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In this primer to the Electrophotographic (EP) laser printing process, we will discuss the main assemblies of a laser printer, the steps involved in the print process, and troubleshooting tips. This is not only good information for any technician to know, but it is also covered on the A+ exam.

Laser Printer Components

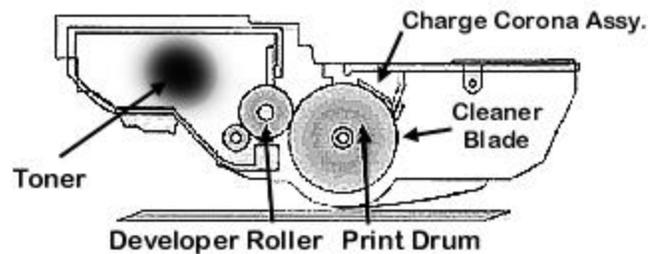
A laser printer typically consists of 8 Field Replaceable Units (FRU):

- Toner Cartridge
- Laser Scanning Assembly
- High Voltage Power Supply
- DC Power Supply
- Paper Transport Assembly
- Transfer Corona Assembly
- Fuser Assembly
- Formatter Board

Toner Cartridge

A toner cartridge comprises of a toner, print drum, charge corona wire and the cleaning blade. Toner consists of a carbon substance mixed with iron oxide and polyester resins.

Side View of a Toner Cartridge



Laser Scanning Assembly

A laser reflects off of a mirror onto the drum and discharges the drum. Once the drum is discharged (to about -100 VDC), toner will stick to it.

High Voltage Power Supply (HVPS)

This converts the input AC voltage to DC and supplies high voltages (-600 VDC) to the Charge corona wire and Transfer corona wire.

DC Power Supply (DCPS)

This applies +5 and -5 VDC to the formatter board and +24 VDC to the paper transport motors.

Paper Transport Assembly

This is responsible for moving the paper through the printer. It comprises of a motor and rollers. The **pickup rollers** pick up a single sheet of paper from the paper tray, whereas the **registration rollers** synchronize the paper movement with the image on the print drum.

Transfer Corona Assembly

This is either a wire or roller just beneath the printer cartridge, which applies a high positive charge to the paper as it is pulled through the printer. The positively charged paper attracts the negatively charged toner particles to form an image on the paper.

Fusing Assembly

The fuser contains 3 components, a halogen heating lamp, a Teflon coated fusing roller and a pressure roller. The halogen lamp heats the fusing roller to 350 F before the toner is melted onto the paper by the fuser unit.

Formatter Board

This is the main circuit board in the printer that is responsible for translating data received from the computer into data that the printer can understand.

Electrophotographic (EP) Print Process

This is the process a laser printer uses to form an image onto the paper. The EP Print Process consists of 6 stages:

- Charging
- Exposing
- Developing
- Transferring
- Fusing
- Cleaning

Charging

At the charging stage, the charge corona wire within the toner cartridge applies a strong uniform negative charge (-600 VDC) to the toner drum's surface.

Exposing

The laser unit scans the drum from side to side, turning off according to the signals received from the formatter board. The drums charge is reduced from -600VDC to -100VDC in those areas that the laser beam touches. As the drum rotates around an image is built up on the toner drums surface.

Developing

Toner is transferred to those areas of the drum with a slight negative charge (-100VDC) at this stage. A developer roller inside the EP cartridge receives a charge of -600VDC. The toner sticks to this roller because of the magnet inside and the electrostatic charges. When the toner comes between the developing roller and the photosensitive drum, the toner is attracted to those areas on the drum that have been touched by the laser i.e. -100VDC. The drum now has toner stuck to it where the laser has written.

Transfer

The formatter board signals to the registration rollers that the paper should be guided through. The registration rollers move the paper underneath the drum and the image is transferred to the paper. The Transfer corona wire applies a high positive charge (+600VDC) to the paper and the negatively charged toner on the print drum's surface is attracted to the paper because opposites attract. A static eliminator comb then removes any charge from the paper to prevent the paper sticking to the toner cartridge, which would result in a printer jam.

Fusing

Up to this point the toner is only loosely attached to the paper. The fuser melts the toner onto the paper via a high temperature halogen lamp and a pressure roller (at about 350 degrees Fahrenheit.).

Cleaning

A rubber blade inside the toner cartridge removes any untransferred toner into a used toner receptacle inside the cartridge and a fluorescent light discharges any remaining charge on the drum's surface. (For the HP Print process, LED's are used instead of a fluorescent lamp.)

Hewlett Packard (HP) Print Process

The steps for the HP Print Process are the same as the EP Print process with the exception of the first two stages. In the HP method, Charging is replaced with Conditioning, and exposing is replaced with Writing. This is the process a laser printer uses to form an image onto the paper. The HP Print Process also consists of 6 stages:

- Conditioning
- Writing
- Developing
- Transferring
- Fusing
- Cleaning

Conditioning

A charge roller applies a uniform negative charge to the drum.

Writing

Selected areas of the print drum are discharged to ground. (In the EP Print Process, the drum is only discharged to a state of the "more negative -100 VDC" instead of ground.

Developing

The drum passes by the developing roller as its rotates, and toner is attracted to the discharged areas on the drum. The drum now has toner stuck to it where the laser has written.

