

## Lab 2: Forensic Electronics

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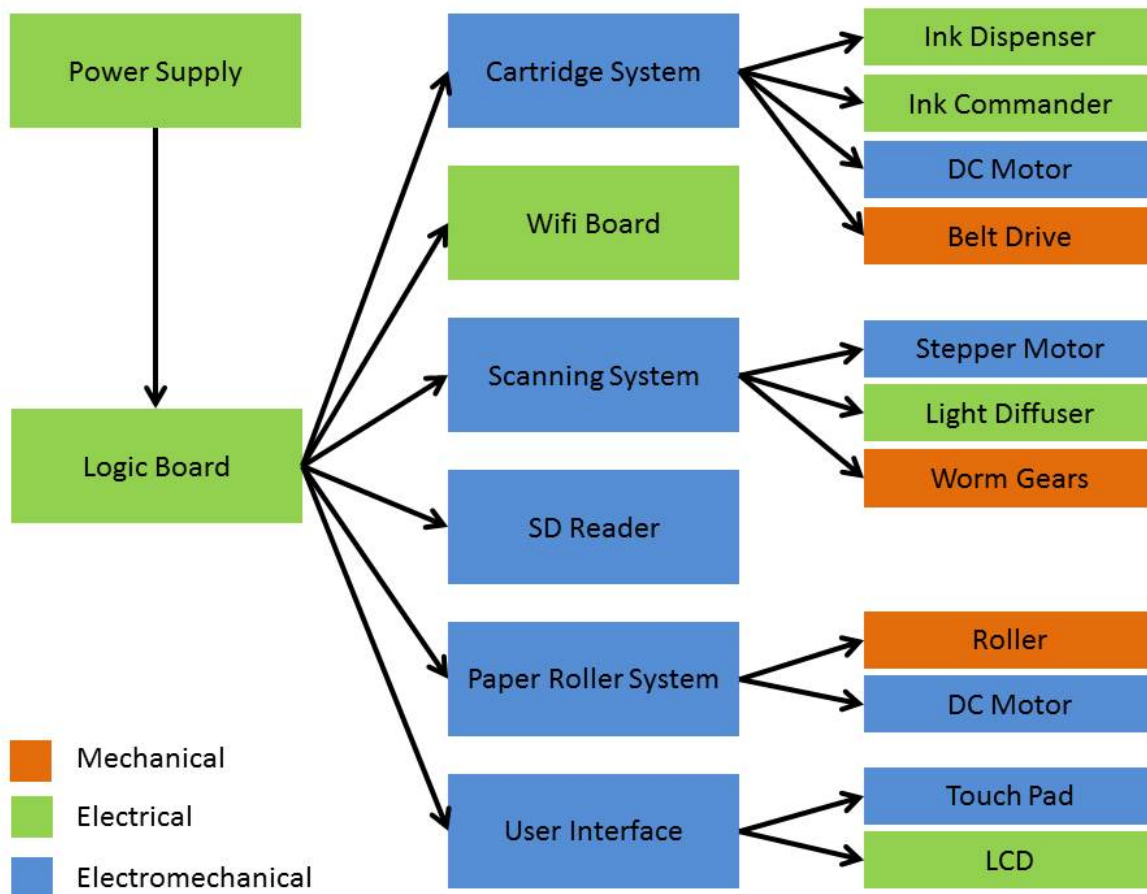
### Overview

The Epson XP-400 is a sleek all-in-one printer, with the whole package: print, scan, copy. We opened it up to see what was inside and how it worked! Unfortunately, the service manual is not available for free anywhere... someone's selling it on eBay, and the only free manual around is the [user manual](#) on the Epson site. (It's not particularly helpful with disassembly beyond the basics.)

### Testing

Our first observation was that the printer didn't come with a power cable. The logic board smelled somewhat burnt so a power component may have burnt out but given the appearance of the device (only surface blemishes), we suspect that it was still fully operational. We weren't able to verify that due to lacking the requisite cable, we considered splicing wires into the transformer directly, but we decided to take the path of fewer electrical burns or electrocution and get straight to disassembly.

### Block Diagram



## Mechanical Design

The outside of the device is polished and modern. The touch-sensitive controls flip out at an angle for easy user interaction, with an LCD screen placed right in the middle of the control panel. The main method of manufacturing was thermoforming, as many of the body panels were made out of plastic, and held smaller fasteners, springs, and pins for cable harnessing.

One stepper and two DC motors were used in this design. The stepper motor was used for the scanner. It contained a cute worm drive, which turned a worm gear coupled to several other gears (Figure 11). These gears moved a circuit board that contained a scanning device back and forth along the glass that the paper lay upon.

