Theory of Operation

LaserWriter

Introduction

This document presents a Macintosh-to-laser-printer system, and provides an overview of page creation, data transfer, and print generation. A Macintosh-to-laser-printer system includes these major components:

- Macintosh computer (any model)
- Application software (such as a word processing program)
- Apple laser printer (any model)
- Printer software (in the System Folder)
- Data transfer technology (between the Macintosh and laser printer—including all cards, cables, and connectors)

All Apple laser printers use the printing technology described in this document. When you understand how a Macintosh-to-laser-printer system functions, and can identify common causes of faulty operation, you will have learned much of the functional information you need to troubleshoot and repair faulty systems.

This document has four sections:

- “Page Creation and Conversion” presents a functional overview of the page description languages that Macintosh computers and Apple laser printers use to display and print text and graphic information, as well as the common symptoms and causes of faulty page creation and conversion.

- “Data Transfer Technology” introduces four types of data transfer technology that exchange information between the computer and the laser printer, as well as the common symptoms and causes of faulty data transfer.
- “Print Generation” presents the ready states, a functional description of the print cycle stages, and the common symptoms and causes of faulty operation at each stage.
- “Laser Printer Types” describes the major features that distinguish network and direct printers.

Page Creation and Conversion

The printing process begins with the creation of a page (or pages) that contain text and/or graphic information. The information appears on the Macintosh screen and is stored in Macintosh RAM. When you print, the laser printer page description language converts the information, transfers it to printer RAM, and stores the data to be printed.

This section begins by defining key page creation terms, followed by a description of the page description languages that convert and transfer the pages to the printer.

The following terms describe the page creation process:

QuickDraw performs all Macintosh graphic and text operations. QuickDraw is a set of routines (coded instructions that perform a series of operations) in Macintosh ROM. Applications access QuickDraw to create

graphics and text, which outputs to the computer screen or other devices (such as printers). Graphics and text appear on the screen as bitmapped images.

Bitmapped images display on the computer screen as a collection of black dots and white spaces. **Bitmapping** refers to a method of storing information in computer memory. RAM stores bitmap fonts and graphics as dots and spaces in a corresponding location (or bit) in memory.

Resolution describes the sharpness of an image in dots per inch (dpi). The Macintosh displays pixels (or dots) at approximately 72 dpi. The dots per inch correspond to a printer's point (1/72 inch), which is a standard of the printing industry.

The Macintosh computer screen has a relatively low resolution when compared to laser printers. Laser printers have a resolution of 300 to 600 dpi, depending on the

printer. Phototypesetters print at even higher resolutions (1,000 dpi and higher). A page printed by a laser printer or phototypesetter appears much sharper than the image on the screen because it has a larger number of smaller dots.

The user selects screen fonts (bitmapped) that QuickDraw uses to display text on the computer screen. **Fonts** are a set of characters in one size and style. Font sizes are expressed in points (such as 12 point). **Style** refers to the shape and weight of a font. A **font family** is a complete set of characters for one font, including all styles and sizes. Times bold and Times italic are two styles of the Times font family.

Laser printer drivers are Macintosh system software files that interface the Macintosh with a laser printer.

QuickDraw Page Description Language

QuickDraw performs all Macintosh graphic and text operations. Once information is created and stored in RAM, either the QuickDraw or PostScript page description language converts the information and transfers it to printer RAM. QuickDraw is for single-user, non-network systems. PostScript is for single-user and multiuser networks. This section describes the QuickDraw and PostScript page description languages.

The laser printer driver manages the page conversion process. Laser printers that use QuickDraw require a printer driver represented on screen by a non-networked LaserWriter icon, followed by the name of the printer.

QuickDraw laser printers require a Prep file in addition to the appropriate printer driver. The Prep file enhances performance by compressing the bitmaps. The prep file has

- The name of the printer that requires the prep file
- The word Prep following the printer name

The QuickDraw laser printer driver converts information from computer RAM into the 300-dpi resolution the printer requires. Graphic images are converted by using QuickDraw routines. Text is converted by using “4x” (four times) or TrueType fonts.

