AC	21/03/02	Some syntax and legal wrapping	D.LALLEMENT		JL.PHILIPPE	
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Ind	**date**	**Modification**	Nom *Name* **Réalisé par *Prepared by***	Visa	Nom *Name* **Approuvé par *Approved by***	Visa

Simplified SHUT and HID specification for UPS.

Intellectual Property Provision and Limitation of Liability

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CONTENT

1. INTRODUCTION

This document presents communication between UPS and host computers via HID-SHUT/RS232 link. This protocol is named SHUT (as Serial HID UPS Transfer) and allows to carry on UPS objects all specified under HID formats.

SHUT protocol to take one's inspiration from USB and HID and PDC protocol. But implements an other transport layer (SHUT) is used instead of USB one's.

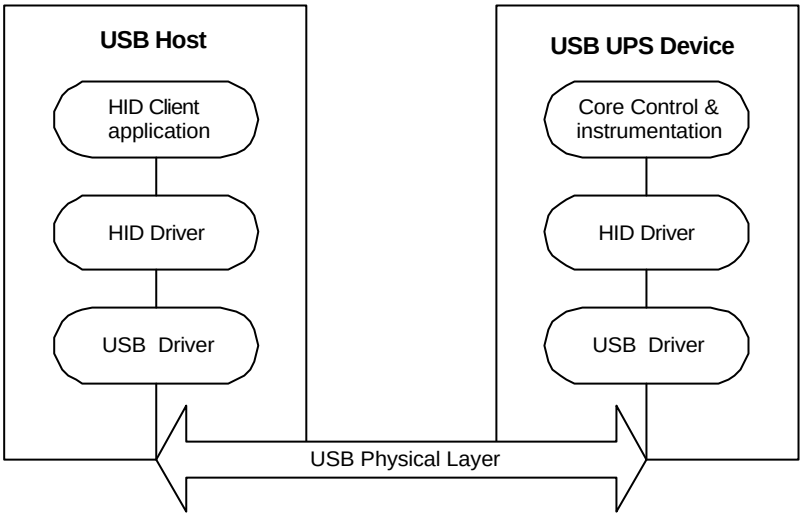

Figure 1 : *General diagram of communication layers between USB host and device using HID.*

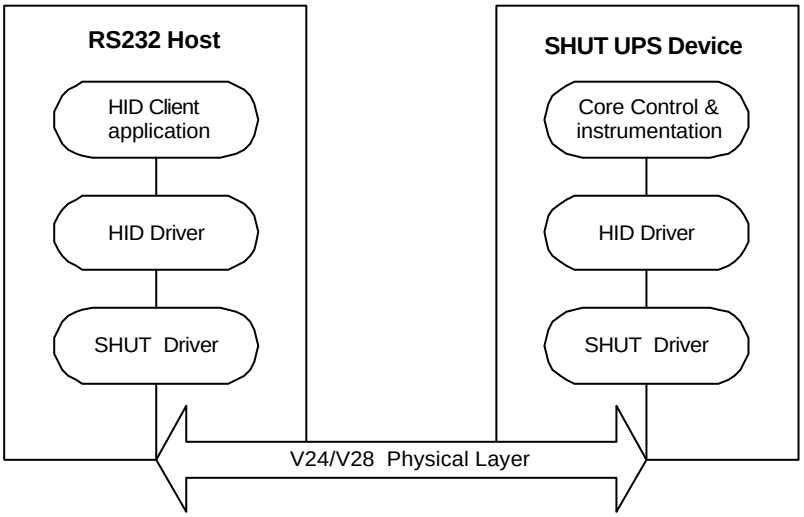

Figure 2: *Communication layers for SHUT UPS of MGE UPS SYSTEMS*

It is not necessary to know USB and HID specifications to read this document.
It describes the direct way to access the data of UPS.

This document will be used by people that develops external software that have to communicate with the UPS.

Related Documents

Title	Location	Description
Universal Serial Bus HID Usage Tables for Power devices. Version 1.0	Also referred to as the **Power Device Class**; posted at www.usb.org	This document defines the communication and Usage Tables of HID Power Devices.
Universal Serial Bus Device Class Definition for Human Interface Devices (HID) Version 1.1	Also referred to as **the HID Class 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, Revision 1.1	Also referred to as the **HID Usage Tables Document** ; 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.
Universal Serial Bus Revision 2.0 Specification	Also referred to as **the USB Specification**; posted at www.usb.org	This document defines an industry standard Universal Serial Bus.

