

Inkjet Printer Guide

Technical Manual

Inkjet Printer Technology

Introduction:

Although inkjets were available in the 1980s, it was only in the 1990s that prices dropped enough to bring the technology to the typical computer user. Traditionally, inkjets have had one massive attraction over laser printers; their ability to produce color, and that is what makes them so popular with home users. Since the late 1990s, when the price of color laser printers was lowered enough to make them feasible for home users, this advantage has been less definitive. However, in that time the development of inkjets capable of photographic-quality output has done much to help them retain their advantage in the realm of color. Plus, they have become very inexpensive over this time period.



Inkjet Printers cost less than a typical black & white laser printer, and much less than a color laser printer. The down side is that although inkjets are generally cheaper to buy than lasers, they are more expensive to maintain. Cartridges need to be changed more frequently and the special coated paper required to produce high-quality output is expensive. When it comes to comparing the cost per page, inkjets work out about ten times more expensive than laser printers.

The paper used on an inkjet printer has a great effect on the quality of the image. Standard copier paper works, but doesn't provide as crisp an image as paper made for inkjet printers. Brightness and Absorption affect image quality. The brightness of a paper is normally determined by how rough the surface of the paper is. Course or rough paper will scatter light whereas smooth paper reflects more light back in the same direction. This makes the paper appear brighter, which in turn makes any image on the paper appear brighter. Any paper that is listed as being bright is generally a smoother-than-normal paper.

The other key factor in image quality is absorption. When the ink is sprayed onto the paper, it should stay in a tight, symmetrical dot. The ink should not be absorbed too much into the paper. If that happens, the dot will begin to feather. This means that it will spread out in an irregular fashion to cover a slightly larger area than the printer expects it to. The result is a page that looks somewhat fuzzy, particularly at the edges of objects and text. High-quality inkjet paper is coated with a waxy film that keeps the ink on the surface of the paper. Coated paper normally yields a much better print than other paper. The low absorption of coated paper is key to the high-resolution capabilities of many of today's inkjet printers. For example, a typical inkjet printer can print at a resolution of up to 720x720 dpi on standard paper. With coated paper, the resolution increases to 1440x720 dpi. The reason is that the printer can actually shift the paper slightly and add a second row of dots for every normal row, knowing that the image will not feather and cause the dots to blur together.

Words and Terms You Should Know:

- Piezoelectric
- Inkjet printer
- Print head
- Control circuitry
- Ink cartridges
- Ink cartridges
- Print head stepper motor
- Belt
- Interface port
- Stabilizer bar
- Paper tray/feeder
- Rollers
- Paper feed stepper motor
- Power supply
- Absorption

Inkjet printers place tiny droplets of ink onto the paper or film as they print. An image is formed as the print head moves from side to side and the paper is moved up past the print head. The dots are extremely small... usually between 50 and 60 microns in diameter. As a reference, the diameter of a human hair is about 70 microns so the ink dots are really pretty small. Additionally, the dots are positioned in a very exact manner, with resolutions of up to 1440x720 dots per inch (dpi). In creating photo-quality images, the dots may have many different colors combined together. It's also important to note that inkjet printers are NON-IMPACT printers because they do not actually touch the paper when creating an image. Instead they use a series of nozzles (jets) to spray drops of ink directly on the paper. Inkjet printers are by far the most popular type of printers, followed by the laser printers.

Inside an Inkjet Printer

Inkjet printers are comprised of the following major components:

Print Head Assembly:

- **Print Heads** – This part applies ink to the medium. The print head contains a set of jets for each color to create the ink droplets. Each jet also includes an ink reservoir as part of the print head.
- **Ink Cartridges** - Depending on the manufacturer and model of the printer, ink cartridges come in various combinations, such as separate black and color cartridges, color and black in a single cartridge or even a cartridge for each ink color. Some inkjet printers also include the print head as part of the cartridge.
- **Print Head Stepper Motor** – This motor moves the print head horizontal to the paper in discrete steps so each ink dot can be precisely positioned.
- **Belt** – The print head belt is a toothed belt that attaches the print head assembly to the stepper motor.
- **Stabilizer Bar** – The stabilizer bar ensures that the movement of the print head is precise and controlled.

