3 Functional Overview

Chapter contents

Basic functions

This chapter presents a functional overview of the HP LaserJet 1100 Printer's processes. The following systems are discussed:

- engine controller unit (ECU) system/power system
- formatter system
- image formation system
- paper feed system (printer) and document feed system (optional document scanner)
- document scanner system (optional)
- optical system (located in the optional document scanner)

The HP LaserJet 1100 Printer consists of the printer and the document scanner (HP LaserJet 1100A Printer-Copier-Scanner). Operation sequences of the printer are controlled by the ECU. Operation sequences of the document scanner are controlled by the video controller.

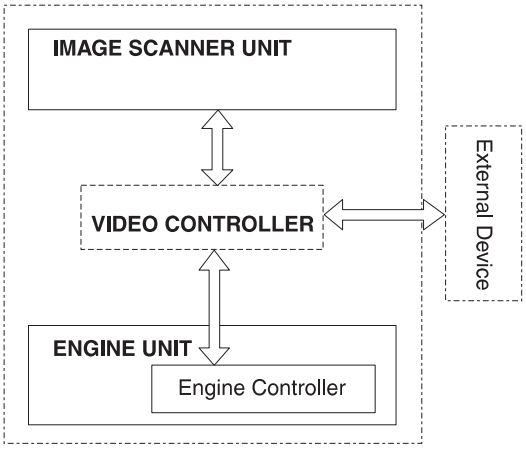

Figure 3-1 Basic configuration

Printer functions

Printer functions are divided into six groups:

1 ECU/power system

2 formatter system

3 image formation system

4 printer paper feed system

5 document scanner system

6 basic sequence of operation (formatter to printer)

The following figure is a block diagram of the printer unit:

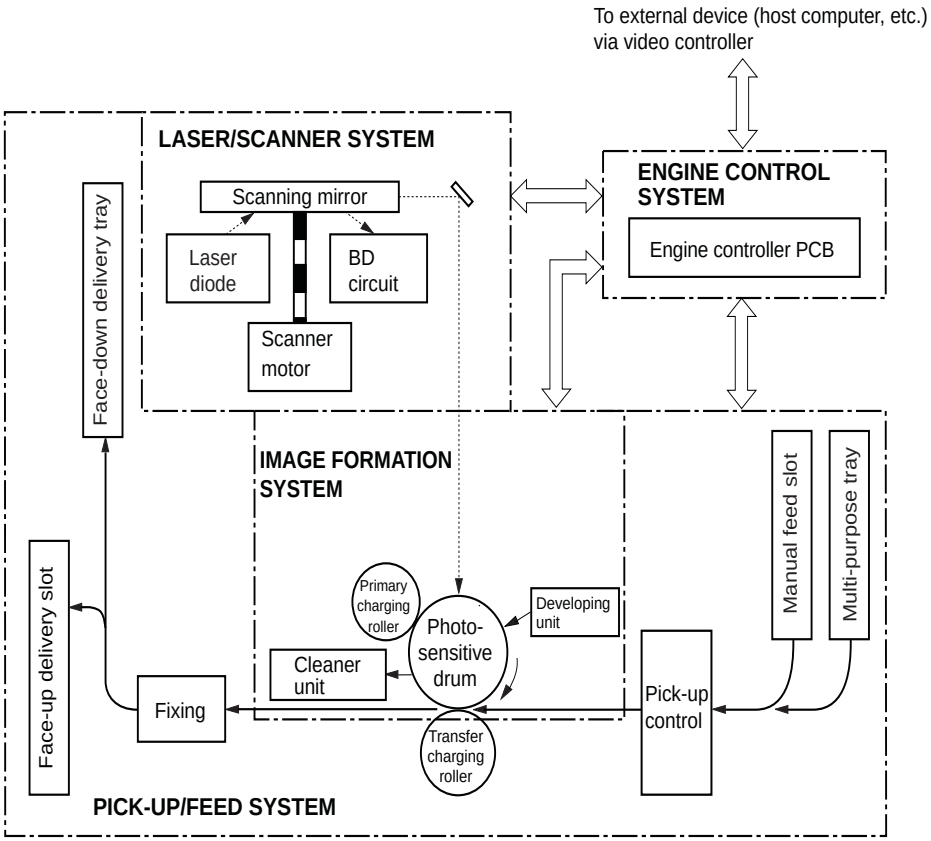

Figure 3-2 Printer unit functional block diagram

Engine Control Unit (ECU)/power system

The Engine Control Unit (ECU) coordinates all print engine activities, drives the laser, and coordinates print data from the formatter with the image formation process. The ECU also includes power supply and distribution circuitry. The ECU controls the following systems and functions:

- **Printer engine control**
  - printer laser/scanner drive
  - paper motion monitoring and control
  - motor
- **Power system**
  - AC power distribution
  - DC power distribution
  - overvoltage/undervoltage protection
  - high-voltage power distribution

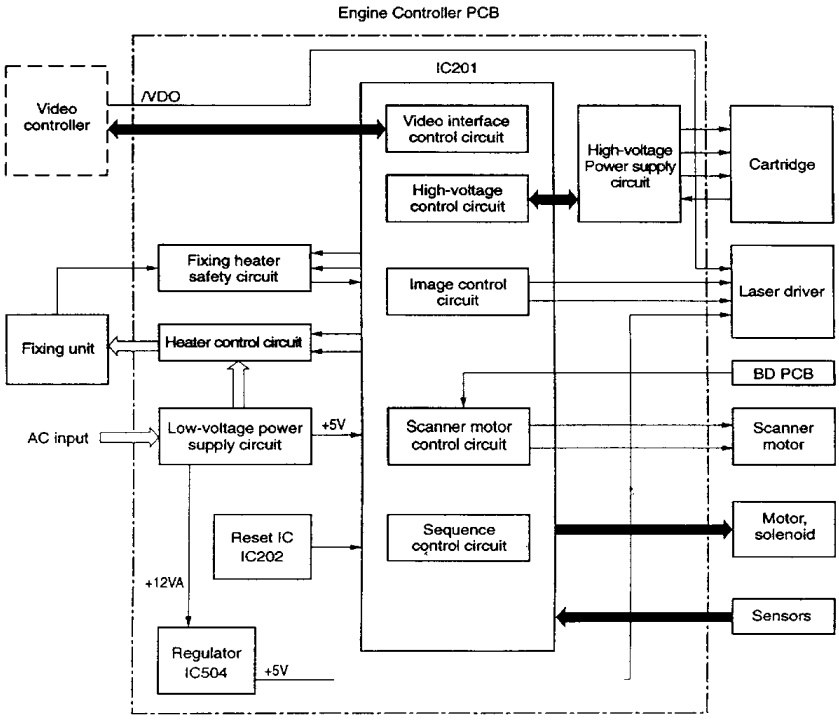

Figure 3-3 ECU loads

Printer engine control system

Printer laser/scanner drive

Based on information received from the formatter, the ECU sends signals to the laser/scanner assembly to modulate the laser diode “on” and “off” and to drive the laser/scanner motor. For more information, see “Image formation system” later in this chapter.

Paper motion monitoring and control

The ECU controls paper motion by continuously monitoring the various paper sensors and coordinating the timing with the other print processes.

For a detailed explanation of paper movement, and the interaction of photosensors and solenoid with the paper movement process, see “Printer paper feed system.”

Motor

The motor is controlled by the ECU. The motor provides all of the printer's paper movement.

Power system on ECU

The AC, DC, and high-voltage power supply circuits are all contained within the ECU.

AC power distribution

The AC power circuitry supplies AC voltage whenever the power cord is connected to the AC power source. AC voltage is distributed to the DC power supply circuitry and to the AC driver circuitry, which controls AC voltage to the fusing assembly's heating element.

