USB Simply Buffered (USB)

Device Enumeration

Environment

- Debian Etch 4.0.
- x86 system.
- Sandisk Cruzer Mini 256 MB USB thumb drive.

USB is a master/slave protocol. The host keeps sending packets for the device, and also sends packets to the device to fill in data, and return it to the host.

The steps involved in USB device enumeration are as follows:

- SetAddress
- GetDescriptor (Device)
- GetDescriptor (Configuration)
- GetDescriptor (Configuration)
- GetDescriptor (String Language Ids)
- GetDescriptor (String 2)
- GetDescriptor (String 1)
- GetDescriptor (Sring 3)
- SetConfiguration

The Sandisk USB thumb drive was connected to a GNU/Linux host PC, and the device enumeration steps were observed. The steps involved are explained below in detail:

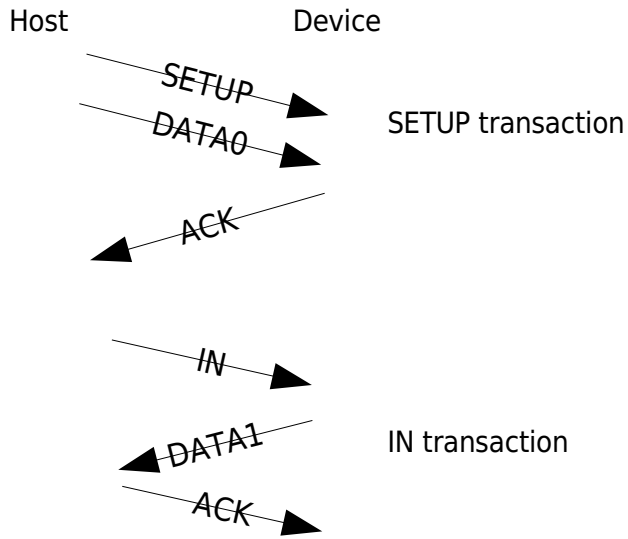
1. SetAddress

At the top-level of USB are the transfers. Transfers consists of transactions, and transactions consist of packets.

SetAddress is an example of a USB transfer. It consists of:

- SETUP transaction (->)
- IN transaction (<-)

-> means the data flow is from host to device.
<- means the data flow is from device to host.



Every transaction has packets going to and from the device.

========== *BEGIN* ==========

What is a USB packet?

The USB packet consists of the following:

	SYNC	PID	!PID	Function Address	Endpoint	Frame Number	Data	CRC
(bits)	8/32	4	4	7	4	11	0-1024	5/16

- SYNC is 8-bits for low-speed/full-speed.
  32-bits for high-speed.

- PID, and !PID in the above are each 4-bits long, as shown below:

	PID 0	PID 1	PID 2	PID 3	!PID 0	!PID 1	!PID 2	!PID 3
(bits)								

- !PID is the ones' complement of PID.
- Function address and Endpoint field constitute a 11-bit address (ADDR) field.
- Frame number (FN) field is 11-bit.
- Data field varies from 0-1024 bytes.
- Token CRCs are 5-bit, while Data CRCs are 16-bit.

What are the types of USB packets?

The different types of packets and their PID values are listed below:

PID Type	PID Name	PID <3:0>	Hex	!Hex	PID <0:3>	Packets
Token	OUT	0001	1	E	1000	PID ADDR CRC
	IN	1001	9	6	1001	PID ADDR CRC
	SOF	0101	5	A	1010	PID FN CRC
	SETUP	1101	D	2	1011	PID ADDR CRC
Data	DATA0	0011	3	C	1100	PID DATA CRC
	DATA1	1011	B	4	1101	PID DATA CRC
	DATA2	0111	7	8	1110	PID DATA CRC
	MDATA	1111	F	0	1111	PID DATA CRC
Handshake	ACK	0010	2	D	0100	PID
	NAK	1010	A	5	0101	PID
	STALL	1110	E	1	0111	PID
	NYET	0110	6	9	0110	PID
Special	PRE	1100	C	3	0011	
	ERR	1100	C	3	0011	
	SPLIT	1000	8	7	0001	
	PING	0100	4	B	0010	
	Reserved	0000	0	F	0000	

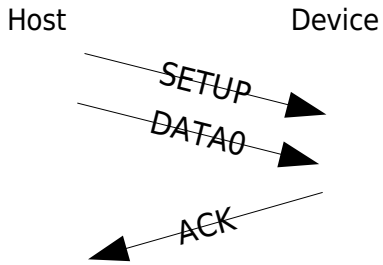
Reference: Chapter 8: Protocol Layer, pages 195-199.
========== END ==========

Let us see each transaction in detail.

