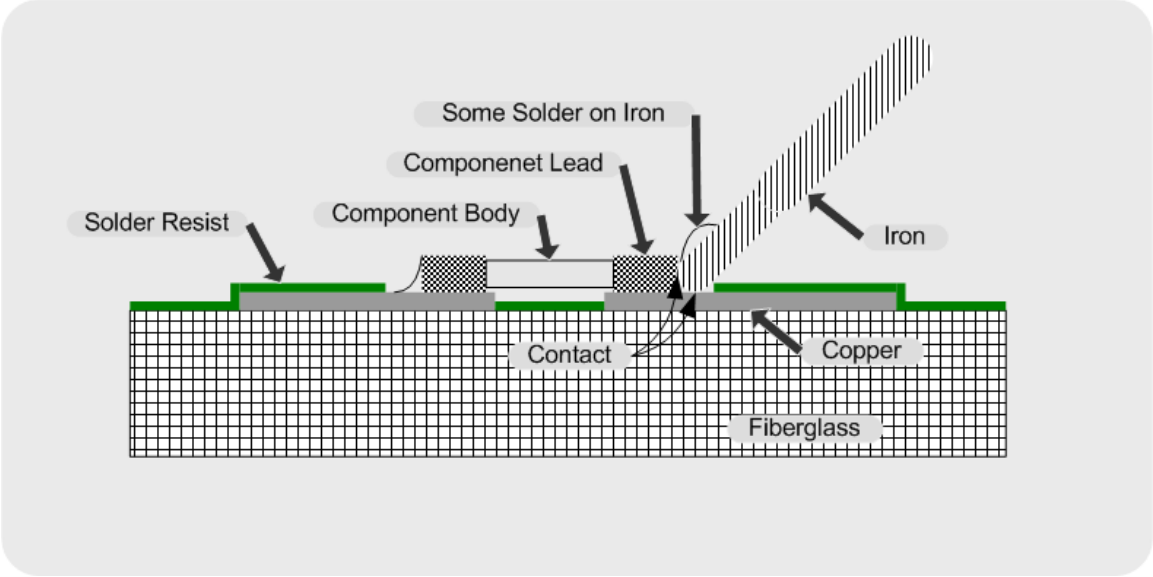
Home soldering of Surface Mount Components

This manual can't teach the art of surface mount part soldering, but here are the basics. Remember, you need to make about 193 **GOOD** solder joints.

The professional process is to silkscreen a solder paste onto the pads, then place or even glue the component to the board, followed by a bake in an oven that raises the temperature just enough to flow the solder and electrically attach the components to the PC board.

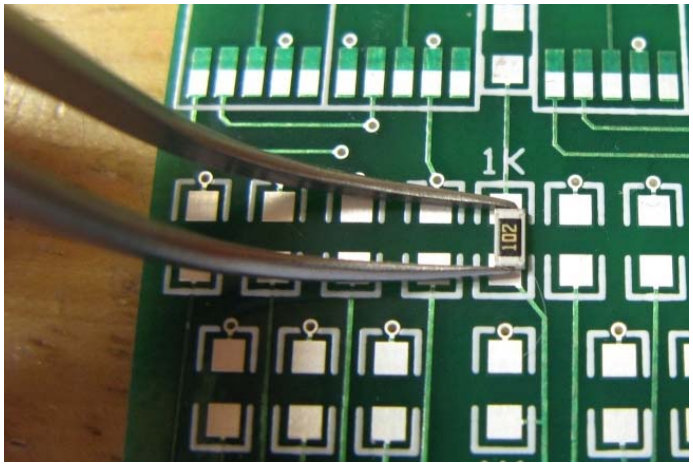
Fortunately, this kit can be build using a sharp soldering iron and some tweezers.

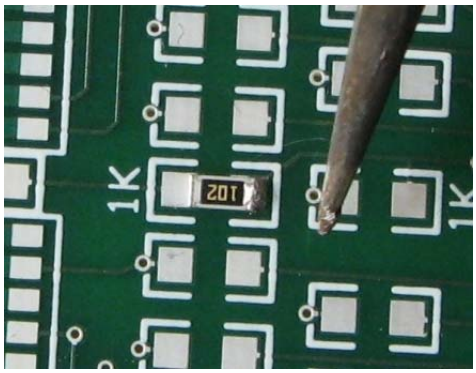
For this kit, each component will have to be carefully placed and held down by just enough force to stop the component from sliding off the pads while you solder each pad.



Place the component on the board, hold it down with something, I use tweezers, a wood stick would also work. You have to use something, or the surface tension of the solder will draw the component off the board and onto the iron, which is the last place you want the component to go. Clean the tip of the hot iron, place a small amount of solder on the tip, and touch both the component and the PC Board at the same time. The solder will flow onto the part, onto the pad, and also flow between the part and the pad.

The key to success is to heat the pad on the board enough to allow the solder to flow, the component part will heat instantly since it is tiny, the PC board is the controlling item in this joint.

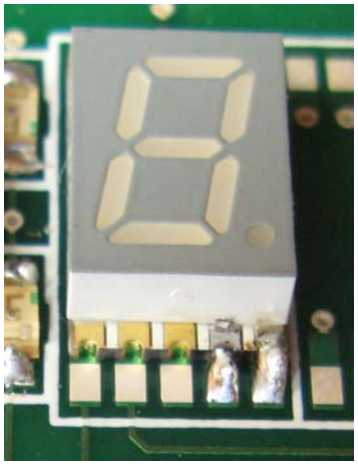




Shown above is a 1206 1K resistor being placed, and right after soldering. The curved tweezers were used to gently press down the component while the soldering iron was touched to the pad and the component simultaneously.

After placing this 28 pin SOIC (Small Outline Integrated Circuit) on the pads, I found that stroking the soldering iron along each pin, from the package to the end of each pin, heated the pad and pin just enough to draw off a small amount of solder from the iron. I had to reapply solder to the iron every few pins.

The SOIC had to be held down until a few pins had been soldered. A solder blob did short out a pair of pins, but I was able to clear it with another stroke of the soldering iron.



This 7 segment part was challenging. I found that having an ample amount of solder on the iron, and then heating the top of the pin first, then drawing the iron down the half circle channel to the pad, pulling down a solder waterfall worked well. It didn't leave a pretty solder joint, but it held the part on the board.

Build Order

You have about 53 components with about 193 solder joints to make.

The only part load order dependency of this kit is to solder the 4 discrete LEDs before soldering the 6 7-segment displays, because there is not room for the iron between the displays.

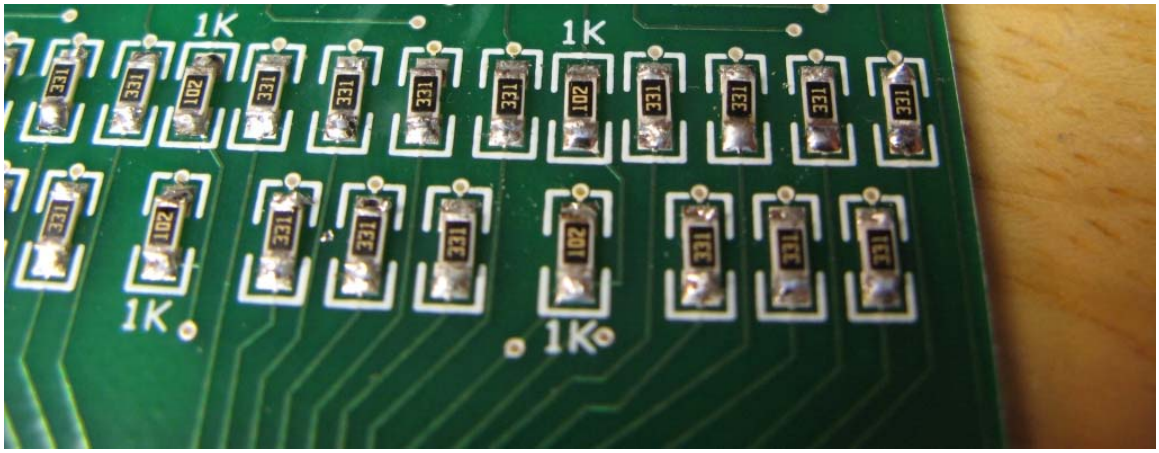
(You will note that the following pictures have not been taken in build order, don't get confused if you see component in these picture before I have mentioned them.)