DC power distribution

The DC power distribution circuitry, located on the ECU, distributes +3.3 V DC, +5 V DC and +24 V DC as follows:

Table 3-1. DC power distribution

+3.3 V DC	Formatter Laser/Beam Detect Circuitry ECU
+5 V DC:	Formatter Photosensors ECU Laser/Beam Detect Circuitry
+24 V DC:	Motor Laser Scanner Motor Document Scanner Motor Solenoid Formatter
+24VA DC:	High Voltage Power Supply

Overcurrent/overvoltage

There are two overvoltage devices in this printer:

- Fuse F101 provides overcurrent protection for the fusing system circuitry. To check or replace the fuse requires the removal of the ECU. Fuse F102 (found only on 110V units) provides overcurrent protection to the printer DC power supply circuitry.
- In addition, the +24V DC, +3.3 V DC, and +5V DC power circuitry contains an overcurrent protection circuit which automatically shuts off the output voltage when an overcurrent condition occurs due to a short or abnormal voltage on the load side.

High-voltage power distribution

The high-voltage power supply PCA applies an overlap of DC and AC voltage to the primary charging roller and the developing roller. This circuit also applies a positive or negative DC voltage to the transfer roller according to the instructions from the ECU.

This circuit also controls the image density by changing the primary AC voltage and the developing AC bias according to the print density setting.

High voltage is disabled when the printer door is open.

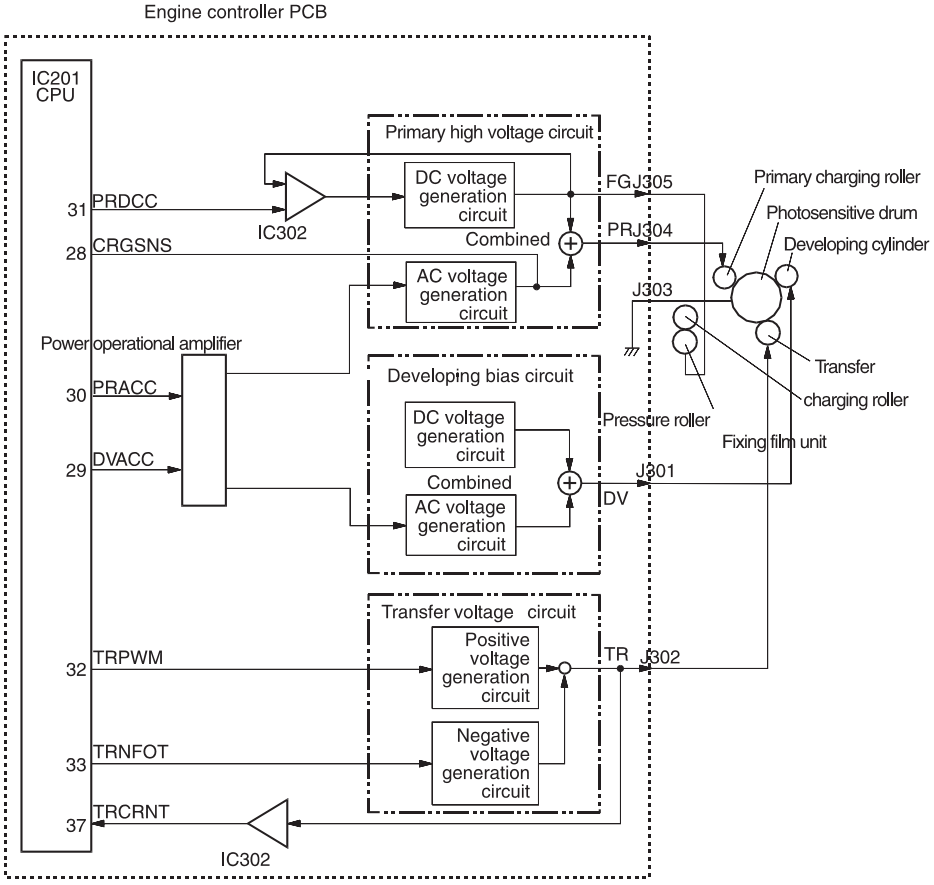

Figure 3-4 High-voltage power supply circuit

Formatter system

The formatter is responsible for the following:

- controlling the optional document scanner
- formatting and controlling copies
- receiving and processing print data from the printer interface
- monitoring the control panel and relaying printer status information
- developing and coordinating data placement and timing with the print engine
- communicating with the host computer through the bidirectional interface

The formatter receives print data from the bidirectional Extended Capabilities Port (ECP) mode interface and converts it into a dot image. The ECU synchronizes the image formation system with the paper feed system and signals the formatter to send the print image data. The formatter sends the print image data (dots) in the form of a video signal and the printing process begins.