1.1 SETUP transaction

The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)



1.1.1 SETUP packet

A SETUP packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1011	0100	0000 000	0000	01000
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

00010 0000 000 0000 0010 1101

Regrouping in groups of 4-bits:

0001 0000 0000 0000 0010 1101

Hex values:

1 0 0 0 2 D

Regrouping as a byte:

M L

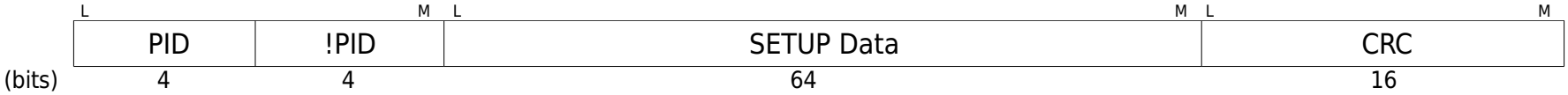
10 00 2D

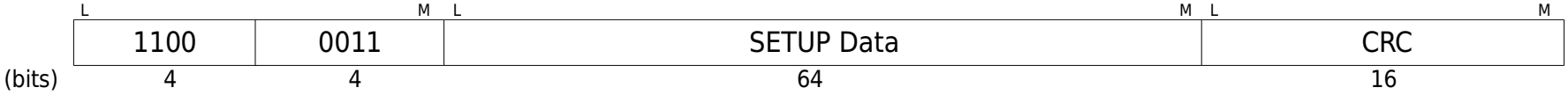
Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00000000	2D	00
02	00010000		10	

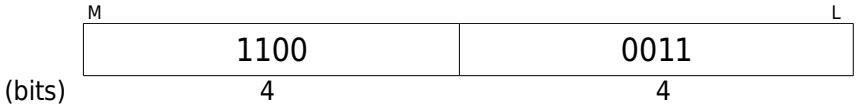
1.1.2 DATA0 packet

A DATA0 packet consists of:





The PID arranged in MSB to LSB order:



Hex values (PID):

Since this is for a SETUP packet, the data consists of 8 bytes.

========== *BEGIN* ==========

Format of SETUP packet data

A SETUP packet consists of:

	L M	L M	L M	L M	L M
	bmRequestType	bRequest	wValue	wIndex	wLength
(bytes)	1	1	2	2	2

- bmRequestType has a bitmap value with the following fields:

	D7	D6 D5	D4 D3 D2 D1 D0
(bits)	1	2	5

D7: Data transfer direction
0 = Host-to-device
1 = Device-to-host

D6..D5: Type
0 = Standard
1 = Class
2 = Vendor
3 = Reserved

D4..D0: Recipient
0 = Device
1 = Interface
2 = Endpoint
3 = Other
4..31 = Reserved

- bRequest follows Table 9-4, Standad Request Codes (page 251).

bRequest	Value
GET_STATUS	0
CLEAR_FEATURE	1
Reserved	2
SET_FEATURE	3
Reserved	4
SET_ADDRESS	5
GET_DESCRIPTOR	6
SET_DESCRIPTOR	7
GET_CONFIGURATION	8
SET_CONFIGURATION	9
GET_INTERFACE	10
SET_INTERFACE	11
SYNCH_FRAME	12

- wValue field follows Table 9-3, Standard Device Requests (page 250).

bmRequestType	bRequest	wValue	wIndex	wLength	Data
00000000 00000001 00000010	CLEAR_FEATURE	Feature Selector	Zero Interface Endpoint	0	None
10000000	GET_CONFIGURATION	0	0	1	Configuration Value
10000000	GET_DESCRIPTOR	Descriptor Type and Descriptor Index	0 or Language ID	Descriptor Length	Descriptor
10000001	GET_INTERFACE	0	Interface	1	Alternate Interface
10000000	GET_STATUS	0	Zero Interface Endpoint	2	Device, Interface, or Endpoint status
00000000	SET_ADDRESS	Device Address	0	0	None
00000000	SET_CONFIGURATION	Configuration Value	0	0	None
00000000	SET_DESCRIPTOR	Descriptor Type and Descriptor Index	0 or Language ID	Descriptor Length	Descriptor
00000000 00000001 00000010	SET_FEATURE	Feature Selector	Zero Interface Endpoint	0	None
00000001	SET_INTERFACE	Alternate	Interface	0	None
10000001	SYNCH_FRAME	0	Endpoint	2	Frame Number

- The Descriptor Index is in the lower byte, and used only for Configuration and String descriptors.

- The descriptor types are in Table 9-5 (page 251):

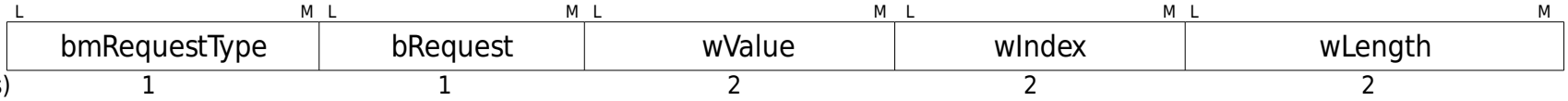
Descriptor Type	Value
DEVICE	1
CONFIGURATION	2
STRING	3
INTERFACE	4
ENDPOINT	5
DEVICE_QUALIFIER	6
OTHER_SPEED_CONFIGURATION	7
INTERFACE_POWER	8

- Standard feature selectors are in Table 9-6 (page 280):