The 4x fonts are identical to and four times larger than screen fonts. They must be installed in the System Folder for every screen font and are included on the laser printer Fonts disk. The 4x fonts translate the 72-dpi screen font to 300 dpi more efficiently than QuickDraw. For example, 72 (screen font dpi) times four equals 288, which is very

close to the laser printer 300 dpi. If a 4x font is not installed, QuickDraw uses the less efficient process of scaling to create a 300-dpi image. QuickDraw scaling causes text to look jagged—a common customer complaint.

QuickDraw laser printers can also use the TrueType fonts on the laser printer Fonts disk. TrueType works on all models of Macintosh computers using system software version 6.0.7 or later. A single TrueType font allows you to create any size of character (even odd sizes like 31-point). The font will look smooth both on screen and on paper. TrueType fonts permit a single font to be scaled to any size or style, and eliminate the need for 4x fonts. When TrueType runs on QuickDraw laser printers, files still travel page-by-page to the printer, where the TrueType fonts convert to bitmaps.

PostScript Page Description Language

PostScript is one of the industry-standard page description languages that uses outline font technology to describe text, graphics, and digitized images for printed pages. Outline font technology defines each character as a combination of straight and curved lines that form the outline of a character.

The characters are stored as mathematical formulas that specify the formation of font sizes and styles, as well as graphics. The Laser Prep file stores the definitions that interpret the mathematical formulas. The printer controller uses Laser Prep to process the formulas. After the size and style of each letter is defined, the controller fills in the outline with dots at the specific resolution of the print device.

Again, the laser printer driver manages the page conversion process. PostScript laser printers require the printer driver called “LaserWriter.”

The PostScript laser printer driver uses Laser Prep to convert the pages of text and graphic bitmap images in computer RAM to mathematical formulas. Laser printers using the LaserWriter printer driver incorporate the LaserPrep file for driver versions 6.1 and higher.

Laser Prep does not reside in printer drivers below version 6.1. Older versions of the PostScript printer driver require the installation of a separate Laser Prep file into the System Folder.

QuickDraw uses fonts in the System Folder, whereas PostScript uses PostScript fonts in printer ROM and RAM. PostScript laser printers permanently store several PostScript font families in ROM. Fonts that are not from a

resident font family must be loaded into printer RAM before you print a document.

Font Downloading

The process of copying nonresident fonts from a computer to printer RAM is called "font downloading." Some applications automatically search computer RAM for the font and download it to laser printer RAM. When using applications that do not automatically download the fonts in a document, the user must use a font-downloading utility to manually download the font(s). If a needed font is not downloaded, the printer controller creates a bitmap version of the font. Bitmap font creation slows the printing process and generates characters that are less well-defined.

If a limited amount of printer RAM is available, the printer may download the font temporarily until the file prints, and

then erase the font. If enough RAM is available, the printer may download the font until the printer is switched off, or until a user removes it by using a font-downloading utility. If the laser printer has a SCSI port, you can attach up to six hard disks to permanently store downloaded fonts so that they are always available to the laser printer, just as if they were in printer RAM. The fonts are permanent until they are removed by the user, even if the printer is switched off.

TrueType Fonts

When TrueType is used with Macintosh computers printing to PostScript printers, you need only one font installed in the System file for each family of fonts. TrueType fonts eliminate the need for a separate set of bitmapped fonts for each size and style of font. TrueType is primarily a screen font and does not replace the PostScript fonts, which are required by PostScript laser printers.

With TrueType fonts, PostScript converts a file to mathematical formulas before the file arrives at the printer. The printer uses PostScript fonts to re-create the page in printer RAM. If the file requires a PostScript font that is not available in printer RAM for downloading, but is an available TrueType font, PostScript can use the TrueType font to print the file.

Faulty Page Creation and Conversion

Improper installation of printer files and fonts usually results in the inability to print, poor print quality, and/or poor printer performance. You are likely to hear these symptoms from many of your customers when they try to print to laser printers that have just been set up.

The likely causes of each of these common symptoms are listed in the following table.