Central processing unit

The formatter incorporates an MCF5202 custom microprocessor operating at 35 megahertz (MHz).

Random-access memory (RAM)

- One bank of Non-Volatile RAM (NVRAM) stores parameters
- DRAM (Dynamic RAM) provides temporary storage of copy, scan, and print data

Parallel interface

The formatter receives incoming data through its ECP interface. This interface provides high speed and two-way communication between the printer and the host, allowing the user to change printer settings and monitor printer status from the host computer.

Control panel

- Three front panel status lights (one contained in the Go key)
- **Go** key

Draft mode

Depending on which printer driver is used, selecting “draft” or EconoMode from the printer driver allows the HP LaserJet 1100 Printer to use approximately 50% less toner, extending the life of the toner cartridge.

Memory Enhancement technology (MEt)

The Hewlett-Packard Memory Enhancement technology (MEt) effectively doubles the standard memory through a variety of font and data compression methods.

Enhanced I/O

The Enhanced I/O feature allows printer memory to be used for storing data received from the host computer. When Enhanced I/O is enabled, you can send more data to the printer in shorter amounts of time, which allows you to return to your application sooner. Enhanced I/O has the following options:

- **Auto** - Allows the printer to use Enhanced I/O memory allocating to increase the speed of data transfer from the host computer to the printer, if necessary.
- **Off** - Uses the minimum amount of printer memory for storing data sent from the host computer.

Page Protect

Page complexity (rules, complex graphics, or dense text) may exceed the printer’s ability to create the page image fast enough to keep pace with the Image Formation process. If Page Protect is disabled and a page is too complex, the page may print in parts (for example, the top half on one page and the bottom half on the next page). Some print data loss is likely in these instances, and the printer will display an error message.

Page Protect allows the Formatter to create the entire page image in page buffer memory before physically moving the paper through the printer. This process ensures that the entire page will be printed. The default setting is Auto.

PJL Overview

Printer Job Language (PJL) is an integral part of configuration, in addition to the standard Printer Command Language (PCL). With standard ECP cabling, PJL allows the printer to perform functions such as:

- **Two-way communication** with the host computer through a bidirectional Parallel connection. The printer can tell the host such things as the control panel status.

- **Isolation of print environment settings** from one print job to the next. For example, if a print job is sent to the printer in landscape mode, the subsequent print jobs print in landscape only if they are formatted for landscape printing.

Image formation system

Laser printing requires the interaction of several different technologies including electronics, optics, and electrophotographics to provide a printed page. Each process functions independently and must be coordinated with the other printer processes. Image formation consists of six processes:

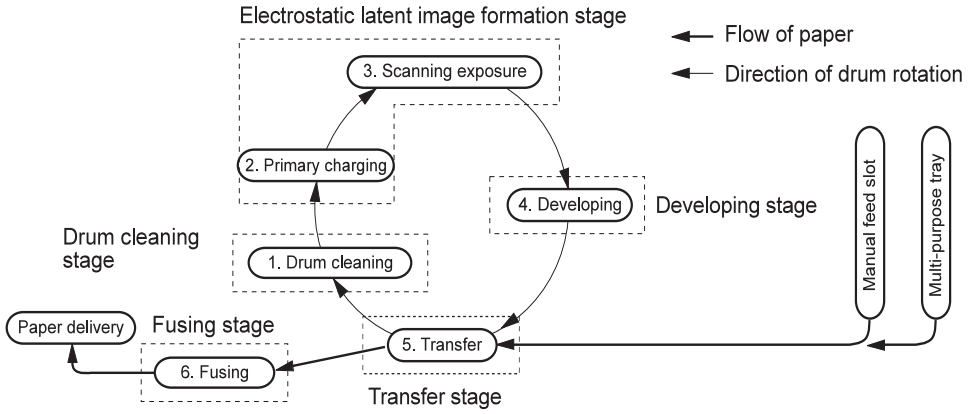

Figure 3-5 Image formation block diagram

Toner cartridge

As the heart of the image formation system, the Toner Cartridge houses the cleaning, conditioning, and developing steps of the process. The Toner Cartridge contains the photosensitive primary charging roller, developing station, toner cavity, and cleaning station. Including these components (which wear, degrade, or are consumed) in the replaceable Toner Cartridge eliminates the need for a service call when replacement is required. The special photosensitive properties of the drum allow an image to be formed on the drum surface and then transferred to paper.

