5

Functional Overview

Introduction

This chapter contains a simplified description of the DesignJet 700, 750C and 750C Plus plotters and DesignJet 755CM printer circuits and mechanical functions. Mechanical and Printed Circuit Assembly (PCA) overviews present a functional description of how the plotter operates.

Simplified Description of Circuits

Communications

HP DesignJet 700, 750C, 750C Plus and 755CM circuits communicate with an external controller by way of either a Bi-tronics or an RS-232-C interface.

Bi-tronics is handled by a separate gate array.

RS-232-C communications are handled by a universal asynchronous receiver-transmitter (UART) and baud rate generator built into the processor-support application-specific integrated circuit (ASIC).

If an approved modular input/output (MIO) printed circuit assembly is installed, the circuits can communicate via an HP-IB interface or can be connected to a network. The main processor reads Bi-tronics, HP-IB, and Ethernet communications through the port it uses to read memories (ROM or DRAM).

Plotting

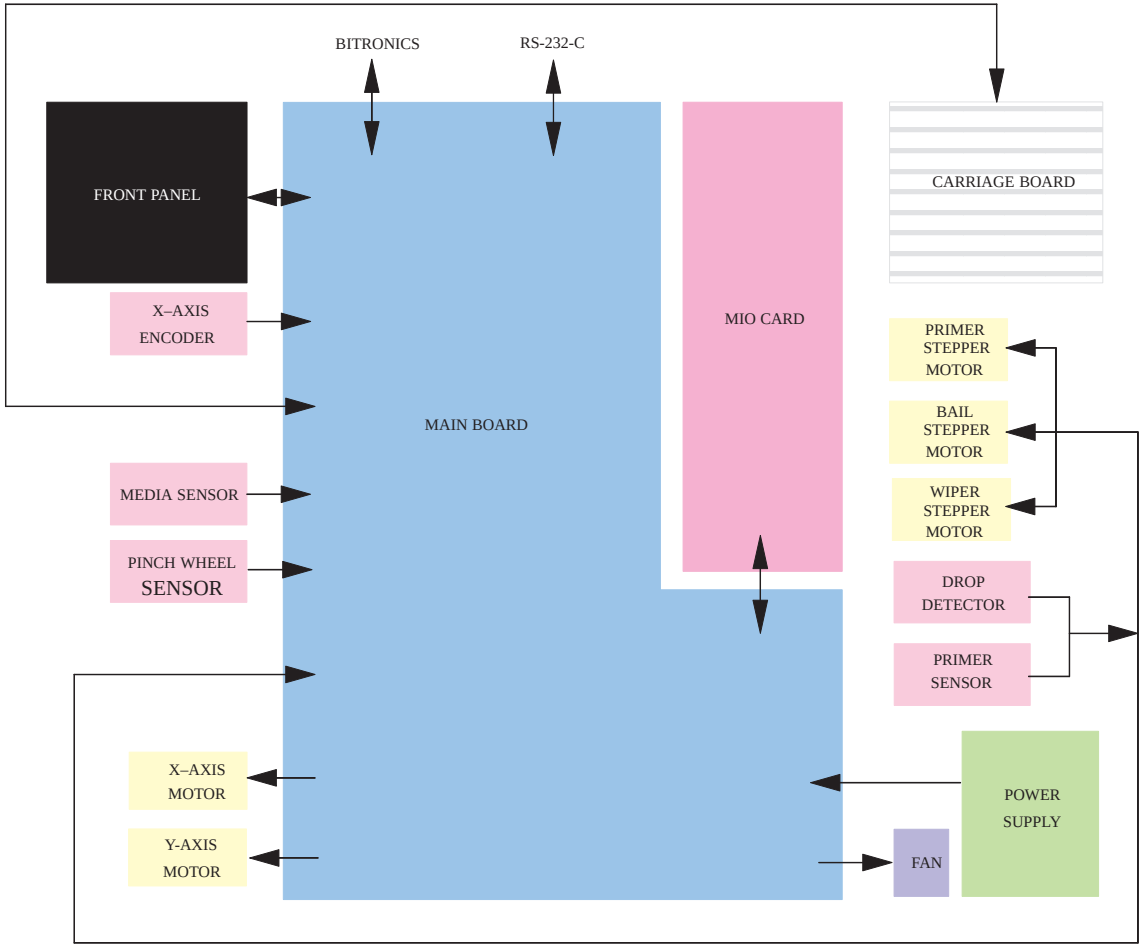
HP DesignJet 700, 750C, 750C Plus and 755CM plotters/printers accept plots in the following forms:

- Hewlett-Packard Graphics Language (HP-GL).
- Hewlett-Packard Graphics Language 2 (HP-GL/2).
- Hewlett-Packard Raster Transfer Language (HP RTL).