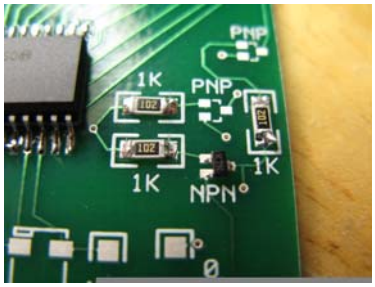
Resistors

I suggest you start with the zero ohm resistor in the lower right part of the board. Two are supplied to allow you to break one while you learn. If you break the 2nd one, you can solder a small wire across the pads instead of using a resistor. Solder the four 1K resistors in the top two rows of resistors. They are in pairs in the rows of 330 ohm resistors, and are labeled 1K on the silk screen.

Your choice, you can solder in the four 1206 LEDs and the power jack to see them light up, or you can keep soldering the other resistors onto the board.

There are twenty one 330 ohm resistors to solder in the two rows below the 7 segment displays.

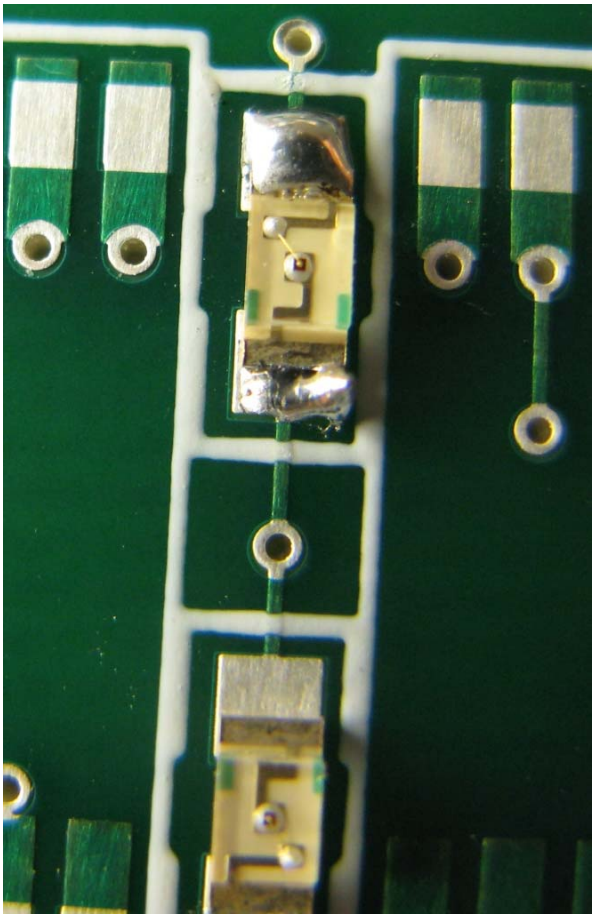




The last three 1K resistors go to the right of the microprocessor.

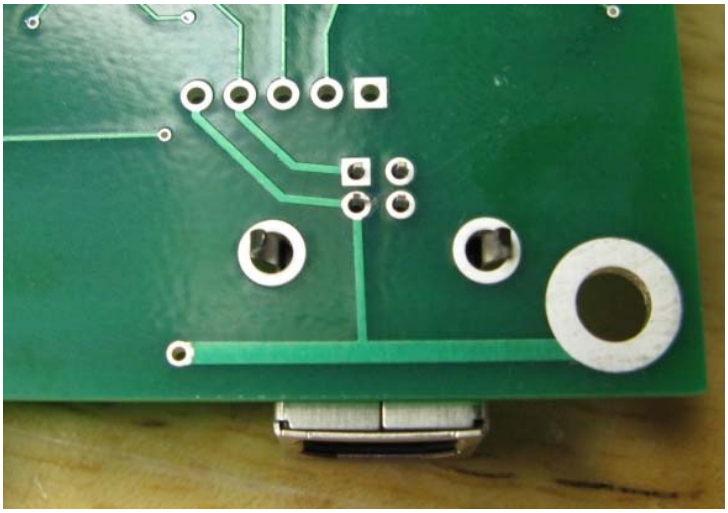
A 100K resistor goes to the left of the microprocessor.

LEDs



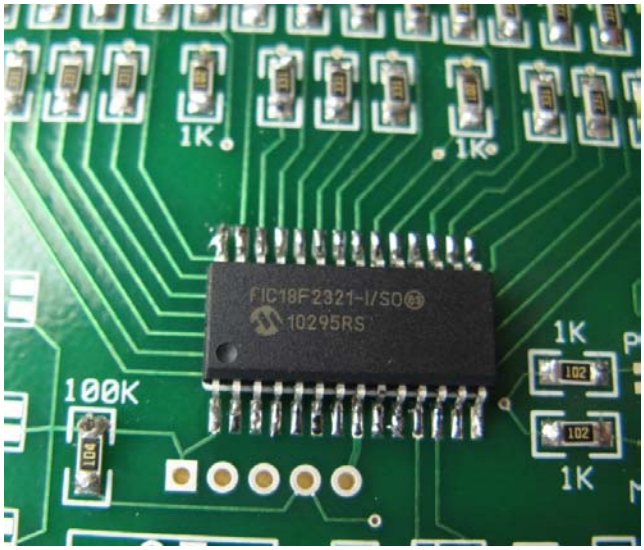
Solder in the 4 LEDs in the 1206 package. These are polarized; the little green lines in the clear part (see the Parts ID chapter) need to go closest to the centerline of the displays. That means the upper left and right LED have the green lines facing down and the lower pair have it facing up.

Power



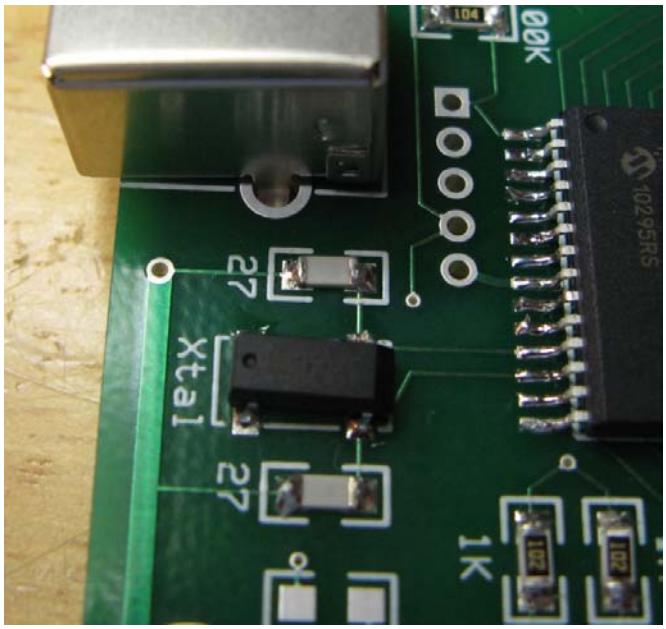
Hold the USB connector in place and solder the 4 leads in place, then also solder the two legs. You can plug in the board now and you should see the 4 LEDs turn on.

