Universal Serial Bus
Usage Tables
for
HID Power Devices

Release 1.0

November 1, 1997

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Please send comments via electronic mail to techsup@usb.org.

Scope of this revision

Revision history

Version	Issue Date	Author	Comments
0.6	December 15, 1995	C. Adam Stolinski	Initial Release - Purpose & Scope only
0.7	January 31, 1996	Daniel Friel, Dominique Lallement	First comprehensive draft including all three (3) Subclasses.
0.8	March 20, 1996	Mike Flora, Dominique Lallement,	Inclusion of Microsoft “OnNow” (ACPI) Specification.
0.8a	May 17, 1996	Robert Dunstan, Mike Flora, Dominique Lallement,	Modification of Chap. 6.1 PDC Specific Descriptors, and inclusion of recent SMB Battery Specification update.
0.8b	June 14, 1996	Robert Dunstan, Dominique Lallement	Modification of Chap. 6.1 PDC Specific Descriptor.
0.8c	August 26, 1996	Robert Dunstan, Dominique Lallement	Modification of Chap. 6.1 PDC Specific Descriptor.
0.8d	September, 1996	Robert Dunstan, Dominique Lallement, Douglas Rademacher, Erik Willey	Deletion of Chap 6 (PDC Specific Descriptors concepts are shifted in Common Power Management Specification).
0.8e	October, 1996	Robert Dunstan, Dominique Lallement, Douglas Rademacher, Erik Willey	Redefining Requests. Add comments on Battery system and Power Supply. Charger is now in Battery system. Add topology links. Add examples.
0.8h	November 28, 1996	Dominique Lallement, Dave G.Lawrence, Erik Willey	First implementation of PDC as a HID class.
0.8j	February 25, 1997	Dominique Lallement, Dave G.Lawrence	Proposal of PDC as a HID class.
0.8k	April 7, 1997	Robert Dunstan, Mike Flora, Dominique Lallement, Dave G.Lawrence, Douglas Rademacher, Erik Willey	Proposal of PDC for 0.9 candidate – Internal document.
0.9 candidate	May 20, 1997	Tom Brennan, Mike Flora, Dominique Lallement, Dave G.Lawrence, Douglas Rademacher	Proposal of PDC for 0.9 candidate – Release document on DWGDOCS.
0.9	June 5, 1997	Dominique Lallement, Anthony Raiola, Douglas Rademacher,	Proposal of PDC for 0.9 – Release document on DWGDOCS.

Version	Issue Date	Author	Comments
0.9a	September 1, 1997	Kristi Hollis, Dominique Lallement,	First version after technical reediting.
1.0RC	October 1, 1997	Dominique Lallement, Mark Williams, Carol Buchmiller	Final editing for 1.0 release candidate draft
1.0	November 1, 1997	Dominique Lallement, Peter Laponder, Carol Buchmiller	Final editing for 1.0 draft

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1. Introduction

This document defines the communication of Power Source Devices within the Universal Serial Bus (USB) protocol as a Human Interface Device (HID).

Various devices can have integrated hardware power control of internal components and/or batteries. The same functionality can also be associated with devices powered from external power sources, such as uninterruptible power supplies (UPS). In either case, status and control communication within the USB protocol is desirable for energy conservation, reset, and/or system shutdown.

1.1 Scope

This document fully describes HID usages for USB Power Devices.

The USB Power Device protocol was designed within the framework of the USB Human Interface Device (HID) Class specification. The Power Device builds on the foundation provided by a HID Class driver in the host environment. This allows Power Device drivers to be simpler because they can rely on the HID Class driver for direct access to their devices and don't need to be concerned with the interaction between the HID Class driver and lower system software layers.

1.2 Purpose

This specification provides information to guide implementers in using the USB logical structures for Power Devices. OS, BIOS, peripheral, and UPS designers can use the common descriptions of the USB Power Device usages and reports.

- Section 2, "Overview" presents an overview of Power Devices, including a physical description of power objects, their definitions and properties, and implementation examples.
- Section 3, "HID Implementation of Power Devices" describes how a Power Device can be defined in terms of HID, including descriptors, requests, and reports.
- Section 4, "Power Device Usages," describes the usages that pertain to Power Devices.
- Section 5, "Recommendations for Implementing Collections and Usages," offers recommendations for implementing Power Device usages in various collections.
- Appendix A, "Example of a Simple UPS," and Appendix B, "Power Supply of a Typical USB Device," each provide a sample set of descriptors for a simple UPS and power supply, respectively.

1.3 Related Documents

It is assumed that the reader is familiar with the HID Specification and HID Usage Tables.

Title	Location	Description
Universal Serial Bus Device Class Definition for Human Interface Devices (HID) Version 1.0 – Final	Also referred to as the HID Specification; posted at www.usb.org	This document describes the Human Interface Device (HID) class for use with Universal Serial Bus (USB).
Universal Serial Bus HID Usage Tables, Release Candidate 1.0	Also referred to as the HID Usage Tables; posted at www.usb.org	Many usages are defined within the USB Specification. This document is the most current and complete list of defined usages.

Title	Location	Description
Universal Serial Bus Specification, 1.0 final draft	Also referred to as the USB Specification; posted at www.usb.org	This document defines an industry standard Universal Serial Bus.
System Management Bus Specification, Version 1.0 final release	www.mediacity.com/~sbs	This document describes the communication protocols available for use by devices on SMBus.
Smart Battery Data Specification Version 1.0	www.mediacity.com/~sbs	This document specifies the data set that is communicated to or from a Smart Battery on SMBus.
Smart Battery Charger Specification Version 1.0	www.mediacity.com/~sbs	This document specifies the data set that is communicated to or from a SBCharger on SMBus.
Smart Battery Selector Specification, Version 1.0	www.mediacity.com/~sbs	This document specifies the data set used by a Smart Battery Selector and the minimal functionality that such devices must provide on SMBus.
UPS Management Information Base, IETF - RFC1628	Also referred to as the UPS MIB; posted at www.ietf.org	This document defines the managed objects for Uninterruptible Power Supplies that are to be manageable via the Simple Network Management Protocol (SNMP).
Advanced Configuration and Power Interface (ACPI) Specification, Version 1.0	www.teleport.com/~acpi	This document describes the structures and mechanisms necessary to move to operating system (OS) directed power management and enable advanced configuration architectures.
OnNow Power Management and the Universal Serial Bus, Microsoft Technology Brief	www.microsoft.com/hwdev/onnow.ht)	This document describes the requirements and the implication for USB hardware in an OnNow power managed system.

1.4 Terms and Abbreviations

AC Alternating Current.

HID Human Interface Device. For definitions of the following HID terms, see the HID Specification and HID Usage Tables.

Collection
Feature
Get_Report
HID Descriptor
Input
Item
Logical Maximum
Logical Minimum
Output
Report Count
Report
ReportSize
Set_Report
Unit
UnitExponent
Usage Page
Usage

DC Direct Current.

MIB Management Information Base.

PD Power Device.

PS Power Supply.

SMBus System Management Bus.

UPS Uninterruptible Power Supply.

USB Universal Serial Bus. For definitions of the following USB terms, see the USB Specification.

Device Descriptor
Configuration Descriptor
Interface Descriptor
Endpoint Descriptor

2. Overview

A Power Device is a set of interconnected power modules (Battery Systems, Power Converters, Outlet Systems, and Power Summaries). Each module may include one or several interconnected sub-modules. Some sub-modules are located inside modules (Batteries, Chargers) and some are located at the interface of modules (Inputs, Outputs, and Outlets). All modules, sub-modules, and interconnections are defined as objects.

The following sections define:

- The physical description of power module objects.
- The general definitions of objects including data composition, identification, hierarchy, and interconnection rules.
- Implementation examples.

2.1 Physical Description of Power Objects

This section defines the distinct Power Device objects for the following power supplying devices: Battery, Charger, Battery System, Power Supply or Power Converter, Outlet and Outlet System, Gang, Input and Output, Flow, and Power Summary.

2.1.1 Battery

A Battery is typically a sealed pack of rechargeable electrochemical cells that provides a primary or auxiliary source of stored direct current (DC) energy to electronic devices. Some examples are the battery pack for cellular phones (principal source), the battery pack(s) for notebook computers (auxiliary source), and the sealed batteries in uninterruptible power supplies (auxiliary source).

Battery management may differ significantly for different Power Devices. It is therefore necessary to define three battery models in theBattPackModelLevel item: 0: Basic model, 1: Intelligent model, and 2: Smart Battery.

To comply with the Smart Battery Specification, the Battery System must support the functions defined in the Battery and Charger usage tables. For details, see Section 4.2, “Battery System Page (x85).”

2.1.2 Charger

A Charger is typically a controlled converter (AC/DC or DC/DC) that charges batteries.

2.1.3 Input and Output

Inputs and Outputs are the connection points of a module with other modules. They are associated with dynamic data such as electric measurement and status. In addition to basic features such as Voltage, Current or Frequency, they may include controls such as SwitchOnControl or SwitchOffControl.

2.1.4 Battery System

A Battery System is a collection of Batteries, Charger, Inputs, and Outputs. Battery systems have intelligent switching systems that provide a solution for many of the complexities associated with the implementation of multiple-battery systems such as notebook computers.

2.1.5 Power Supply or Power Converter

A Power Supply or Power Converter is an electrical converter of source energy of a particular voltage, frequency, and current into a different specific voltage, frequency, and current. Typical supplies are AC to DC, DC to DC, DC to AC, AC to AC, and AC to DC to AC. Some examples are PC/notebook power supplies (AC

to DC), battery chargers (AC to DC or DC to DC), and uninterruptible power supplies (AC to DC to AC). A Power Supply has Inputs and Outputs.

2.1.6 Outlet and Outlet System (or Power Source Node)

In its most general sense, an Outlet System is a set of physical connections by which devices requiring electrical energy are attached to a power source. The attachment point may be switched (capable of on/off control) or unswitched (incapable of on/off control). Of interest to the Power Device are outlets that are capable of being remotely switched. Examples are certain rackmount/enclosure-outlet receptacle strips and some uninterruptible power supplies. An Outlet is an individual switch and an Outlet System is a set of Outlets.

2.1.7 Gang

A Gang is a set of objects that have the same properties and act together. For example, a Gang of Outlets is composed of different Outlets that are connected to the same power source. If they are switchable, then they are switched by the same local or remote on/off control.

2.1.8 Flow

The electric power Flows are an abstraction of power lines that power some Inputs (external to a module), are generated by some Outputs (a module to the external world), and may connect some Outputs to some Inputs (inter-module relation). Flow defines only the electric configuration of the power line.

2.1.9 Power Summary

The Power Summary is an abstraction that summarizes data from the power source that supplies the load of the Power Device. Its configuration is defined by an associated Flow. There is associated dynamic data defining the present power source (AC Input, Battery, etc.) of the Flow. Implemented in a Power Device that includes a battery, the Power Summary contains the same information as ACPI Battery Control Methods.

All of the data of the power source that supplies a particular load of a Power Device is distributed through different related modules. Without a Power Summary, an application would have to browse all of these modules in order to get the pertinent data. The Power Summary module therefore facilitates power management application design.

Power Management software (e.g., Microsoft OnNow) could use a Power Summary to associate a USB Node with its power source. Implementing only a Power Summary within a Power Device is the simplest way to expose characteristics of a power source to power management.

2.2 Object Definitions and Properties

An object is composed of a set of the following data items or collections of these data items:

- Controls: Manipulate present state or setting of the object.
- Settings: Factory settings.
- Status: Present or Changed status.
- Measures: Values related to Electrical or Power Devices.

Each object has an unique identifier (ID). The ID identifies the object inside a type. It is included in the static data of each object and used to define links between objects.

The object hierarchy of a Power Device is the following:

1. Battery Systems (zero to many), each having:

- Inputs (zero to many), each being connected to an input Flow.
- Chargers (one to many).
- Batteries (one to many), each capable of being exclusively connected to a Charger or to an Output.
- Outputs (one to many), each being connected to an output Flow.

2. Power Converters (zero to many), each having:
   - Inputs (one to many), each being connected to an output Flow and capable of being connected to any Output.
   - Outputs (one to many), each being connected to an input Flow and capable of being connected to any Input.
3. Outlet Systems (zero to many), each having:
   - Individual Outlets (1 to many), each being connected to an output Flow.
   - One input Flow.
   - Output Flow (one per Outlet).
   - Power Summary (zero to many), each being connected to an output Flow.

The sub-modules of a module are directly connected. For example, an Input is connected to a Charger inside a Battery System, or an Input is connected to an Output inside a Power Converter.

The different modules are connected to each other and to entities outside the Power Device by Flows. The connection points are the Inputs and the Outputs of the modules. For example, a Flow connects the outside world to an Input of a Battery System; it is the main AC Flow. Or, a Flow connects the Output of a Battery System to the Input of a Power Converter; it is the battery backup DC Input of the Converter.

The connection inside or outside a module could be static or dynamically controlled. For example, the connection of an Input to a Charger inside a Battery System is generally static. Or, the connection of an Input to an Outlet inside an Outlet System is generally dynamically controlled.

2.3 Implementation Examples

Power Devices can be implemented with one or more objects. The figures in this section illustrate how multiple objects can be contained in a single device.

The following legend defines the symbols used in these figures.

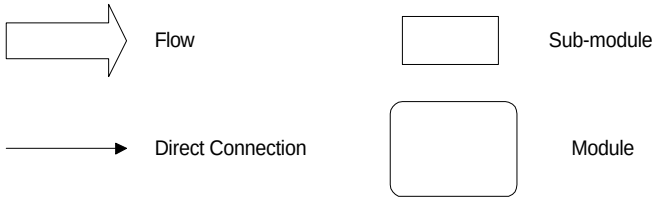

Figure 1: Legend for Power Device Configuration Figures

2.3.1 A Simple Power Supply

The following figure shows a Power Device configuration for a simple power supply.

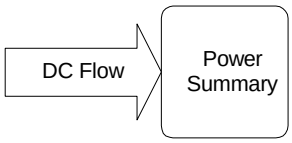

Figure 2: A Simple Power Supply

This configuration contains the following objects:

- One DC Output Flow (optional)
- One Power Summary

2.3.2 The Power Supply of a Typical USB Device

The following figure shows a Power Device configuration for the power supply of a typical USB device.