Transfer

A strong positive charge is applied to the corona wire/roller, and the image is pulled onto the paper from the drum.

Fusing

Up to this point the toner is only loosely attached to the paper. The fuser melts the toner onto the paper via a high temperature halogen lamp and a pressure roller (at about 350 degrees Fahrenheit.).

Cleaning

A rubber blade inside the toner cartridge removes any untransferred toner into a used toner receptacle inside the cartridge and LED's clear the drum, preparing to cycle the process again.

Troubleshooting Laser Printers

Paper Jams

There are a number of reasons for paper jams including:

- **Paper feed rollers** - These often become worn and the easiest solution is to replace them. To extend the life of rollers either use Platenclene or scruff the surfaces of the rollers with an abrasive pad. This latter tip will only work the once however.
- **Drive gear** - A broken drive gear or clutch belonging to the pickup rollers may have teeth missing. To discover if the problem is related to the pickup rollers or a broken gear, print a test page but leave the paper tray out. Examine the paper feed opening to see if the Pickup rollers are turning evenly and don't skip. If they are turning evenly the problem is likely to be associated with the rollers.
- **Worn exit rollers** - These rollers guide the paper out of the printer and into the exit tray. These jams occur just before the paper reaches the exit rollers indicating that they have become worn. Open the rear printer door to see if the paper is jamming just prior to the exit rollers.
- **Incorrect paper** - Paper-absorbing moisture from the air can cause paper jams. If your printer is picking up several pages at once when printing the chances are that the paper isn't dry enough. Always keep paper wrapped until required.
- **Missing Static Eliminator Strip** - If this item is either missing or broken the charge on the paper from the transfer corona wire will remain as it is fed though the printer causing it to stick to the printer drum. This will result in a printer jam.

Blank Pages

Blank pages can be attributed to either:

- **The Toner Cartridge**
An empty toner will obviously cause the printer to produce blank pages. As a short-term solution remove the toner cartridge and shake it well before re-installing it. In the long term, the printer will need to be replaced. Recycled toners may be another possible cause of blank pages since the toner in them may be the wrong type causing toner to be repelled instead of attracted to the toner drum. Finally, make sure that the plastic strip inside the toner is removed before installing it into the printer.
- **The Transfer Corona Assembly**
A missing or damaged corona wire will result in no toner being transferred to the printer drum thus no image will be placed on the paper.
- **The High Voltage Power Supply**
This provides a charge to both the charge and transfer corona wires. If the HVPS is broken, the corona will not charge, therefore, the toner will not be attracted to the paper.

Black Pages

- This is normally the result of a malfunctioning charge or transfer corona wire in the EP toner cartridge failing to place a charge on the printer drum. In this case, the drum will have no charge and anything with a positive charge such as toner will stick to it. The toner will then attach itself to the paper as the drum rotates. To correct this, replace the toner.

Repetitive small marks or defects

- A scratched toner drum or spilt toner on a roller inside the printer is normally the cause of this problem. In either case a printer manual will normally contain a chart that when lined up next to test page will indicate which roller is at fault because a mark will occur each time the suspect roller rotates fully round. To correct this, replace the toner.

Vertical black lines

- A scratch in the EP toner drum is normally responsible for the appearance of vertical black lines running down a page. Alternatively a dirty charge corona wire. To correct this, replace the toner.

Vertical white lines

- This is normally the result of toner being stuck on the transfer corona wire. The dirty locations on the wire prevent toner from being transferred to the paper at these specific areas on the wire, causing white streaks to appear. To correct this, clean the transfer corona wire inside the toner if possible or replace the toner cartridge.

Image Smudging

- This normally indicates a problem with the fusing unit especially if the toner is not sticking to the paper. To correct this, replace the fuser unit.

Ghosting

- This is characterized by images of earlier printed pages on the present one. A defective cleaning blade or non-working erasure lamp is at fault. If the erasure lamps are not working then not all the electrostatic charges are removed from the printer drum causing toner to stick to these area's of the drum. This will result in a ghosting effect.
- A broken cleaning blade will lead to toner build up on the EP drum and this will be transferred to the paper at the next print out.

Printer is Printing Garbage Symbols

- This may be due to an incorrect printer driver or the formatter board, which translates data from the PC into information the printer can understand not working.

Hewlett Packard Self Tests

A number of tests can be performed on HP printers to help determine the cause of the problem:

Engine Self Test - This test bypasses the formatter board in the printer so if a test print can be performed you know that the print engine is okay and the problem may be related to the printer's logic board.

Half Self Test - A half test is carried out the same way but you interrupt it at various intervals by opening the top cover to narrow down the root cause of the problem. If there is a partial image on the print drum and also on the paper then you can eliminate the pickup rollers, registration rollers, laser scanner, printer drum, charging and transfer wires.

Common Laser Error Messages

00 Ready	The printer is ready to print
02 Warming Up	The fuser is being warmed up
05 Self Test	A self test is being carried out
11 Paper Out	Paper tray sensor has detected there is no paper
13 Paper Jam	Paper is caught in the paper path
14 No EP Cart	No toner cartridge is installed
15 Engine Test	A self test is in progress
16 Toner Low	The toner is running out
50 Service	A fuser error has occurred
51 Error	Laser scanning assembly problem
52 Error	The scanner motor inside the laser unit is not working
55 Error	Communication problem between the formatter and DC controller