Common Symptoms	Likely Causes
Can't print to printer	• Printer driver is not installed. • Wrong printer driver is installed. • Laser Prep file (PostScript) or Prep file (QuickDraw) is not installed (if required). • TrueType fonts are installed on a Macintosh with a system software version lower than 6.0.7.
Poor print quality	QuickDraw laser printers: TrueType or matching 4x fonts are not installed. PostScript laser printers: PostScript fonts are not available to support screen fonts.

Common Symptoms	Likely Causes
Poor printing performance	QuickDraw laser printers: • TrueType or matching 4x fonts are not installed. • Large files with minimum of printer RAM. PostScript laser printers: • PostScript fonts are not available to support screen fonts. • Large files with minimum of printer RAM.

This list emphasizes the need to install the correct combination of printer driver(s), Prep file (if required), and fonts to ensure high-quality output and efficient printer system operation.

Data Transfer Technology

This section introduces the types of data-transfer technology that Macintosh computers and laser printers use to communicate with each other, and identifies common symptoms and causes of faulty data transfer.

The Macintosh computer and Apple laser printer use three types of data transfer technology to communicate: serial, SCSI, and AppleTalk technology. Serial and SCSI technologies are for single-user system configurations using QuickDraw (non-networked) laser printers. AppleTalk technology is for single-user and multiuser network system configurations.

Serial and SCSI Technology

Laser printers using the QuickDraw page description language transfer data between the computer and a printer by using serial and/or SCSI technology. As discussed in the previous section, QuickDraw converts the pages in computer RAM into 300-dpi bitmap pages. The data then transfers page-by-page to the print controller on the printer I/O PCB (Printed Circuit Board), where the 300-dpi bitmap pages are re-created. The re-created pages are stored in the page buffer until they print. Like the page conversion process, the QuickDraw printer driver manages the data transfer process.

Serial technology is the slowest of the three laser printer data transfer technologies. A serial interface sends one bit of data at a time on one line from the computer to the printer. To enhance the transfer rate, the printer driver for serial

laser printers uses a Prep file to compress the data before it transfers. The laser printer decompresses the data before storing it in printer memory.

SCSI (Small Computer System Interface) technology is faster than serial technology. SCSI technology provides a parallel interface that moves 8 bits of data at a time, 1 bit on each of eight lines. As with all SCSI devices, laser printers that use SCSI technology must have unique identification numbers and proper termination.

Faulty Serial and SCSI Operation

Two common symptoms indicate faulty serial or SCSI technology.

Common Symptoms	Likely Causes
Computer can't find the laser printer and/or can't print to the printer.	One or more of the following conditions exists: • The correct driver (and Prep file, if required) is not installed. • The correct driver is not selected. • The printer is off. • The printer is not correctly connected to the computer (cables fastened and connected to correct port, and so on). • The SCSI identification number is not unique.

AppleTalk Technology

Laser printers with the PostScript page description language use AppleTalk technology to transfer data between the computer and the printer. As discussed in the previous section, PostScript converts the pages in computer RAM into mathematical formulas by using Laser Prep. Once converted, the formulas transfer to the print controller on the printer I/O PCB and reconvert into bitmap pages. The bitmap pages are stored in the page buffer until they print. Like the page conversion process, the PostScript printer driver manages the data transfer process.

Network communication protocols are the rules that control interaction between devices on a network. Protocols determine how devices on a network transfer data on the same cable in an orderly manner. AppleTalk is the name of Apple's network communication protocols. An AppleTalk

network is a collection of devices that exchange information by using AppleTalk over some medium. Two of the most common media for AppleTalk networks and Apple laser printers are LocalTalk and EtherTalk.

LocalTalk

LocalTalk is an inexpensive AppleTalk medium for moderate data transfer rates. LocalTalk consists of cables, connectors, and cable extenders. The LocalTalk shielded, twisted-pair cable from Apple supports a maximum of 32 devices and can span up to 1,000 feet. LocalTalk requires each device to have a connector and to be daisy-chained to other devices with connector cables. With some printers, a single Peripheral-8 cable can be used to communicate between a single computer and a laser printer. Refer to the appropriate owner's guide for more information about LocalTalk cabling requirements.

