Universal Serial Bus
Device Class Definition
for
Printing Devices

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USB Communication Device Class Definition for Printer Devices

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Table of Contents

List of Tables

1. Introduction

The Universal Serial Bus (USB) is a communications architecture that gives a PC the ability to interconnect a variety of devices via a simple four-wire cable. One such device is the printer. Traditionally, printers have been interfaced using the following technologies:

- Unidirectional parallel port
- Bi-directional parallel port
- Serial port
- SCSI port
- Ethernet/LAN

There are other, more sophisticated printer interfaces, but the ones previously listed are the most popular. USB offers a much greater throughput capability than the serial port and is comparable in speed to the parallel port. This makes both parallel and serial printers good candidates for interfacing with USB.

There are two different types of bi-directional parallel ports: ECP and EPP. EPP is a standard parallel port based on IEEE-1284 which supports one device. ECP is a parallel port standard based on both IEEE-1284 and IEEE-1284.3. Conventional USB addressing techniques very closely mimic the IEEE-1284.3 concept of multiple devices. This specification supports printers by defining a way for USB devices to emulate an ECP or EPP parallel port.

1.1 Scope

This document fully describes the Printer Class of USB devices, including:

- The Printer Class subclass and protocol.
- Device, configuration, interface, and endpoint descriptors.
- The USB standard requests used by printer devices.
- The USB class-specific requests and responses used by printer devices.

1.2 Purpose

The purpose of this document is to describe configuration, interface, and endpoint descriptors as well as a communications protocol for operating system, BIOS, and peripheral designers implementing support for USB printers. These definitions allow an operating system designer to design a single software package to support a given class or subclass of device. These definitions also provide a framework for designing the peripherals in each class or subclass.

Note This specification does not define Page Description Languages (PDL) or Printer Control Protocols (PCP). This specification defines *interfaces* that are intended to support existing PDLs and PCPs.

1.3 Related Documents

The Printer Class defines an architecture for delivering existing printer-command sets to a USB printer. The following documents include relevant USB publications as well as some popular printer PDLs and PCPs:

- *Universal Serial Bus Specification*, 1.0 revision 1.0 (also referred to as the *USB Specification*). In particular, see Chapter 9, “USB Device Framework.” This specification is available on the World Wide Web site http://www.usb.org.
- *PostScript Language Reference Manual, Second Edition.* Addison-Wesley Publishing Company, Inc. ISBN: 0-201-18127-4.
- PCL / PJL Technical Reference Package. HP part number 5961-0937. Hewlett-Packard Company. 1-800-227-8164 or http://www.hp.com

  - Includes: PCL 5 Language Technical Reference Manual and Printer Job Language Technical Reference Manual
- IEEE 1284
- IEEE 1284.1
- IEEE 1284.3
- IEEE P1284.4
- RFC-1759

2. Management Overview

Printing devices are unique because they convert a Page Description Language (PDL) into a human-readable printed page. Printers require a mechanism for sending these PDLs, in the form of data, to the printer; and a mechanism for returning status information from the printer. Conventional parallel printers use a bi-directional printer port to support these languages. USB uses a Bulk OUT endpoint to send the data to the printer, and a Bulk IN endpoint for status and other data received from the printer. The Bulk IN endpoint is sufficient for status data retrieval because in today's existing implementations, the parallel status information is retrieved via polling mechanisms in the host. Some PDLs allow the printer to return large amounts of data, such as font definitions. If the printer implements this capability, it returns the data on the same Bulk IN endpoint which is typically used for status. Some examples of PDLs are: *PostScript and Hewlett Packard Graphics Language (HPGL).* Examples of Printer Control Protocols (PCP) are: *Hewlett Packard PJL, IEEE 1284.1,* and *Microsoft Windows Printing System (WPS)*. The *USB Device Class Definition for Printing Devices* provides a mechanism for administering all of the previously listed capabilities.

USB printers report their capabilities via the class-specific command GET_DEVICE_ID which returns a device ID string that is compatible with IEEE-1284. This string lists all the PDLs and PCPs supported by the printer.