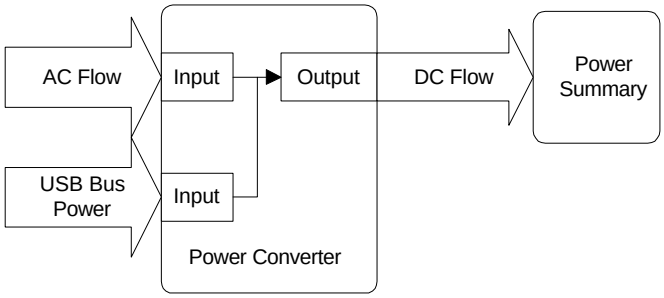

Figure 3: The Power Supply of a Typical USB Device

This configuration contains the following objects:

- One AC Input Flow, one DC Input Flow (USB Bus Power)
- One Power Converter consisting of one AC Input, one DC Input, and one DC Output
- One DC Output Flow
- One Power Summary

2.3.3 A Rackmount Receptacle Strip with Three Outlets

The following figure shows a Power Device configuration for a rackmount receptacle strip with three outlets.

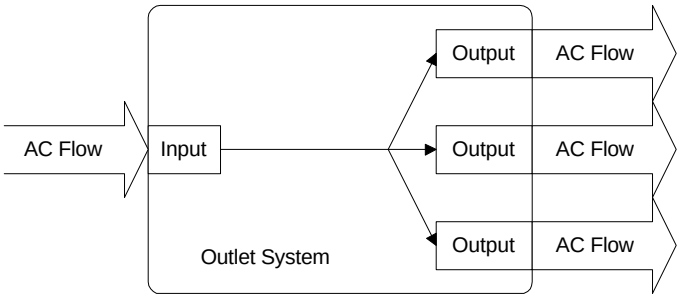

Figure 4: A Rackmount Receptacle Strip with Three Outlets

This configuration contains the following objects:

- One AC Input Flow
- One Outlet System consisting of one AC Input and three individual AC Outlets
- Three AC Output Flows

2.3.4 A Simple UPS with One Non-Switchable Output

The following figure shows a Power Device configuration for a simple UPS with one non-switchable output.

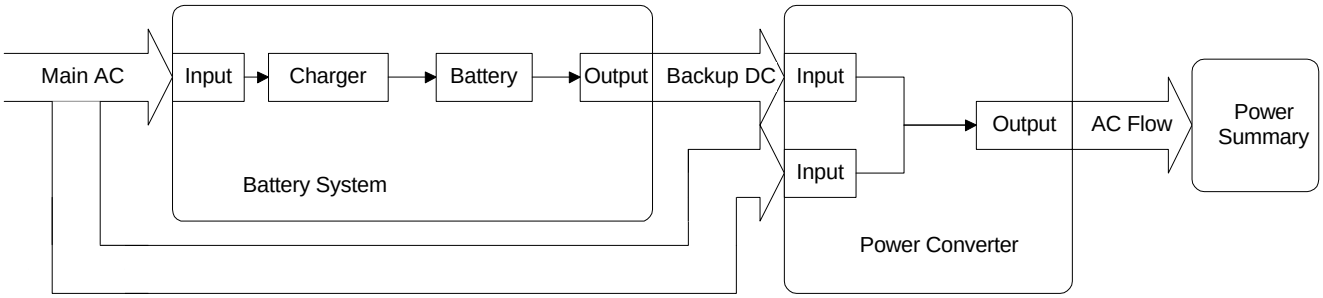

Figure 5: A Simple UPS with One Non-Switchable Output

This configuration contains the following objects:

- One AC Input Flow (Main AC)
- One Battery System consisting of one AC Input, one Battery, one Charger, and one DC Output
- One DC Flow (Backup DC)
- One Power Converter consisting of one DC Input, one AC Input and one AC Output
- One AC Output Flow (AC Flow)
- One Power Summary

2.3.5 A UPS with One Non-Switchable Output and Two Switchable Outlets

The following figure shows a Power Device configuration for a UPS with one non-switchable output and two switchable outlets.

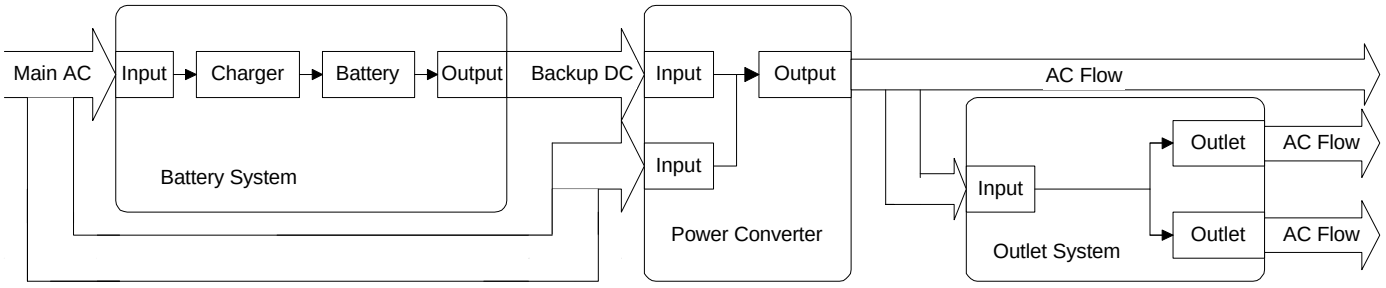

Figure 6: A UPS with One Non-Switchable Output and Two Switchable Outlets

This configuration contains the following objects:

- One AC Input Flow (Main AC)
- One Battery System consisting of one AC Input, one Battery, one Charger), and one DC Output
- One DC Flow (Backup DC)
- One Power Converter consisting of one DC Input, one AC Input, and one AC Output
- One AC Output Flow (AC Flow)
- One Outlet System with two outlets
- Two AC Output Flows (AC Flow)

3. HID Implementation of Power Devices

This section describes Power Device descriptors, requests and reports. The class code for the Power Device is 00, which is the same class code as for HID devices, because Power Devices are defined as HID devices with unique usage pages.

Four usage pages (x84 to x87) are reserved for Power Device usages in the usage space of the HID Class.

3.1 Power Device Descriptors and Requests

USB Power Devices use HID Class connection semantics. Therefore, they use the same set of descriptors as any HID Device. These include all of the standard descriptors: Device, Configuration, Interface, Endpoint, and String. They also use an HID descriptor associated with the interface containing the interrupt endpoint and a Report descriptor as defined in the USB HID.

USB Power Devices support the standard USB requests that are appropriate for the Power Device's implementation. USB Power Devices do not use any of the other HID class-specific requests, such as Get Idle, Set Idle, Get Protocol, and Set Protocol.

3.2 Power Device Reports

This section describes how controls, settings, status, and measures contained in Power Device collections are reported using HID reports (Feature, Input, and Output).

3.2.1 Controls and Settings in Reports

Controls manipulate the current state or setting of the object. They are implemented in Feature reports. They can be read or write accessible. The written value is the control (e.g., "connect"). The read value is the actual result of the control (e.g., "connected").

Factory settings are implemented in Feature reports. They are read-only.

3.2.2 Status in Reports

Present status is gathered in PresentStatus collections. It is implemented in Input, Output or Feature reports. Present status can be read or write.

- Read values in the collection: Present status.
- Write value in the collection: Setting commands (it is another way to implement controls).

Changed status items are gathered in ChangedStatus collections that are similar to Present status collections, but each element is a Boolean. They are implemented in Input, Output, or Feature reports. They can be read or write.

- Read values in the collection: Status as changed or remains unchanged.
- Write values in the collection: Change acknowledgment.

3.2.3 Measures and Physical Units in Reports

Numerical values related to Electrical or Power Devices are implemented in Feature or Input reports. They are read-only.

Physical units of Power Device values (measures and settings) are implemented using HID syntax. For those values, the following table gives examples of codification of Power-Device-related physical units in HID descriptors (HID Unit, HID Unit Code, and HID Unit Exponent). It also gives an example of value size (HID Size).

Table 1: Power Device Physical Units Implemented in HID Units

	Physical Unit	HID Unit	HID Unit Code	HID Unit Exponent	HID Size
AC Voltage	Volt	Volt	x00F0D121	7	8
AC Current	centiAmp	Amp	x00100001	-2	16
Frequency	Hertz	Hertz	xF001	0	8
DC Voltage	centiVolt	Volt	x00FOD121	5	16
Time	second	s	x1001	0	16
DC Current	centiAmp	Amp	x00100001	-2	16
Apparent or Active Power	VA or W	VA or W	xD121	7	16
Temperature	°K	°K	x00010001	0	16
Battery Capacity	AmpSec	AmpSec	x00101001	0	24
None	None	None	x0	0	8

For Battery Capacity units, the industry uses “mAh” (milliampère-hour). To fit with HID Units coding rules, use “As” (Ampère-second) (1 mAh = 3.6 As).

4. Power Device Usages

Four usage pages are reserved for Power Devices: 0x84 to 0x87. This specification defines two usage pages: the Power Device Page (x84) and the Battery System Page (x85). Pages x86 and x87 are reserved for Power Devices but are not currently defined in this specification.

Usage pages xFF00 to xFFFF are reserved by HID for vendor-specific implementation.

4.1 Power Device Page (x84)

The following table lists usages defined on the Power Device Page (x84). Usages are described in the section indicated in the Section column of the table.

The Usage Type column indicates the recommended type of the usage, as defined in the HID Usage Tables:

CA – Application collection
CL – Logical collection
CP – Physical collection
DF – Dynamic Flag
DV – Dynamic Value
SF – Static Flag
SV – Static Value

For a detailed description of usage types, see Section 3.4 in the HID Usage Tables document.

An ‘x’ in the I, O, or F column indicates that the usage can be implemented as an Input, Output, or Feature report, respectively.

The Data Access column indicates whether the usage is read/write (R/W), read-only (R/O), or neither (N/A).

Table 2: Power Device Page

Usage ID	Usage Name	Usage Type	I	O	F	Data Access	Section
00	Undefined						
01	iName	SV	x		x	R/W	4.1.1
02	**PresentStatus**	CL				N/A	4.1.1
03	**ChangedStatus**	CL				N/A	4.1.1
04	**UPS**	CA				N/A	4.1.1
05	**PowerSupply**	CA				N/A	4.1.1
06-0F	Reserved						4.1.1
10	**BatterySystem**	CP				N/A	4.1.1
11	BatterySystemID	SV	x		x	R/W	4.1.1
12	**Battery**	CP				N/A	4.1.1
13	BatteryID	SV	x		x	R/W	4.1.1
14	**Charger**	CP				N/A	4.1.1
15	ChargerID	SV	x		x	R/W	4.1.1
16	**PowerConverter**	CP				N/A	4.1.1
17	PowerConverterID	SV	x		x	R/W	4.1.1

Usage ID	Usage Name	Usage Type	I	O	F	Data Access	Section
18	**OutletSystem**	CP				N/A	4.1.1
19	OutletSystemID	SV	x		x	R/W	4.1.1
1A	**Input**	CP				N/A	4.1.1
1B	InputID	SV	x		x	R/W	4.1.1
1C	**Output**	CP				N/A	4.1.1
1D	OutputID	SV	x		x	R/W	4.1.1
1E	**Flow**	CP				N/A	4.1.1
1F	FlowID	Item	x		x	R/W	4.1.1
20	**Outlet**	CP				N/A	4.1.1
21	OutletID	SV	x		x	R/W	4.1.1
22	**Gang**	CL/CP				N/A	4.1.1
23	GangID	SV	x		x	R/W	4.1.1
24	**PowerSummary**	CL/CP					4.1.1
25	PowerSummaryID	SV	x		x	R/W	4.1.1
26-2F	Reserved						
30	Voltage	DV	x		x	R/O	4.1.2
31	Current	DV	x		x	R/O	4.1.2
32	Frequency	DV	x		x	R/O	4.1.2
33	ApparentPower	DV	x		x	R/O	4.1.2
34	ActivePower	DV	x		x	R/O	4.1.2
35	PercentLoad	DV	x		x	R/O	4.1.2
36	Temperature	DV	x		x	R/O	4.1.2
37	Humidity	DV	x		x	R/O	4.1.2
38	BadCount	DV	x		x	R/O	4.1.2
39-3F	Reserved						
40	ConfigVoltage	SV/DV			x	R/W	4.1.3
41	ConfigCurrent	SV/DV			x	R/W	4.1.3
42	ConfigFrequency	SV/DV			x	R/W	4.1.3
43	ConfigApparentPower	SV/DV			x	R/W	4.1.3
44	ConfigActivePower	SV/DV			x	R/W	4.1.3
45	ConfigPercentLoad	SV/DV			x	R/W	4.1.3
46	ConfigTemperature	SV/DV			x	R/W	4.1.3
47	ConfigHumidity	SV/DV			x	R/W	4.1.3
48-4F	Reserved						
50	SwitchOnControl	DV			x	R/W	4.1.4
51	SwitchOffControl	DV			x	R/W	4.1.4