Paper Transport Assembly

- **Paper Tray/Feeder** – Both of these are different methods of releasing paper, however a paper tray tends to hold more paper than a feeder does.



Figure 1. Print Head Assembly



Figure 2. Some inkjet printers also include the print head as part of the cartridge. When the ink runs out, you replace both the print head and ink cartridge as a single unit.



Figure 3. The paper tray tends to hold more paper than a feeder does.

- **Rollers** - A set of rollers pull the paper in from the tray or feeder and advance the paper when the print head assembly is ready for another pass.



Figure 4. Feed Rollers pull paper in from the feeder or paper tray and help transport the paper through the printer.

- **Paper Feed Stepper Motor** – Powers the rollers to move the paper in the exact increment needed to ensure a continuous image is printed.

Other Major Assemblies

- **Power Supply** - A part of the computer that converts the power from a wall outlet into the lower voltages, typically 5 to 12 volts DC, required internally in the computer.
- **Control Circuitry** - controls all the mechanical aspects of operation, as well as decoding information sent to the printer from the computer.
- **Interface Port(s)** - The parallel port is still used by many printers, but most new printers use the USB port. A few printers connect using a serial port or small computer system interface (SCSI) port. However, most professional inkjet printers feature a built-in NIC that connects directly to a local area network for network printing.

Print Head and Ink Cartridge Removal



For inkjet printers with independent print heads, there is a separate print head for each color. The print head is held in the print head assembly. It's the print head assembly that moves back and forth to print the page. When you change a print head you'll have to use the printer's utility software to align the new head with the others in the print head assembly.



The ink cartridges may be mounted in a fixed location. The cartridges pump ink into a reservoir on the print head assembly.



The ink cartridges can be removed and replaced as the printer indicates they're low. Notice that the colors are black, cyan, magenta, and yellow. Any color can be created with the combination of these four colors.

Ink Delivery - Heat vs. Vibration

There are a couple of ways for inkjet printers to form their droplets of ink. They revolve around two technologies currently used by inkjet printer manufacturers:

- **Thermal bubble** - Used by manufacturers such as Canon and Hewlett Packard, this method is commonly referred to as bubble jet. Canon claims to have invented what it terms this new technology in 1977, when a researcher accidentally touched an ink-filled syringe with a hot soldering iron. The heat forced a drop of ink out of the needle and so began the development of a new printing method. In a thermal inkjet printer, tiny resistors create heat, and this heat vaporizes ink to create a bubble. As the bubble expands, some of the ink is pushed out of a nozzle onto the paper. When the bubble "pops" (collapses), a vacuum is created. This pulls more ink into the print head from the cartridge. A typical bubble jet print head has 300 or 600 tiny nozzles, and all of them can fire a droplet simultaneously, creating photo-quality images.
- **Piezoelectric** - Patented by Epson, this technology uses piezo crystals. A crystal is located at the back of the ink reservoir of each nozzle. The crystal receives a tiny electric charge that causes it to vibrate. When the crystal vibrates inward, it forces a tiny amount of ink out of the nozzle. When it vibrates out, it pulls some more ink into the reservoir to replace the ink sprayed out.

Printing

Here's what happens after you click "Print":

1. The software application you are using sends the data to be printed to the printer driver.
2. The driver translates the data into a format that the printer can understand and checks to see that the printer is online and available to print.
3. The driver sends the data from the computer to the printer via the connection interface (parallel, USB, etc.).
4. Upon receiving data, the computer stores a certain amount of data in a buffer. The buffer can range from 512 KB random access memory (RAM) to 128 MB RAM, depending on the model. Buffers are useful because they allow the computer to finish with the printing process quickly, instead of having to wait for the actual page to print.
5. If the printer has not been used in a while, it will first ensure that the print head(s) are clean. Once this "clean cycle" is complete, the printer is ready for printing.
6. The control circuitry activates the paper feed stepper motor. This engages the rollers, which feed a sheet of paper from the paper tray/feeder into the printer. A small trigger mechanism in the tray/feeder is depressed when there is paper in the tray or feeder. If the trigger is not depressed, the printer sends an alert to the computer, saying that it is "out of paper".
7. Once the paper is fed into the printer and positioned at the start of the page, the print head stepper motor uses the belt to move the print head assembly across the page. Though it may appear as a continuous motion, the motor pauses for the merest fraction of a second each time that the print head sprays dots of ink on the page and then moves a tiny bit before stopping again.