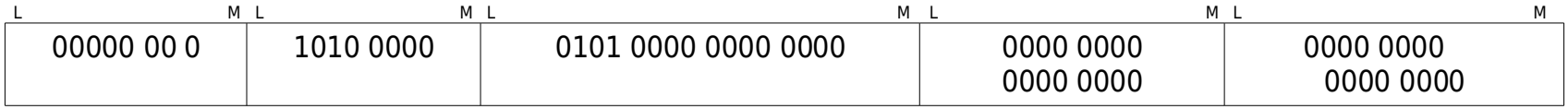
Feature Selector	Recipient	Value
DEVICE_REMOTE_WAKEUP	Device	1
ENDPOINT_HALT	Endpoint	0
TEST_MODE	Device	2

Reference: Chapter 9: USB Device Framework, pages 250-251, 280
========== *END* ==========

So, the SETUP packet consists of:



The 8 bytes for SETUP details are as follows:



bmRequestType:

D7: Data transfer direction
0 = Host-to-device

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

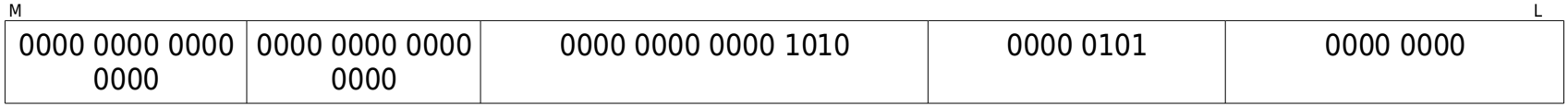
bRequest:

SET_ADDRESS request code is 5.

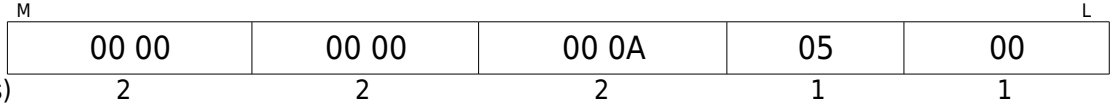
wValue:

Address to be assigned to device is 10 for SET_ADDRESS.

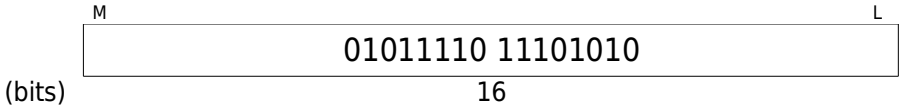
Putting it in MSB to LSB order:



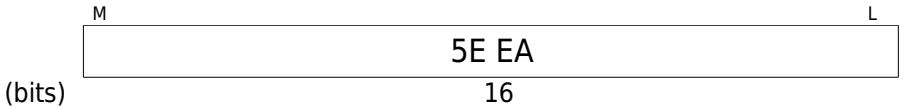
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



Putting it all (PID + SETUP DATA + CRC) together,

Summary (DATA0 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	00000000	C3	00
02	00000101	00001010	05	0A
04	00000000	00000000	00	00
06	00000000	00000000	00	00
08	00000000	11101010	00	EA
10	01011110		5E	

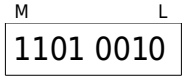
1.1.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

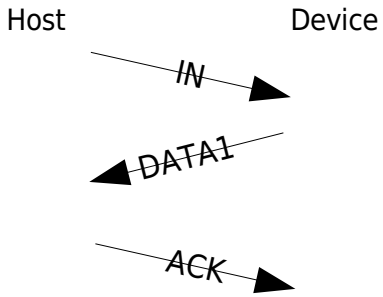
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

1.2 IN transaction

The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)



1.2.1 IN packet

A IN packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1001	0110	0000 000	0000	01000
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

00010 0000 000 0000 0110 1001

Regrouping in groups of 4-bits:

0001 0000 0000 0000 0110 1001

Hex values (as a byte):

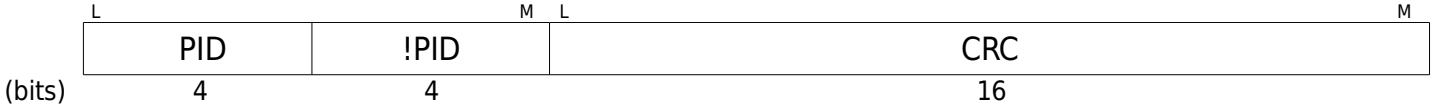
10 00 69

Summary (IN packet):

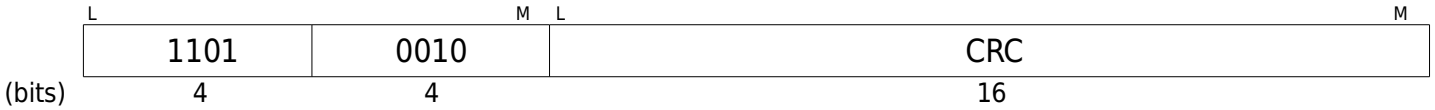
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00000000	69	00
02	00010000		10	

1.2.2 DATA1 packet

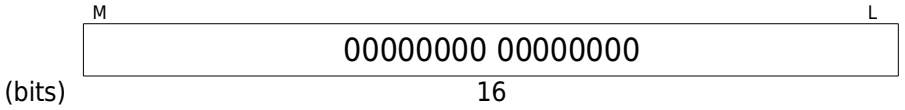
A DATA1 packet for SetAddress has no data. It consists of:



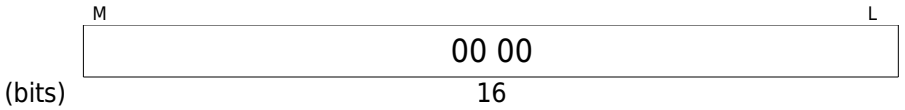
Values:



The CRC observed in the sample capture is:

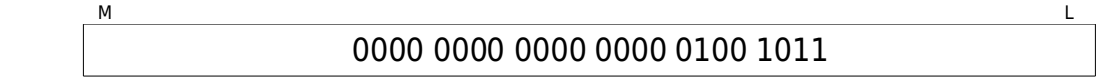


CRC (in Hex):

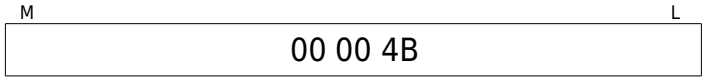


The packet arranged in MSB to LSB order:

In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

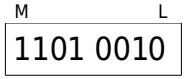
1.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

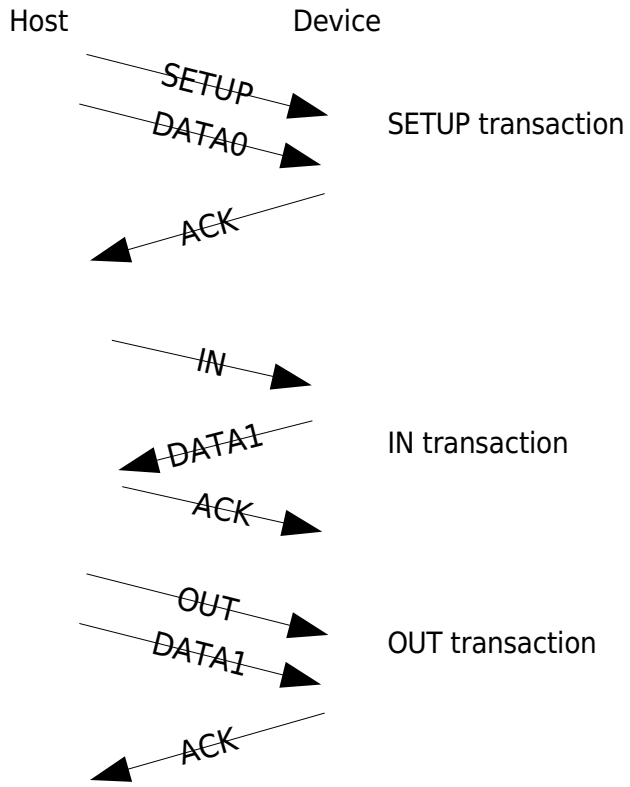
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

2. GetDescriptor (Device)

GetDescriptor (Device) transfer consists of the following transactions:

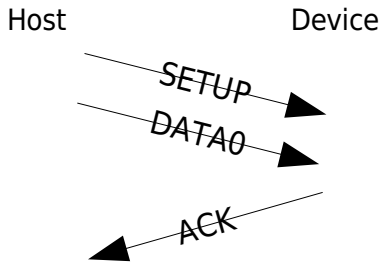
- SETUP transaction (->)
- IN transaction (<-)
- OUT transaction (->)



2.1 SETUP transaction

The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)



2.1.1 SETUP packet

A SETUP packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1011	0100	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

11011 0000 000 1010 0010 1101

Regrouping in groups of 4-bits:

1101 1000 0000 1010 0010 1101

Hex values:

D 8 0 A 2 D

Regrouping as a byte:

M L

D8 0A 2D

Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00001010	2D	0A
02	11011000		D8	

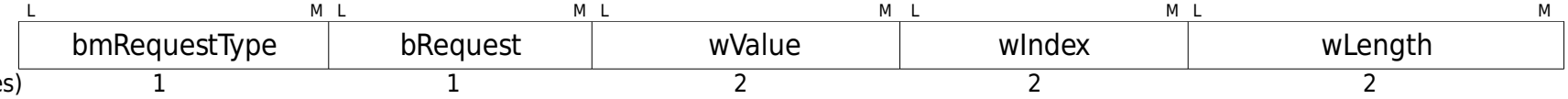
2.1.2 DATA0 packet

A DATA0 packet consists of:

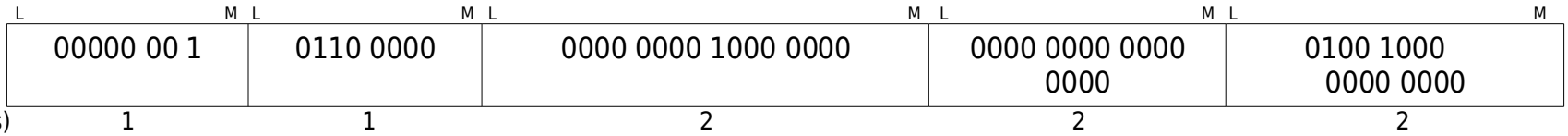
The PID arranged in MSB to LSB order:

Hex values (PID):

Since this is for a SETUP packet, the data consists of 8 bytes. The format is:



The 8 bytes for SETUP details are as follows (in decimal):



bmRequestType:

D7: Data transfer direction
1 = Device-to-host

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

bRequest:

GET_DESCRIPTOR request code is 6.

wValue:

Descriptor type is DEVICE, the value is 1. Descriptor index is 0.