Usage ID	Usage Name	Usage Type	I	O	F	Data Access	Section
52	ToggleControl	DV			x	R/W	4.1.4
53	LowVoltageTransfer	DV			x	R/W	4.1.4
54	HighVoltageTransfer	DV			x	R/W	4.1.4
55	DelayBeforeReboot	DV			x	R/W	4.1.4
56	DelayBeforeStartup	DV			x	R/W	4.1.4
57	DelayBeforeShutdown	DV			x	R/W	4.1.4
58	Test	DV			x	R/W	4.1.4
59	ModuleReset	DV			x	R/W	4.1.4
5A	AudibleAlarmControl	DV			x	R/W	4.1.4
5B-5F	Reserved						
60	Present	DF	x	x	x	R/W	4.1.5
61	Good	DF	x	x	x	R/W	4.1.5
62	InternalFailure	DF	x	x	x	R/W	4.1.5
63	VoltageOutOfRange	DF	x	x	x	R/W	4.1.5
64	FrequencyOutOfRange	DF	x	x	x	R/W	4.1.5
65	Overload	DF	x	x	x	R/W	4.1.5
66	OverCharged	DF	x	x	x	R/W	4.1.5
67	OverTemperature	DF	x	x	x	R/W	4.1.5
68	ShutdownRequested	DF	x	x	x	R/W	4.1.5
69	ShutdownImminent	DF	x	x	x	R/W	4.1.5
6A	Reserved	DF	x	x	x	R/W	4.1.5
6B	SwitchOn/Off	DF	x	x	x	R/W	4.1.5
6C	Switchable	DF	x	x	x	R/W	4.1.5
6D	Used	DF	x	x	x	R/W	4.1.5
6E	Boost	DF	x	x	x	R/W	4.1.5
6F	Buck	DF	x	x	x	R/W	4.1.5
70	Initialized	DF	x	x	x	R/W	4.1.5
71	Tested	DF	x	x	x	R/W	4.1.5
72	AwaitingPower	DF	x	x	x	R/W	4.1.5
73	CommunicationLost	DF	x	x	x	R/W	4.1.5
74-FC	Reserved	DF					
FD	iManufacturer	SV			x	R/O	4.1.6
FE	iProduct	SV			x	R/O	4.1.6
FF	iserialNumber	SV			x	R/O	4.1.6

4.1.1 Power Device Structure

iName	Index of a string descriptor containing the physical description of the object.
PresentStatus	A collection of Present status information related to an object.
	Read values in the collection: Present status.
	Write value in the collection: Setting commands.
ChangedStatus	Read values in the collection: Status changed (1)/status unchanged (0).
	Write values in the collection: Change acknowledgment (1).
UPS	A collection of data that defines an Uninterruptible Power Supply.
PowerSupply	A collection of data that defines a Power Supply.
BatterySystem	A collection of data that defines a Battery System power module.
BatterySystemID	A number that points to a particular Battery System.
Battery	A collection of data that defines a Battery.
BatteryID	A number that points to a particular Battery.
Charger	A collection of data that defines a Charger.
ChargerID	A number that points to a particular Charger.
PowerConverter	A collection of data that defines a Power Converter power module.
PowerConverterID	A number that points to a particular Power Converter.
OutletSystem	A collection of data that defines a Outlet System power module.
OutletSystemID	A number that points to a particular Outlet System.
Input	A collection of data that defines an Input.
InputID	A number that points to a particular Input.
Output	A collection of data that defines an Output.
OutputID	A number that points to a particular Output.
Flow	A collection of data that defines a Flow.
FlowID	A number that points to a particular Flow.
Outlet	A collection of data that defines an Outlet.
OutletID	A number that points to a particular Outlet.
Gang	A collection of data that defines ganged objects.
GangID	A number that points to a particular Gang.
PowerSummary	A collection of data that defines a Power Summary.
PowerSummaryID	A number that points to a particular Power Summary.

4.1.2 Power Measures

Voltage	Actual value of the voltage. (HID units are Volts.)
Current	Actual value of the current. (HID units are Amps.)
Frequency	Actual value of the frequency. (HID units are Hertz.)

ApparentPower	Actual value of the apparent power. (HID units are Volt-Amps.)
ActivePower	Actual value of the active (RMS) power. (HID units are Watts.)
PercentLoad	The actual value of the percentage of the power capacity presently being used on this input or output line, i.e., the greater of the percent load of true power capacity and the percent load of ApparentPower.
Temperature	The actual value of the temperature. (HID unit is degrees K.)
Humidity	The actual value of the humidity. (Unit is %.)
BadCount	The number of times the device, module, or sub-module entered a bad condition (e.g., an AC Input entered an out-of-tolerance condition).

4.1.3 Power Configuration Controls

ConfigVoltage	Nominal value of the voltage. (HID units are Volts.)
ConfigCurrent	Nominal value of the current. (HID units are Amps.)
ConfigFrequency	Nominal value of the frequency. (HID units are Hertz.)
ConfigApparentPower	Nominal value of the apparent power. (HID units Volt-Amps.)
ConfigActivePower	Nominal value of the active (RMS) power. (HID units are Watts.)
ConfigPercentLoad	Nominal value of the percentage load that could be used without critical overload.
ConfigTemperature	Nominal value of the temperature. (HID units are 0.1 degrees K.)
ConfigHumidity	Nominal value of the humidity. (Unit is %.)

4.1.4 Power Controls

SwitchOnControl — Controls the Switch On sequence.

Write value:
0: Stop sequence
1: Start sequence

Read value:
0: None
1: Started
2: In Progress
3: Completed

SwitchOffControl — Controls the Switch Off sequence.

Write value:
0: Stop sequence
1: Start sequence

Read value:
0: None
1: Started
2: In Progress
3: Completed

ToggleControl	Controls the Toggle sequence. A Toggle sequence is a Switch Off sequence followed immediately by a Switch On sequence. Write value: 0: Stop sequence 1: Start sequence Read value: 0: None 1: Started 2: In Progress 3: Completed
LowVoltageTransfer	The minimum line voltage allowed before the PS system transfers to battery backup. (HID units are RMS volts.)
HighVoltageTransfer	The maximum line voltage allowed before the PS system transfers to battery backup. (HID units are RMS volts.)
DelayBeforeReboot	Writing this value immediately shuts down (i.e., turns off) the output for a period equal to the indicated number of seconds in DelayBeforeReboot, after which time the output is started. If the number of seconds required to perform the request is greater than the requested duration, then the requested shutdown and startup cycle shall be performed in the minimum time possible, but in no case shall this require more than the requested duration plus 60 seconds. If the startup should occur during a utility failure, the startup shall not occur until the utility power is restored. When read, DelayBeforeReboot returns the number of seconds remaining in the countdown, or –1 if no countdown is in progress.
DelayBeforeStartup	Writing this value starts the output after the indicated number of seconds in DelayBeforeStartup. Sending this command with 0 causes the startup to occur immediately. Sending this command with –1 aborts the countdown. If the output is already on at the time the countdown reaches 0, nothing happens. On some systems, if the USB driver on the device side is restarted while a startup countdown is in effect, the countdown is aborted. If the countdown expires during a utility failure, the startup shall not occur until the utility power is restored. Writing this value overrides the effect of any DelayBeforeStartup countdown or DelayBeforeReboot countdown in progress. When read, DelayBeforeStartup returns the number of seconds remaining in the countdown, or –1 if no countdown is in progress.

DelayBeforeShutdown	Writing this value shuts down (i.e., turns off) either the output after the indicated number of seconds, or sooner if the batteries become depleted. Sending this command with 0 causes the shutdown to occur immediately. Sending this command with –1 aborts the countdown. If the system is already in the desired state at the time the countdown reaches 0, there is no additional action (i.e. there is no additional action if the output is already off). On some systems, if the USB driver on the device side is restarted while a shutdown countdown is in effect, the countdown may be aborted. Writing this value overrides any DelayBeforeShutdown countdown already in effect. When read, DelayBeforeShutdown will return the number of seconds remaining until shutdown, or –1 if no shutdown countdown is in effect.	
Test	Write value:	Test request value. 0: No test 1: Quick test 2: Deep test 3: Abort test
	Read value:	Test result value. 1: Done and Passed 2: Done and Warning 3: Done and Error 4: Aborted 5: In progress 6: No test initiated
ModuleReset	Write value:	Module Reset request value. 0: No Reset 1: Reset Module 2: Reset Module’s Alarms 3: Reset Module’s Counters
	Read value:	Module Reset result value.
AudibleAlarmControl	Read or Write value: 1: Disabled (Never sound) 2: Enabled (Sound when an alarm is present) 3: Muted (Temporarily silence the alarm) This is the requested state (Write value) or the present state (Read value) of the audible alarm. The Muted state (3) persists until the alarm would normally stop sounding. At the end of this period the value reverts to Enabled (2). Writing the value Muted (3) when the audible alarm is not sounding is accepted but otherwise has no effect.	

4.1.5 Power Generic Status

Present	Present (1)/Not Present (0)
Good	Good (1)/Bad (0)
InternalFailure	Failed (1)/Not Failed (0)
VoltageOutOfRange	Out Of Range (1)/In Range (0)

FrequencyOutOfRange	Out Of Range (1)/In Range (0)
Overload	Overloaded (1)/Not Overloaded (0)
Overcharged	Overcharged (1)/Not Overcharged (0)
OverTemperature	Over Temperature (1)/Not Over Temperature (0)
ShutdownRequested	Requested (1)/Not Requested (0)
ShutdownImminent	Imminent (1)/Not Imminent (0)
SwitchOn/Off	On (1) indicates the switch is closed. Off (0) indicates the switch is opened. The status could be On (1) but the load still not powered if the input source power is not present. The controls associated with this status could be used to connect or disconnect Input or Output from Flow or any module or sub-module.
Switchable	Switchable (1)/Not Switchable (0)
Used	Used (1)/Unused (0) The status indicates this Input is presently used in the module (e.g., the Power Converter converts or transfers this Input into Output(s)).
Boost	Boosted (1)/Not Boosted (0) The status indicates this Input is used in the module but voltage is increased to fit within nominal range values.
Buck	Bucked (1)/Not Bucked (0) The status indicates this Input is used in the module but voltage is reduced to fit with nominal range values.
Initialized	Initialized (1)/Not Initialized (0)
Tested	Tested (1)/Not Tested (0)
AwaitingPower	Awaiting Power (1)/Not Awaiting Power (0) The status indicates that the device, module, or sub-module is awaiting power from any available input source.
CommunicationLost	Communication is lost (1)/Communication is not lost (0) The status indicates that the USB agent of the device, module, or sub-module is not able to communicate with the corresponding control part of the device, module, or sub-module. As a consequence, all of the related data are no longer reliable and will not be updated until communication is reestablished.

4.1.6 Power Device Identification

iManufacturer	Index of a string descriptor describing the manufacturer.
iProduct	Index of a string descriptor describing the product.
iSerialNumber	Index of a string descriptor describing the device’s serial number.

4.2 Battery System Page (x85)

The following table lists usages defined on the Battery System Page (x85).

Usages are described in the sections indicated in the Section column of the table. These sections include all the necessary information to implement Smart Battery capability. Usages formatted in italics are not defined in the Battery System Page, but are placeholders for usages defined in the Power Device Page.

The Usage Type column indicates the recommended type of the usage, as defined in the HID Usage Tables:

CA – Application collection
CL – Logical collection
CP – Physical collection
DF – Dynamic Flag
DV – Dynamic Value
SF – Static Flag
SV – Static Value

For a detailed description of usage types, see Section 3.4 in the HID Usage Tables document.

An ‘x’ in the I, O, or F column indicates that the usage can be implemented as an Input, Output, or Feature report, respectively.

The Data Access column indicates whether the usage is read/write (R/W), read-only (R/O), or neither (N/A).

An ‘x’ in the SMBL (Smart Battery Level) column indicates that the usage pertains to application-level software rather than to deeper Smart Battery Management software.

Table 3: Battery System Page

Usage ID	Usage Name	Usage Type	I	O	F	Data Access	SMBL	Section
00	Undefined							4.2.1
01	**SMBBatteryMode**	CL				N/A		4.2.1
02	**SMBBatteryStatus**	CL				N/A		4.2.1
03	**SMBAlarmWarning**	CL				N/A		4.2.1
04	**SMBChargerMode**	CL				N/A		4.2.1
05	**SMBChargerStatus**	CL				N/A		4.2.1
06	**SMBChargerSpecInfo**	CL				N/A		4.2.1
07	**SMBSelectorState**	CL				N/A		4.2.1
08	**SMBSelectorPresets**	CL				N/A		4.2.1
09	**SMBSelectorInfo**	CL				N/A		4.2.1
0A-0F	Reserved							
10	OptionalMfgFunction1	DV			x	R/W		4.2.2
11	OptionalMfgFunction2	DV			x	R/W		4.2.2
12	OptionalMfgFunction3	DV			x	R/W		4.2.2
13	OptionalMfgFunction4	DV			x	R/W		4.2.2
14	OptionalMfgFunction5	DV			x	R/W		4.2.2
15	ConnectionToSMBus	DF			x	R/W		4.2.2

Usage ID	Usage Name	Usage Type	I	O	F	Data Access	SMBL	Section
16	OutputConnection	DF			x	R/W		4.2.2
17	ChargerConnection	DF			x	R/W		4.2.2
18	BatteryInsertion	DF			x	R/W		4.2.2
19	Usenext	DF			x	R/W		4.2.2
1A	OKToUse	DF			x	R/W		4.2.2
1B	BatterySupported	DF			x	R		4.2.2
1C	SelectorRevision	DF			x	R		4.2.2
1D	ChargingIndicator	DF			x	R		4.2.2
1E-27	Reserved							
28	ManufacturerAccess	DV			x	R/W		4.2.3
29	RemainingCapacityLimit	DV			x	R/W	x	4.2.3
2A	RemainingTimeLimit	DV			x	R/W	x	4.2.3
2B	AtRate	DV			x	R/W		4.2.3
2C	CapacityMode	DV			x	R/W	x	4.2.3
2D	BroadcastToCharger	DV			x	R/W		4.2.3
2E	PrimaryBattery	DV			x	R/W	x	4.2.3
2F	ChargeController	DV			x	R/W		4.2.3
30-3F	Reserved							
40	TerminateCharge	DF	x	x	x	R/W	x	4.2.4
41	TerminateDischarge	DF	x	x	x	R/W	x	4.2.4
42	BelowRemainingCapacityLimit	DF	x	x	x	R/W	x	4.2.4
43	RemainingTimeLimitExpired	DF	x	x	x	R/W	x	4.2.4
44	Charging	DF	x	x	x	R/W	x	4.2.4
45	Discharging	DV	x	x	x	R/W	x	4.2.4
46	FullyCharged	DF	x	x	x	R/W	x	4.2.4
47	FullyDischarged	DV	x	x	x	R/W	x	4.2.4
48	ConditioningFlag	DV	x	x	x	R/W		4.2.4
49	AtRateOK	DV	x	x	x	R/W		4.2.4
4A	SMBErrorCode	DF	x	x	x	R/W		4.2.4
4B	NeedReplacement	DF	x	x	x	R/W	x	4.2.4
4C-5F	Reserved							
60	AtRateTimeToFull	DV	x		x	R/O		4.2.5
61	AtRateTimeToEmpty	DV	x		x	R/O		4.2.5
62	AverageCurrent	DV	x		x	R/O		4.2.5
63	Maxerror	DV	x		x	R/O		4.2.5
64	RelativeStateOfCharge	DV	x		x	R/O		4.2.5