3. Functional Characteristics

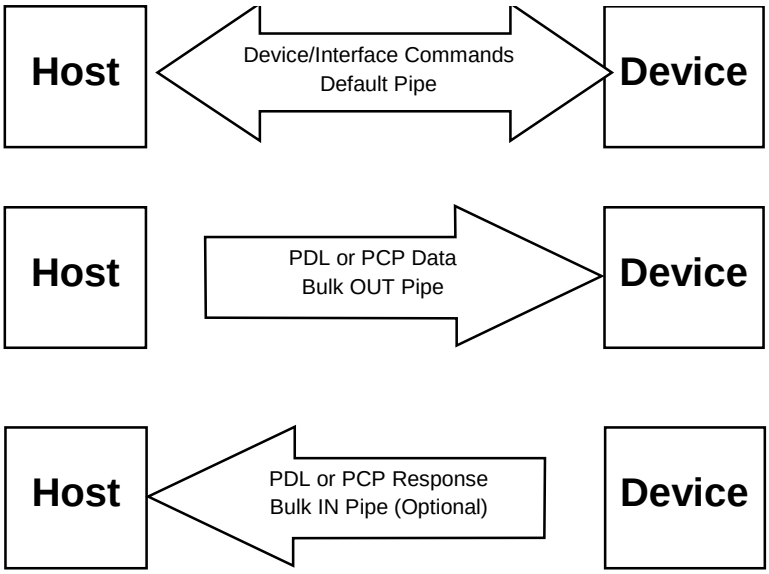
This section describes the functional characteristics of printers, including:

- The operational model
- Interfaces

3.1 Operational Model

Printers have two different types of commands: those that transfer data, and those that control the USB interface or printer interface. The host prints something on a printer by delivering data on the Bulk OUT endpoint. This data may take the form of *PostScript, HP PCL,* or any other PDL. This data may also be encapsulated in a PCP, such as *IEEE 1284.1,* or something that is vendor-specific. In addition, the data may also be simple text, or it may be a proprietary PDL. The printer can respond periodically on the Bulk IN endpoint with status regarding the data it is receiving, or because of an asynchronous event. A typical printed page takes the following sequence:

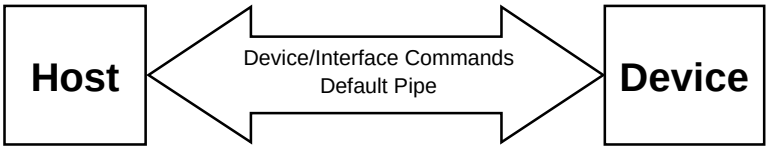
Figure 1 Printing a Page



The PDL data is sent to the device on the Bulk OUT pipe. If the device uses a PCP, then the PDL is encapsulated in the PCP; the Bulk IN pipe is used for any responses, such as errors and printer status as defined in the PCP. For a unidirectional interface, the status is retrieved by issuing a GET_PORT_STATUS on the default pipe and the status is returned on the default pipe.

The second type of command controls the USB interface. These commands include the standard requests, such as GET_DESCRIPTOR and SET_CONFIGURATION. These requests are described in Chapter 9, "USB Device Framework," in the *Universal Serial Bus Specification*. Printer-specific commands, such as SOFT_RESET or GET_PORT_STATUS, are included as well. The following diagram shows a control command sequence of a typical interface:

Figure 2 Interface Control Command



Commands sent on the default pipe report information back to the host on the default pipe. If an error occurs, they generate a standard USB error status. This applies to all class-specific requests in addition to the general requests described in Chapter 9, "USB Device Framework," in the *Universal Serial Bus Specification.*

3.2 Interfaces

Printers support two possible interfaces, but only one can be enabled at any given time. The interfaces are defined as follows:

- Unidirectional Interface. The unidirectional interface only supports the sending of data to the printer via a Bulk OUT endpoint. Status data that is compatible with Centronics parallel port is retrieved via the class-specific command GET_PORT_STATUS over the default pipe.
- Bi-directional Interface. The bi-directional interface supports sending data to the printer via a Bulk OUT endpoint, and receiving status and other information from the printer via a Bulk IN endpoint. Status data that is compatible with a Centronics parallel port is also available when this interface is in use via the GET_PORT_STATUS class-specific command over the default pipe. For more information about status data, see Section 4.2.2, “GET_PORT_STATUS.”

One of these interfaces shall be supported. If both interfaces are supported, they shall be implemented as alternate interfaces. The Protocol field in the interface descriptor informs the host of the interface type: 01 is the unidirectional interface and 02 is the bi-directional interface.

3.3 Status Reporting

USB printers have several ways of reporting status information; the host selects the method of status retrieval based on the type of status desired.

3.3.1 Compatibility with a Centronics Parallel Port

The GET_PORT_STATUS class-specific command returns 1 byte of information that is compatible with the Centronics parallel port, as described in Section 4.2.2 “GET_PORT_STATUS.”

3.3.2 Printer Capabilities

The GET_DEVICE_ID command returns a variable-length string that describes this printer. The capabilities include PDLs, such as *PostScript* or *HPGL*, to manufacturer ID strings. Host software reads this string to determine the supported PCPs.

3.3.3 Protocol-Specific Status

PCPs support extensive methods of status reporting. Status information for PCPs is returned on the Bulk IN endpoint.