Processor



Carefully place the microprocessor, centering each pin on the pads. As mentioned in the soldering section above, solder each pin by quickly drawing the iron along each pin and pad leaving a slight amount of solder in the joint.

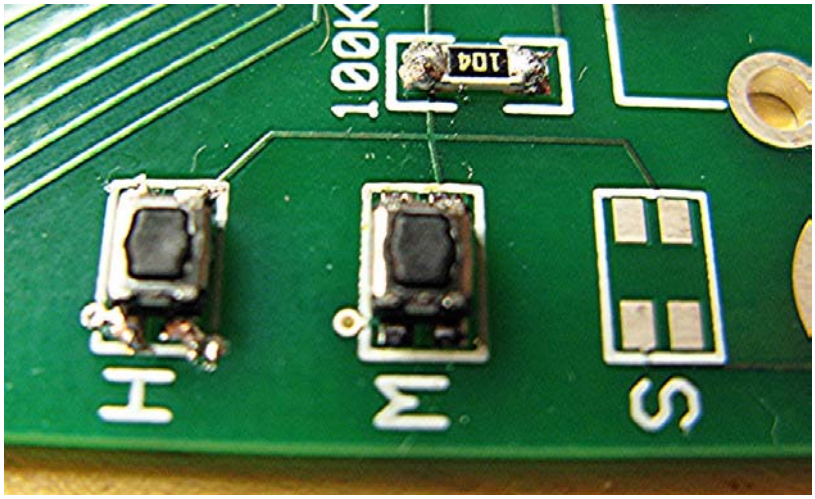
Time Components



Solder the crystal with the four leads. Be sure to place the sloped end towards the microprocessor.

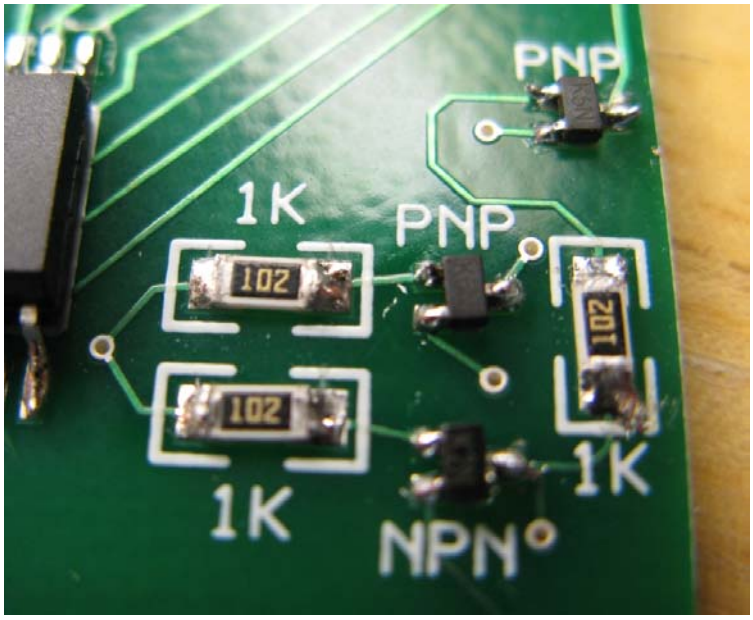
Solder the two 27 pF capacitors. These caps are unlabeled, there is no up or down, any orientation will do.

Switches



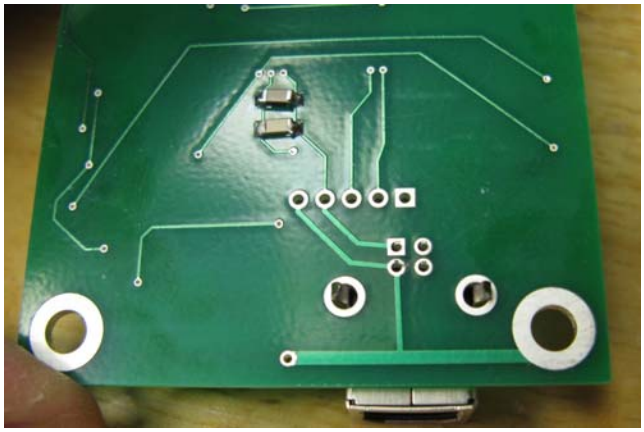
Solder the three switches. These are a bit tricky, heating the pad and the lead - but not melting the part - is doable, but stay alert and don't overcook this part. Let it cool off a bit before pressing the switch.

Transistors



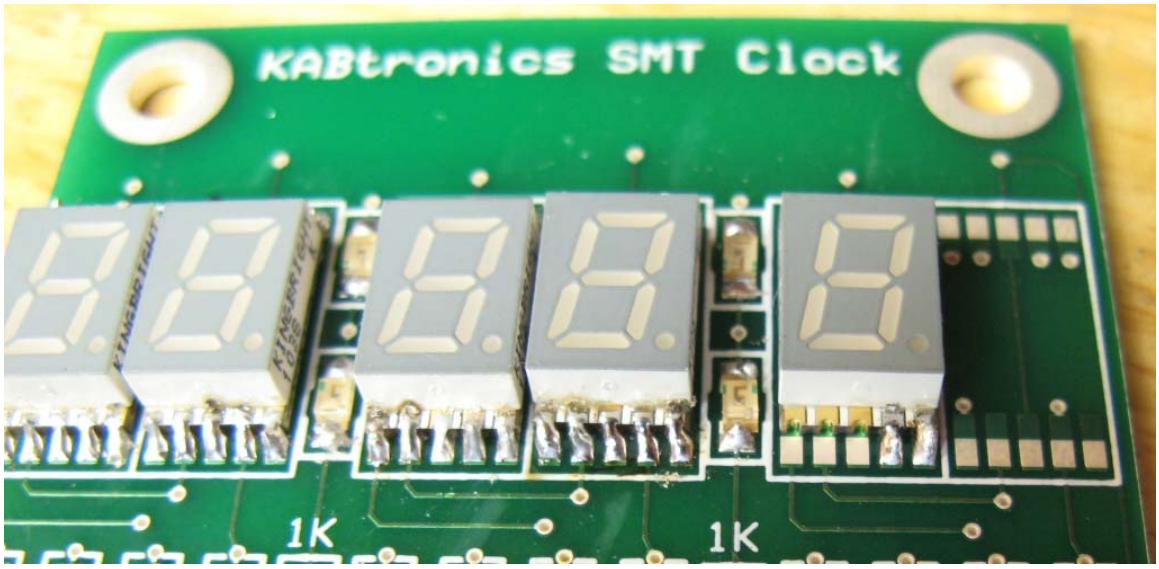
One at a time, place a transistor on the proper footprint, and quickly solder the tiny lead. These are the smallest components in this kit.

Capacitors



Solder the 0.1uF and the 10uF caps on the bottom of the board. It doesn't matter which goes in which location.

Displays



Carefully place each LED 7 segment display on its pads. As described in the soldering section, and as shown above, create a solder blob that wets to the top of the lead and reaches the pad on the board. The solder mask should actually be a bit smaller, exposing a bit more metal, but you can get this to work as shown above.

