Atari CO60472 delay line replacement

Installation instructions

Enclosed in the package is a soldering kit to build a replacement for the CO60472 delay line used in the Atari 600XL and 800XL computers.

Instructions for assembly

In order to the assembly, the following tools and materials are recommended:

- Soldering iron
- Tweezers
- Soldering tin

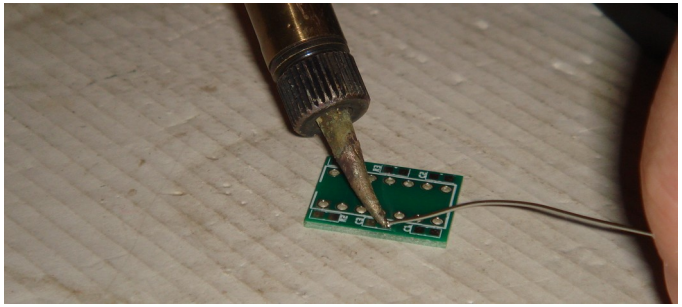
In order to be able to correct errors, you may want to have:

- Desolder wick
- Hot air gun

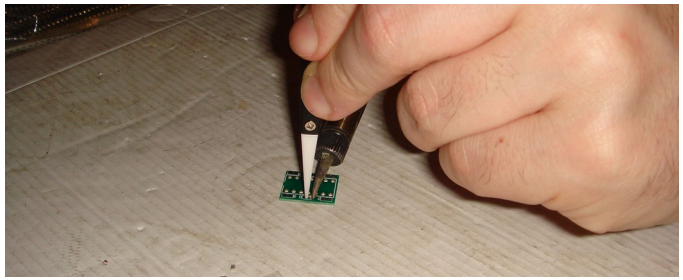
The replacement PCB needs SMD components. The list of components and their position is:

R1	Resistor 820Ω
R2	Resistor 120Ω
R3	Resistor 270Ω
C1..C3	Capacitor 150pF

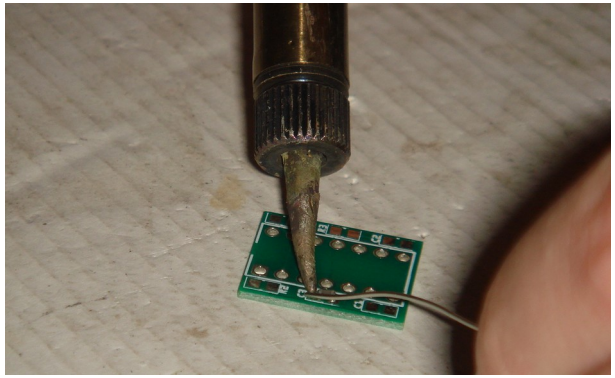
A good way to solder these components is as follows. Apply some solder to one of the pads of a component:



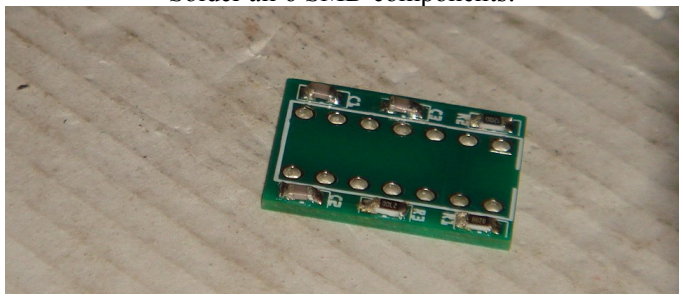
Pickup a component with tweezers. Hold your soldering iron in your other hand. Heat up the pad you just applied solder to again and move the component into place:



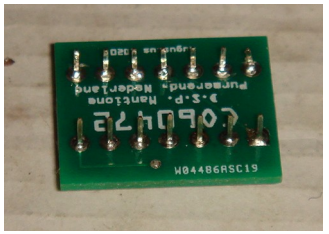
Remove the soldering iron and the component will fix into position. Now, apply solder to the other side of the component:

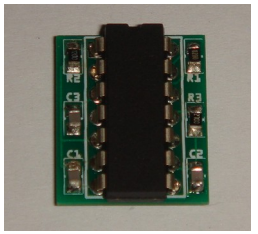


Solder all 6 SMD components:



Push the 74HC14 IC into the holes of the PCB. Take care of the orientation! Solder the IC into position:

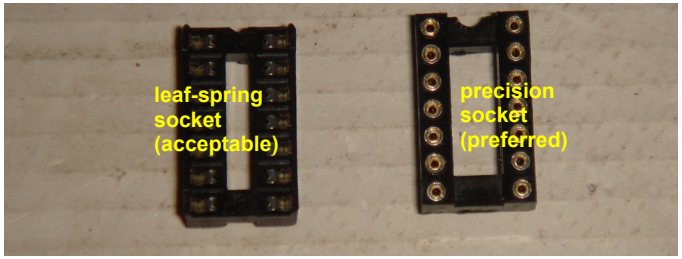




The delay line is ready to be used!

Sockets

Due to the way the delay line is constructed, it will fit best into a machine pin socket. Because a leaf spring socket has edges, the fit is slightly worse. The delay line will still fit into a leaf spring socket and if your mainboard already contains such a socket and you are unhappy with the fit, you can solve this by pushing a precision socket into the existing leaf-spring socket.



Installation

You can plug the delay line into position U29 of the Atari mainboard. Power on the computer, it should power up and start normally.

Measurements

The delay line replacement has been designed to achieve delays close to the original delay line. The delay line generates the RAS, CAS and MUX signals. I have measured the delay between PIN of U19 on the mainboard and the actual signal. This delay includes both the delay of the delay line itself and U30. Therefore I have taken the value from the Atari CO60472 specifications and added to this the expected delay from the 74LS51 (U30) datasheet. I then measured the deviations of both the original delay line and the replacement:

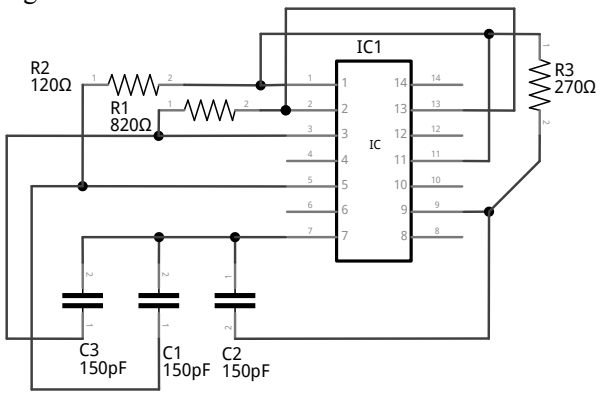
	Measurement		Expected	Measured		Deviation	
Signal	From	To		Original	Replacement	Original	Replacement
RAS	PIN 2 U19	PIN 4 RAM	202	179	211	-12,8%	+4,3%
MUX	PIN 2 U19	PIN 1 74LS158	260	275	287	+5,5%	+9,5%
CAS	PIN 2 U19	PIN 15 RAM	327	323	332	-1,2%	+2,3%

(numbers are nanoseconds)

The MUX signal has the largest deviation, but is unavoidable from the way the replacement works (by inverting Φ2). It is still compliant timing, because the 74LS158 multiplexers have a maximum propagation delay of 24ns, so the multiplexers have stabilized the RAM address well on time before the CAS signal commands the RAM to use it.

Schematic of the delay line

The adapter works by chaining the inverters of the 74HC14 and inserting RC delays between them. Thanks to the Schmitt-Trigger function of the 74HC14, this results in safe digital behaviour.



The chosen resistor and capacitor values are only valid for a 74HC14, if you use another IC, e.g. 74HCT14 or 74LS74, the values need adjustment.

The values are also only valid for the Atari clock speed of approximately 1.73 MHz. The original CO60472 is an EP8212 by PCA Electronics; if the replacement would be used to replace an EP8212 in a system with a different clock speed, different values will be needed.

Contact

In case of problems, you can contact me on daniel.mantione@freepascal.org. Besides, English, you can also write me in Dutch, German, Italian or Afrikaans.