The main processor converts the plot into an internal format and stores the entire plot, in its dynamic random-access memory (DRAM) − except for special types of RTL plots which may begin to print while they are still being received.

Then, it transfers the plot, one swath at a time, into the swath RAM via the processor-support ASIC.

Electronics Block Diagram



ASICs

On the main PCA, the processor-support ASIC is designed to manipulate swath data into the actual firing order for the nozzles on the four cartridges that are mounted on the carriage assembly. The processor-support ASIC receives pixels from the physical swath RAM and sends them serially to the carriage ASIC.

A main processor on the main PCA controls all plotter operations with the help of the processor-support ASIC and the servo processor. Communications between the servo processor and the main processor take place through registers in the processor-support ASIC.

The processor-support ASIC provides pulse-width-modulated signals to the Y-axis (carriage-axis) and the X-axis (media-axis) motor drivers, to drive the Y-axis and the X-axis motors. The linear encoder connected to the carriage PCA gives the processor-support ASIC feedback about the position of the carriage. The X-axis motor encoder on the X-axis motor gives the processor-support ASIC feedback about the position of the X-axis motor.

In addition, the processor-support ASIC contains a DRAM controller that generates multiplexor control-and-enable strobes for the DRAM row and column addresses during a memory access. The DRAM controller also arbitrates between a memory request and a refresh request and performs the refresh operation.

Servo Processor

The servo processor communicates with the main processor through registers in the processor-support ASIC. The servo processor writes information into the registers and sends an interrupt to the main processor. The main processor then reads the registers, and the interrupt is automatically cleared. Using this procedure, the servo processor provides the main processor with information from the plotter sensors. The sensors give the main processor the ability to check status conditions.

The servo processor controls the:

- Servo motors.
- Front panel.
- Fan.
- Sensors.
- Electrically erasable read-only memory (EEROM).
- Stepper motors.

Stepper Motors

There are three types of stepper motors:

- The primer stepper motor is used to drive the nozzle primer.
- The bail stepper motor drives the bail.
- The wiper stepper motor drives the orthogonal wiper.

Cartridges

A line sensor on the carriage PCA provides the servo processor with information used to align the cartridges. It also provides a media edge-sensing capability to the plotter (for width measurement).

The carriage ASIC controls the firing of the cartridges. It receives pixel data from the processor-support ASIC over a synchronous serial channel. The carriage ASIC contains:

- A 2 x 208-bit shift register (one bit per cartridge nozzle), which performs a serial-to-parallel conversion on the data.
- Timing and sequencing circuitry to ensure that cartridge nozzles are fired in the correct sequence and at the correct time.
- Fire waveform generators to create the fire-pulse waveforms used to fire the cartridges.
- Circuitry for controlling the temperature of the cartridge while printing (brilliant pulse warming).

Cartridge drivers provide the power necessary to fire the cartridges under the control of the carriage ASIC.

During cartridge testing, when the carriage is docked in the service station, the processor-support ASIC provides a means to generate a fire position pulse. The carriage ASIC will receive this signal and fire selected nozzles. If a drop is sensed by the drop detector each time a nozzle is fired, the nozzle is working properly. The independently generated fire position pulse is also used for firing to clear clogged nozzles.

Warm-up pulses are generated when in the “Warm-up When Idle” mode.

Mechanical Overview

Carriage-Axis Mechanism

The carriage (Y-axis) motor is mounted under the plotter’s right endcover. It is electrically connected to the main PCA, which contains a carriage-motor driver. Its drive shaft is mechanically connected to the carriage via a drive belt. When the carriage motor rotates, it moves the carriage assembly. An optical encoder, located on the carriage assembly, provides positional feedback for carriage servo control.

Line Sensor

The line sensor on the cartridge carriage is used to:

- Detect and measure lines when performing cartridge alignment and accuracy calibration.
- Detect media width and skew during media loading.
- Calibrate the media-axis (for banding reduction) using a mark on the roller.

Media-Axis Mechanism

The media (X-axis) motor is mounted under the right endcover and is electrically connected to the main PCA, which contains the media-motor driver. It has a worm-style pinion gear, which meshes with a gear at the right end of the drive roller. When the media motor rotates, it moves the drive roller and, consequently, the media. The encoder mounted on the motor sends feedback about the media motor position to the main PCA.

In DesignJets 700, 750C Plus and 755CM the media motor has a zero position which is indicated to the main PCA via the encoder.

Primer Stepper Motor

The primer stepper motor is mounted on the plotter's left side-plate and connects to the main PCA through the service-station cable. It is controlled by the servo processor on the main PCA and is used to drive the nozzle primer.

Bail Stepper Motor

The bail stepper motor is mounted on the plotter's left side-plate and connects to the main PCA through the service-station cable. It is controlled by the servo processor on the main PCA and is used to drive the bail.