EtherTalk

Apple's EtherTalk medium permits AppleTalk protocols to run on high-speed Ethernet coaxial cable and has the fastest data transfer rate of the technologies described in this document. Apple's Ethernet Thick Coax supports up to 40 active nodes and a total cable length of 200 meters. An EtherTalk network is often part of an internet (two or more networks connected together) that includes one or more LocalTalk networks and can potentially include millions of users. To use the EtherTalk medium, some Macintosh computers require the installation of an EtherTalk card.

Networks

Networks can have different sizes, shapes, and types of devices. One function of communication protocols is to define network device addresses. By assigning a unique address to each device, users can transfer data between devices. The AppleTalk communication protocols refer to this addressing process as “naming.” Each device on the network receives a unique name that the network recognizes as the device address. When you open the Chooser and select the laser printer icon, a list of all the names of the laser printers on the network appears. To print to a specific laser printer, you simply select the name of that laser printer. The AppleTalk protocols translate the name into the laser printer network address.

The LaserWriter utility on the laser printer Utilities disk allows you to name each laser printer on a network. If a

printer is not named, the network uses a default naming scheme. The model name (for example, LaserWriter II) of the first laser printer on the network that is switched on is assigned to the printer. The same printer models are then assigned a number, beginning with 1 (for example, 1 LaserWriter II, 2 LaserWriter II, and so on) in the order in which each one was switched on.

In order for the network to “see” a laser printer and list printer names in the Chooser, the following conditions must exist:

- The correct laser printer driver must be installed in the System Folder. All users on the network must use the same laser printer driver version.
- The printer driver icon must be highlighted in the Chooser.

- AppleTalk must be active. Even if the correct driver is installed and selected, the printer name will not appear in the Chooser unless AppleTalk is active.
- The correct zone must be selected if the network is divided into zones.
- The correct cables must be connected from a computer and laser printer to the network.
- The laser printer must be switched on. The laser printer name will not appear in the Chooser until after the self-test executes and the User Test Page prints. The laser printer utilities (version 6.0.7 and higher) allow users to disable the User Test Page. The laser printer name will then appear in the Chooser after the self-test finishes.

Faulty AppleTalk Operation

Two common symptoms indicate faulty AppleTalk communication.

Common Symptoms	Likely Causes
Laser printer name not listed in the Chooser, or the user can't print to the printer.	One or more of the following conditions exists: • The correct laser printer driver (and Prep file, if required) is not installed. • The driver icon is not highlighted. • AppleTalk is not active. • The correct zone is not selected (if the network is divided into zones). • The user's computer and the laser printer are not correctly connected to the network. • The laser printer is off.

If none of the these conditions exists, and the laser printer name still does not appear in the Chooser, the problem is most likely a user's computer, a user's computer system software, or the network software (if the user is on a multiuser network).

Print Generation

This section discusses the print generation cycle of the printing process—specifically, how a laser printer generates a printed page and the functions of the I/O PCB and print engine.

I/O PCB Overview

The I/O PCB provides the interface between the computer (or network) and the laser printer. The QuickDraw Laser Printer I/O PCB communicates with the Macintosh by way of the SCSI connector or the serial port. The PostScript laser printer I/O PCB communicates with a network by using AppleTalk protocols over LocalTalk or EtherTalk media.

Both types of I/O PCBs contain cable connectors, a SCSI ID number selector (when configured with a SCSI interface), ROM, RAM, and a microprocessor. Some PostScript laser printer I/O PCBs also have a SCSI connector for connecting a hard disk to the printer for additional font storage.

Print Engine Overview

The print engine has four systems—the Power Distribution System, the Control System, the Image Formation System, and the Pickup/Feed System. The four print engine systems interact during each stage of the print cycle.

Power Distribution System

The Power Distribution System receives power through the AC power cord receptacle and provides power to the other three systems. Power flows directly to some systems, while others receive power indirectly through the DC Controller PCB. The Power Distribution System provides AC and DC current, as well as high voltage.