8. Multiple dots are made at each stop. It sprays the cartridge colors in precise amounts to make any other color imaginable.
9. At the end of each complete pass, the paper feed stepper motor advances the paper a fraction of an inch. Depending on the inkjet model, the print head is reset to the beginning side of the page, or, in most cases, simply reverses direction and begins to move back across the page as it prints.
10. This process continues until the page is printed. The time it takes to print a page can vary widely from printer to printer. It will also vary based on the complexity of the page and size of any images on the page. For example, a printer may be able to print 16 pages per minute (PPM) of black text but take a couple of minutes to print one, full-color, page-sized image.
11. Once the printing is complete, the print head moves back to its place. The paper feed stepper motor spins the rollers to finish pushing the completed page into the output tray. Most printers today use inks that dry quickly so that you can immediately pick up the sheet without smudging it.

Conclusions:

Inkjet printers are capable of printing on a variety of media. There are a number of specialty papers, ranging from adhesive-backed labels or stickers to business cards and brochures. You can even get iron-on transfers that allow you to create an image and put it on a T-shirt! One thing is for sure... inkjet printers definitely provide an easy and affordable way to unleash your creativity.

Since the invention of the inkjet, color printing has become immensely popular. Research in inkjet technology is making continual advances, with each new product on the market showing improvements in performance, usability, and output quality. As the process of refinement continues, so the price of an inkjet printer continues to fall.



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Exercise 1 - Inkjet Printer Technology

Instructions:

Study the content carefully before attempting the questions listed below. Consider using other information sources as well. Periodicals, reference materials, and the Internet are great resources to find the answers to the technical problems you're going to face when servicing computers.

Name:	
Period:	
Date:	

Speaking of resources... Let's save some of our natural resources. Rather than printing out the entire lesson, print out only the worksheet. Study the lesson on-screen and then record your answers on this worksheet. When you're finished, return the worksheet to your supervisor for evaluation. Be sure to complete this assignment before moving onto the next.

Research Resources:

Company	Web Site	Description
How Stuff Works	http://computer.howstuffworks.com/inkjet-printer.htm	This website provides simple knowledge of the basic features of an inkjet printer, its components and how it works.
The PC Technology Guide	http://www.pctechguide.com/13inkjets.htm	This website provides more in-depth insight to the operation of the inkjet printers.
Inkjet Troubleshooting	http://204.118.40.12/lasercycle/troubleshoot_inkjet.htm	If you have problems with your printer, this is the site to help you figure out what it is and how to fix it.

Questions:

1. ✓ Research and develop a detailed definition for each of the following terms. Many words have multiple definitions... Some of which may have nothing to do with the field of Computer Service and Support. Make sure your definition falls within the context of this lesson. Refer to the list of Research Resources and Required Materials as well as other materials you feel are appropriate. Write your definitions on the reverse side of this worksheet or a separate piece of paper with each definition being two sentences or more.

- ✓ Piezoelectric
- ✓ Control Circuitry
- ✓ Print Head Stepper Motor
- ✓ Interface Port
- ✓ Stabilizer Bar
- ✓ Inkjet Printer
- ✓ Print Head
- ✓ Paper Feed Stepper Motor
- ✓ Power Supply

2. ✓ When it comes to cost per page, which printer is cheaper to purchase – Laser or Inkjet?

3. ✓ What two paper qualities affect image quality?

- 4.√ What is the approximate diameter of one dot of ink (in microns)?

- 5.√ What components make-up the print head assembly?