CAUTION: The printer's Toner Cartridge does not include a light-blocking shutter. Be careful to avoid exposing the drum to light, which can permanently damage the drum. Protect the Toner Cartridge whenever removing it from the printer.

Step 1 Cleaning stage. The cleaning blade is in contact with the surface of the drum at all times. As the drum rotates during printing, excess toner is wiped off and stored in the waste toner receptacle.

Step 2 Conditioning stage. This process consists of applying a uniform negative charge to the surface of the drum with the primary charging roller located in the Toner Cartridge. The primary charging roller is coated with conductive rubber. An AC bias is applied to the roller to erase any residual charges from any previous image. In addition, a negative DC bias is applied by the charging roller to create a uniform negative potential on the drum surface. The amount of DC voltage is modified by the print density setting.

Step 3 Writing stage. During this process, a modulated laser diode projects the beam onto a rotating scanning mirror. As the mirror rotates, the beam reflects off the mirror, first through a set of focusing lenses, then off a mirror, and finally through a slot in the top of the Toner Cartridge, and onto the photosensitive drum. The beam sweeps the drum from left to right, discharging the negative potential wherever the beam strikes the surface. This creates a latent electrostatic image, which later is developed into a visible image.

Because the beam is sweeping the entire length of the drum and the drum is rotating, the entire surface area of the drum can be covered. At the end of each sweep, the beam strikes the beam detect lens, generating the beam detect signal (BD signal). The BD signal is sent to the ECU where it is converted to an electrical signal used to synchronize the output of the next scan line of data.

Step 4 Developing stage. At this stage of the process, the latent electrostatic image is present on the drum. The toner particles obtain a negative surface charge by rubbing against the developing cylinder which is connected to a negative DC supply. The negatively charged toner is attracted to the discharged (exposed, grounded) areas of the drum, and repelled from the negatively charged (unexposed) areas.

Step 5 Transferring stage. During the transferring process, the toner image on the drum surface is transferred to the paper. A positive charge applied to the back of the paper by the transfer roller causes the negatively charged toner on the drum surface to be attracted to the paper. After separation, the drum is cleaned and conditioned for the next image.

During the separating process, the paper separates from the drum. To stabilize the feed system and prevent dropouts on the printed image at low temperature and humidity, the charge on the back of the paper is reduced by the static charge eliminator.

Step 6 Fusing stage. During the fusing process, the toner is fused into the paper by heat and pressure to produce a permanent image. The paper passes between a heated fusing element and a soft pressure roller. This melts the toner and presses it into the paper.

Printer paper feed system

The paper input bin and the single-sheet input slot merge into one, main input area. Paper placed in either of these areas enables the paper-out sensor (PS001), which informs the ECU that paper is present. The following steps occur when the printer receives a print job:

Step 1 The ECU enables the laser/scanner assembly and the motor. Paper motion begins when the ECU energizes the solenoid (SL001).

Step 2 The paper pickup roller rotates once. The paper kick plate pushes the paper against the pickup roller.

Step 3 The pickup roller grabs the top sheet and advances it to the feed assembly drive rollers. To ensure that only one sheet is fed, a main separation pad and two subpads hold the remainder of the stack in place.

Step 4 The feed assembly drive rollers advance the paper to the paper top photosensor (PS002). This sensor informs the ECU of the exact location of the paper's leading edge, so that the image being written on the photosensitive drum can be precisely positioned on the page.

Step 5 The feed assembly drive rollers then advance the paper to the transfer area where the toner image on the photosensitive drum is transferred to paper.