Usage ID	Usage Name	Usage Type	I	O	F	Data Access	SMBL	Section
65	AbsoluteStateOfCharge	DV	x		x	R/O	x	4.2.5
66	RemainingCapacity	DV	x		x	R/O	x	4.2.5
67	FullChargeCapacity	DV	x		x	R/O	x	4.2.5
68	RunTimeToEmpty	DV	x		x	R/O	x	4.2.5
69	AverageTimeToEmpty	DV	x		x	R/O		4.2.5
6A	AverageTimeToFull	DV	x		x	R/O		4.2.5
6B	CycleCount	DV	x		x	R/O	x	4.2.5
6C-7F	Reserved							
80	BattPackModelLevel	SV			x	R/O	x	4.2.6
81	InternalChargeController	SF			x	R/O		4.2.6
82	PrimaryBatterySupport	SF			x	R/O	x	4.2.6
83	DesignCapacity	SV			x	R/O	x	4.2.6
84	SpecificationInfo	SV			x	R/O	x	4.2.6
85	ManufacturerDate	SV			x	R/O	x	4.2.6
86	SerialNumber	SV			x	R/O	x	4.2.6
87	iManufacturerName	SV			x	R/O	x	4.2.6
88	iDevicename	SV			x	R/O	x	4.2.6
89	iDeviceChemistery	SV			x	R/O	x	4.2.6
8A	ManufacturerData	SV			x	R/O		4.2.6
8B	Rechargable	SV			x	R/O	x	4.2.7
8C	WarningCapacityLimit	SV			x	R/O	x	4.2.7
8D	CapacityGranularity1	SV			x	R/O	x	4.2.7
8E	CapacityGranularity2	SV			x	R/O	x	4.2.7
8F	iOEMInformation	SV			x	R/O	x	4.2.7
90-BF	Reserved							
C0	InhibitCharge	DF			x	R/W		4.2.8
C1	EnablePolling	DF			x	R/W		4.2.8
C2	ResetToZero	DF			x	R/W		4.2.8
C3-CF	Reserved							
D0	ACPresent	DF	x	x	x	R/W	x	4.2.9
D1	BatteryPresent	DF	x	x	x	R/W	x	4.2.9
D2	PowerFail	DF	x	x	x	R/W		4.2.9
D3	AlarmInhibited	DF	x	x	x	R/W		4.2.9
D4	ThermistorUnderRange	DF	x	x	x	R/W		4.2.9
D5	ThermistorHot	DF	x	x	x	R/W		4.2.9
D6	ThermistorCold	DF	x	x	x	R/W		4.2.9

Usage ID	Usage Name	Usage Type	I	O	F	Data Access	SMBL	Section
D7	ThermistorOverRange	DF	x	x	x	R/W		4.2.9
D8	VoltageOutOfRange	DF	x	x	x	R/W		4.2.9
D9	CurrentOutOfRange	DF	x	x	x	R/W		4.2.9
DA	CurrentNotRegulated	DF	x	x	x	R/W		4.2.9
DB	VoltageNotRegulated	DF	x	x	x	R/W		4.2.9
DC	MasterMode	DF	x	x	x	R/W		4.2.9
DD-EF	Reserved							
F0	ChargerSelectorSupport	SF			x	R/O		4.2.10
F1	ChargerSpec	SV			x	R/O		4.2.10
F2	Level2	SF			x	R/O		4.2.10
F3	Level3	SF			x	R/O		4.2.10
F2-FF	Reserved							

4.2.1 Battery System Usages

SMBBatteryMode An SMB-specific 16-bit bitmap predefined collection used by the battery for mode setting. It includes:

Status/Alarm	Position in word	Access
CapacityMode	0x8000	R/W
ChargerMode	0x4000	R/W
PrimaryBattery	0x0200	R/W
ChargerControllerEnabled	0x0100	R/W
ConditioningFlag	0x0080	R/O
PrimaryBatterySupport	0x0002	R/O
InternalChargeController	0x0001	R/O

SMBBatteryStatus An SMB-specific 16-bit bitmap predefined collection used by the battery for Status and Alarm read. It includes:

Status/Alarm	Position in word	Type
Overcharged	0x8000	Alarm
TerminateCharge	0x4000	Alarm
OverTemperature	0x1000	Alarm
TerminateDischarge	0x0800	Alarm
BelowRemainingCapacityLimit	0x0200	Alarm
RemainingTimeLimitExpired	0x0100	Alarm
Initialized	0x0080	Status

Discharging	0x0040	Status
FullyCharged	0x0020	Status
FullyDischarged	0x0010	Status
SMBErrorCode	0x0000 - 0x000F	Error

SMBAlarmWarning An SMB-specific 16-bit bitmap predefined collection used by the battery for Alarm transmission to Charger and Host. It includes the same fields as SMBBatteryStatus.

SMBChargerMode An SMB-specific 16-bit bitmap predefined collection used by the Charger for mode setting that includes:

Status / Alarm	**Position in word**	**Access**
ResetToZero	0x0008	R/W
PORReset	0x0004	R/W
EnablePolling	0x0002	R/W
InhibitCharge	0x0001	R/W

SMBChargerStatus An SMB-specific 16-bit bitmap predefined collection used by the Charger for status transmission. It includes:

Status/Alarm	**Position in word**
ACPresent	0x8000
BatteryPresent	0x4000
PowerFail	0x2000
AlarmInhibited	0x1000
ThermistorUnderRange	0x0800
ThermistorHot	0x4000
ThermistorCold	0x2000
ThermistorOverRange	0x1000
VoltageOutOfRange	0x0080
CurrentOutOfRange	0x0040
Level3	0x0020
Level2	0x0010
MasterMode	0x0002
InhibitCharge	0x0001

SMBChargerSpecInfo An SMB-specific 16-bit bitmap predefined collection used by the Charger for extended status information. It includes:

Status/Alarm	Position in word
ChargerSelectorSupport	0x0010
ChargerSpec	0x0008 to 0x0001

SMBSelectorState An SMB-specific 16-bit bitmap predefined collection to manage Selector Features. Up to four batteries could be present (or inserted).

Battery	Battery ID
A	1
B	2
C	3
D	4

The batteries could be connected to the communication bus (SMBus), the system power (the unique output), or the charger (the unique charger).

Status/Control	Battery	Position in word	Access
ConnectionToSMBus	D	0x8000	R/W
ConnectionToSMBus	C	0x4000	R/W
ConnectionToSMBus	B	0x2000	R/W
ConnectionToSMBus	A	0x1000	R/W
OutputConnection	D	0x0800	R/W
OutputConnection	C	0x0400	R/W
OutputConnection	B	0x0200	R/W
OutputConnection	A	0x0100	R/W
ChargerConnection	D	0x0080	R/W
ChargerConnection	C	0x0040	R/W
ChargerConnection	B	0x0020	R/W
ChargerConnection	A	0x0010	R/W
BatteryInsertion	D	0x0008	R
BatteryInsertion	C	0x0004	R
BatteryInsertion	B	0x0002	R
BatteryInsertion	A	0x0001	R

SMBSelectorPresets An SMB-specific 16-bit bitmap predefined collection to select the next battery to power the system in the event the current battery is removed or falls below its cutoff voltage. It defines Selector Features.

Status/Control	Battery	Position in word	Access
UseNext	D	0x0080	R/W
UseNext	C	0x0040	R/W
UseNext	B	0x0020	R/W
UseNext	A	0x0010	R/W
OKToUse	D	0x0008	R/W
OKToUse	C	0x0004	R/W
OKToUse	B	0x0002	R/W
OKToUse	A	0x0001	R/W

SMBSelectorInfo An SMB-specific 16-bit bitmap predefined collection of information used by the host to determine the capabilities of the selector.

Status	Battery	Position in word	Access
ChargingIndicator		0x0080	R
SelectorRevision		0x0040	R
BatterySupported	D	0x0008	R
BatterySupported	C	0x0004	R
BatterySupported	B	0x0002	R
BatterySupported	A	0x0001	R

4.2.2 Battery System (or Selector) Settings and Controls

OptionalMfgFunction1 … OptionalMfgFunction5 An optional SMB-manufacturer-specific Read and Write function. Defined as a 16-bit word.

ConnectionToSMBus

Read Value: State of connection to the system SMBus.
1: Connected
0: Not Connected

Write Value: Connection command.
1: Connect
0: Disconnect

OutputConnection

Read value: Connection status of the specified Output to the specified battery.
0: No Output is connected.
n: ID of the connected Output (only 1 for SMB).

Write value: Connection command.
0: Disconnect the output.
n: ID of the output to connect (only 1 for SMB).

ChargerConnection	Read value:	ID of the specified Charger to the specified Battery. 0: No Charger is connected. *n*: ID of the connected Charger (only 1 for SMB).
	Write value:	Connection command. 0: Disconnect the Charger. *n*: ID of the Charger to connect (only 1 for SMB).
BatteryInsertion	Read value:	Insertion status of the specified Battery into the system. 0: No Battery is connected. 1: A Battery is connected.
	Write value:	Insertion command. 0: Remove 1: Insert
UseNext	Read Value:	Whether or not this Battery will be used for next discharge. 0: Will not be used. 1: Will be used.
	Write value:	Set command. 0: Will not be used. 1: Will be used.
OKToUse	Read value:	Whether or not this Battery is usable. 0: Unusable 1: Usable
	Write value:	Set command. 0: Unusable 1: Usable
BatterySupported	Read value:	Whether or not this Battery is supported by the selector. 0: Not supported 1: Supported
SelectorRevision	Read value:	Version of the Smart Battery Selector specification. For revision 1.0, the value will be 001.
ChargingIndicator	Read value:	A bit flag that indicates whether the selector reports the charger's status in the POWERBY nibble of SelectorState. 0: Charger status not supported 1: Charger status supported

4.2.3 Battery Controls

ManufacturerAccess	Read/Write according to the *Smart Battery Data Specification*. This usage is optional and implementation-specific.
RemainingCapacityLimit	Sets the value of the battery's remaining capacity, which causes a RemainingCapacity alarm to be sent. Whenever the battery's remaining capacity falls below the value in the RemainingCapacity alarm register, the battery periodically issues a RemainingCapacity alarm. (Units are defined by CapacityMode.)

RemainingTimeLimit	Sets the value of the battery's remaining time, which causes the RemainingTimeLimit control to be activated. Whenever the battery's remaining time falls below the value in the RemainingTimeLimit register, the battery periodically issues a RemainingTimeLimitExpired alarm. (Units are seconds.)
AtRate	Sets the value used by the battery to calculate AtRateTimeToFull, AtRateTimeToEmpty or ATRateOK. (AtRate units are defined by CapacityMode.)
CapacityMode	Can be set or read. Battery capacity units are as follows: 0: maH, (used in SMB) 1: mwH (used in SMB) 2: % 3: Boolean support only (OK or failed)
BroadcastToCharger	Can be set or read. 1: Enable broadcast to charger 0: Disable broadcast to charger
PrimaryBattery	Can be set or read. 1: Battery operates in its primary role 0: Battery operates in its secondary role
ChargeController	Can be set or read. 1: Internal charge control enabled 0: Internal charge control disabled

4.2.4 Battery Status

Initialized	Not included in this usage page. Use Initialized in the Power Device Page; see Section 4.1.5, "Power Generic Status."
Good	Not included in this usage page. Use Good in the Power Device Page; see Section 4.1.5, "Power Generic Status."
Overcharged	Not included in this usage page. Use Overcharged in the Power Device Page; see Section 4.1.5, "Power Generic Status."
TerminateCharge	Terminated (1)/Not Terminated (0).
OverTemperature	Not included in this usage page. Use OverTemperature in the Power Device Page; see Section 4.1.5, "Power Generic Status."
TerminateDischarge	Terminated (1)/Not Terminated (0).
BelowRemainingCapacityLimit	Below (1)/Not Below (0).
RemainingTimeLimitExpired	Expired (1)/Not Expired (0).
Charging	Charging (1)/Not Charging (0).
Discharging	Discharging (1)/Not Discharging (0).
FullyCharged	Fully Charged (1)/Not Fully Charged (0).
FullyDischarged	Fully Discharged (1)/Not Fully Discharged (0).
ConditioningFlag	Need Conditioning Cycle (1)/Battery OK (0).

AtRateOK	After an AtRate value setting, the device sets AtRateOK to 0 and calculates the AtRateTimeToFull and AtRateToEmpty values. When these values are already available, the device sets AtRateOK to 1.
SMBErrorCode	An SMB-specific 4-bit error code.
NeedReplacement	Need Replacement (1)/ No Need (0).

4.2.5 Battery Measures

AtRateTimeToFull	The predicted remaining time to fully charge the battery at the AtRate value. (Units are minutes.)
AtRateTimeToEmpty	The predicted operating time if the battery is discharged at the AtRate value.
Temperature	Not included in this usage page. Use Temperature in the Power Device Page; see Section 4.1.2, “Power Measures.”
Voltage	Not included in this usage page. Use Voltage in the Power Device Page; see Section 4.1.2, “Power Measures.”
Current	The current being supplied or accepted through the battery terminals. See BatteryUnits for units. Current is positive for charge and negative for discharge. Not included in this usage page. Use Current in the Power Device Page; see Section 4.1.2, “Power Measures.”
AverageCurrent	A one-minute rolling average of the current being supplied or accepted through the battery terminals.
Maxerror	The expected margin error (%) in the state of charge calculation.
RelativeStateOfCharge	The predicted remaining battery capacity expressed as a percentage of the last measured full charge capacity. (Units are %.)
AbsoluteStateOfCharge	The predicted remaining battery capacity expressed as a percentage of design capacity. (Units are %. The value may be greater than 100%.)
RemainingCapacity	The predicted remaining capacity. (See CapacityMode for units.)
FullChargeCapacity	The predicted pack capacity when it is fully charged. (See CapacityMode for units.)
RunTimeToEmpty	The predicted remaining battery life, in minutes, at the present rate of discharge. The RunTimeToEmpty is calculated based on either current or power depending on the CapacityMode setting.
AverageTimeToEmpty	A one-minute rolling average, in minutes, of the predicted remaining battery time life. The AverageTimeToEmpty is calculated based on either current or power depending on the CapacityMode setting.
AverageTimeToFull	A one-minute rolling average, in minutes, of the predicted remaining time until the battery reaches full charge.
CycleCount	The number, in cycles, of charge/discharge cycles the battery has experienced.