4. Requests

A printer can respond to two different types of requests:

- Standard USB device requests, which perform general functions for supporting the bus and bus-related functions.
- Class-specific requests, which cause the device to transfer command data to or from the device.

4.1 Standard Requests

A printer device supports all of the standard device requests described in Chapter 9, “USB Device Framework,” of the *Universal Serial Bus Specification*:

- Clear Feature
- Get Configuration
- Get Descriptor
- Get Interface
- Get Status
- Set Address
- Set Configuration
- Set Descriptor
- Set Interface
- Set Feature

4.2 Class-Specific Requests

Printers support a variety of class-specific requests. The following table is a comprehensive list of all the class-specific requests supported by printers:

Table 1 - Class-Specific Requests

Label	bmRequestType	bRequest	wValue	wIndex	wLength	Data
GET_DEVICE_ID	10100001B	0	Config Index	Interface & Alternate Setting	Maximum Length	1284 Device ID String
GET_PORT_STATUS	10100001B	1	Zero	Interface	1	BYTE
SOFT_RESET	00100011B	2	Zero	Interface	Zero	[None]

4.2.1 GET_DEVICE_ID (0)

This class-specific request returns a device ID string that is compatible with IEEE-1284. See IEEE-1284 for syntax and formatting information. A printer with multiple configurations, interfaces, or alternate settings may contain multiple IEEE-1284 device ID strings. The wValue field is used to specify a zero-based configuration index. The high-byte of the wIndex field is used to specify the zero-based interface index. The low-byte of the wIndex field is used to specify the zero-based alternate setting. The device ID string is returned in the following format:

Table 2 - Capabilities String

Offset	Type	Description
0...n-1	Data	IEEE-1284 device ID string (including length in the first two bytes in big endian format).

4.2.2 GET_PORT_STATUS (1)

This class-specific request returns the current status of the status register of the Centronics parallel port. The following table defines the data returned. USB data transfers use ACK and NAK replacing Centronics Busy and ACK status.

Note Some USB printers may not be able to determine this information when using a bi-directional interface. In this case, they are allowed to return benign status of "Paper Not Empty," "Selected," and "No Error."

Table 3 - Printer Port Status

7	6	5	4	3	2	1	0
Reserved		Paper Empty	Select	Not Error	Reserved		

Bit(s)	Field	Description
7 .. 6	Reserved	Reserved for future use; device shall return these bits reset to zero.
5	Paper Empty	1 = Paper Empty, 0 = Paper Not Empty
4	Select	1 = Selected, 0 = Not Selected
3	Not Error	1 = No Error, 0 = Error
2 .. 0	Reserved	Reserved for future use; device shall return these bits reset to zero.

4.2.3 SOFT_RESET (2)

This class-specific request flushes all buffers and resets the Bulk OUT and Bulk IN pipes to their default states. This request clears all stall conditions. This reset does NOT change the USB addressing or USB configuration.

5. Standard Descriptors

Printer Class devices support the following standard USB descriptors:

- **Device**. Each printer has one device descriptor.
- **Configuration**. Each device has one default configuration descriptor which supports at least one interface.
- **Interface**. Printer device has a single data interface with possible alternates.
- **Endpoint**. A printer device supports the following endpoints:
  - Bulk OUT endpoint. PDL/PCP data.
  - Optional Bulk IN endpoint. Provides status and other return information.

Printers have no class-specific descriptors.

The rest of this section describes the standard USB device, configuration, interface, and endpoint descriptors for printer devices. For information about other standard descriptors, see Chapter 9, "USB Device Framework," of the *Universal Serial Bus Specification*.

5.1 Device Descriptor

There is only one device descriptor for each USB device. This descriptor contains the definitions of the device class and the device subclass, among other following device descriptor information:

Table 4 - Device Descriptor

Offset	Field	Size	Value	Description
0	bLength	Byte	12h	Size of this descriptor, in bytes.
1	bDescriptorType	Byte	01h	DEVICE descriptor type.
2	bcdUSB	Word	0100h	USB Specification Release Number, in Binary-Coded Decimal (BCD).
4	bDeviceClass	Byte	00h	See Section 5.3, “Interface Descriptors.”
5	bDeviceSubClass	Byte	00h	See Section 5.3, “Interface Descriptors.”
6	bDeviceProtocol	Byte	00h	See Section 5.3, “Interface Descriptors.”
7	wMaxPacketSize0	Byte	??h	Maximum packet size for endpoint 0.
8	idVendor	Word	????h	Vendor ID (assigned by the USB).
9	idProduct	Word	????h	Product ID (assigned by the manufacturer).
10	bcdDevice	Word	????h	Device release number, in BCD.
14	iManufacturer	Byte	??h	Index of string descriptor describing manufacturer.
15	iProduct	Byte	??h	Index of string descriptor describing this product.
16	iSerialNumber	Byte	??h	Index of string descriptor describing the device’s serial number.
17	bNumConfigurations	Byte	??h	Number of possible configurations. There must be at least one default configuration.