Terms and Abbreviations

HID	Human Interface Device.
MGE	MGE UPS SYSTEMS
UPS	Uninterruptible Power Supply.
USB	Universal Serial Bus. For definitions of the following USB terms, see the USB Specification. **DEVICE DESCRIPTOR**

2. SHUT simplified transport semantics :

2.1. Serial port settings

Default settings of a UPS SHUT serial port are :
- Baud rate : 2400
- 8 data bits
- No parity
- 1 stop bit
- Flow control : none

2.2. Synchronization

To establish communication with UPS, start by sending it a <SYNC> character (0x16, ^V). The UPS should respond by transmitting a <SYNC> character to the host within 200 mS.

If the UPS does not respond in a 500 ms delay, try sending <SYNC> no more frequently than 600 ms intervals up to 4 times until the UPS responds. If the UPS fails to respond after 4 attempts, a communication fault exists.

Sending <SYNC> is only required during the initialization phase (e.g. after the UPS is turned on). It is usually not necessary to send <SYNC> again after the initial handshake, however, periodically sending <SYNC> is a good way for the host to verify the presence of the UPS.

Under certain conditions (such as a “data collision”, explained later), it may be necessary to repeat the initialization procedure discussed above to get the host and UPS back in sync.

2.3. SHUT data packets

All data sent to, or received from, the UPS must be packetized within a “SHUT data packet”. The format of this packet is:

Packet type	Data length	Data bytes D0..Dn	Checksum-8
1 byte	1 byte	1-8 bytes	1 byte

Packet type:
0x01 (^A) – REQUEST (from host to UPS)
0x04 (^D) – RESPONSE (from UPS to host)
0x05 (^E) – NOTIFY (unsolicited transmission from UPS to host)
Add 0x80 to the above types to indicate the end of transmission.

Example : Hosts usually send REQUEST packets - type 0x01. If the packet being sent by the host is the last one of a given transaction, the host should send the (last) packet using type code 0x81 to signify end of transaction. When the host sends the UPS a command sequence, it is not executed until the last packet (with type byte bit 7 set) is received.

Data length:
The number of bytes in the <Data> field.
Example: If data field contains 5 bytes, <Length> should be 0x55
<Length> allowed values: 0x11, 0x22, …, 0x88

Data field:
The raw data being sent. May be 1-8 bytes long. <Length> must be set to reflect the size of this field (see above).

Checksum-8:
The XOR checksum is calculated on the n Data bytes.
<Chk> = <D0> XOR <D1> XOR … XOR <Dn>

2.4. Error handling

The RECEIVER of a packet must verify it’s integrity, and respond in a “timely fashion” (say, < 500 mS) with an acknowledgement code. The acknowledgement code is a single character, one of:
<ACK>, 0x06 – Packet received OK, no errors (sometimes referred to as <OK>)
<NAK>, 0x15 – Error detected in packet (sometimes referred to as <NOK>)

If the receiver of a transmission sends <ACK>, the sender will send the next packet in the queue (if any exist). If <NAK> is sent, the transmitter of the packet is instructed to re-send the last packet.

Both host and UPS must be able to recover from timeout errors. These can occur if the receiving device looses or misreads data (perhaps due to line noise or related faults). The best way to recover from a timeout error on the host side is to simply start sending <SYNC> characters (spaced 600mS apart) until the UPS responds with <SYNC> in return.

2.5. UPS Commands

All command sequences to the UPS must be sent in SHUT data packets. In almost all cases, only a single SHUT packet is needed to send a command, although there are a few exceptions to this rule. As this document is intended as a simplified supplement to the main SHUT specification, only a few of the UPS commands will be discussed here.

GET REPORT command:

Field	Request Type 1	Request Type 2	Report ID	Report Type	Interface LSB	Interface MSB	Length LSB	Length MSB
Data	0xA1	0x01	(variable)	0x03	0x00	0x00	0x00	0x00

Note: Each column (except the labels in the leftmost column) represents 1 byte.

The only variable field in the GET REPORT request, for practical purposes, is the <Report ID> field. This field should contain the number of the desired UPS "report" (a collection of data from the UPS).