Control System

The Control System manages the print engine. The DC Controller PCB (which monitors all functions of the laser printer) receives a print command from the I/O PCB. It then issues control signals to the modules and parts in all other systems during the print cycle. The Control System communicates print engine status to the user by way of the display panel LEDs on the front of the laser printer. Always remember to check the DC Controller PCB as part of your troubleshooting procedures because it controls the entire engine. A module may seem faulty, but in reality may not have received the command or voltage it needs.

1

Laser Being Scanned

2

Laser Scan (magnified)

3

Development (magnified)

Image Formation System

The Image Formation System uses a laser beam to transfer bitmap images waiting in the page buffer to print (bit by bit) to a photosensitive drum (1 & 2). Charged particles or toner jumps to the image on the drum (3) and transfers to the page as the drum moves. After passing the photosensitive drum, the printed page moves through the Fuser Assembly, where the toner melts onto the paper.

Paper Pickup/Feed System

The Pickup/Feed System (or Paper Pickup/Feed System) moves sheets of paper through the print engine. Starting at the paper cassette, each sheet lifts, aligns, and moves past the Photosensitive Drum, where the image transfers to the paper. Finally, the Pickup/Feed System delivers the printed page to the paper delivery tray.

Ready States

"Ready states" are the conditions that must exist before a print cycle initiates. A ready state means that the laser printer can begin a print cycle. There are nine key ready states, some of which do not apply to all laser printers. Knowing the ready states will help you more quickly and accurately isolate the cause of a faulty laser printer.

One of the DC Controller sensors constantly monitors each ready state. When the sensor confirms the existence of all nine ready states, it initiates a print cycle after receiving a command from the I/O PCB. When troubleshooting, try to determine whether the DC Controller or the sensor is faulty before you isolate the problem to a module or part.

The nine ready states are

- **Access door closed.**
- **Correct paper cassette and paper installed.** A sensor determines if the paper cassette is installed. Another sensor determines if the paper cassette is the correct size for the page setup parameters set by the user. A third sensor determines if the paper cassette contains paper. If the sensors are faulty, the printer cannot come to a ready state.
- **Toner cartridge installed.**
- **No paper jam.** Paper jams occur when
  - A sheet of paper sticks in the paper path when the laser printer is started up.
  - A sheet of paper does not reach or clear the delivery sensor (the final sensor before the page exits the printer) within the required time.
- **Main motor rotates properly (LaserWriter and LaserWriter Plus only).** The main motor rotates briefly and the fuser

rollers (part of the Fuser Assembly) turn after the printer is started up. Listen for the high-pitched whine of the main motor and watch for the turning fuser rollers immediately after starting up the laser printer.

- **Scanning motor scans at proper speed.** The scanning motor turns the scanning mirror, which rotates at a very precise speed. The mirror reflects the laser scan beam from the Laser Assembly onto the photosensitive drum inside the toner cartridge. If the scanning motor does not turn the mirror at the correct speed, an accurate image will not scan onto the photosensitive drum. You can determine if the scanning motor is functioning by listening for a high-pitched whine (a higher pitch than the main motor) during a print cycle. If the ready light is on, but the print cycle immediately stops, the problem may be the scanning motor.

- **Laser beam temperature is normal.** The laser beam produces images on the photosensitive drum. The DC Controller checks the laser beam temperature before a print cycle initiates. To verify proper operating temperature, refer to the wiring diagram for laser voltage levels.
- **Fuser roller temperature is acceptable.** The Fuser Assembly fuses the toner image onto the paper and houses two pressure rollers. The fuser roller contains a heater bulb that heats the toner and paper. A cool fuser roller will not fuse the toner. If the roller is too hot, the paper and roller can be damaged, or the paper may move to the delivery tray without an image.

You can determine if the fuser heater bulb lights by looking through the door or tray openings near the Fuser Assembly when you start up the printer or during the print cycle. If the bulb lights, you know it has power and has not burned out.

- **Fan rotates (Personal LaserWriter only).** The fan must rotate on all Personal LaserWriter models. If the fan wire breaks, or an object prevents the fan from turning, the printer will not come to a ready state.