Mounting

Finish the plaque. I recommend spray shellac. Drill pilot holes and use the nylon spaces provided to space the board off the plaque.

Initial Test

Power the clock using the USB cable and the power block. You can also plug the USB cable in to any computer to power the clock, the data lines are not connected so the computer will not notice the clock.

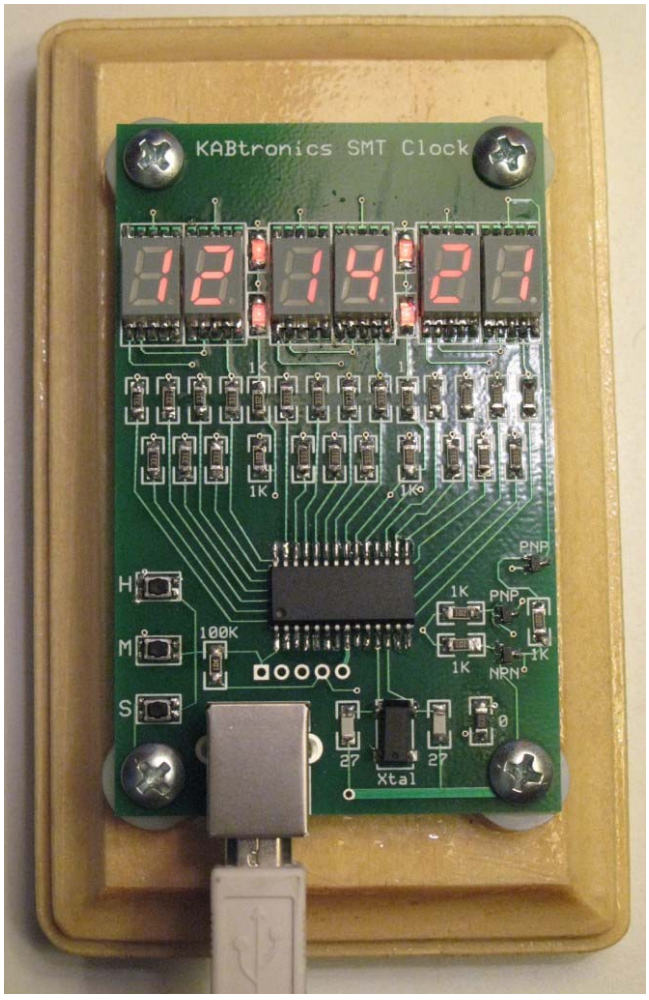
The clock should power up set to 10:48:00 with the seconds counting.

Spend a minute watching the seconds until you reach 20. At that point you have seen every segment in the seconds light up. Press the M button and watch it count until you have seen every minute segment light. Next - test the hours using the H button.

The S button will clear the seconds to zero. You can set the proper time now. If the clock doesn't work properly, see the debugging section later in this manual.

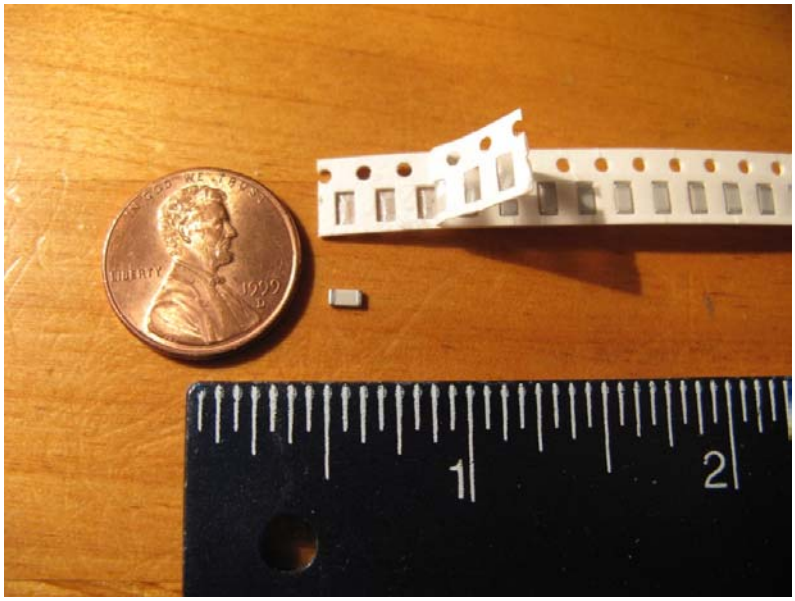
You are done!

Enjoy your clock, show it off to your friends, and be proud of your work.



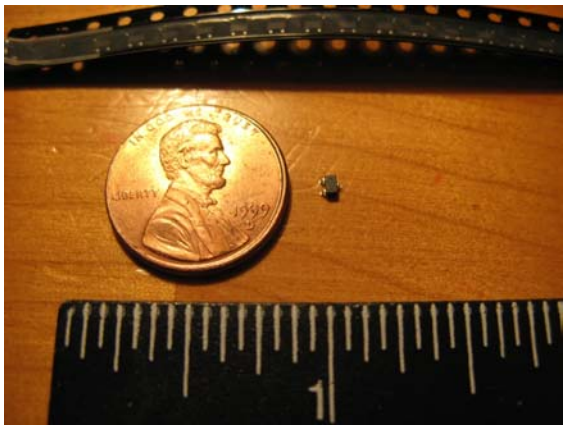
Parts Identification

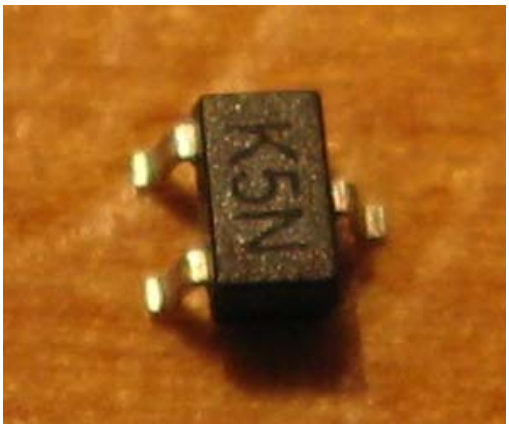
1206 Part



Resistors and capacitors come in these ceramic 1206 sized packages. The resistors are labeled, the caps may not be. Professional engineers have tweezers with a built-in meter to identify components, but since you likely don't have one, (neither do I), open only one 1206 type component at a time to prevent mixing them up.