Wiper Stepper Motor

The wiper stepper motor is mounted on the service station and connects to the main PCA through the service-station cable. It is controlled by the servo processor on the main PCA and is used to drive the orthogonal wiper.

Fan

An internal cooling fan is supplied with +12 V. It is switched ON and OFF by the servo processor and is mounted in the electronics enclosure at the rear of the plotter. The fan is primarily used to cool the power supply PCA and the main PCA when plotting.

Window Sensor

The window sensor is a mechanical switch mounted on the right side-plate at its top front edge. Feedback about the window's position (up or down) is sent to the main PCA through the front panel.

Pinch-Wheel Sensor

An optical pinch-wheel sensor is mounted on the lower rear portion of the plotter's right side-plate and is electrically connected to the main PCA. When the pinch arms are raised, a cam in the pinch-arm lift mechanism interrupts the beam of the optical sensor, and, when the pinch-arms are lowered, the beam path is cleared. Thus, the position of the pinch-wheel can be determined from the electrical state of the sensor.

Media Sensor

The media sensor is an optical sensor and is mounted towards the right end of the entry platen.

Two articulated levers block the optical path between the emitter and the receiver when media is not loaded. When media is loaded, both levers are rotated, thus clearing the optical path and changing the sensor state from *open* to *closed*. This double-lever system provides the plotter with leading and trailing edge-sensing capability (for media-length measurement). The media sensor is electrically connected to the main PCA.

Drop Sensor

The drop sensor is an infrared detector mounted in the service station. It is used to test whether the nozzles in the cartridges are operating properly. It is part of a drop-detection system that measures the time from the firing of a nozzle to the sensing of a drop (typically < 900 μsec). The operation of the sensor system depends upon an illuminated infrared optical path, in which the received power is modulated a small amount by a drop passing through an aperture on the way to the waste containment system. The illumination is provided by an infrared LED, which is regulated by an automatic power control to provide a fixed operating point in the optical receiver photo-diode. The automatic power control compensates for contamination, device aging and environmental effects.

Primer-Cam Sensor

An optical sensor mounted on the primer assembly determines the initial position of the primer assembly cam. When the stepper motor that drives the primer assembly rotates in one direction, it obtains the values for selecting each cartridge for priming. When rotated in the opposite direction, a clutch engages a diaphragm to provide the vacuum for priming.

Printed Circuit Assembly (PCA) Overview

Main PCA

There are two clocks on the main PCA. The main clock provides a 32.00-MHz signal directly to the main processor. The 32.00 MHz are divided by the main processor, and the resulting signal is provided to the processor-support ASIC and the Bi-tronics gate array. A separate clock provides a 12-MHz signal to the servo processor.

To perform its functions, the main processor must have access to its memories (ROM and DRAM). To create plots at the direction of an external controller, it must be able to communicate with the controller by its interfaces (MIO, Bi-tronics and RS-232-C). To address the ROM or DRAM interface, the main processor places the appropriate address on the address bus and reads or writes the data directly. Data is passed to the main processor by a transceiver in the case of ROM or DRAM SIMM data. MIO or Bi-tronics input and output data passes through another transceiver on its way to the main processor.

The main PCA ROM contains the following types of information:

- Programs.
- Program constants.
- Character sets.
- Demonstration plot(s).

The main PCA DRAM is used to store the following types of information:

- Variables.
- Temporary constants.
- Plots.

As a plot is received from an external controller by way of one of the plotter interfaces, it is stored in DRAM. When the complete plot is in DRAM, the main processor converts it, one swath at a time, to a format suitable for storage and sends it to swath RAM by way of the processor-support ASIC. A swath has variable height (depending on the print mode) and extends from border to border across the width of the plot. The processor-support ASIC extracts the plot data from the swath RAM, converts it to pixels, and sends the pixels serially by way of the trailing cable to the carriage ASIC on the carriage PCA.

Part of the cartridge shutdown circuitry is on the main PCA. The cartridges are shutdown:

- When the +5V falls below a certain value (during power-up/down).
- When the carriage ASIC asserts shutdown during an access cartridges command.
- Between swath printing.
- When idle.

Carriage PCA

The carriage PCA contains an ASIC that controls the operation of the cartridge drivers that switch power pulses from the ASIC to fire the cartridges. The carriage board also provides feedback to the main PCA for the current position of the carriage assembly. A line-sensor module mounted on the carriage PCA senses the lines produced by the cartridges and is used for cartridge alignment. The line sensor also provides an edge-sensing capability used to identify the media loaded in the plotter. Voltage-sensing circuitry senses deviations in the cartridge voltages supplied to the print heads and sends signals to the voltage regulators on the main PCA.

The carriage processor and the print-control ASIC on the carriage PCA are driven by a 12.288-MHz, on-board clock. At power-on time, the main PCA reset circuit delays the operation of the print control ASIC until the +5 V reaches a steady state.