Step 6 After the image is transferred, the paper enters the fusing assembly where heat from the fuser and pressure from the pressure roller permanently bond the toner image to paper. The paper exit sensor (PS201) determines that paper has successfully moved out of the fusing area.

Step 7 The fusing assembly exit rollers deliver paper to either the paper output bin or the front paper output slot, depending upon the position of the face-up/face-down lever.

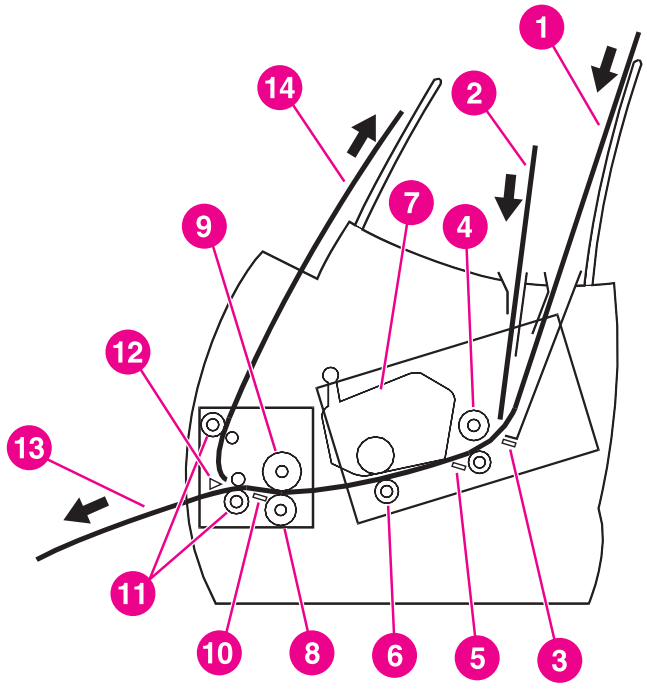

Figure 3-6 Simplified paper path

1 Paper input bin

2 Single sheet input slot

3 Paper sensor (PS001)

4 Pickup roller

5 Paper sensor (PS002)

6 Transfer roller

7 Toner cartridge

8 Pressure roller

9 Fusing unit

10 Paper exit sensor

11 Delivery rollers

12 Face-up/Face-down deflector

13 Face-down output path

14 Face-up output path

Paper jam detection

The paper out sensor (PS001), paper registration sensor (PS002), and the paper exit sensor (PS201) detect paper moving through the HP LaserJet 1100 Printer. If a paper jam is detected, the ECU immediately stops the printing process and displays a paper jam message on the control panel.

A paper jam can be detected under any of the following conditions:

- Power-on jams. Paper is present under either (PS201) or (SL001) at power on.
- Pickup jams. Paper does not reach and clear photosensor (SL001) within a specified period of time. The time period begins when the Paper Pickup Solenoid (SL001) is energized.
- Delay jams. Paper does not reach or clear the photosensor (PS201) within a specified period of time.
- Wrapping Jam Photosensor (PS201) detects the trailing edge of the paper within a specified period of time after photosensor (SL001) detects the trailing edge.

Solenoid, photosensors, and switches

The following figure shows the locations of the solenoid, photosensors, and switches.

Table 3-2. Solenoid, photosensors, and switches

1	Pickup solenoid (SL001)	Enables the pickup roller.
2	Paper top sensor (SL001)	Detects the leading and trailing edges of the paper. Synchronizes the photosensitive drum and the top of the paper.
3	Door open sensor (SW301)	Detects whether or not the printer door is closed and the Toner Cartridge is present. Printing cannot continue until the printer door is closed and the Toner Cartridge is in its correct position.
4	Paper out sensor (PS001)	If the sensor does not sense paper in the Paper Input Bin or the Single Sheet Input Slot, the Control Panel displays the paper-out message. Paper must be loaded before printing can resume.
5	Document sensor (PS1)	Detects the presence and leading edge of a document in the document feed path.
7	Paper exit sensor (PS201)	Senses when paper has successfully moved out of the fusing area.
8	Engine test switch (SW201)	See “Troubleshooting” in this chapter for information about engine tests.
9	Power Switch (SW101)	Turns power to printer on and off (220V units only).