Transistor

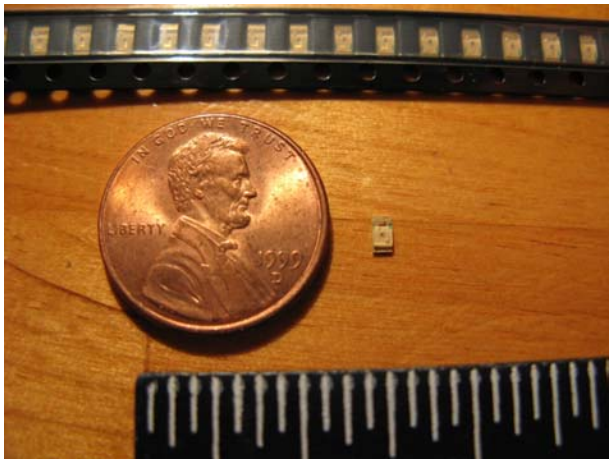


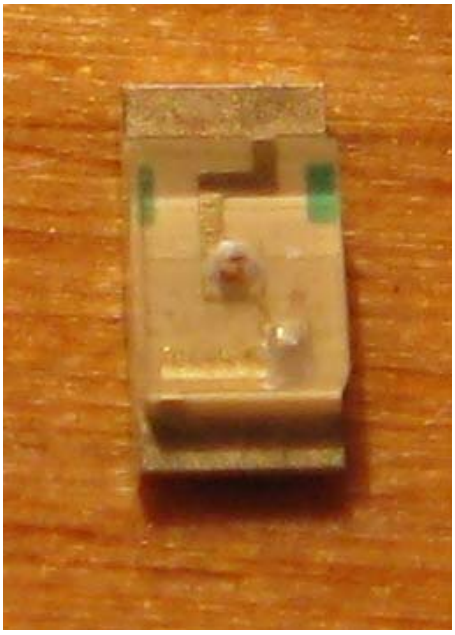


This is a transistor in a SOT-323 package. This is the smallest part you will be soldering.

The PNPs and NPNs look identical but have different markings. Try not to mix them up so you don't need to read the microscopic text on the part.

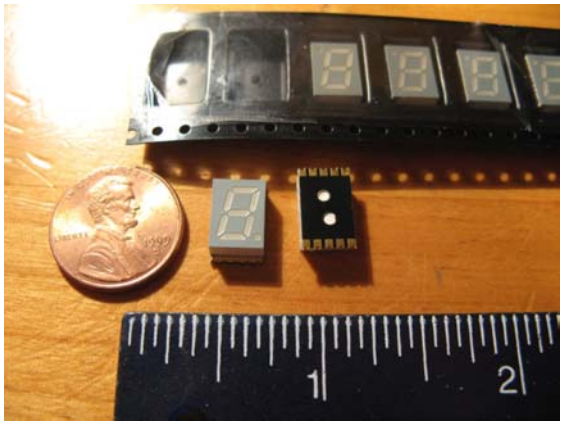
LED

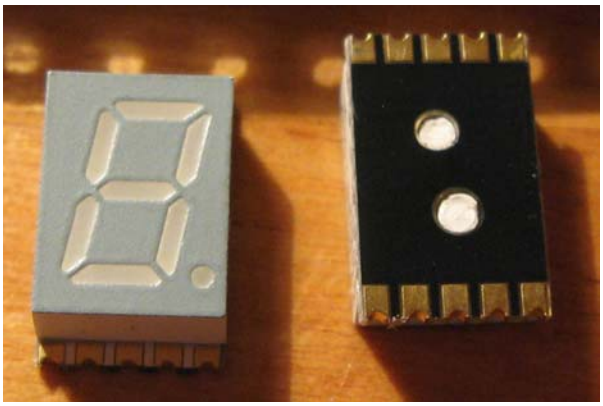




This is a single LED in a 1206 package. The green lines mark the cathode, or the negative side when current is flowing through the diode. In this kit, these lines are closest to the center line of the displays.

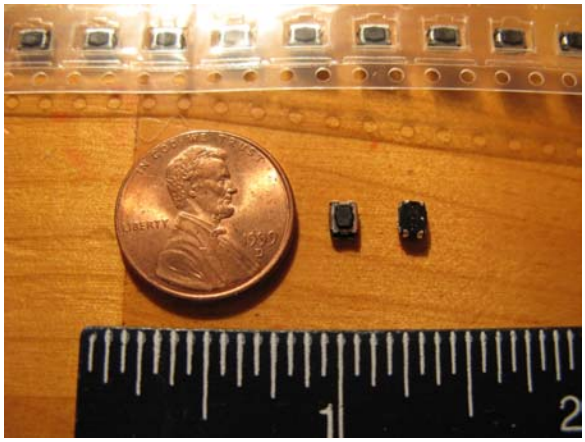
7 Segment Display

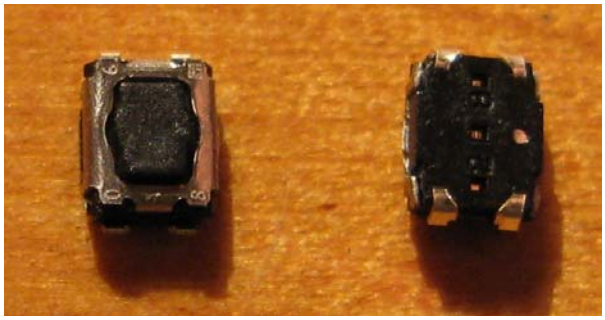




This is a 7 Segment LED Display. Try not to overheat this part when soldering it to the board.

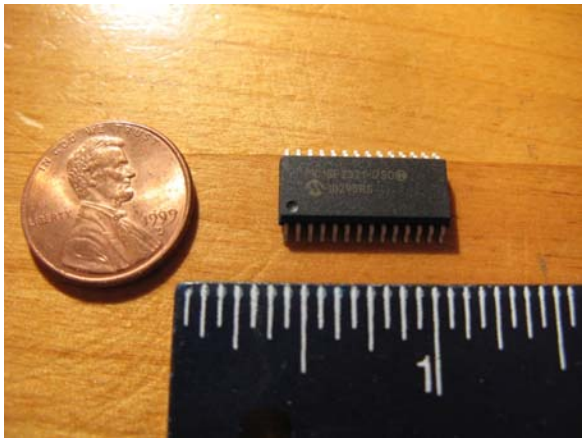
Push Switch

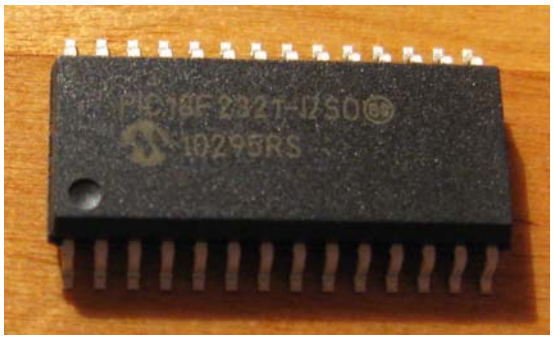




This is a push button momentary switch. These are used to set the time

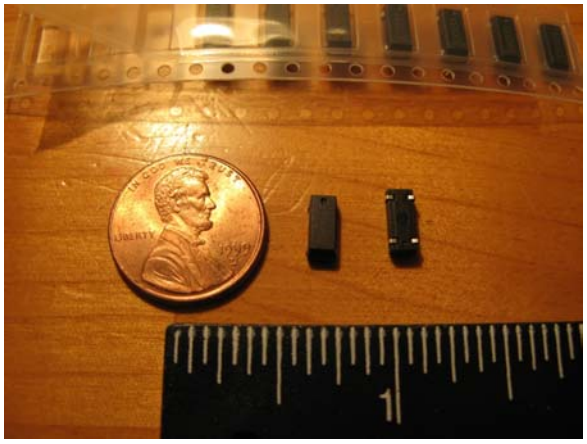
Controller





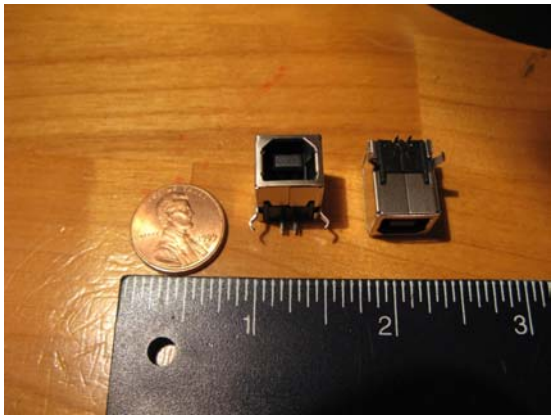
This is the Microcontroller. Be careful not to bend the leads, the part comes with the leads coplanar, which means all the leads will sit on the PC board ready for soldering. If you end up deforming a few leads, you will spend much time fiddling with leads to get it sitting right for soldering. The dimple indicates pin 1.