The first DC motor moved the paper through a set of rollers (Figure 14) using several gears and axles. The main axle had gears press fit onto both ends of it (Figure 20). It was powered on one end, and coupled with several other gears on the other. These gears were in turn linked to several other axles also intended to move the paper forward. One of these axles also contained a cam, which we believed lifted up the paper and pulled it forward.

The second DC motor moved the ink cartridge back and forth along a track subassembly (Figure 16) using a belt drive. The ink cartridges were mounted next to each other, with circuits determining how much ink each would dispense.

Certain parts of the printer are clearly meant for user disassembly and repair, such as the central cavity containing the print heads (so that the user can replace the ink cartridges and clear paper jams). The user-accessible areas aren't marked, but it's still obvious which parts are meant to separate - they come apart easily, without requiring any unlocking or force. From what we could see, anything with a screw or that needed to be forced was not intended for user access. Screws and tension springs were the main methods used to contain components.

## Components Of Interest

We've listed several key components of the printer below. Something interesting that we found while itemizing these components is that Epson uses many ICs and modules that are not available off the shelf. Some of them are registered to Epson in particular, like the wifi module, meaning that they've formed a large contract with a semiconductor or other component company. Others are just not available to consumers.

Part Number	Function	Component Area	Price	Datasheet Link	Notes
WLU6117-D69	Shielded wifi module	Wifi board	\$9 (on eBay)	Not available	Several unlabelled / unknown ICs under silver plating
RTS5186	SD card interface IC	SD card board	Unknown	Not available	Probably USB / SPI bridge (SD cards use SPI, and this

					board is connected to the main logic board via mini USB)
K3115B	High voltage N-fet	AC power supply	\$5.50	<a href="#">K3115</a>	Connected to large metal heat sink
C018CAN01	LCD Display	Display and Touchpad	\$40 (on ebay)	<a href="#">C018CAN01</a>	Not sure if link is entirely accurate, but same company and similar size
Rubycon Capacitor	Part of a Rectifier Circuit	Power Supply	7 euros	<a href="#">3M1216</a>	Huge ass capacitor
BCM4319	wifi IC	Logic Board	\$7 aliexpress	no datasheet	radio, MAC, baseband and integrated power amplifier (PA
SA2222	Bipolar Transistor	Logic Board	\$0.29 digikey	<a href="#">2SA2222SG</a>	High speed switching. relay or lamp driver -50V, -10A
SC6144	Bipolar Transistor	Logic Board	\$0.36	<a href="#">2SC6144SG</a>	High speed switching. relay or lamp driver 50V, 10A
Q064A	Flash Memory	Logic Board	\$1.84 findchips	<a href="#">N25Q064A</a>	Write protection, high speed SPI bus interface
CP7437AT	8-bit MCU	Display and Touchpad	\$0.80	Not available	Processes touches on the capacitive sensing keypad

The other interesting electrical feature of the printer is the unique design of the PCB trace antennas on the wifi board. Instead of spirals, L-shapes, or square wave designs, Epson engineers chose to draw squiggles for the antennas:





Figure 1



Figure 2



Figure 3



Figure 4

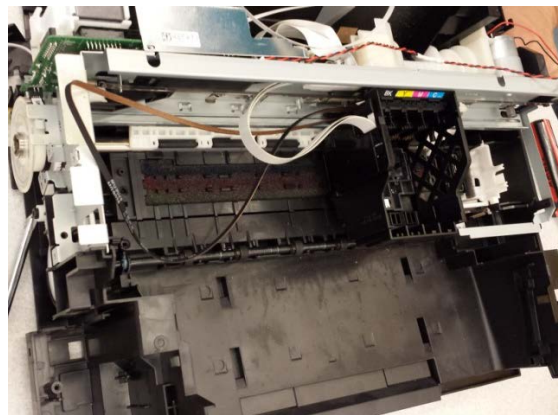


Figure 5

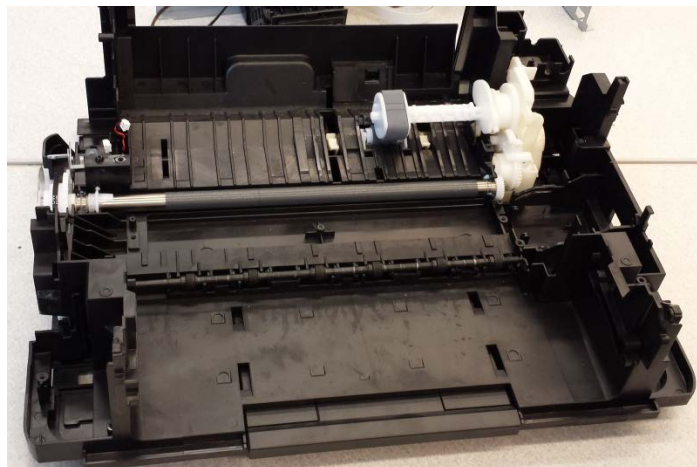


Figure 6



Figure 7

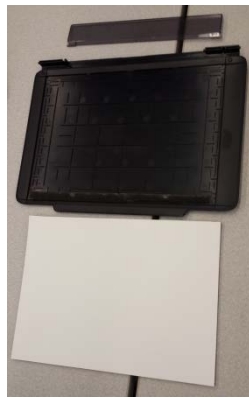


Figure 8

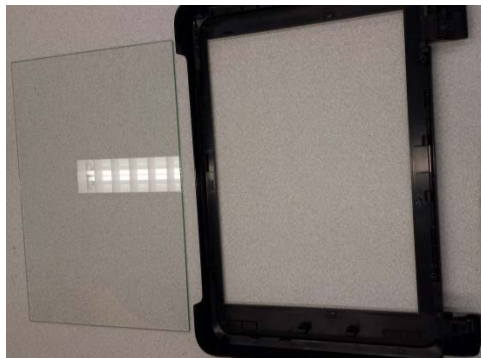


Figure 9





Figure 10

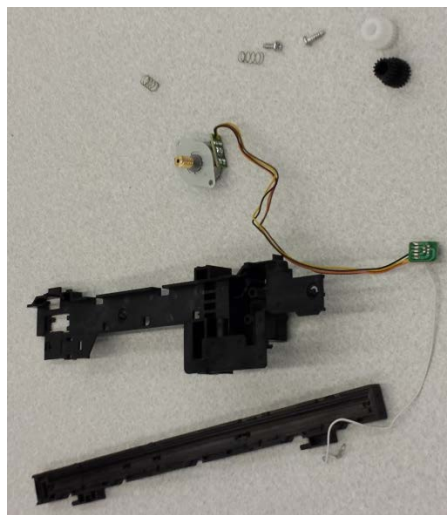


Figure 11

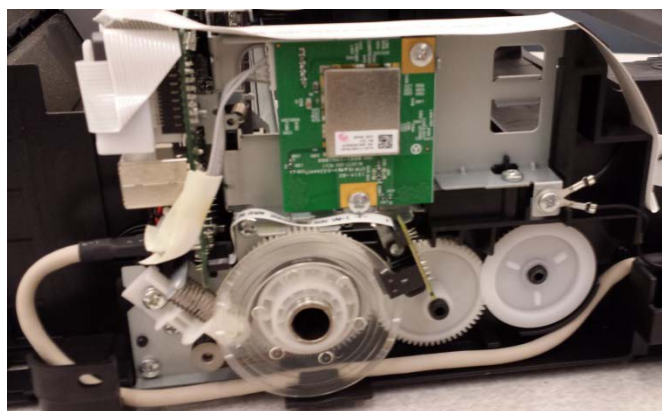


Figure 12