- 6.√ What components make-up the paper transport assembly?

- 7.√ What paper feeding method tends to hold more paper?

- 8.√ What's the difference between thermal bubble and bubble jet printing technologies?

- 9.√ If the printer hasn't been used in awhile... What happens in the print process before the printer is ready to print?

- 10.√ Summarize and list the 11 steps of the inkjet print process... What happens when you click "Print"?



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Exercise 2 – Inkjet Printer PMI

Exercise Objective:

In this exercise, you'll perform Preventive Maintenance Inspection of an Inkjet printer. You'll collect the appropriate tools together and use them correctly to complete this exercise.

Name:	
Period:	
Date:	

Discussion of Fundamentals:

We perform the preventive maintenance inspection (PMI) to preserve the reliability of the equipment we use. Through careful inspection, cleaning, and maintenance our computer workstations will perform better and longer than those that are neglected. The PMI also allows us to detect serious problems before they occur and perhaps prevent system crashes and reduce equipment down time.

Required Materials:

- Work Order
- Equipment ID Tag
- Inkjet Printer
- Spray and Wipe Cleaner
- Alcohol
- Soft-Bristled Brush
- Stiff-Bristled Brush
- Cotton Swabs
- Lint-Free Towels
- Compressed Air
- Vacuum
- PC Technician Toolkit
- Adhesive Remover
- Diagnostics Software

Procedure:

Complete each of the following steps in this exercise. When you see a ✓... That's an indication that you need to do something. This is an **abbreviated** guide to performing a preventive maintenance inspection of an inkjet printer. Refer to the previous section for details on how to complete each step. Print out this exercise and use it to keep track of your progress while performing the following steps.

A. INITIAL PRINTER INSPECTION

Preparation: Printer completely assembled and operational. Power **OFF**. Rings, watches and jewelry must be removed.

1. ✓ Make sure you have a valid work order. If the item is in the shop make sure it has an Repairable Item Tag on it.
2. ✓ Inspect for any broken or missing parts. Record the parts and a description of their defect on the work order.
3. ✓ Rattle test the printer. Remove paper, detach any removable covers, and slowly rock the printer while listening for loose or traveling parts inside the case. Investigate and report your findings to your supervisor if the printer fails the rattle test.

CAUTION: Most printers manufactured for the United States operate on 110 Volts **ONLY**. If you plug the printer into the wrong voltage you will destroy it. Examine the ID plate and attach the correct power cord to the printer.

4. ✓ Connect the printer to a power source.
5. ✓ Reassemble the printer and make sure the printer is loaded with paper.
6. ✓ Perform a printer Self-Test.

Tech Note: Most printers have a built-in self-test function. Different manufacturers use different combinations of keys to activate the self-test. Consult the printer's user's manual to determine how to run the printer self test. **NOTE:** Most printers incorporate safety interlock switches into the covers and lids. The printer must be assembled before it can print.

- 7.√ Check the quality of the print for darkness and clarity. If the quality of the print is light or broken up, chances are the cartridge may be old and need changing.
- 8.√ Turn the printer's power off.

() **Supervisor Check**

B. INTERNAL CLEANING

Preparation: Printer completely disassembled. Power **OFF and Unplugged**. Rings, watches and jewelry must be removed.

- 1.√ Use compressed air and a soft bristle brush to remove dust and debris from inside the printer.
- 2.√ Carefully reassemble the printer.
- 3.√ Remove, clean, and replace each print head one at a time.
 - ✓ Remove a print head from the print head assembly.
 - ✓ Wet a lint-free towel with alcohol and gently wipe the jets to remove old ink.
 - ✓ Replace the cleaned print head.
 - ✓ Repeat until each print head is clean.
 - ✓ Run the printer's utility program to align the print heads.

() **Supervisor Check**

C. EXTERNAL CLEANING

Preparation: Printer completely assembled and operational. Power **OFF and Unplugged**. Rings, watches and jewelry must be removed.