Crystal



This is the quartz crystal time element of the clock. Careful! The sloped end indicates pin one, not the dimple. For this kit, the sloped end goes towards the microprocessor.

USB

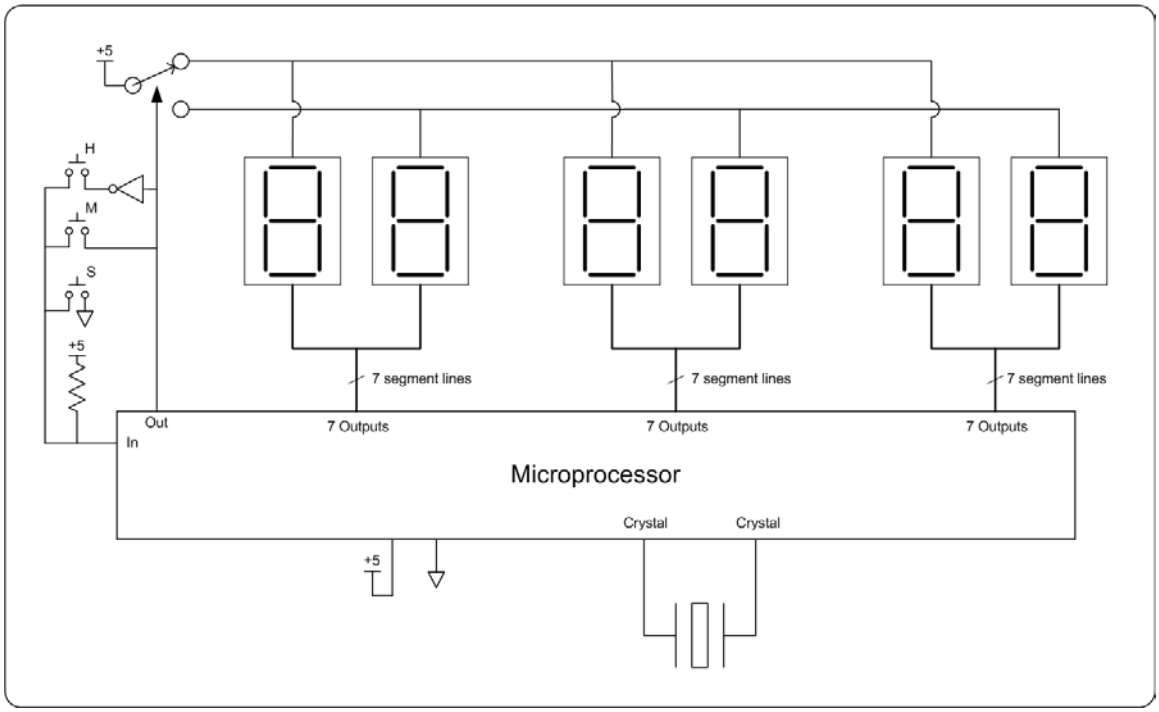


This socket is a through-hole part. The surface mount sockets were unsolderable with home equipment, so I chose this part.

Power module and USB cable

This is a power module and a USB cable used to power the clock. You can also plug the USB cable into a computer to get power. The data lines are open so the computer will not notice the clock.

Theory of Operation



The microprocessor has 25 IO Pins.

- 21 are set to output and drive 3 sets of 7 segments.
- 1 is set to output and is the left/right select pin
- 2 are Crystal input pins
- 1 is set to input and reads the switch line.

The code in the processor displays 6 digits by looping through the following steps;

- Set all 21 segments off
- Flip the left/right drive line to the other direction
- Compute the segments to light to show 3 digits
- Turn on the segments for about 3 milliseconds
- Loop to top

There is a timer that interrupts the display loop every second and increments the time.

A second timer interrupt timer reads the switch inputs and decodes which switch was pressed by discriminating grounding or short to one of either drive line or inverse of drive line. An interesting point is that there was only one input and three switches to detect, so three dissimilar signals were chosen, ground, drive and drive not.

Software

The software is available on the details page of the mini clock web site at KABtronics.com

In Case of Difficulty

The clock is completely dead, nothing lights up.

No numbers, no LEDs lit.

The numbers depend upon the microprocessor, but the 4 LEDs between the displays must light up if there is 5 volts on the board.

Check for a short between +5 and ground, perhaps near the USB socket or on the back side of the board under the microprocessor, in those locations, +5 and ground are close together. Use a voltmeter to test the resistance across the supply and ground on the unpowered board. Then change the meter for volts and check for 5 volts on a powered board. Be sure you mounted the LEDs properly.

LEDs light up, no numbers are showing.

The microprocessor must be running for the digits to display. Carefully check the soldering of the microprocessor pins, checking for shorts between pins. The transistors on the right are used to supply +5 volts to the displays, check the three 1K resistors and the three transistors for proper soldering.

Only the right or left of each pair of digits light up.

One of the transistors Q1 or Q3 is not pulling the display line high. Fix it.

Some of the segments are not lighting up.

If the corresponding segment in the adjacent digit also doesn't light up, check the 330 ohm resistors, otherwise check the soldering on the display pins, they are tricky.

Time is not advancing.

The crystal runs a timer used to advance the time, if it is not working, the rest of the clock works but the time stands still. Check the soldering on the crystal and 27pF caps.

If you have attempted to fix your problem but need some more hints, email me at customerservice@transistorclock.com

Specifications

PC board Size: 3.5 inches wide by 2.2 inches high

(Allow 1/8 inch behind board and 0.5 inches above when loaded for parts clearance)

Weight: About 1 oz. (loaded board, not cable and power module)