The UPS replies by sending the requested data (in SHUT packets), using the following structure:

Byte 0: Report ID
Byte 1..n: Data

Data for multi-byte objects is sent LSB first (Intel "big endian" format)

SET REPORT command:

Field	Request Type 1	Request Type 2	Report ID	Report Type	Interface LSB	Interface MSB	Length LSB	Length MSB	Data 1..n
Data	0x21	0x09	(variable)	0x03	0x00	0x00	(variable)	0x00	(variable)

There are three variable fields in this request. <Report ID> is set to the ID of the UPS data object to be changed. <Length> is the size, in bytes, of the <Data> field. <Data> is the value to be written to the UPS.

Typcially, the <Length> field will be a value from 0x01 – 0x04. Thus, the MSB of the <Length> field will always be 0x00.

The first byte in the <Data> field should be the <Report ID>. Subsequent data represents the value to set the object(s) in the specified <Report ID> to. Multi-byte (16, 24, 32 bit) objects in the <Data> must be formatted in Intel-style "big endian" form, LSB first, MSB last.

GET DESCRIPTOR command:

This command is typically used only in circumstances where the host wants to perform full USB/HID style processing. However, in some cases, the information provided by the various system descriptors can be useful to the host, even if it is not implementing a fully HID-compliant link, especially to get string descriptor.
The format of the GET DESCRIPTOR command is:

Field	Request Type 1	Request Type 2	Descriptor ID	String Index	Interface LSB	Interface MSB	Length LSB	Length MSB
Data	0x80: USB 0x81: HID	0x06	(variable)	0x00 or (variable)	0x00	0x00	0x00	0x00

The <Descriptor ID> is one of:
0x01 – Device descriptor
0x02 – Configuration descriptor
0x03 – String descriptor (<String Index> field relevant for this one)
0x04 – Interface descriptor
0x05 – Endpoint descriptor
0x21 – HID descriptor
0x22 – Report descriptor

For types 0x21, 0x22 the <Request Type 1> field must be set to 0x81. Other types use 0x80 in this field.

The <String Index> field is relevant only for String Descriptor (0x03) requests. It can be set to 0x00 for other descriptor requests.

The UPS responds by transmitting the requested descriptor in a series of SHUT packets. The format of each of these descriptors is beyond the scope of this document; refer to the official SHUT specification for more detail.

2.6. Notification Reports

In most cases, the UPS only sends data to the host after it has been specifically requested by the host; e.g. as a result of issuing a GET REPORT or GET DESCRIPTOR request. However, the UPS can, and will, send unsolicited “notify reports” (input reports in HID nomenclature) when certain key UPS parameters change – such as when the UPS switches from utility to battery backup, or the battery percent charge changes. These notification reports have the same structure as the response to a GET DESCRIPTOR request, and as such identify themselves with the report ID of the content being sent. The only difference between a notify report and the response to GET DESCRIPTOR request is that notify reports are sent via SHUT transport using the NOTIFY packet type (0x05 / 0x85).

Notify reports are never sent while a SHUT transaction is in process, except “by accident” when the host and UPS both decide to send data at the same time (see the “Error Handling” section for information concerning collisions). The UPS will not send a notify report unless the comm interface is idle. If the host has to send a multi-packet sequence to the UPS to initiate a command request, which is possible in the case of the SET REPORT, the UPS will NOT send any notify reports until the last packet of a given host command has been sent and the UPS’s normal response (if any) is issued.

The host must respond to a SHUT notify packet just like any other SHUT packet sent by the UPS – it must analyze the contents of the packet, and provide an appropriate response code (<ACK> or <NAK>). Other than the required ACK/NAK handshake, the host is not obligated to act on the data sent by the UPS in any special way. Notify reports are provided as a “convenience” to the host, allowing it to minimize or eliminate it’s own polling activity for key parameters.

2.7. Collision handling

Requests coming out from the host and notification coming up from the UPS can collide. In this case the UPS does not send any response to the request and the host does not acknowledge the notification, it's another possible fault condition.

So it's important to respect following rules to restore the communication in a right state :
- The notification has priority, so it is generally entirely sent by the UPS.
- As soon as possible, the host must stop to send the request.
- SHUT resynchronisation is done when the host emits a SYNC
- Until the UPS respond to synchronization, the host sends SYNC periodically before sending any requests.

It is the responsibility of the host to re-sync the UPS by repeating the synchronization procedure discussed earlier.

2.8. Notification control

Collisions can be a real problem when notifications occurs oftenly (for example when Main AC is noisy and generates frequently transfer on battery) or if the host generates a lot of requests in polling mode.

To prevent this, most of UPS support notification modes to reduce or suppress the collisions.