Print Cycle

The steps of the print cycle are very similar for all Apple laser printers, although some differences exist (such as the number of lenses, mirrors, or gears). The print cycle has the following six steps:

Step1 Drum charging

Step2 Image formation

Step3 Development

Step4 Transfer

Step5 Fusing

Step6 Drum cleaning

Drum Charging

The first step exposes the photosensitive drum (located in the toner cartridge) to light so that the drum is ready to receive charges during Step 2. The light passes through the preconditioning exposure shutter on the toner cartridge.

Note: Some laser printers do not require this step.

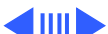
Image Formation

The second step produces on the photosensitive drum a pattern of electrical charges that is identical to the print image. Image formation has several stages. First, the photosensitive drum passes under the primary corona wire, which applies a uniform layer of negative charges over the drum surface.

Next, the DC Controller receives a print command from the I/O PCB and sends a command to the Laser/Scanner Assembly. The Laser/Scanner Assembly consists of the Laser Unit, scanning mirror, scanning motor, and focusing lenses.

The Laser/Scanner Assembly generates the laser beam that hits the photosensitive drum. The modulated laser beam first passes through a focusing lens and strikes a multifaced scanning mirror on the scanning motor, which rotates at a constant speed. The beam passes through additional lenses that reflect the beam onto the photosensitive drum. The laser beam exposes the drum surface, neutralizes the charges, and creates an invisible pattern.

During image formation, the photosensitive drum rotates at a constant speed that matches the speed of the beam. In the time it takes for the beam to return to its original position,



the drum surface shifts down enough to accept the next scan line. When the beam reaches a new line, the beam detect mirror sends a light beam signal over the fiberoptic cable. This signal alerts the DC controller that the beam is at the home position. Another modulated beam then scans the drum. As each successive beam scans the drum, an image accumulates on the drum in the form of tiny dots that match the bitmapped image in the page buffer.

Charging and Image Formation: Faulty Operation

The charging and image formation steps of the print cycle have several common symptoms of faulty operation.

Common Symptoms	Likely Cause(s)
Printer does not print.	Inoperable laser unit and/or scanner motor. These parts must function to specification in order for the printer to come to a ready state and initiate a print cycle.
A page displays parts of the previously printed page, or appears gray or cloudy.	Check to see that the preconditioning exposure lamps function properly. If the lamps are inoperable, the photosensitive drum does not erase completely between print cycles.

Common Symptoms	Likely Cause(s)
The image does not appear on the photosensitive drum after the print cycle executes. (You can verify that an image does not appear on the drum by opening the printer in the middle of a print cycle. Then open the drum shutter on the toner cartridge and look for an image.)	Any one of the following conditions can cause this symptom: • The fiberoptic cable from the Laser/ Scanner Assembly to the DC Controller is damaged. • The DC Controller malfunctioned and did not send the required commands to the Laser/Scanner Assembly. • The toner cartridge is damaged, or the cartridge flange that opens the laser shutter is broken. • The Laser/Scanner Assembly is damaged.

Development

During the third step the image on the surface of the photosensitive drum develops into a visible image of toner particles. This process starts inside the toner cartridge with the developing cylinder that contains negatively charged toner powder. The toner particles jump from the cylinder to the exposed areas on the photosensitive drum that have a high positive potential. The difference in potential between the development cylinder and photosensitive drum is controlled by the print density adjustment dial, which allows you to create lighter or darker images.

Development: Faulty Operation

There is one common symptom of faulty operation at the development step of the print cycle.

Common Symptom	Likely Cause(s)
The image is created in Step 2 (Charging and Image Formation) but is not developed. (To verify that an image did not develop, open the printer in the middle of a print cycle. Open the drum shutter and check for an undeveloped image on the drum.)	One or more of the following conditions exists: • The toner cartridge is faulty, or the toner tape must be removed. • The high-voltage power supply is faulty. • The DC Controller PCB malfunctioned and did not signal the high-voltage power supply to provide the correct voltage to the toner cartridge.