4.2.6 Battery Settings

BattPackModelLevel	Battery model level for the battery pack: 0: Basic model 1: Intelligent model 2: Smart Battery
InternalChargeController	1: Charge controller function supported in the battery pack 0: Function not supported
PrimaryBatterySupport	1: Primary battery function supported in the battery pack 0: Function not supported
DesignCapacity	The theoretical capacity of a new pack. (See CapacityMode for units.)
DesignVoltage	The theoretical voltage of a new pack. Not included in this usage page. Use ConfigVoltage in Power Device Page; see Section 4.1.3, “Power Configuration Controls.”
SpecificationInfo	The version number of the *Smart Battery Data Specification***.**
ManufacturerDate	The date the pack was manufactured in a packed integer. The date is packed in the following fashion: (year – 1980)*512 + month*32 + day.
SerialNumber	The cell pack serial number.
iManufacturerName	Index of a string descriptor containing the battery manufacturer’s name.
iDevicename	Index of a string descriptor containing the battery’s name.
iDeviceChemistry	Index of a string descriptor containing the battery’s chemistry.
ManufacturerData	A binary data block containing manufacturer specific data.

4.2.7 Battery Settings (ACPI specific)

Rechargable	Rechargeable Battery (1)/Not Rechargeable Battery (0).
WarningCapacityLimit	OEM-designed battery warning capacity. (Units are defined by CapacityMode.)
CapacityGranularity1	Battery capacity granularity between low and warning. (Units are defined by CapacityMode.)
CapacityGranularity2	Battery capacity granularity between warning and full. (Units are defined by CapacityMode)
IOEMInformation	Index of a string descriptor defining OEM specific information for the battery**.**

4.2.8 Charger Controls

ChargingCurrent	The desired charging rate. Not included in this usage page. Use ConfigCurrent in the Power Device Page; see Section 4.1.3, “Power Configuration Controls.”
ChargerVoltage	The desired charging voltage. Not included in this usage page. Use ConfigVoltage in the Power Device Page; see Section 4.1.3, “Power Configuration Controls.”

InhibitCharge	Write value:	1: Inhibit charging 0: Enable charging
	Read value:	1: Charger is inhibited 0: Charger is enabled
EnablePolling	Write value:	1: Enable polling 0: Disable polling
ResetToZero	Write value:	1: Reset Charging Current and Voltage values to zero. 0: Values remain unchanged.
PORReset	Not included in this usage page. Use ModuleReset in the Power Device Page; see Section 4.1.4, “Power Controls.”	

4.2.9 Charger Status

ACPresent	Present (1)/Not Present (0)
BatteryPresent	Present (1)/Not Present (0)
PowerFail	Low (1)/Not Low (0)
AlarmInhibited	Inhibited (1)/Not Inhibited (0)
ThermistorUnderRange	Under (1)/Not Under (0)
ThermistorHot	Hot (1)/Not Hot (0)
ThermistorCold	Cold (1)/Not Cold (0)
ThermistorOverRange	Over (1)/Not Over (0)
VoltageOutOfRange	Not Valid (1)/Valid (0)
CurrentOutOfRange	Not Valid (1)/Valid (0)
CurrentNotRegulated	Not Regulated (1)/ Regulated (0)
VoltageNotRegulated	Not Regulated (1)/Regulated (0)
MasterMode	1: Master mode (polling is enabled). 0: Slave mode (polling is disabled).

4.2.10 Charger Settings

Level3 and Level2 — Charger level flags:

Level3	**Level2**	**Charger Level**
0	0	Level 1
0	1	Level 2
1	1	Level 3

ChargerSelectorSupport — Selector support
0: No
1: Yes

ChargerSpec — Specification reference. (0001 for SMB charger 1.0)

5. Recommendations for Implementing Collections and Usages

This section offers recommendations for both implementation of firmware (device side) and application software (host side) of Power Devices. Specifically, the following tables in this section indicate:

- Which module collections are typically found in various Power Devices (Section 5.1)
- Which sub-module collections are contained in module collections (Section 5.2)
- Which identification items of the Power Device usage page are typically found in module, sub-module and flow collections (Section 5.3)
- Which other items of the Power Device usage page are typically found in module, sub-module and flow collections (Section 5.4)
- Which items of the Battery System usage page are typically found in module and sub-module collections (Section 5.5)

The tables in the following sections give recommendations, not requirements, of this specification. However, the *Smart Battery Specification* and *OnNow Power Management Specification* require certain items to be compliant (refer to those specifications for up-to-date information.). The tables in the following sections indicate those items as follows:

- R – This specification's recommendations
- S – Smart Battery requirements
- O – OnNow requirements

Power Device usage names and Smart Battery names are the same. But Power Device usage names and OnNow – ACPI names are not identical. The table in Section 5.6 gives equivalence between Power Summary usage names and related information in ACPI.

5.1 Module and Flow Collections within Power Device Examples

Table 4: Module and Flow Collections in Power Device Examples

	Power Device Examples				
Modules Collections Usage Names	A Simple Power Supply	USB Power Supply	A Rackmount Receptacle Strip	A Simple UPS	A More Complex UPS
BatterySystem		R		R	R
PowerConverter		R		R	R
OutletSystem			R		R
Flow	R	R	R	R	R
Power Summary	R,O	R,O		R,O	R,O

5.2 Submodule Collections within Submodules or Module Collections

Table 5: Sub-module Collections in Sub-modules or Module Collections

	Module (M) and Sub-module (SM) Collections								
Collection Usage Name	Battery System (M)	Battery (SM)	Charger (SM)	Power Converter (M)	Outlet System (M)	Input (SM)	Output (SM)	Outlet (SM)	Power Summary (M)
PresentStatus		R	R			R	R	R	R
ChangedStatus		R	R			R	R	R	R
Battery	R								
Charger	R								
Input	R			R	R				
Output	R			R	R				
Outlet					R				
Gang					R				

5.3 Power Device Page Identification Items within Sub-modules or Module or Flow Collections

Table 6: Power Device Page ID Usages in Sub-modules or Module or Flow Collections

	Modules (M), Sub-modules (SM), and Flow Collections										
ID Usage Names	Battery System (M)	Battery (SM)	Charger (SM)	Power Conver. (M)	Outlet System (M)	Input (SM)	Output (SM)	Flow	Outlet (SM)	Gang (SM)	Power Summ. (M)
iName	R	R	R	R	R	R	R	R	R	R	R
BatterySystemID	R										
BatteryID		R									R
ChargerID			R								
PowerConverterID				R							
OutletSystemID					R						
InputID						R					R
OutputID							R				
FlowID						R	R	R	R		R
OutletID									R		
GangID										R	
PowerSummaryID											R,O
iManufacturer											R
iProduct											R,O
iSerialNumber											R,O

5.4 Other Power Device Page Items within Modules, Submodules, or Flow Collections

Table 7: Other Power Device Page Items in Modules, Sub-modules, or Flow Collections

	Modules (M), Sub-modules (SM), or Flow Collections										
Item Usage Names	Battery System (M)	Battery (SM)	Charger (SM)	Power Conver. (SM)	Outlet System (M)	Input (SM)	Output (SM)	Flow	Outlet (SM)	Gang (SM)	Power Summ. (M)
Voltage		R	R,S			R	R				R,O
Current		R,S	R,S			R	R				R,O
Frequency						R	R				
ApparentPower						R	R				
ActivePower						R	R				
PercentLoad							R				R
Temperature	R	R	R	R	R						
Humidity	R			R	R						
BadCount						R	R				
ConfigVoltage		R,S	R,S					R			R,O
ConfigCurrent		R,S	R,S					R			

Item Usage Names	Modules (M), Sub-modules (SM), or Flow Collections										
	Battery System (M)	Battery (SM)	Charger (SM)	Power Conver. (SM)	Outlet System (M)	Input (SM)	Output (SM)	Flow	Outlet (SM)	Gang (SM)	Power Summ. (M)
ConfigFrequency								R			
ConfigApparentPower								R			
ConfigActivePower								R			
ConfigPercentLoad								R			
ConfigTemperature											
ConfigHumidity											
SwitchOnControl							R		R	R	R
SwitchOffControl							R		R	R	R
ToggleControl							R		R	R	
LowVoltageTransfer							R				
HighVoltageTransfer							R				
DelayBeforeReboot							R		R	R	
DelayBeforeStartup							R		R	R	
DelayBeforeShutdown							R		R	R	R
Test		R	R				R		R		R
ModuleReset											R
AudibleAlarmControl											R
Present		R (ST)	R (ST)			R (ST)	R (ST)				
Good		R,S (ST)				R (ST)	R (ST)				R
InternalFailure		R,S (ST)	R				R (ST)				
VoltageOutOfRange						R (ST)	R (ST)				
FrequencyOutOfRange						R (ST)	R (ST)				
Overload							R (ST)				R (ST)
OverCharged		R,S (ST)									
OverTemperature		R,S (ST)					R (ST)				
ShutdownRequested							R (ST)				
ShutdownImminent							R (ST)				R (ST)
SwitchOn/Off			R (ST)			R (ST)	R (ST)		R (ST)	R (ST)	
Switchable			R (ST)			R (ST)	R (ST)		R (ST)	R (ST)	
Used		R (ST)	R (ST)			R (ST)					
Boost							R (ST)				
Buck							R (ST)				
Initialized		R,S (ST)	R (ST)				R (ST)		R (ST)		
Tested		R (ST)	R (ST)				R (ST)		R (ST)		
AwaitingPower							R (ST)				
CommunicationLost											R (ST)

(ST) = May be implemented in a nested PresentStatus or ChangedStatus collection.

5.5 Battery System Page Items within Sub-modules and Module Collections

Table 8: Battery System Page Items in Sub-modules and Module Collections

Item Usage Names	Modules and Sub-module Collections			
	Battery System	Charger	Battery	Power Summary
SMBBatteryMode		R,S (ST)	R,S (ST)	
SMBBatteryStatus			R,S (ST)	
SMBAlarmWarning		R,S (ST)	R,S (ST)	
SMBChargerMode		R,S (ST)		
SMBChargerStatus		R,S (ST)		
SMBChargerSpecInfo		R,S		
SMBSelectorState	R,S (ST)			
SMBSelectorPreset	R,S (ST)			
SMBSelectorInfo	R,S			
OptionalMfgFunction1		R	R	
OptionalMfgFunction2		R	R	

Item Usage Names	Modules and Sub-module Collections			
	Battery System	Charger	Battery	Power Summary
OptionalMfgFunction3		R	R	
OptionalMfgFunction4		R	R	
OptionalMfgFunction5		R	R	
ConnectionToSMBus	R,S			
OutputConnection	R,S			
ChargerConnection	R,S			
BatteryInsertion	R,S			
Usenext	R,S			
OKToUse	R,S (ST)			
ManufacturerAccess			R,S	
RemainingCapacityLimit			R,S	R,O
RemainingTimeLimit			R,S	R
AtRate			R,S	
CapacityMode			R,S	R,O
BroadcastToCharger			R,S	
PrimaryBattery			R,S	
ChargeController			R,S	
TerminateCharge			R,S(ST)	
TerminateDischarge			R,S (ST)	
BelowRemainingCapacityLimit			R,S (ST)	R,O
RemainingTimeLimitExpired			R,S (ST)	
Charging			R,S (ST)	R,O
Discharging			R,S (ST)	R,O
FullyCharged			R,S (ST)	
FullyDischarged			R,S (ST)	
ConditioningFlag			R,S (ST)	
AtRateOK			R,S (ST)	
SMBErrorCode			R,S (ST)	
NeedReplacement			R,S (ST)	
AtRateTimeToFull			R,S	
AtRateTimeToEmpty			R,S	
AverageCurrent			R,S	
Maxerror			R,S	
RelativeStateOfCharge			R,S	
AbsoluteStateOfCharge			R,S	
RemainingCapacity			R,S	R,O
FullChargeCapacity			R,S	R,O
RunTimeToEmpty			R,S	R
AverageTimeToEmpty			R,S	
AverageTimeToFull			R,S	
CycleCount			R,S	
BattPackModelLevel			R,S	
InternalChargeController			R,S	
PrimaryBatterySupport			R,S	
DesignCapacity			R,S	R,O
SpecificationInfo			R,S	
ManufacturerDate			R,S	
SerialNumber			R,S	
iManufacturerName			R,S	R
iDevicename			R,S	
iDeviceChemistry			R,S	R,O
ManufacturerData			R,S	
Rechargable			R	R,O
WarningCapacityLimit				R,O
CapacityGranularity1				R,O
CapacityGranularity2				R,O
iOEMInformation				R,O
InhibitCharge		R,S		
EnablePolling		R,S		
ResetToZero		R,S		
ACPresent		R,S (ST)		R,O
BatteryPresent		R,S (ST)		

Item Usage Names	Modules and Sub-module Collections			
	Battery System	Charger	Battery	Power Summary
PowerFail		R,S (ST)		
AlarmInhibited		R,S (ST)		
ThermistorUnderRange		R,S (ST)		
ThermistorHot		R,S (ST)		
ThermistorCold		R,S (ST)		
ThermistorOverRange		R,S (ST)		
VoltageOutOfRange		R,S (ST)		
CurrentOutOfRange		R,S (ST)		
CurrentNotRegulated		R,S (ST)		
VoltageNotRegulated		R,S (ST)		
MasterMode		R,S (ST)		
ChargerBattery/HostControlled		R,S		
ChargerSpecInfo		R,S		
ChargerSpecRef		R,S		
Level2		R,S		
Level3		R,S		

(ST) = May be implemented in a nested PresentStatus or ChangedStatus collection.