Document scanner system (optional)

The document scanner system consists of the optical system and document pickup and feed systems.

The optical system, also known as the contact image sensor, contains the following:

- light-emitting diode (LED) array
- contact glass
- rod lens array
- phototransistor array

The LED array, which emits light from two LEDs, is controlled by the formatter. Light reflected from documents passes through the rod lens array and focuses on the phototransistor array.

The phototransistor array consists of 2,574 phototransistors: 11 driver chips amplify the light reception output in units of 234 phototransistors. The image data is converted and sent from the driver circuits to the formatter.

The document pickup and feed systems contain a pickup roller and CIS roller, both of which are driven by the document scanner motor.

The following figure shows a simplified Document Scanner document path.

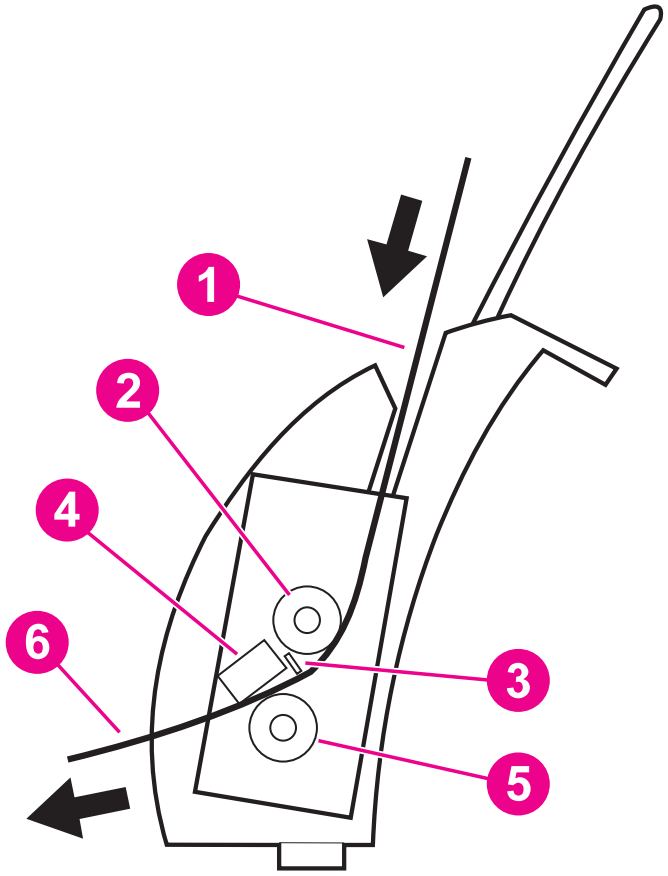

Figure 3-7 Simplified scanner document path

1 Input path

2 Document pickup roller

3 Document sensor

4 Contact image sensor (CIS)

5 CIS roller

6 Output path

Basic sequence of operation (formatter to printer)

The formatter and the ECU share information during printer operation. The ECU-to-formatter connector (J201) forms a link that operates as a serial data bus. This allows printer status, command information, and dot-image data to be passed between the two. The following events take place during normal printer operation:

Period	Purpose	Remarks
WAIT From the power-ON until the end of the main motor initial rotation.	To clear the drum surface of potential and to clean the transfer charging roller.	Detects whether the cartridge is installed or not.
STBY (Standby) From the end of the WAIT period or the LSTR period until the pick-up command is input from the video controller. Or, from the end of the LSTR period until power-OFF.	To keep the printer ready to print.	
INTR Initial Rotation Period After the pick-up command has been input from the video controller until the paper reaches the paper top sensor.	To stabilize the photosensitive drum sensitivity in preparation for printing. Also to clean the transfer charging roller.	
PRINT (Print) From the end of the initial rotation until the primary voltage goes OFF.	To form images on the photosensitive drum based on the VIDEO signals (/VDO, VDO) input from the video controller and to transfer the toner image onto the paper.	
LSTR (Last Rotation Period) After the primary voltage goes OFF until the main motor stops rotating.	To delivery the last page. Also to clean the transfer charging roller.	When the pick-up command is input from the video controller, the printer enters the INTR period immediately after the end of the LSTR period.