Transfer

During the fourth step of the laser printer print cycle the toner image on the drum surface transfers onto the paper in two stages. The paper passes between the photosensitive drum and the transfer corona wire assembly (or transfer roller on some laser printers), where the back of the paper receives a positive charge. The charge attracts the negatively charged toner particles to the paper.

Next, the stiffness of the paper and the negative voltage produced by a static-charge eliminator cause the paper to separate from the drum. By weakening the attractive force between the paper and the drum, the eliminator prevents thin paper from wrapping around the drum.

Transfer: Faulty Operation

There is one common symptom of faulty operation at the transfer step of the print cycle.

Common Symptom	Likely Cause(s)
The image developed in Step 3 (development) does not transfer to the paper.	One or more of the following conditions exists: • The corona wire (or transfer roller on some laser printers) is damaged. • The DC controller PCB did not provide the signal to the high-voltage power supply, which provides the voltage to the corona wire. • The high-voltage power supply failed.

Fusing

The fifth step permanently fuses the image to the paper. After transfer, the toner remains on the paper only because of electrostatic attraction and a slight physical adhesion. A light touch smears the image.

The Fuser Assembly contains a
fusing roller and a
lower roller.

The fusing roller contains a heater bulb that heats the toner and paper. The heat and pressure from both rollers fuses the toner particles onto the paper, creating a permanent image. The nonstick resin on the fusing roller keeps the paper from sticking to the roller and prevents offsetting (adhesion of toner from a page to the roller, and subsequent transfer of that toner to another page).

Fusing: Faulty Operation

There is one common symptom of faulty operation at the fusing step of the print cycle.

Common Symptom	Likely Cause
The image transfers in Step 4 (transfer) but fails to fuse to the paper.	If the upper or lower fuser rollers are worn, the proper amount of pressure to bond the toner to the paper is not applied. For the printer to come to a ready state, an operating fuser bulb is required.

Cleaning the Drum

During the last step of the print cycle, the drum is cleaned. Residual toner from the image is cleaned off the drum by the cleaning blade so that new images are clear and distinct.

Cleaning: Faulty Operation

There is one common symptom of faulty operation at this step of the print cycle.

Common Symptom	Likely Cause(s)
Pages have random black dots, spots, stripes, or parts of the previous page.	One or both of the following conditions exists: • The cleaning blade is malfunctioning. • The photosensitive drum is damaged and cannot be cleaned. In both cases, replace the toner cartridge.

Laser Printer Types

Apple offers a variety of LaserWriter printers that have both common and unique features. Apple groups these features into two types:

- Network laser printer
- Direct laser printer

Network Laser Printers

Network printers can be connected to a network and shared by many users. Network cables connect the computers and printers of several users. Apple network LaserWriter printers connect to several kinds of networks, including LocalTalk and EtherTalk.

Apple network LaserWriter printers normally use the PostScript page description language (or imaging language), which makes it easy to communicate with Apple computers that use PostScript.

Apple network LaserWriter printers can also operate in emulation mode. In emulation mode, the printer uses a different page description language (such as Hewlett-Packard's HP PCL4). This language allows Apple network LaserWriter printers to communicate with non-Apple computers that do not use the PostScript page description language. Users enable emulation mode by setting DIP or rotary switches, or using Apple LaserWriter printer utility software. The instructions for configuring the printer to operate in emulation mode are in the printer owner's manual.

Direct Laser Printers

Direct laser printers can only connect to a single computer and cannot be shared by users on a network. Direct laser printers connect to a computer by using one of two connections: serial or SCSI.

You can connect some Apple direct LaserWriter printers to a computer modem or printer serial port. If you are connecting the printer to a Macintosh or Apple II computer, you can use the Apple serial cable.

Note: Some network printers can also connect to a computer serial port. These printers offer the user a choice of connection types and allow simultaneous printer access to direct and network users.

Other Apple direct LaserWriter printers connect to a computer SCSI port. As with any Apple SCSI device, you must use correct SCSI termination, cabling, and ID numbers.

All Apple direct LaserWriter printers use the QuickDraw page description language. Direct laser printers cannot operate in emulation mode (that is, they cannot use a page description language other than QuickDraw) because they were designed to operate only with Apple computers.