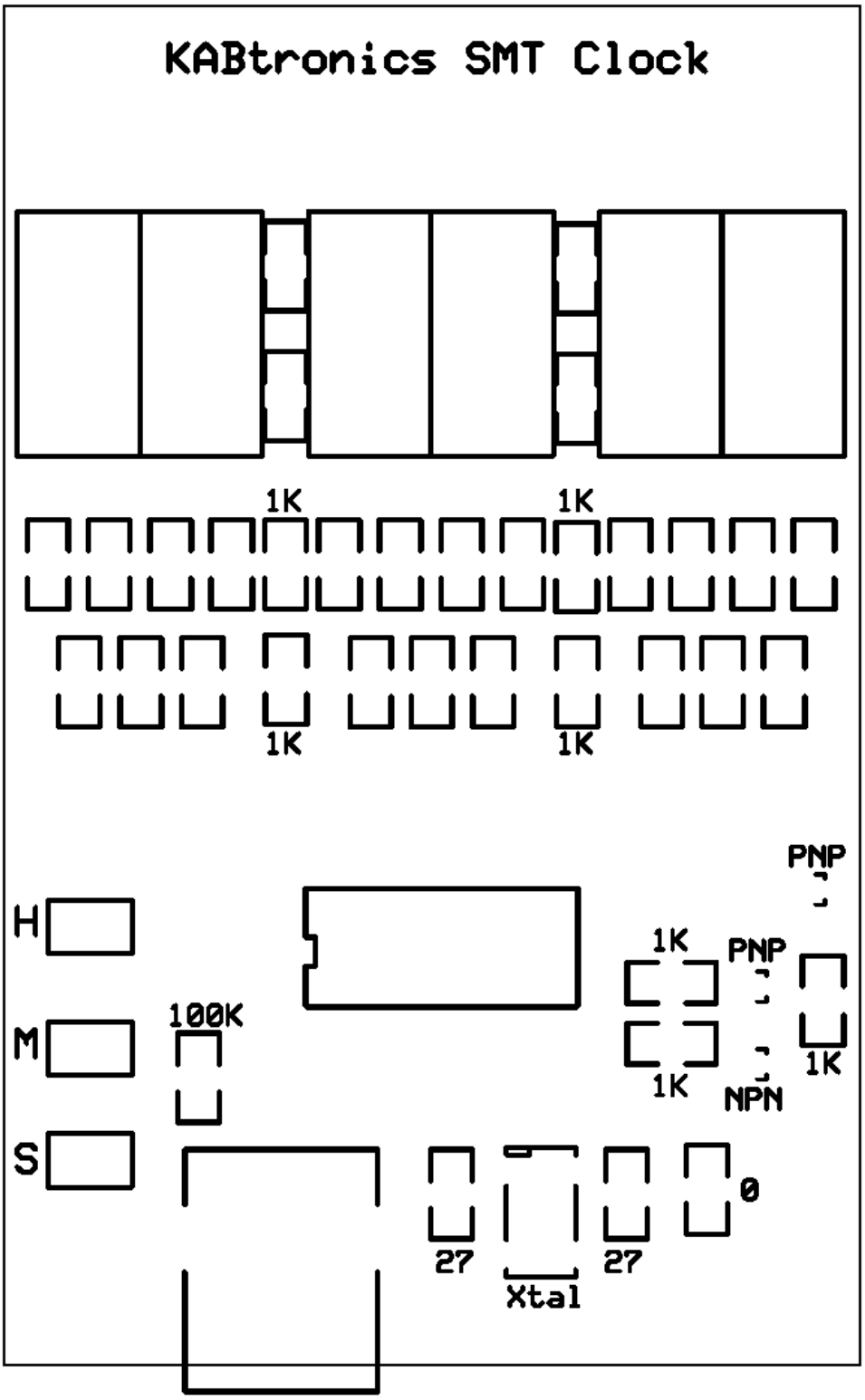
Power consumption: about 1/2 watt, (100 mA @ 5 volts DC)

Temperature limits: Designed for room temperature operation, 60-80 °F

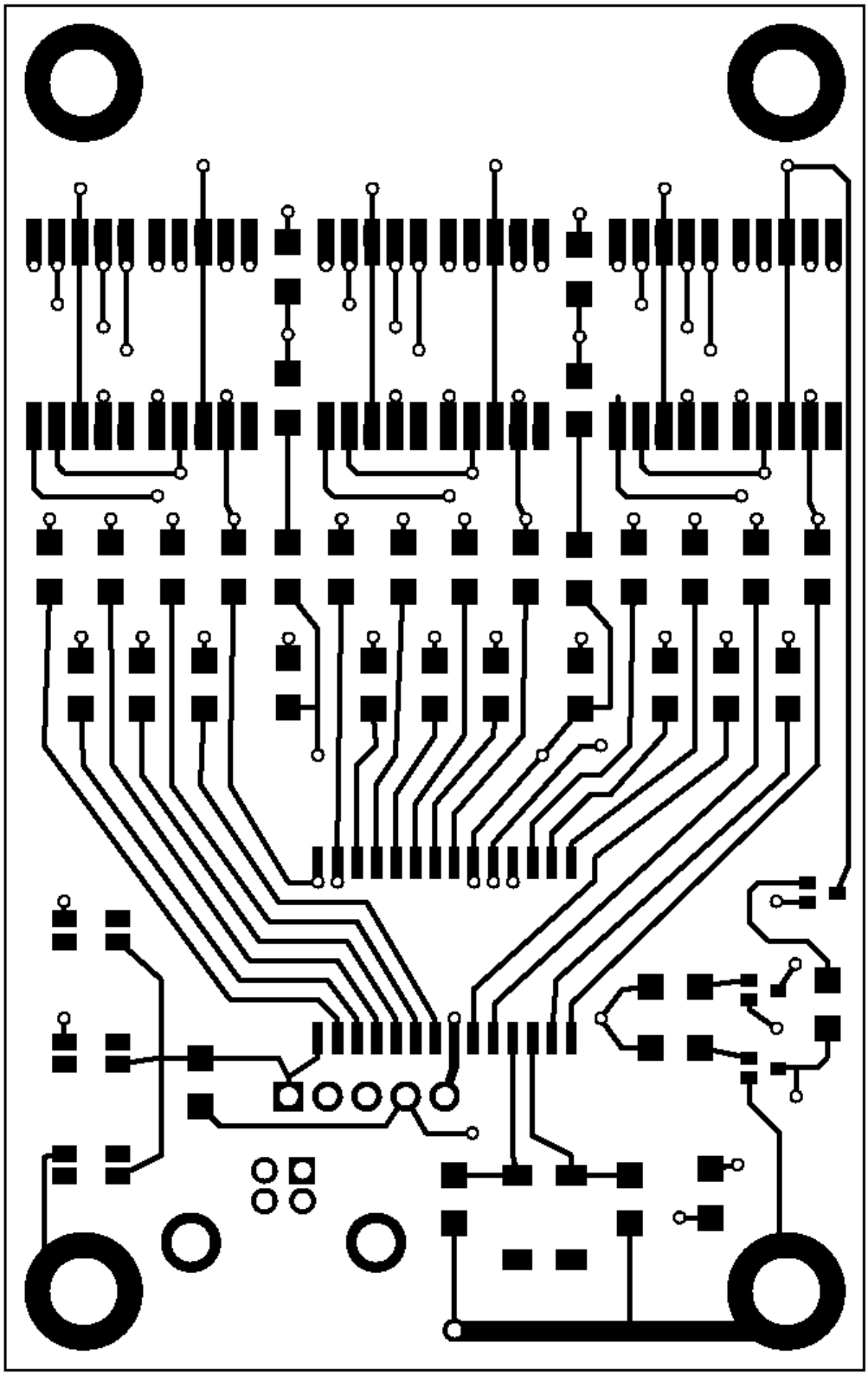
Longevity: No short lived components have been used, the flash memory in the microprocessor expects 100 year typical data retention, The LEDs have on the order of 100K hours to half brightness (10+ years) yours will likely exceed that.

Warrantee: There is no warrantee of any kind. KABtronics wants you to succeed and be happy with your clock, so don't hesitate to email customerservice@transistorclock.com with questions if you are having difficulty.