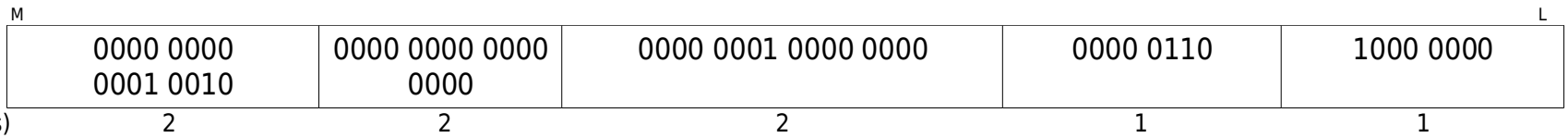
wIndex:

Value is zero.

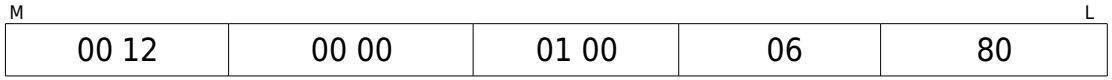
wLength:

Size of descriptor data, which is 18 bytes.

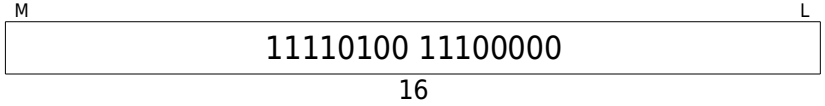
Putting it in MSB to LSB order:



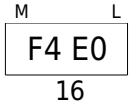
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



Putting it all (PID + SETUP DATA + CRC) together,

Summary (DATA0 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	10000000	C3	80
02	00000110	00000000	06	00
04	00000001	00000000	01	00
06	00000000	00010010	00	12
08	00000000	11100000	00	E0
10	11110100		F4	

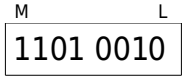
2.1.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

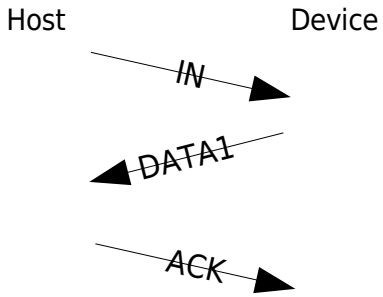
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

2.2 IN transaction

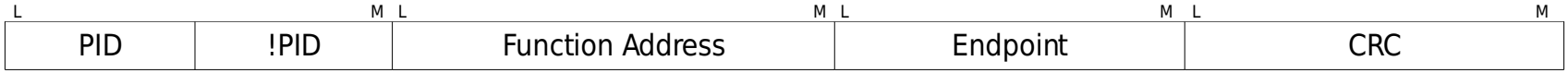
The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)

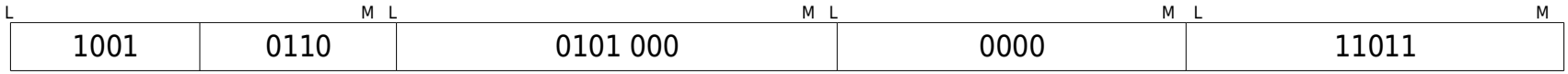


2.2.1 IN packet

A IN packet consists of:

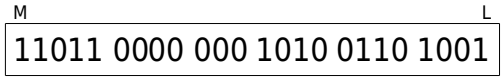


Values:

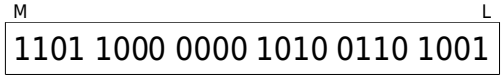


USB is little-endian. LSB goes out of the wire, first.

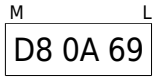
Displaying from MSB to LSB:



Regrouping in groups of 4-bits:



Hex values (as a byte):



Summary (IN packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00001010	69	0A
02	11011000		D8	

2.2.2 DATA1 packet

A DATA1 packet for GetDescriptor (Device) provides the 18 bytes of data. It consists of:

Values:

========== *BEGIN* ==========
Standard Device Descriptor

Table 9-8: Standard Device Descriptor

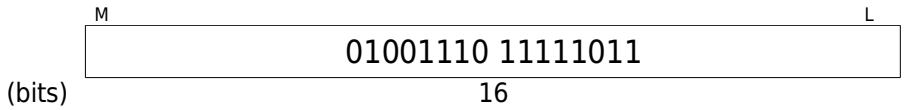
Offset	Field	Size	Value	Description
0	bLength	1	Number	Length of this descriptor (bytes)
1	bDescriptorType	1	Constant	DEVICE descriptor type
2	bcdUSB	2	BCD	USB Specification Release Number in BCD format (210H)
4	bDeviceClass	1	Class	Class code (by USB-IF)
5	bDeviceSubClass	1	SubClass	Subclass code (by USB-IF)
6	bDeviceProtocol	1	Protocol	Protocol code (by USB-IF)
7	bMaxPacketSize0	1	Number	Maximum packet size for endpoint zero (8, 16, 32 or 64)
8	idVendor	2	ID	Vendor ID (by USB-IF)
10	idProduct	2	ID	Product ID (by manufacturer)
12	bcdDevice	2	BCD	Device release number in BCD
14	iManufacturer	1	Index	Index of string descriptor describing manufacturer
15	iProduct	1	Index	Index of string descriptor describing product
16	iSerialNumber	1	Index	Index of string descriptor describing the device's serial number
17	bNumConfigurations	1	Number	Number of possible configurations