Line-Sensor PCA

The line-sensor PCA is used to calibrate the writing system for mechanical tolerances as well as sensing the left and right edges of the media. It consists of a light-sensing IC connected to the PCA through a ZIF connector. The resulting voltages are coupled and then measured by an eight-bit, analog-to-digital (A/D) converter whose bits are sent serially to the carriage microprocessor. A green and blue LED illuminates the surface being read by the line-sensor. A dual lens system with a unity conjugate ratio system directs the light from the illuminated surface to the line-sensor.

Temperature-Sensor IC

A temperature-sensor IC is used to measure ambient temperature in the PCA near the print heads. It is used to calibrate the cartridge temperature control circuitry.

Linear-Encoder IC

A linear encoder detects cartridge carriage position, as the carriage assembly moves along the encoder strip. The linear-encoder IC is connected to the carriage PCA via a 5-pin ZIF connector.

Print Control

The carriage processor operates at 12.288 MHz. The clock signal is generated by a crystal-oscillator circuit, internal to the ASIC. The primary task of the processor is to configure the print-control ASIC and read data to control cartridge energy and cartridge calibration. It communicates with the servo processor on the main PCA using a serial port.

The print control (carriage) ASIC receives pixel data from the processor-support ASIC on the main PCA via four synchronous serial channels and an on-board line driver. Signals from the print-control ASIC fire the nozzles in the print heads. Whenever a print head nozzle is fired, a comparator sends a pulse to a counter in the carriage microprocessor.

The dual-voltage, remote sensing circuitry sends an analog sensing signal to the dual voltage regulators on the main PCA. When the voltage to the print heads deviates from the optimum cartridge voltages the regulator will adjust the voltage to bring it back to the optimum value. Cartridge voltages are ON when printing a swath and briefly at power-up, but OFF when idle or accessing cartridges.

PWM Signals

The main board contains the drivers for the media and carriage motors. The drivers are controlled by the PA and PB signals from the processor-support ASIC. PA and PB are pulse-width-modulated (PWM) signals. The PA signal to the media-motor driver causes the media-motor to drive the media up and out of the front of the plotter. The PB signal to the media motor driver causes the media motor to drive the media down, over the entry platen and out of the plotter. The PA signal to the carriage-motor driver causes the carriage motor to drive the carriage toward the right side of the plotter. The PB signal to the carriage-motor drives the carriage towards the left side of the plotter.

Front-Panel PCA

The front panel consists of:

- A 2-row by 20-character vacuum-fluorescent display (VFD).
- Seven LED indicators (six LEDs on the HP DesignJet 700).
- A 10-button key pad.

The servo processor on the main PCA writes serially to the VFD and the LEDs and reads the key pad on its input/output lines. It provides local control, configuration and testing of the plotter and displays various plotter conditions.

Drop Sensor PCA

The drop sensor is located in the drop-detect assembly. Its purpose is to detect ink drops during cartridge testing. The drop sensor contains a detector system that detects the presence of a drop shortly after it is fired into the detector. In order for the drop to be fired into the detector, the cartridge must be positioned over the sensor. An infrared LED sends a beam across an aperture which is received at the other side by a photo-sensitive diode. When a drop passes through the beam, it causes a disturbance in the reception. The slight modulation in power output by the receiving diode is amplified by the pre-amplifier, further amplified by the amplifier, and sent to the processor-support ASIC on the main PCA. The processor-support ASIC can measure the time between the firing of a print-head nozzle and reception of the amplified drop-detect signal in less than 900 microseconds.

Power-Supply PCA

An auto-ranging power supply is located in the electronics enclosure assembly. It accepts and automatically adjusts to an ac input of 90 V through 264 V and produces regulated voltages of +5 V, +12 V, and −12 V and an unregulated +24 V. These voltages, produced by the power supply, are used as follows:

- +24 V — Motor drivers and cartridge voltage regulator on the main PCA. (Regulated +9 to +15 V for cartridge circuits on the carriage PCA).
- +12 V — Fan power, MIO, RS-232 driver, Carriage PCA, Drop Sense PCA. Also used for programming Flash SIMMs on the Main Board.
- −12 V — RS-232 driver.
- +5 V — IC power and sensors, and Front-Panel PCA.

The primary portion of the supply contains fusing and input protection circuitry, line filters, and a rectifier. The primary output is converted to a pulse-width-modulation (PWM), unidirectional current by a flyback dc-to-dc converter.

The secondary portion of the power supply contains the four secondary windings of the transformer that convert the PWM current in the primary to four ac voltages, which are rectified to the +5 V, +12 V, −12 V and +24 V dc voltages required by the plotter. Standard +12 V and −12 V regulators are included in the secondary portion of the power supply.