5.6 Equivalence between ACPI Battery Information and Power Summary Usages

In regards to the implemented data format in the HID Report descriptor, some format translation must be done in application software in order to present information to the OS in ACPI data format.

Table 9: Equivalence Between ACPI Battery Information and Power Summary Usages

ACPI Battery Control Method	ACPI data in Control Method	PD HID Usage in Power Summary
_BIF	Power Unit	CapacityMode
_BIF	Designed Capacity	DesignCapacity
_BIF	Last Full Charge Capacity	FullChargeCapacity
_BIF	Battery Technology	Rechargable
_BIF	Design Voltage	ConfigVoltage
_BIF	Design capacity of Warning	WarningCapacityLimit
_BIF	Design capacity of Low	RemainingCapacityLimit
_BIF	Battery capacity granularity 1	CapacityGranularity1
_BIF	Battery capacity granularity 2	CapacityGranularity2
_BIF	Model Number	iProduct
_BIF	Serial Number	iSerialNumber
_BIF	Battery Type	iDeviceChemistery
_BIF	OEM Information	iOEMInformation
_BST	Battery State bit 0	Discharging
_BST	Battery State bit 1	Charging
_BST	Battery State bit 2	BelowRemainingCapacityLimit
_BST	Battery Present Rate	Current
_BST	Battery Remaining Capacity	RemainingCapacity
_BST	Battery Present Voltage	Voltage
_BTP	Trip point for Battery Remaining Capacity	RemainingCapacityLimit
_PSR	Current Power Source	ACPresent

Appendix A: Example of a Simple UPS

This appendix contains a sample set of descriptors for an simple UPS product. The following figure shows the topology of such a device.

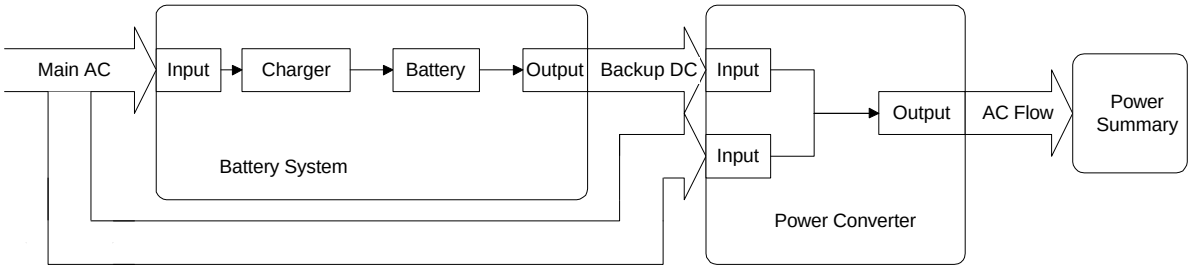

Figure 7: A Simple UPS

This Power Device configuration contains the following objects:

- One AC Input Flow (main AC)
- One Battery System consisting of one AC Input, one Battery, one Charger, and one DC Output
- One DC Flow (backup DC)
- One Power Converter consisting of one DC Input, one AC Input, and one AC Output
- One AC Output Flow (AC flow)
- One Power Summary

There is a single Interface, a single Endpoint, HID, and Report descriptors for this device. This device would also use standard String descriptors as defined in the *HID Specification*; see that document for details. In the following tables, grey indicates standards for such HID Devices and bold indicates typical values. Question marks (????) indicate values that must be defined by the implementer.

A.1 Device Descriptor

Table 10: UPS Example Device Descriptor

Part	Offset/Size (Bytes)	Description	Sample Value
bLength	0/1	Numeric expression specifying the size of this descriptor.	0x12
bDescriptorType	1/1	Device descriptor type (assigned by USB).	0x01
bcdUSB	2/2	USB HID Specification Release 1.0.	0x100
bDeviceClass	4/1	Class code (assigned by USB). Note that the HID class is defined in the Interface descriptor.	0x00
bDeviceSubClass	5/1	Subclass code (assigned by USB). These codes are qualified by the value of the bDeviceClass field.	0x00
bDeviceProtocol	6/1	Protocol code. These codes are qualified by the value of the bDeviceSubclass field.	0x00

Part	Offset/Size (Bytes)	Description	Sample Value
bMaxPacketSize0	7/1	Maximum packet size for endpoint zero (only 8, 16, 32, or 64 are valid).	0x08
idVendor	8/2	Vendor ID (assigned by USB). For this example we'll use xFFFF.	**0xFFFF**
IdProduct	10/2	Product ID (assigned by manufacturer).	**0x????**
BcdDevice	12/2	Device release number (assigned by manufacturer).	**0x????**
IManufacturer	14/1	Index of String descriptor describing manufacturer.	**0x??**
IProduct	15/1	Index of String descriptor describing product.	**0x??**
ISerialNumber	16/1	Index of String descriptor describing the device's serial number.	**0x??**
BNumConfigurations	17/1	Number of possible configurations.	**0x01**

A.2 Configuration Descriptor

Table 11: UPS Example Configuration Descriptor

Part	Offset/Size (Bytes)	Description	Sample Value
BLength	0/1	Size of this descriptor in bytes.	0x09
BDescriptorType	1/1	Configuration (assigned by USB).	0x02
WTotalLength	2/2	Total length of data returned for this configuration. Includes the combined length of all returned descriptors (configuration, interface, endpoint, and HID) returned for this configuration. This value includes the HID descriptor but none of the other HID class descriptors (report or designator).	**0x????**
bNumInterfaces	4/1	Number of interfaces supported by this configuration.	0x01
bConfigurationValue	5/1	Value to use as an argument to Set Configuration to select this configuration.	0x01
iConfiguration	6/1	Index of string descriptor describing this configuration. In this case there is none.	0x00
BmAttributes	7/1	Configuration characteristics 7 Bus Powered 6 Self Powered 5 Remote Wakeup 4..0 Reserved (reset to 0)	**01100000B**
MaxPower	8/1	Maximum power consumption of USB device from bus in this specific configuration when the device is fully operational. Expressed in 2 mA units—for example, 50 = 100 mA. The number chosen for this example is arbitrary.	**0x32**

A.3 Interface Descriptor

Table 12: UPS Example Interface Descriptor

Part	Offset/Size (Bytes)	Description	Sample Value
BLength	0/1	Size of this descriptor in bytes.	0x09
BDescriptorType	1/1	Interface descriptor type (assigned by USB).	0x04
BInterfaceNumber	2/1	Number of interface. Zero-based value identifying the index in the array of concurrent interfaces supported by this configuration.	0x00
BAlternateSetting	3/1	Value used to select alternate setting for the interface identified in the prior field.	0x00
bNumEndpoints	4/1	Number of endpoints used by this interface (excluding endpoint zero). If this value is zero, this interface only uses endpoint zero.	0x01
bInterfaceClass	5/1	Class code (HID code assigned by USB).	0x03
bInterfaceSubClass	6/1	Subclass code. 0 No subclass 1 Boot Interface subclass	0x01
BinterfaceProtocol	7/1	Protocol code. 0 None	0x00
Iinterface	8/1	Index of string descriptor describing this interface.	**0x00**

A.4 Endpoint Descriptor

Table 13: UPS Example Endpoint Descriptor

Part	Offset/Size (Bytes)	Description	Sample Value
bLength	0/1	Size of this descriptor in bytes.	0x07
bDescriptorType	1/1	Endpoint descriptor type (assigned by USB).	0x05
bEndpointAddress	2/1	The address of the endpoint on the USB device described by this descriptor. The address is encoded as follows: Bit 0..3 The endpoint number Bit 4..6 Reserved, reset to zero Bit 7 Direction, ignored for Control endpoints: 0 OUT endpoint 1 IN endpoint	10000001B

Part	Offset/Size (Bytes)	Description	Sample Value
bmAttributes	3/1	This field describes the endpoint's attributes when it is configured using the bConfigurationValue. Bit 0..1 Transfer type: 00 Control 01 Isochronous 10 Bulk 11 Interrupt All other bits are reserved.	00000011B
wMaxPacketSize	4/1	Maximum packet size this endpoint is capable of sending or receiving when this configuration is selected. For interrupt endpoints, this value is used to reserve the bus time in the schedule, required for the per frame data payloads. Smaller data payloads may be sent, but will terminate the transfer, and thus require intervention to restart.	**0x08**
bInterval	6/1	Interval for polling endpoint for data transfers, expressed in milliseconds.	**0x0A**

A.5 HID Descriptor

Table 14: UPS Example HID Descriptor

Part	Offset/Size (Bytes)	Description	Sample Value
BLength	0/1	Size of this descriptor in bytes.	0x09
BDescriptorType	1/1	HID descriptor type (assigned by USB).	0x21
BcdHID	2/2	HID Class Specification release number in binary-coded decimal. For example, 2.10 is 0x210.	0x100
BCountryCode	4/1	Hardware target country.	0x00
BNumDescriptors	5/1	Number of HID class descriptors to follow.	0x01
BDescriptorType	6/1	Report descriptor type.	0x22
WDescriptorLength	7/2	Total length of Report descriptor.	**0x????**

A.6 Report Descriptor

This Report descriptor is a series of nested collections for all the different objects included in the UPS. Its skeleton is defined below. (PresentStatus and ChangedStatus collections are not shown here.)

UPS application collection
- *Main AC flow physical collection*
- *End Main AC flow collection*
- *Backup DC flow physical collection*
- *End Backup DC flow collection*
- *Output AC flow physical collection*
- *End Output AC flow collection*
- *Battery System physical collection*
  - *AC Input physical collection*
  - *End AC Input collection*
  - *Charger physical collection*
  - *End Charger collection*
  - *Battery physical collection*
  - *End Battery collection*
  - *DC Output physical collection*
  - *End DC Output collection*
- *End Battery System collection*
- *Power Converter physical collection*
  - *AC Input physical collection*
  - *End AC Input collection*
  - *AC Output physical collection*
  - *End AC Output collection*
  - *DC Input physical collection*
  - *End DC Input collection*
- *End Power Converter collection*
- *PowerSummary physical collection*
- *End PowerSummary collection*

End UPS collection

A.6.1 Header of UPS application collection

```
UsagePage(Power Device),
Usage(UPS), Collection(Application),                          ; UPS collection
```

A.6.2 Main AC flow physical collection

The main AC flow contains the flow ID (1), name, configuration voltage, and configuration frequency of AC. Feature report ID 1 begins.

```
UsagePage(Power Device),
Usage(Flow), Collection(Physical), ReportID (1),              ; Main AC Flow
  Usage(FlowID), Unit(none),                                  ; Constant = 1
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  ReportSize(4), ReportCount(1),
  Feature(Constant, Variable, Absolute),                      ; 4-bit pad
  Usage(iName),
  ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigVoltage),
  ReportSize(8), ReportCount(1), Unit(Volt), UnitExponent(7),  ; In Volts (110 or 220)
  Logical Minimum (0), Logical Maximum (250),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigFrequency),
  ReportSize(8), ReportCount(1), Unit(Hertz), UnitExponent(0), ; In Hertz (50 or 60)
  Logical Minimum (0), Logical Maximum (60),
  Feature(Constant, Variable, Absolute),
End Collection(),                                        ; End of Main AC Flow collection
```

A.6.3 Backup DC flow physical collection

The backup DC flow contains the flow ID (2), name, configuration voltage, and configuration frequency of DC. Feature report ID 2 begins.

```
UsagePage(Power Device),
Usage(Flow), Collection(Physical), ReportID (2),              ; Backup DC
  Usage(FlowID), Unit(none),                                  ; Constant = 2
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  ReportSize(4), ReportCount(1),
  Feature(Constant, Variable, Absolute),                      ; 4-bit pad
  Usage(iName),
  ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigVoltage),
  ReportSize(16), ReportCount(1), Unit(Volt), UnitExponent(5),  ; In cVolts
  Logical Minimum (0), Logical Maximum (0xFFFE),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigFrequency),
  ReportSize(8), ReportCount(1), Unit(Herz), UnitExponent(0),   ; In Hertz (0)
  Logical Minimum (0), Logical Maximum (60),
  Feature(Constant, Variable, Absolute),
End Collection(),                                             ; End of DC Flow collection
```

A.6.4 Output AC flow physical collection

The output AC flow contains the flow ID (3), name, configuration voltage, configuration frequency, and configuration power of AC. Feature report ID 3 begins.

```
UsagePage(Power Device),
Usage(Flow), Collection(Physical), ReportID (3),        ; UPS Output
  Usage(FlowID), Unit(none),                            ; Constant=3, connected to flow 3
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  ReportSize(4), ReportCount(1),
  Feature(Constant, Variable, Absolute),                        ; 4-bit pad
  Usage(iName),
  ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigVoltage),
  ReportSize(8), ReportCount(1), Unit(Volt), UnitExponent(7),   ; In Volts (110 or 220)
  Logical Minimum (0), Logical Maximum (250),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigFrequency),
  ReportSize(8), ReportCount(1), Unit(Hertz), UnitExponent(0),  ; in Hertz (50 or 60)
  Logical Minimum (0), Logical Maximum (60),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigApparentPower),
  ReportSize(16), ReportCount(1), Unit(Watt), UnitExponent (7), ; In VA
  Logical Minimum (0), Logical Maximum (0xFFFE),
  Feature(Constant, Variable, Absolute),
End Collection(),                                       ; End of Output AC Flow collection
```

A.6.5 Header of Battery System Physical Collection

The header of the Battery System contains the battery system ID (1), followed by the collection corresponding to its sub-modules. Feature Report ID 4 begins.

```
UsagePage(Power Device),
Usage(BatterySystem), Collection(Physical), ReportID (4),       ; Battery System
  Usage(BatterySystemID), Unit(none),                           ; Constant = 1
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  ReportSize(4), ReportCount(1),
  Feature(Constant, Variable, Absolute),                        ; 4 bit pad
```