Reference: Chapter 9: USB Device Framework, pages 262-263
========== *END* ==========

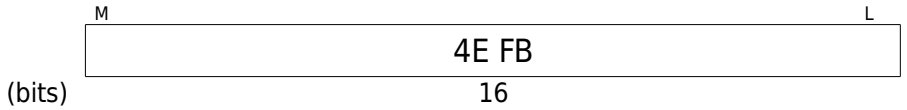
So, the data for our capture was:

Offset	Field	Size	Value	Hex
0	bLength	1	18 (bytes)	0x12
1	bDescriptorType	1	DEVICE descriptor (1)	0x01
2	bcdUSB	2	2.0	0x0200
4	bDeviceClass	1	Class defined at interface level	0x00
5	bDeviceSubClass	1	SubClass defined at interface level	0x00
6	bDeviceProtocol	1	None	0x00
7	bMaxPacketSize0	1	64	0x40
8	idVendor	2	SanDisk Corporation	0x0781
10	idProduct	2	SDCZ2 Cruzer Mini Flash Drive (thin)	0x5150
12	bcdDevice	2	0.1	0x0010
14	iManufacturer	1	1 (“SanDisk Corporation”)	0x01
15	iProduct	1	2 (“Cruzer Mini”)	0x02
16	iSerialNumber	1	3 (“SNDK40E1641758600106”)	0x03
17	bNumConfigurations	1	1	0x01

The CRC observed in the sample capture is:



CRC (in Hex):



Putting it together (PID + 18 bytes of data + CRC):

	Binary (M…L)		Hexadecimal (M…L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00010010	4B	12
02	00000001	00000000	01	00
04	00000010	00000000	02	00
06	00000000	00000000	00	00
08	01000000	10000001	40	81
10	00000111	01010000	07	50
12	01010001	00010000	51	10
14	00000000	00000001	00	01
16	00000010	00000011	02	03
18	00000001	11111011	01	FB
20	01001110		4E	

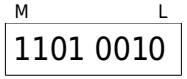
2.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

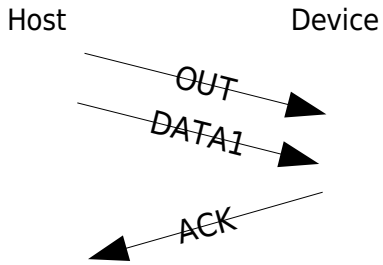
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

2.3 OUT transaction

The OUT transaction has the following three packets:

- OUT packet (->)
- DATA1 packet (->)
- ACK packet (<-)



2.3.1 OUT packet

An OUT packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1000	0111	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

11011 0000 000 1010 1110 0001

Regrouping in groups of 4-bits:

1101 1000 0000 1010 1110 0001

Hex values (as a byte):

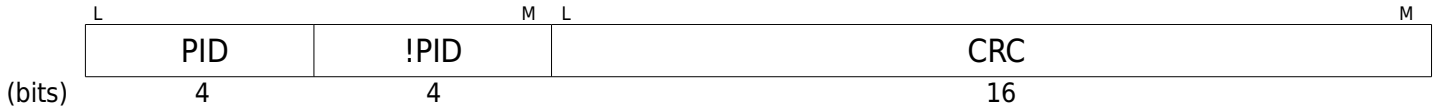
D8 0A E1

Summary (OUT packet):

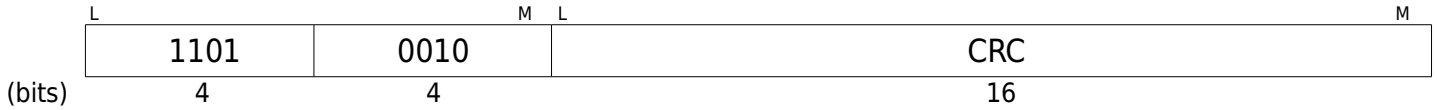
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11100001	00001010	E1	0A
02	11011000		D8	

2.3.2 DATA1 packet

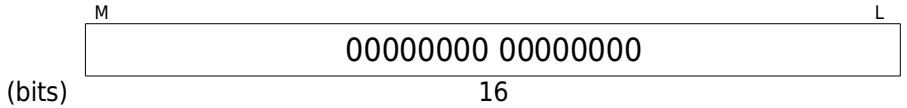
The DATA1 packet has no data. It consists of:



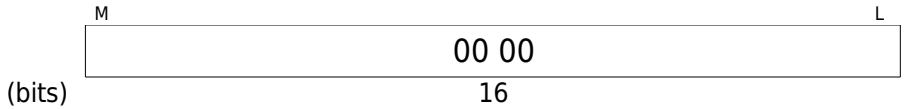
Values:



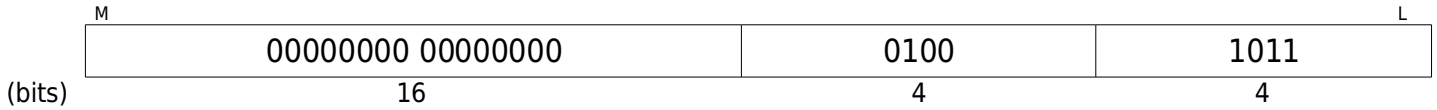
The CRC observed in the sample capture is:



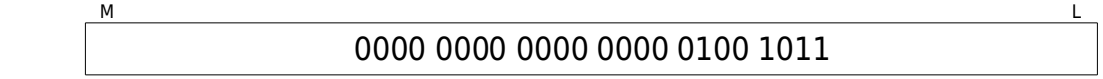
CRC (in Hex):



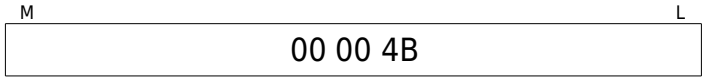
The packet arranged in MSB to LSB order:



In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

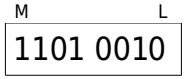
2.3.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

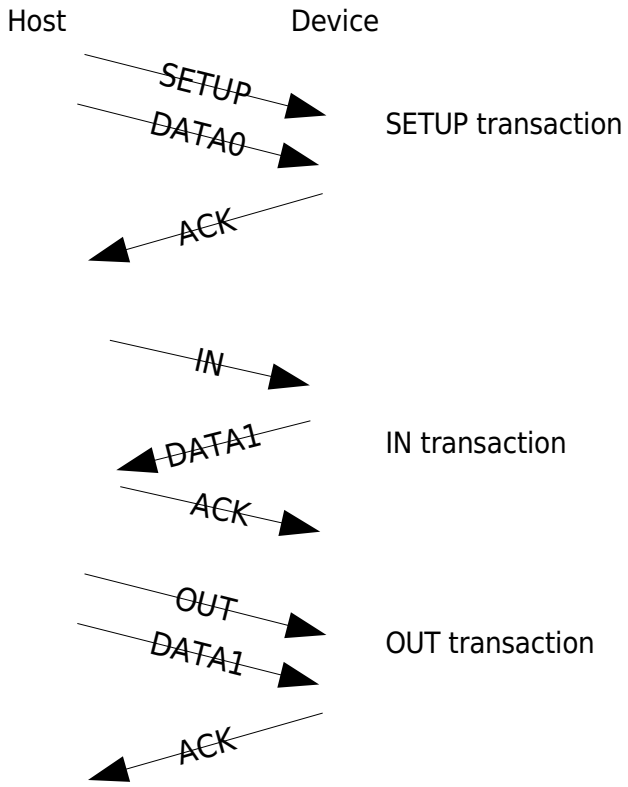
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

3. GetDescriptor (Configuration)

GetDescriptor (Configuration) transfer consists of the following transactions:

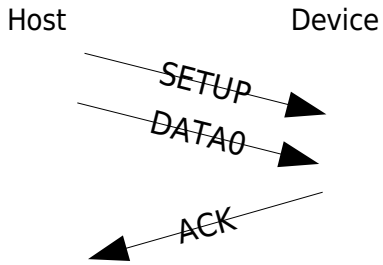
- SETUP transaction (->)
- IN transaction (<-)
- OUT transaction (->)



3.1 SETUP transaction

The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)



3.1.1 SETUP packet

A SETUP packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1011	0100	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

```
11011 0000 000 1010 0010 1101
```

Regrouping in groups of 4-bits:

```
1101 1000 0000 1010 0010 1101
```

Hex values:

```
D 8 0 A 2 D
```

Regrouping as a byte:

M L

D8 0A 2D

Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00001010	2D	0A
02	11011000		D8	

3.1.2 DATA0 packet

A DATA0 packet consists of:

	PID	!PID	SETUP Data	CRC
(bits)	4	4	64	16

	1100	0011	SETUP Data	CRC
(bits)	4	4	64	16

The PID arranged in MSB to LSB order:

	1100	0011
(bits)	4	4

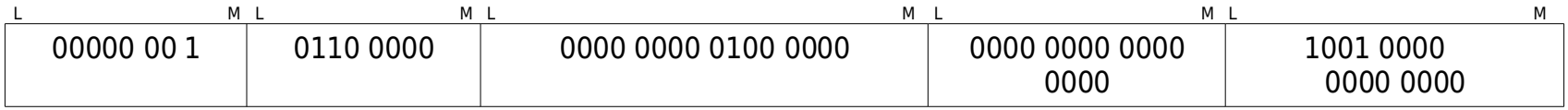
Hex values (PID):

C 3

Since this is for a SETUP packet, the data consists of 8 bytes. The format is:

	bmRequestType	bRequest	wValue	wIndex	wLength
(bytes)	1	1	2	2	2

The 8 bytes for SETUP details are as follows (in decimal):



bmRequestType:

D7: Data transfer direction
1 = Device-to-host

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

bRequest:

GET_DESCRIPTOR request code is 6.

wValue:

Descriptor type is CONFIGURATION, the value is 2. Descriptor index is 0.