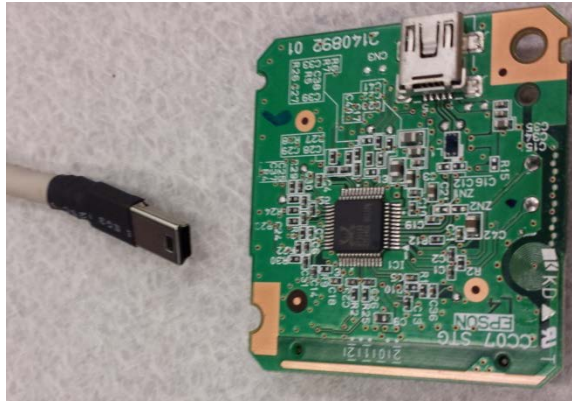


Figure 13



Figure 14

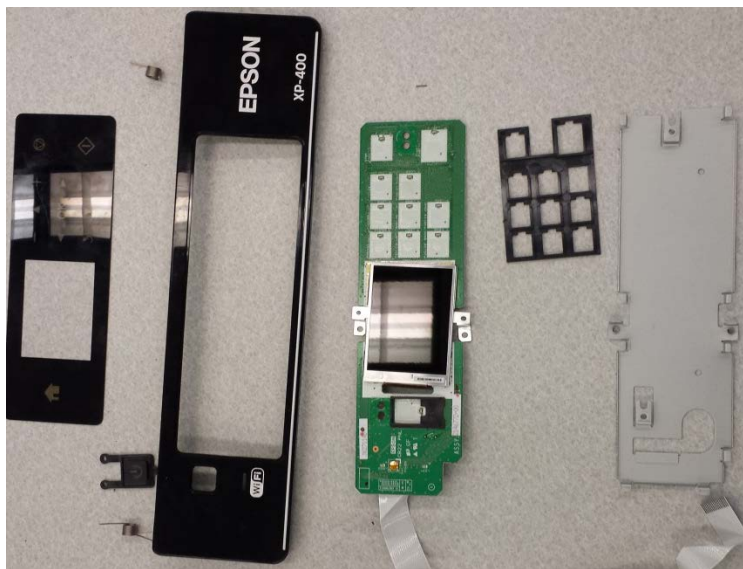


Figure 15



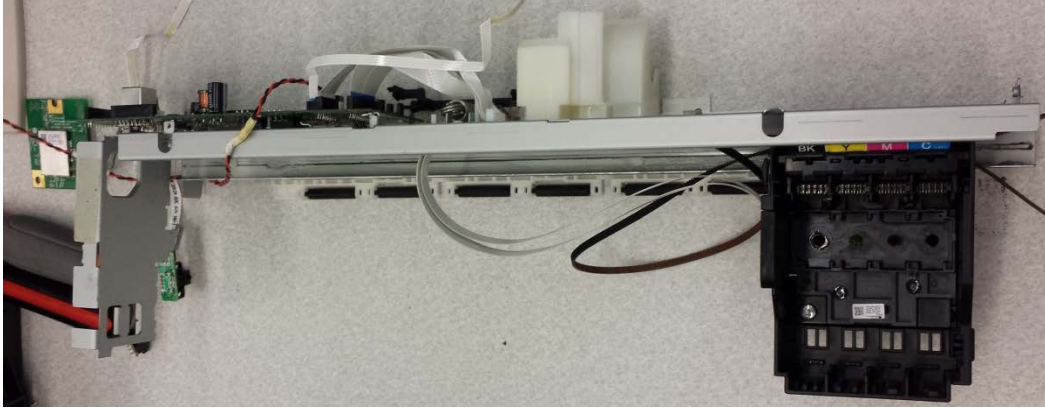


Figure 16

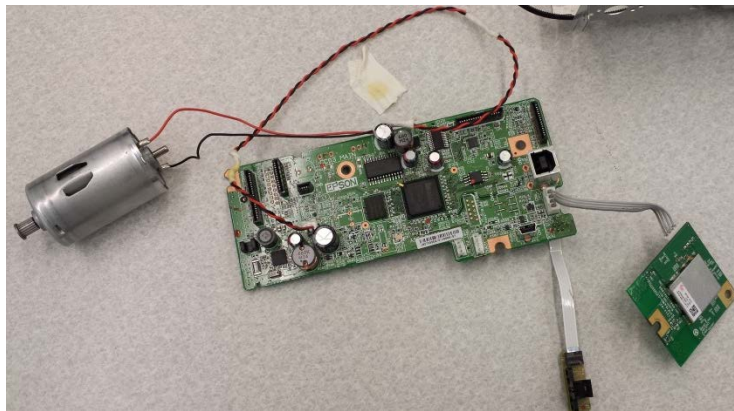


Figure 17

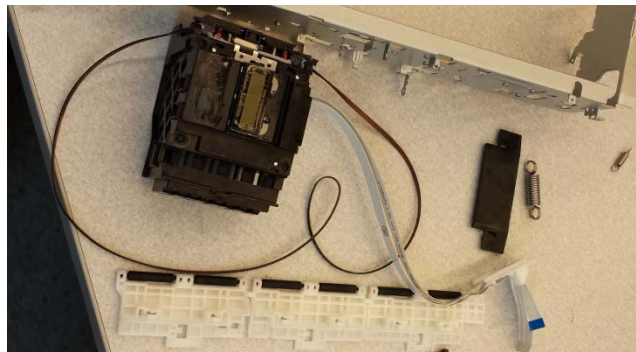


Figure 18



**Figure 19**



**Figure 20**



Figure 21



Figure 22

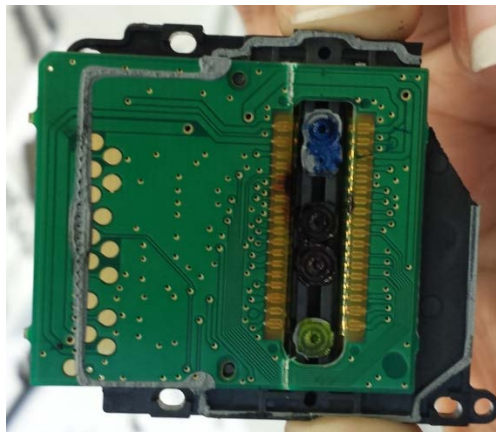


Figure 23



Figure 24