A.6.6 Battery System: AC Input Physical Collection

The Battery System AC input contains the input ID (1), the ID of the connected flow (1), and two status items: Used and Good. Feature report ID 4 continues. Input report ID 4 begins.

```
Usage(Input),
Collection(Physical),                                   ; Battery System: AC Input
  Usage(InputID),                                       ; Constant=1
  Usage(FlowID),                                        ; Constant=1, connected to flow 1
  ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  Usage(CurrentStatus), Collection(Logical),            ; Present status collection
    Usage(Used), Usage(Good),
    ReportSize(1), ReportCount(2), Logical Minimum (0), Logical Maximum (1),
    Feature(Constant, Variable, Absolute, Volatile),
  End Collection(),                                     ; End of Present Status collection
  Usage(ChangedStatus), Collection(Logical),            ; Changed Status collection
    Usage(Used), Usage(Good),
    ReportSize(2), ReportCount(2), Logical Minimum (0), Logical Maximum (1),
    Input(Data, Variable, Absolute, Volatile),
  End Collection(),                                     ; End of Changed Status collection
End Collection(),                                       ; End of AC Input collection
```

A.6.7 Battery System: Charger Physical Collection

The Battery System Charger contains the charger ID (1). Feature report ID 5 begins.

```
Usage(Charger), Collection(Physical), ReportID (5),     ; Battery system: Charger
  Usage(ChargerID),                                     ; Constant = 1
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
End Collection(),                                       ; End of Charger collection
```

A.6.8 Battery System: DC Output Physical Collection

The Battery System DC output contains the output ID (1) and the ID of the connected flow (2). Feature report ID 5 continues.

```
Usage(Output), Collection(Physical),                    ; Battery System: DC Output
  Usage(OutputID),                                      ; Constant = 1
  Usage(FlowID),                                        ; Constant = 2, Connected to flow 2
  ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
End Collection(),                                       ; End of DC Output collection
```

A.6.9 Battery System: Battery Physical Collection

The Battery System battery contains the battery ID (1), the capacity mode, the design capacity, the configuration voltage, the remaining capacity, and four status items: Good, BelowRemainingCapacityLimit, Charging, and Discharging. Feature report ID 6 and Input report ID 6 begin.

```
Usage(Battery), Collection(Physical), ReportID (6),           ; Battery System: Battery
  Usage(BatteryID),                                           ; Constant = 1
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  UsagePage(Battery System),
  Usage(CapacityMode),
  ReportSize(1), ReportCount(1), Logical Minimum (0), Logical Maximum (1),
  Feature(Constant, Variable, Absolute),
  ReportSize(3), ReportCount(1),
  Feature(Constant, Variable, Absolute),                                  ; 3-bit pad
  Usage(DesignCapacity),
  ReportSize(24), ReportCount(1), Unit(Amp.s), UnitExponent(0),           ; In Amp.secs
  Logical Minimum (0), Logical Maximum (0xFFFFFE),
  Feature(Constant, Variable, Absolute),
  UsagePage(Power Device), Usage(ConfigVoltage),
  ReportSize(16), ReportCount(1), Unit(Volt), UnitExponent(5),            ; In c.Volts
  Logical Minimum (0), Logical Maximum (0xFFFE),
  Feature(Constant, Variable, Absolute),
  UsagePage(Battery System), Usage(RemainingCapacity),
  ReportSize(24), ReportCount(1), Unit(mAh),UnitExponent(0),              ; In Amp.secs
  Logical Minimum (0), Logical Maximum (0xFFFFFE),
  Feature(Constant, Variable, Absolute, Volatile),
```

```
    UsagePage(Power Device), Unit(none),
    Usage(PresentStatus), Collection(Logical),          ; Present status collection
      Usage(Good),
      UsagePage(Battery System), Usage(BelowRemainingCapacityLimit),
      Usage(Charging), Usage(Discharging),
      ReportSize(1), ReportCount(4), Logical Minimum (0), Logical Maximum (1), Unit(0),
      Feature(Constant, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of Present Status collection
    UsagePage(Power Device),
    Usage(ChangedStatus), Collection(Logical),          ; Changed Status collection
      Usage(Good),
      UsagePage(Battery System), Usage(BelowRemainingCapacityLimit),
      Usage(Charging), Usage(Discharging),
      ReportSize(2), ReportCount(4), Logical Minimum (0), Logical Maximum (1),
      Input(Data, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of Changed Status collection
  End Collection(),                                     ; End of Battery collection
End Collection(),                                       ; End of Battery System collection
```

A.6.10 Header of Power Converter Physical Collection

The header of the Power Converter contains the power converter ID followed by the collection corresponding to its sub-modules. Feature report ID 8 and Input report ID 8 begin.

```
UsagePage(Power Device),
Usage(PowerConverter), Collection(Physical), ReportID (8),      ; Power Converter
  Usage(PowerConverterID),                                      ; Constant = 1
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
```

A.6.11 Power Converter: AC Input Physical Collection

The Power Converter AC input contains the input ID (2), the ID of the connected flow (1), and two status items: Used and Good. Feature report ID 8 and Input report ID 8 continue.

```
  Usage(Input), Collection(Physical),                   ; Power Converter: AC Input
    Usage(InputID),                                     ; Constant = 2
    Usage(FlowID),                                      ; Constant = 1, Connected to flow 1
    ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
    Feature(Constant, Variable, Absolute),
    Usage(PresentStatus), Collection(Logical),          ; Present status collection
      Usage(Used), Usage(Good),
      ReportSize(1), ReportCount(2), Logical Minimum (0), Logical Maximum (1),
      Feature(Constant, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of Present Status collection
    Usage(ChangedStatus), Collection(Logical),          ; Changed Status collection
      Usage(Used), Usage(Good),
      ReportSize(2), ReportCount(2), Logical Minimum (0), Logical Maximum (1),
      Input(Data, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of Changed Status collection
  End Collection(),                                     ; End of AC Input collection
```

A.6.12 Power Converter: AC Output Physical Collection

The Power Converter AC output contains the output ID (2), the ID of the connected flow (3), and four status items: Used, Good, Overload, and ShutdownImminent. Feature Report ID 9 and Input Report ID 9 begin.

```
  Usage(Output), Collection(Physical),                  ; Power Converter: AC Output
    ReportID (9),
    Usage(OutputID),                                    ; Constant = 2
    Usage(FlowID),                                      ; Constant = 3, Connected to flow 3
    ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
    Feature(Constant, Variable, Absolute),
    Usage(PercentLoad),
    ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
    Input(Constant, Variable, Absolute, Volatile),
    Usage(PresentStatus), Collection(Logical),          ; Present status collection
      Usage(Used), Usage(Good),
      Usage(Overload), Usage(ShutdownImminent),
      ReportSize(1), ReportCount(4), Logical Minimum (0), Logical Maximum (1),
      Feature(Constant, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of Present Status collection
    Usage(ChangedStatus), Collection(Logical),          ; Changed Status collection
      Usage(Used), Usage(Good),
      Usage(Overload), Usage(ShutdownImminent),
      ReportSize(2), ReportCount(4), Logical Minimum (0), Logical Maximum (1),
      Input(Data, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of Changed Status collection
  End Collection(),                                     ; End of AC Output collection
```

A.6.13 Power Converter: DC Input Physical Collection

The Power Converter DC input contains the input ID (2), the ID of the connected flow (2), and two status items: Used and Good. Feature report ID 10 and Input report ID 10 begin.

```
  Usage(Input), Collection(Physical),
    ReportID (10),                                      ; Power Converter: DC Input
    Usage(InputID),                                     ; Constant = 3
    Usage(FlowID),                                      ; Constant = 2, Connected to flow 2
    ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
    Feature(Constant, Variable, Absolute),
    Usage(PresentStatus), Collection(Logical),          ; Present status collection
      Usage(Used),Usage(Good),
      ReportSize(1), ReportCount(2), Logical Minimum (0), Logical Maximum (1),
      Feature(Constant, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of Present Status collection
    Usage(ChangedStatus), Collection(Logical),          ; Changed Status collection
         Usage(Used),Usage(Good),
      ReportSize(2), ReportCount(2), Logical Minimum (0), Logical Maximum (1),
      Input(Data, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of Changed Status collection
  End Collection(),                                     ; End of DC Input collection
End Collection(),                                       ; End of PowerConverter collection
```

A.6.14 Power Summary Physical Collection

As static data, the Power Summary collection contains the power summary ID (1), the ID of the connected flow (3), the name of the power source, a battery presence indicator, the capacity mode (unit of battery capacity), a battery rechargeability indicator, the battery design capacity, the battery design voltage, the warning capacity limit, battery granularities 1 and 2, the product name, the serial number, the battery chemistry, and the manufacturer name.

As dynamic data, the Power Summary collection contains the last full charge capacity, the battery present voltage, the battery discharge current, the present remaining capacity, the present run time before the battery is empty, the UPS output percent of load, and six status items: for AC input: Present; for battery: BelowRemainingCapacityLimit, Charging, and Discharging; and for output: Overload and ShutdownImminent.

Feature report ID 11 and Input report ID 11 begin.

```
  UsagePage(Power Device), Usage(PowerSummary), Collection(Physical)   ; Power Summary
  ReportID (11),
    Usage(PowerSummaryID),                                ; Constant = 1
    Usage(FlowID),                                        ; Constant = 3, connected to flow 3
    ReportSize(4), ReportCount(2), Logical Minimum(0), Logical Maximum (15), Unit(0),
    Feature(Constant, Variable, Absolute),
    Usage(iName),                        ; Constant = pointer to "UPS Power Output Source"
    ReportSize(8), ReportCount(1), Logical Maximum(255, Unit(0),
    Feature(Constant, Variable, Absolute),
    UsagePage(Battery System),
    Usage(BatteryPresent)                                 ; Constant = 1 (battery present)
    Usage(CapacityMode),                                  ; Constant = 0 (As)
    Usage(Rechargable),                                   ; Constant = 1 (rechargeable)
    ReportSize(1), ReportCount(3), Logical Maximum (1),
    Feature(Constant, Variable, Absolute),
    ReportCount(5),                                       ; 5 bits padding
    Feature(Constant, Variable, Absolute),
    UsagePage(Battery System), Usage(DesignCapacity),     ; Value = Battery Design Capacity
    Usage(WarningCapacityLimit),                          ; Value = x% of DesignCapacity
    Usage(CapacityGranularity1),                          ; Value = y% of DesignCapacity
    Usage(CapacityGranularity2),                          ; Value = z% of DesignCapacity
    ReportSize(24), ReportCount(4), Unit(AmpSec), UnitExponent(0), Logical Maximum (0xFFFFFE),
    Feature(Constant, Variable, Absolute),
    UsagePage(Power Device), Usage(ConfigVoltage),        ; Value = Battery Design Voltage
    ReportSize(16), ReportCount(1), Unit(Volt), UnitExponent(5), Logical Maximum (0xFFFE),
    Feature(Constant, Variable, Absolute),
    UsagePage(Power Device), Usage(iProduct),             ; Value = pointer to "ACME UPS 1000 "
    Usage(iSerialNumber),                                 ; Value = pointer to "1000-234"
    UsagePage(Battery System), Usage(iDeviceChemistry),   ; Value = pointer to "PbAc"
    Usage(iManufacturerName),                     ; Value = pointer to "Battery in ACME UPS"
    ReportSize(8), ReportCount(4), Logical Maximum (0xFF), Unit(0),
    Feature(Constant, Variable, Absolute),
    UsagePage(Power Device), Usage(PercentLoad), ; Value = Present UPS output percent load
    ReportSize(8), ReportCount(1), Logical Maximum (254), Unit(0),
    Input(Constant, Variable, Absolute, Volatile),
    UsagePage(Power Device), Usage(Voltage),      ; Value = Battery present voltage
    ReportSize(16), ReportCount(1), Unit(Volt), UnitExponent(5), Logical Maximum (0xFFFE),
    Feature(Constant, Variable, Absolute, Volatile),
    Usage(Current),                               ; Value = Battery present discharge current
    ReportCount(1), Unit(Amp), UnitExponent(-2),
    Feature(Constant, Variable, Absolute, Volatile),
    UsagePage(Battery System), Usage(FullChargeCapacity),   ; Value = 100% of Design Capacity
    ReportSize(24), ReportCount(1), Unit(AmpSec), UnitExponent(0), Logical Maximum (0xFFFFFE)
    Feature(Constant, Variable, Absolute, Volatile),
    Usage(RemainingCapacity),                     ; Value = Present remaining capacity
    ReportCount(1),
    Input(Constant, Variable, Absolute, Volatile),
    Usage(RunTimeToEmpty),                ; Value = Present run time before battery empty
    ReportSize(16), ReportCount(1), Unit(second), UnitExponent(0), Logical Maximum (0xFFFE),
    Input(Constant, Variable, Absolute, Volatile)
    Usage(PresentStatus), Collection(Logical)             ; PresentStatus collection
      UsagePage(Battery System), Usage(ACPresent)         ; AC Input status
      Usage(Charging),                                    ; Battery status
      Usage(Discharging),                                 ; Battery status
      Usage(BelowRemainingcapacityLimit),                 ; Battery status
      UsagePage(Power Device), Usage(ShutdownImminent),   ; UPS output status
      Usage(Overload),                                    ; UPS output status
      ReportSize(1), ReportCount(6), Logical Maximum (1),
      Input(Constant, Variable, Absolute, Volatile),
    End Collection,                                       ; End of Present Status collection
  End Collection,                                         ; End of Power Summary collection
End Collection()                                          ; End of UPS collection
```

A.7 Related Report Format Samples

This section contains a partial set of report format samples related to Report descriptors defined earlier in this appendix.