Setting these notification modes is possible with other Synchronization tokens :

- Token SYNC(0x16) is the standard synchronization byte for standard notification of HID objects located in input reports.
- Token SYNC_LIGHT(0x17) is the synchronization byte for partial notification. In this mode, only status objects are notified.
- Token SYNC_OFF(0x18) is the synchronization byte to get notification silent. No notifications are emited, the only way for the host to get information from the SHUT device is polling. By GET_REPORT request even for Input typed objects.

A notification mode is active until a synchronization token for an other notification mode is received.

The UPS respond to the synchronization byte with the same byte.

3. HID simplified semantics

3.1. UPS datas

This part of document describes where are located main UPS data necessary for a developer that wants to write a host software with basis function :

- Monitoring the main AC status
- Monitoring the UPS status
- Monitoring the battery status
- Shutdown and restart of UPS

3.2. Data description

The table below describes main data availables for all the UPS.

UPS Data	Comment	Description	Unit	ReadOnly or ReadWrite
UPS.PowerSummary.PresentStatus.ACPresent	Main AC status	1: Main AC is present and correct	-	RO
UPS.PowerSummary.PresentStatus.Charging	Charging battery	1: Battery is charging	-	RO
UPS.PowerSummary.PresentStatus.Discharging	Discharging battery	1: Battery is discharging	-	RO
UPS.PowerSummary.PresentStatus.BelowRemainingCapacityLimit	Below remaining capacity limit	1: Battery level is under RemainingCapacityLimi	-	RO
UPS.PowerSummary.PresentStatus.NeedReplacement	Battery need to be replaced	1: Test battery failed	-	RO
UPS.PowerSummary.PresentStatus.Good	Output status	1: Load is powered	-	RO
UPS.PowerSummary.PresentStatus.ShutdownImminent	UPS shutdown in progress	1: Battery voltage is under low level	-	RO
UPS.PowerSummary.PresentStatus.Overload	Power overload	1: UPS overload	-	RO
UPS.PowerSummary.PresentStatus.InternalFailure	Hardware default	1: UPS internal failure	-	RO
UPS.PowerSummary.RemainingCapacity	Remaining battery capacity	Battery current level	%	RO
UPS.PowerSummary.RunTimeToEmpty	Remaining time	Autonomy time by autonometer	s	RO
UPS.PowerSummary.DelayBeforeShutdown	Action : Temporized UPS shutdown	Writing this data with x to shutdown UPS in x sec.	s	RW
UPS.PowerSummary.RemainingCapacityLimit	Low battery alert threshold	Battery threshold	%	RO
UPS.PowerSummary.PercentLoad	Percent of charge of nominal power		%	RO
UPS.PowerSummary.DelayBeforeStartup	Action : Temporized UPS startup	Writing this data with x to startup UPS in x sec. Caution : x * 10 sec. For some UPS like Ellipse	s	RW
UPS.PowerSummary.iProduct	Product name index in String Descriptor	Index on string descriptor	-	RO

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4. ELLIPSE Report implementation

This annex shows the location of the datas into reports for an **ellipse** UPS.

To get data description for other UPS, contact MGE UPS Communication Software Support : (ssw@mgeups.com)

UPS Data	Comment	ReportId	Offset(nb of bits) in report	Size(nb of bits) in report
UPS.PowerSummary.PresentStatus.ACPresent	Main AC status	2	0	1
UPS.PowerSummary.PresentStatus.Charging	Charging battery	2	1	1
UPS.PowerSummary.PresentStatus.Discharging	Discharging battery	2	2	1
UPS.PowerSummary.PresentStatus.BelowRemainingCapacityLimit	Below remaining capacity limit	2	3	1
UPS.PowerSummary.PresentStatus.NeedReplacement	Battery need to be replaced	2	4	1
UPS.PowerSummary.PresentStatus.Good	Output status	2	5	1
UPS.PowerSummary.PresentStatus.ShutdownImminent	UPS shutdown in progress	2	6	1
UPS.PowerSummary.PresentStatus.Overload	Power overload	2	7	1
UPS.PowerSummary.PresentStatus.InternalFailure	Hardware default	2	8	1
UPS.PowerSummary.RemainingCapacity	Remaining battery capacity	22	0	8
UPS.PowerSummary.RunTimeToEmpty	Remaining time	22	8	16
UPS.PowerSummary.DelayBeforeShutdown	Action : Temporized UPS shutdown	15	0	24
UPS.PowerSummary.RemainingCapacityLimit	Low battery alert threshold	12	8	8
UPS.PowerSummary.PercentLoad	Percent of charge of nominal power	14	8	8
UPS.PowerSummary.DelayBeforeStartup	Action : Temporized UPS startup	17	0	24
UPS.PowerSummary.iProduct	Product name index in String Descriptor	16	16	8

Caution :
- **Offset** does not take in account the first byte of the data field which is always the ReportId
- For **ellipse,** DelayBeforeStartup is coded in 10 seconds units.