5.2 Configuration Descriptor

A printer has one default configuration descriptor. This descriptor has one interface, called the Data interface, which has one or two endpoints: Bulk OUT and the optional Bulk IN.

Table 5 - Configuration Descriptor

Offset	Field	Size	Value	Description
0	bLength	Byte	09h	Size of this descriptor, in bytes.
1	bDescriptorType	Byte	02h	CONFIGURATION descriptor type.
2	bTotalLength	Word	????h	Number of bytes in this configuration. This includes the configuration descriptor plus all of the interface and endpoint descriptors.
4	bNumInterfaces	Byte	??h	Printers have at least one interface.
5	bConfigurationValue	Byte	01h	Value to write to the Device Configuration Register (DCR) to select this configuration.
6	iConfiguration	Byte	??h	Index of string descriptor describing this configuration.
7	bmAttributes	Byte	??h	Configuration characteristics: Bit Description 7 Bus-powered. 6 Self-powered. 5 Remote wakeup. 4-0 Reserved, set to 0. Printers are usually self-powered, but may be both self-powered and bus-powered.
8	MaxPower	Byte	??h	Maximum power consumption of this configuration.

5.3 Interface Descriptors

All printers support a Data interface for transferring data to and/or from the device:

Table 6 - Interface Descriptor

Offset	Field	Size	Value	Description
0	bLength	Byte	09h	Size of this descriptor, in bytes.
1	bDescriptorType	Byte	04h	INTERFACE descriptor type.
2	bInterfaceNumber	Byte	00h	Zero-based value identifying the number of this interface.
3	bAlternateSetting	Byte	??h	Value used to select an alternate interface.
4	bNumEndpoints	Byte	??h	Number of endpoints used by this descriptor. This is 01h or 02h for printers
5	bInterfaceClass	Byte	07h	Base class for printers.
6	iInterfaceSubClass	Byte	01h	The subclass code of Printer device: 01 Printers
7	bInterfaceProtocol	Byte	??h	Printer Interface Type: 00 Reserved, undefined. 01 Unidirectional interface. 02 Bi-directional interface. 03-FEh Reserved for future use. FFh Vendor-specific printers do not use class-specific protocols.
8	iInterface	Byte	??h	Index to string that describes this interface.

5.4 Endpoint Descriptors

Printers support one or two endpoints. In addition to the Default endpoint, printers support only the Bulk OUT endpoint, or both the Bulk OUT and the Bulk IN endpoints:

Table 7 - Endpoint Descriptor

Attributes	IN/OUT	Type	Description
Bulk OUT	OUT	Mandatory	Bulk OUT endpoint.
Bulk IN	IN	Optional	Bulk IN endpoint.

5.4.1 Bulk OUT Endpoint

The Bulk OUT endpoint is used for transferring PDL and PCP data from the host to the printer:

Table 8 - Bulk OUT Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	Byte	09h	Size of this descriptor, in bytes.
1	bDescriptorType	Byte	05h	ENDPOINT descriptor type.
2	bEndpointAddress	Byte	0?h	The address of this endpoint on the USB device. This address is an endpoint number between 1 and 15. Bit 0..3 Endpoint number. Bit 4..6 Reserved, must be 0. Bit 7 0 = Out, 1 = In
3	bmAttributes	Byte	02h	This is a Bulk OUT endpoint.
4	wMaxPacketSize	Word	????h	Maximum data transfer size.
6	bInterval	Byte	00h	Does not apply to Bulk endpoints.

5.4.2 Bulk IN Endpoint

The Bulk IN endpoint is used to return any data generated by the PDL or PCP to the host. If the printer supports a PCP, such as IEEE-1284.1 or IEEE-1284.4, this endpoint will return status or other printer-related information:

Table 9 - Bulk IN Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	Byte	09h	Size of this descriptor, in bytes.
1	bDescriptorType	Byte	05h	ENDPOINT descriptor type.
2	bEndpointAddress	Byte	8?h	The address of this endpoint on the USB device. This address is an endpoint number between 1 and 15. Bit 0..3 Endpoint number. Bit 4..6 Reserved, must be 0. Bit 7 0 = Out, 1 = In
3	bmAttributes	Byte	02h	This is a Bulk endpoint.
4	wMaxPacketSize	Word	????h	Maximum data transfer size.
6	bInterval	Byte	00h	Does not apply to Bulk endpoints.