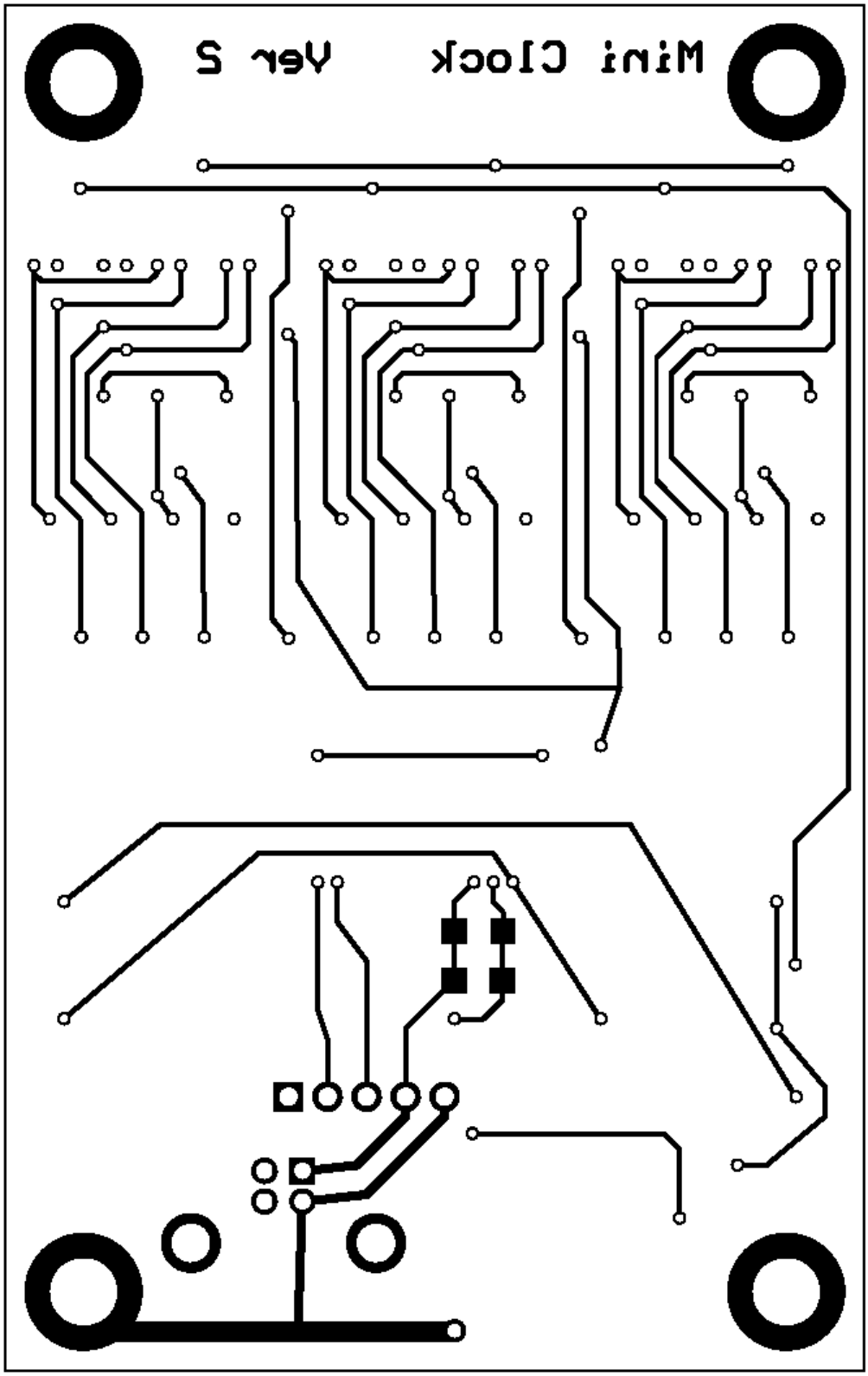
Circuit Board Views



Silk Screen

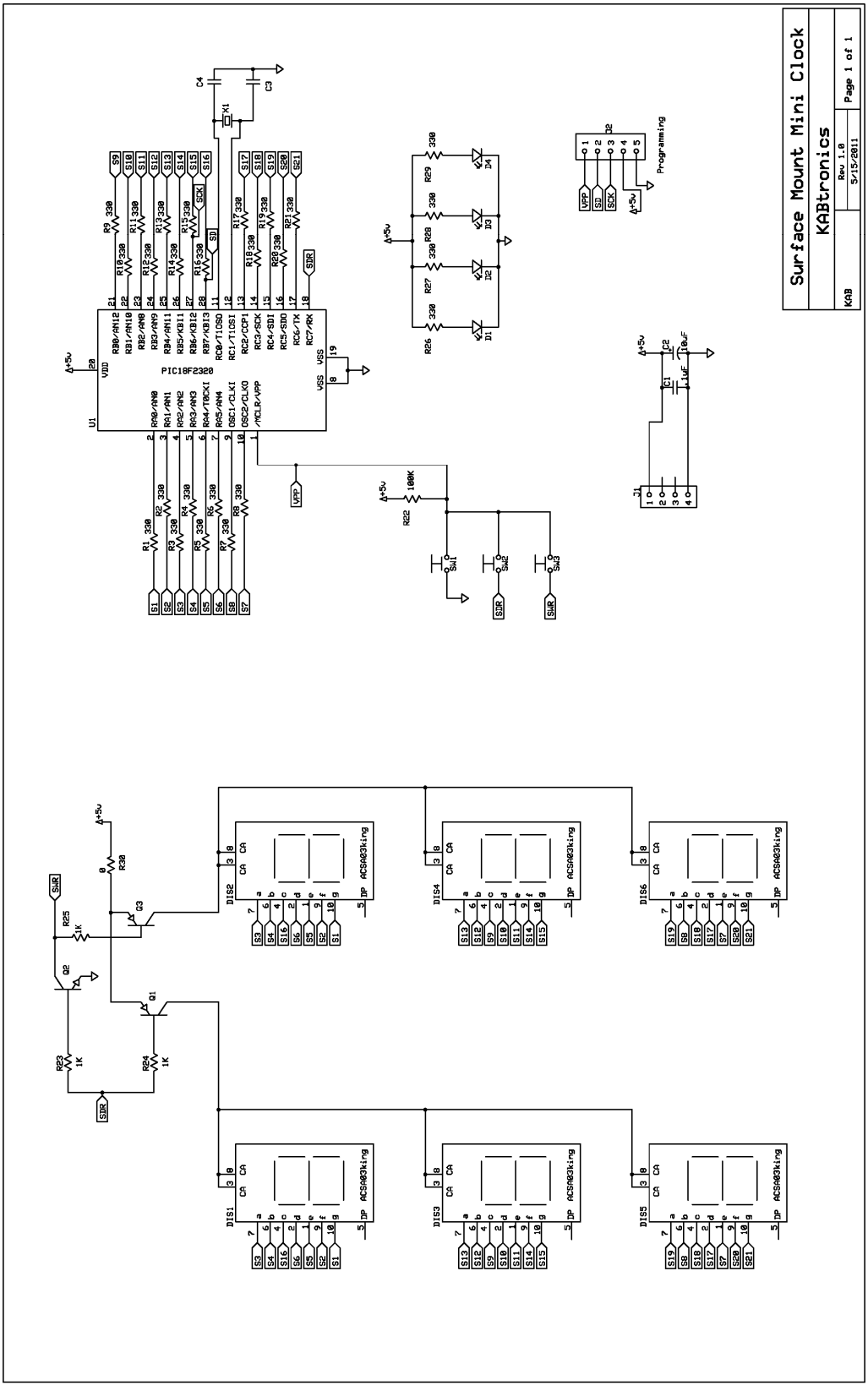


Top Copper Layer



Bottom Copper Layer

Schematic


Surface Mount Mini Clock
KABtronics
Rev 1.0
5/15/2011
KAB
Page 1 of 1
PIC18F2320
Programming
VPP
SDI
SCK
+5v
SDR
SWR
100K
10uF
1uF
ACSA03king