- 1.√ Clean the lids, covers, and external surfaces with spray and wipe cleaner.
- 2.√ Clean air vents with a stiff bristled brush or cotton swab wet with spray and wipe cleaner.
- 3.√ Remove any unnecessary labels or tape using adhesive remover.
- 4.√ Wipe down all surfaces cleaning off streaks and smudges.
- 5.√ Reassemble the printer and load with 5 to 10 sheets of paper.

() **Supervisor Check**

D. OPERATIONAL TESTING

Preparation: Printer completely assembled and operational. Connect the printer to a computer workstation. Turn the Power **ON**. Make sure the printer is **ON-LINE**. Rings, watches and jewelry must be removed.

- 1.√ Boot-up the computer into Windows
- 2.√ Go to the Start menu and open Settings.

- 3.√ Open the Control Panel and open Printers.

Tech Note: If the printer you want to test isn't listed in the printer panel you'll have to add it. Select "Add a Printer" and following the installation instructions. Ask your supervisor for help if you need it.

- 4.√ Right click the printer that you would like to test.
- 5.√ Open Properties
- 6.√ Make sure you are under "General" tab.
- 7.√ Click on "Print Test Page"

() Supervisor Check

E. PRINTER INSTALLATION

Preparation: Printer completely assembled, tested, and operational. Connect the printer to a computer workstation. Turn the Power **ON**. Make sure the printer is **ON-LINE**. Rings, watches and jewelry must be removed.

- 1.√ Position the printer as it would be used by the customer.
- 2.√ Boot-up the computer into Windows and setup the printer in the Control Panel if necessary.
- 3.√ Organize all data and power cables in a neat and orderly fashion.
- 4.√ Gather tools and supplies and throw away used materials.
- 5.√ Wipe down the work area one last time.
- 6.√ Have the customer sign the Work Order once the job is complete.
- 7.√ Return the completed Work Order to the dispatcher.

() Supervisor Check



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Exercise 3 – Inkjet Features/Service

Exercise Objective:

In this exercise you will compare the features of various inkjet printers. At the end of this lab, you should be familiar with the variations in key features between inkjet printers. You will also learn perform basic service on an inkjet printer.

Name:	
Period:	
Date:	

Discussion of Fundamentals:

Now that you're a real computer guru... lots of people are going to start asking you for advice. In this case, they may start asking you, "What kind of inkjet printer should I buy?" This will happen on the job site as well. You really need to be familiar with printer specs and how to recognize a quality product. You'll also need to service the printer once it's purchased. Reviewing the previous material will help you complete the following tasks.

Research Resources:

Company	Web Site	Description
Hewlett Packard	http://www.hp.com	Hewlett Packard Printer Information
Cannon	http://www.canon.com	Cannon Printer Information
Epson	http://www.epson.com	Epson Printer Information

Required Materials:

- Inkjet Printer
- Printer User Manual
- Internet Access

Procedure:

Complete each of the following steps in this exercise. When you see a ✓... That's an indication that you need to do something. Print out this exercise and use it to keep track of your progress while performing the following steps.

A. Inkjet Printer Features

1. ✓ If you have access to an inkjet printer, open it up and carefully examine it.
2. ✓ Study the printer manual to obtain the following specifications:

Specification	Value
Speed Of The Printer (Pages Per Minute):	
Max Resolution:	
Max Colors:	
Number And Types Of Ink Cartridges:	
Price:	

- 3.√ Visit the websites of several inkjet printer manufactures and select the inkjet printer that delivers “the best bang for the buck”. Complete the table below.

Specification	Value
Manufacturer:	
Model Number:	
Speed of the printer (pages per minute):	
Max Resolution:	
Max Colors:	
Number and Types of Ink Cartridges:	
Price:	

() **Supervisor Check**

B. Inkjet Printer Service

- ✓ Exam the inside of a inkjet printer looking for removable or replaceable parts.
- ✓ Practice removing and reinserting the ink cartridges, print heads, and paper.
- ✓ Open the printer to the point where you could clear a paper jam any along the paper transport path.
- ✓ Clean the print heads.
- ✓ Print out a test page using the printer’s self-test feature.

() **Supervisor Check**