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5. Putting it all together

This section presents a sample transaction between the host and an **ellipse** UPS, including all SHUT packetization data. After looking at this section, the relationship between SHUT-required data and command data should be clear. Note that the data and report ID's shown will differ depending on the MGE UPS model being used.

Byte #	Description of event	Host Data	UPS Data
0	Host sends <SYNC> to get attention of UPS and activate SHUT mode	0x16	
1	UPS sends <SYNC> in acknowledgement of entry to SHUT mode		0x16
2	Start of host command sequence: GET REPORT Host sends SHUT packet type (REQUEST w/high bit set, since this is last packet of command)	0x81	
3	SHUT packet length byte: 8 byte data field	0x88	
4/0	SHUT packet data GET REPORT – Request Type 1	0xA1	
5/1	GET REPORT – Request Type 2	0x01	
6/2	GET REPORT – Report ID	0x16	
7/3	GET REPORT – Report type (0x03 = Feature)	0x03	
8/4	GET REPORT – Interface # (always 0)	0x00	
9/5		0x00	
10/6	GET REPORT – Report size (8 is more than the report size)	0x08	
11/7		0x00	
12	SHUT packet checksum (XOR of previous data)	0xBD	
13	UPS sends acknowledgement code (<ACK>)		0x06
14	UPS sends report data via SHUT: SHUT packet type (RESPONSE w/high bit set, since this is last packet of response)		0x84
15	Length byte: 4 byte data field		0x44
16/0	Report ID of response		0x16
17/1	UPS remaining capacity percentage (100%)		0x64
18/2	UPS run time to empty, LSB (1800 seconds)		0x07
19/3	UPS run time to empty, MSB (1800 seconds)		0x08
20	SHUT packet checksum		0x7D
-	At this point, the interface is considered to be "idle". The UPS is free to send a NOTIFY report if one is pending. For purposes of this illustration, a typical NOTIFY report will be shown here.	Time passes	Time passes
21	SHUT packet type – NOTIFY w/high bit set		0x85
22	SHUT packet length: 2 bytes		0x33
23/0	Notify report ID: #2		0x02
24/1	Report data: PresentStatus flags (Discharging=1, Good=1, others=0)		0x24
25/2	(PresentStatus MSB)		0x00
26	SHUT packet checksum		0x26
27	Response FROM HOST: acknowledge	0x06	
-	Interface is idle again. The UPS could send another NOTIFY report if needed. The host is free to initiate a new command.	Time passes	Time passes
28	Start of host command sequence: SET REPORT Send SHUT packet type (0x01, Request, more to follow)	0x01	
29	Length: 8 bytes	0x88	
30/0	SET REPORT – Request type 1	0x21	
31/1	SET REPORT – Request type 2	0x09	
32/2	SET REPORT – Report ID (15, DelayBeforeShutdown)	0x0F	

Byte #	Description of event	Host Data	UPS Data
33/3	SET REPORT – Report type (Feature)	0x03	
34/4	SET REPORT – Interface # (always 0)	0x00	
35/5		0x00	
36/6	SET REPORT – Data size (4 bytes)	0x04	
37/7		0x00	
38	SHUT packet checksum	0x20	
39	UPS acknowledgement		0x06
40	Continuance of SET REPORT command SHUT packet type: REQUEST (0x81, last packet of command)	0x81	
41	SHUT packet length (4 bytes)	0x44	
42	Report ID (again, it's redundant)	0x0F	
43	DelayBeforeShutdown setting, 24 bits, LSB (120 seconds)	0x78	
44	DelayBeforeShutdown Mid byte	0x00	
45	DelayBeforeShutdown MSB	0x00	
46	SHUT packet checksum	0x77	
47	Acknowledgement from UPS		0x06
-	The UPS carries out the SET REPORT function at this point. The interface is idle, UPS can send NOTIFY report(s) if needed.	-	-

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