Figure 8: UPS Example Feature Report ID 1 and ID 2

	Bit							
Byte	7	6	5	4	3	2	1	0
0	1 (for Report ID 1) or 2 (for Report ID 2)							
1	Pad				FlowID			
2	iName							
3	ConfigVoltage							
4	ConfigFrequency							

Figure 9: UPS Example Feature Report ID 3

	Bit							
Byte	7	6	5	4	3	2	1	0
0	3 (for Report ID 3)							
1	Pad				FlowID			
2	iName							
3	ConfigVoltage							
4	ConfigFrequency							
5	ConfigApparentPower Bits 0-7							
6	ConfigApparentPower Bits 8-15							

Figure 10: UPS Example Feature Report ID 9

	Bit							
Byte	7	6	5	4	3	2	1	0
0	9 (for Report ID 9)							
1	FlowID				OutputID			
2	PercentLoad							
3	Pad	Pad	Pad	Pad	Shutdown Imminent	Overload	Good	Used

Figure 11: UPS Example Input Report ID 9

	Bit							
Byte	7	6	5	4	3	2	1	0
0	9 (for Report ID 9)							
1	ShutdownImminent		Overload		Good		Used	

Figure 12: UPS Example Feature Report ID 11

	Bit							
Byte	7	6	5	4	3	2	1	0
0	11 (for Report ID 11)							
1	FlowID				PowerSummaryID			
2	IName							
3	Padding					Recharge-able	Capacity Mode	Battery Present
4	Battery Design Capacity Bits 0-7							
5	Battery Design Capacity Bits 8-15							
6	Battery Design Capacity Bits 16-23							
7	Battery Warning Capacity Limit Bits 0-7							
8	Battery Warning Capacity Limit Bits 8-15							
9	Battery Warning Capacity Limit Bits 16-23							
10	Battery Granularity 1 Bits 0-7							
11	Battery Granularity 1 Bits 8-15							
12	Battery Granularity 1 Bits 16-23							
13	Battery Granularity 2 Bits 0-7							
14	Battery Granularity 2 Bits 8-15							
15	Battery Granularity 2 Bits 16-23							
16	Battery Config Voltage Bits 0-7							
17	Battery Config Voltage Bits 8-15							
18	iProduct							
19	iSerialNumber							
20	iDeviceChemistry							
21	iManufacturerName							
22	Battery present Voltage Bits 0-7							
23	Battery present Voltage Bits 8-15							
24	Battery Discharge Current Bits 0-7							
25	Battery Discharge Current Bits 8-15							
26	Battery Full Charge Capacity Bits 0-7							
27	Battery Full Charge Capacity Bits 8-15							
28	Battery Full Charge Capacity Bits 16-23							

Figure 13: UPS Example Input Report ID 11

	Bit							
Byte	7	6	5	4	3	2	1	0
0	11 (for Report ID 11)							
1	PercentLoad							
2	RemainingCapacity Bits 0-7							
3	RemainingCapacity Bits 8-15							
4	RemainingCapacity Bits 16-23							
5	Run Time To Empty Bits 0-7							
6	Run Time To Empty Bits 8-15							
7	Pad	Pad	Overload	Shutdown Imminent	Below Remaining Capacity Limit	Discharg-ing	Charging	AC Present
			UPS Output		*********Battery**********			*AC Input*

Appendix B: Example of a Power Supply of a Typical USB Device

This appendix contains a Report descriptor for a typical USB Device. The following figure shows the topology of such a device.

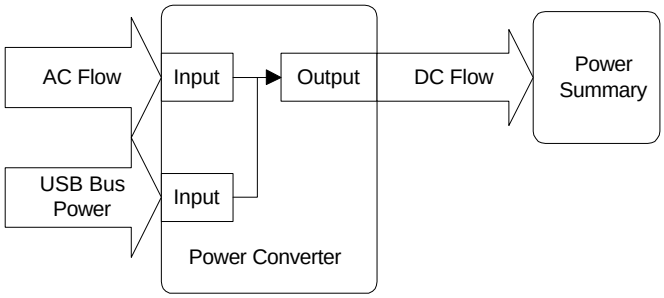

Figure 14: The Power Supply of a Typical USB Device

This Power Device configuration contains the following objects:

- One AC Input Flow (AC flow)
- One DC Input Flow (USB bus power)
- One Power Converter consisting of one AC Input, one DC Input, and one DC Output
- One DC Output Flow (DC flow)
- One Power Summary

B.1 Report Descriptor

This report descriptor is a series of nested collections for all different objects included in the device. Its skeleton is defined below. (PresentStatus collections are not shown here.)

Power Supply application collection
Main AC flow physical collection
End Main AC flow collection
USB Bus Power physical collection
End USB Power collection
Output DC flow physical collection
End Output DC flow collection
Power Converter physical collection
AC Input physical collection
End AC Input collection
AC Output physical collection
End AC Output collection
DC Input physical collection
End DC Input collection
End Power Converter collection
PowerSummary physical collection
End PowerSummary collection
End Power Supply collection

B.1.1 Header of Power Supply Application Collection

```
UsagePage(Power Device),
Usage(PowerSupply), Collection(Application),                    ; UPS collection
```

B.1.2 Main AC flow Physical Collection

The main AC flow contains the flow ID (1), name, configuration voltage, and configuration frequency of AC. Feature report ID 1 begins.

```
UsagePage(Power Device),
Usage(Flow), Collection(Physical), ReportID (1),                ; Main AC Flow
  Usage(FlowID), Unit(none),                                    ; Constant = 1
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  ReportSize(4), ReportCount(1),
  Feature(Constant, Variable, Absolute),                        ; 4-bit pad
  Usage(iName),
  ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigVoltage),
  ReportSize(8), ReportCount(1), Unit(Volt), UnitExponent(7),   ; In Volts (110 or 220)
  Logical Minimum (0), Logical Maximum (250),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigFrequency),
  ReportSize(8), ReportCount(1), Unit(Hertz), UnitExponent(0),  ; In Hertz
  Logical Minimum (0), Logical Maximum (60),
  Feature(Constant, Variable, Absolute),
End Collection(),                                       ; End of Main AC Flow collection
```

B.1.3 USB Power DC flow Physical Collection

The USB Power DC flow contains the flow ID (2), name, configuration voltage, and configuration frequency of DC. Feature report ID 2 begins.

```
UsagePage(Power Device),
Usage(Flow), Collection(Physical), ReportID (2),                ; Backup DC
  Usage(FlowID), Unit(none),                                    ; Constant = 2
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  ReportSize(4), ReportCount(1),
  Feature(Constant, Variable, Absolute),                        ; 4-bit pad
  Usage(iName),
  ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigVoltage),
  ReportSize(16), ReportCount(1), Unit(Volt), UnitExponent(5),  ; In cVolts (500)
  Logical Minimum (0), Logical Maximum (0xFFFE),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigFrequency),
  ReportSize(8), ReportCount(1), Unit(Herz), UnitExponent(0),   ; In Hertz (0)
  Logical Minimum (0), Logical Maximum (60),
  Feature(Constant, Variable, Absolute),
End Collection(),                                               ; End of DC Flow collection
```

B.1.4 Output DC flow Physical Collection

The output DC flow contains the flow ID (3), name, configuration voltage, configuration current, and configuration frequency of AC. Feature report ID 3 begins.

```
UsagePage(Power Device),
Usage(Flow), Collection(Physical), ReportID (3),        ; UPS Output
  Usage(FlowID), Unit(none),                            ; Constant = 3, connected to flow 3
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
  ReportSize(4), ReportCount(1),
  Feature(Constant, Variable, Absolute),                        ; 4-bit pad
  Usage(iName),
  ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigVoltage),
  ReportSize(16), ReportCount(1), Unit(Volt), UnitExponent(5),  ; In c.Volts
  Logical Minimum (0), Logical Maximum (0xFFFE),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigCurrent),
  ReportSize(16), ReportCount(1), Unit(Amp), UnitExponent(-2),  ; In c.Amps
  Logical Minimum (0), Logical Maximum (0xFFFE),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigFrequency),
  ReportSize(8), ReportCount(1), Unit(Hertz), UnitExponent(0),  ; In Hertz (0)
  Logical Minimum (0), Logical Maximum (60),
  Feature(Constant, Variable, Absolute),
  Usage(ConfigApparentPower),
  ReportSize(16), ReportCount(1), Unit(Watt), UnitExponent (7), ; in VA
  Logical Minimum (0), Logical Maximum (0xFFFE),
  Feature(Constant, Variable, Absolute),
End Collection(),                                       ; End of Output AC Flow collection
```

B.1.5 Header of Power Converter Physical Collection

The Power Converter physical collection contains the power converter ID (1), followed by the collection corresponding to its sub-modules. Feature report ID 4 and Input report ID 4 begin.

```
UsagePage(Power Device),
Usage(PowerConverter), Collection(Physical), ReportID (4),      ; Power Converter
  Usage(PowerConverterID),                                      ; Constant = 1
  ReportSize(4), ReportCount(1), Logical Minimum (0), Logical Maximum (15), Unit(0),
  Feature(Constant, Variable, Absolute),
```

B.1.6 Power Converter AC Input Physical Collection

The Power Converter AC input contains the input ID (1), the ID of the connected flow (1), and two status items: Used and Good. Feature report ID 4 and Input report ID 4 continue.

```
  Usage(Input), Collection(Physical),                   ; Power Converter: AC Input
    Usage(InputID),                                     ; Constant = 1
    Usage(FlowID),                                      ; Constant = 1, connected to flow 1
    ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
    Feature(Constant, Variable, Absolute),
    Usage(PresentStatus), Collection(Logical),          ; PresentStatus collection
      Usage(Used), Usage(Good),
      ReportSize(1), ReportCount(2), Logical Minimum (0), Logical Maximum (1),
      Input(Constant, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of PresentStatus collection
  End Collection(),                                     ; End of AC Input collection
```

B.1.7 Power Converter AC Output Physical Collection

The AC Output physical collection contains the output ID (1), the ID of the connected flow (3), the percent load, and three status items: Used, Good, and Overload. Feature report ID 4 and Input report ID 4 continue.

```
  Usage(Output), Collection(Physical),                  ; Power Converter: AC Output
    Usage(OutputID),                                    ; Constant = 1
    Usage(FlowID),                                      ; Constant = 3, connected to flow 3
    ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
    Feature(Constant, Variable, Absolute),
    Usage(PercentLoad),
    ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
    Input(Constant, Variable, Absolute, Volatile),
    Usage(PresentStatus), Collection(Logical),          ; PresentStatus collection
      Usage(Used), Usage(Good), Usage(Overload),
      ReportSize(1), ReportCount(3), Logical Minimum (0), Logical Maximum (1),
      Input(Constant, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of PresentStatus collection
  End Collection(),                                     ; End of AC Output collection
```

B.1.8 Power Converter DC Input Physical Collection

The Power Converter DC input contains the input ID (2), the ID of the connected flow (2), and two status items: Used and Good. Feature report ID 4 and Input report ID 4 continue.

```
  Usage(Input), Collection(Physical),                   ; Power Converter: DC Input
    Usage(InputID),                                     ; Constant = 3
    Usage(FlowID),                                      ; Constant = 2, connected to flow 2
    ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
    Feature(Constant, Variable, Absolute),
    Usage(PresentStatus), Collection(Logical),          ; PresentStatus collection
      Usage(Used), Usage(Good),
      ReportSize(1), ReportCount(2), Logical Minimum (0), Logical Maximum (1),
      Input(Constant, Variable, Absolute, Volatile),
    End Collection(),                                   ; End of PresentStatus collection
  End Collection(),                                     ; End of DC Input collection
End Collection(),                                       ; End of PowerConverter collection
```

B.1.9 Power Summary Physical Collection

As static data, the Power Summary collection contains the power summary ID (1), the ID of the connected flow (3), the name of the power source, and a battery presence indicator.

As dynamic data, the Power Summary collection contains the power supply output percent of load and three status values: for AC input: ACPresent, for USB input: Good, and for power output: Overload.

Feature report ID (5) and Input report ID (5) begin.

```
  Usage(PowerSummary), Collection(Physical),            ; Power Summary
    Usage(PowerSummaryID),                              ; Constant = 1
    Usage(FlowID),                                      ; Constant = 3c Connected to flow 3
    ReportSize(4), ReportCount(2), Logical Minimum (0), Logical Maximum (15), Unit(0),
    Feature(Constant, Variable, Absolute)
    Usage(iName),                                 ; Constant = pointer to "Power Supply"
    ReportSize(8), ReportCount(1), Logical Maximum(255, Unit(0),
    Usage(Present),                                     ; Constant = 0 (not battery)
    ReportSize(1), ReportCount(2), Logical Maximum (1),
    Feature(Constant, Variable, Absolute),
    Usage(PercentLoad),
    ReportSize(8), ReportCount(1), Logical Minimum (0), Logical Maximum (255),
    Input(Constant, Variable, Absolute, Volatile),
    Usage(PresentStatus), Collection(Logical)           ; Present Status collection,
      UsagePage(Battery System), Usage(ACPresent)       ; AC Input status
      UsagePage(Power Device), Usage(Good)                    ; USB Input status
      Usage(Overload),                                  ; Power output status
      ReportSize(1), ReportCount(3), Logical Maximum (1),
      Input(Constant ,Variable ,Absolute, Volatile),
    End Collection,                                     ; End of Present Status collection
  End Collection(),                                     ; End of Power Summary collection
End Collection()                                        ; End of Power Supply collection
```

B.2 Related Report Format Samples

This section contains a partial set of report format samples related to Report descriptors defined earlier in this appendix.

Figure 15: Power Supply Example Feature Report ID 4

	Bit							
Byte	7	6	5	4	3	2	1	0
0	4 (for Report ID 4)							
1	InputID (AC Input)				PowerConverterID			
2	OuputID (DC Output)				FlowID (AC Input)			
3	InputID (USB Bus Power)				FlowID (DC Output)			
4	Pad				FlowID (USB Bus Power)			

Figure 16: Power Supply Example Input Report ID 4

	Bit							
Byte	7	6	5	4	3	2	1	0
0	4 (for Report ID 4)							
1	Pad	Good	Used	Overload	Good	Used	Good	Used
		USB Bus Power		********DC Output*********			****AC Input*****	

Figure 17: Power Supply Example Feature Report ID 5

	Bit							
Byte	7	6	5	4	3	2	1	0
0	5 (for Report ID 5)							
1	FlowID				PowerSummaryID			
2	iName							
3	Padding							Present

Figure 18: Power Supply Example Input Report ID 5

	Bit							
Byte	7	6	5	4	3	2	1	0
0	5 (for Report ID 5)							
1	PercentLoad							
2	Padding					Overload	Good	ACPresent
						DC Output	USB Bus	AC Input

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