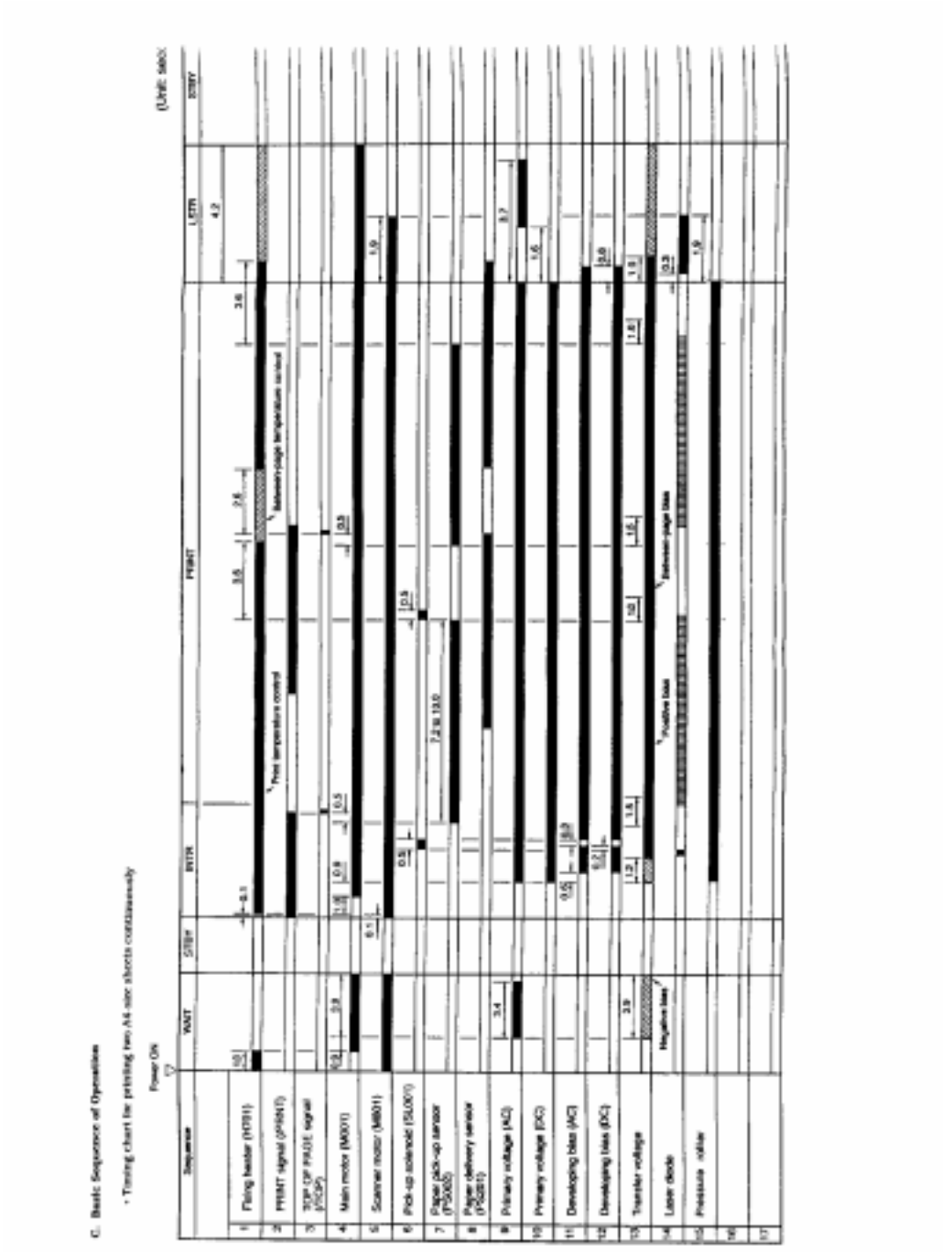

Figure 3-8 **General timing diagram**