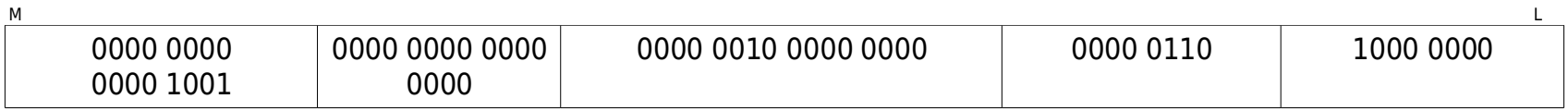
wIndex:

Value is zero.

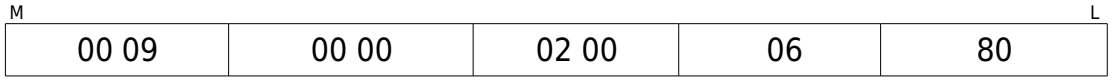
wLength:

Size of descriptor data, which is 9 bytes.

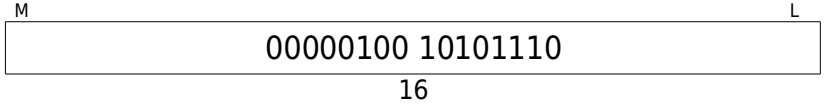
Putting it in MSB to LSB order:



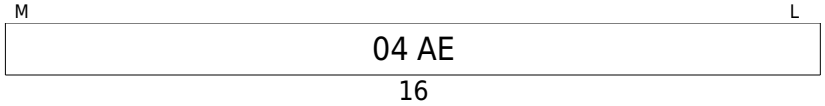
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



Putting it all (PID + SETUP DATA + CRC) together,

Summary (DATA0 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	10000000	C3	80
02	00000110	00000000	06	00
04	00000010	00000000	02	00
06	00000000	00001001	00	09
08	00000000	10101110	00	AE
10	00000100		04	

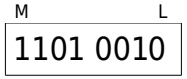
3.1.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

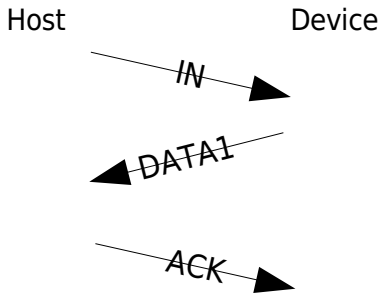
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

3.2 IN transaction

The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)



3.2.1 IN packet

A IN packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
	L M	L M	L M	L M	L M
(bits)	4	4	7	4	5

Values:

	1001	0110	0101 000	0000	11011
	L M	L M	L M	L M	L M
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

M L

11011 0000 000 1010 0110 1001

Regrouping in groups of 4-bits:

M L

1101 1000 0000 1010 0110 1001

Hex values (as a byte):

M L

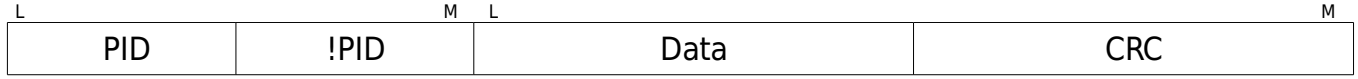
D8 0A 69

Summary (IN packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00001010	69	0A
02	11011000		D8	

3.2.2 DATA1 packet

A DATA1 packet for GetDescriptor (Configuration) provides the 9 bytes of data. It consists of:



(bits)	4	4	72	16

Values:

(bits)	4	4	72	16

========== *BEGIN* ==========
Standard Configuration Descriptor

Table 9-10: Standard Configuration Descriptor

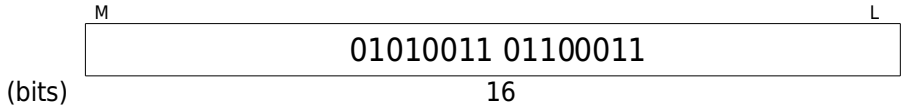
Offset	Field	Size	Value	Description
0	bLength	1	Number	Length of this descriptor (bytes)
1	bDescriptorType	1	Constant	CONFIGURATION descriptor type
2	wTotalLength	2	Number	Total length of all descriptors (configuration, interface, endpoint, class- or vendor- specific) for this configuration.
4	bNumInterfaces	1	Number	Number of interfaces
5	bConfigurationValue	1	Number	Value to be used as argument to SetConfiguration() to select this configuration
6	iConfiguration	1	Index	Index of string descriptor describing this configuration
7	bmAttributes	1	Bitmap	D7: Reserved (set to one) D6: Self-powered D5: Remote wake-up D4...0: Reserved (set to zero) Enable field by setting bit to one.
8	bMaxPower	1	mA	Maximum power consumption expressed in 2 mA units.

Reference: Chapter 9: USB Device Framework, pages 265-266
========== *END* ==========

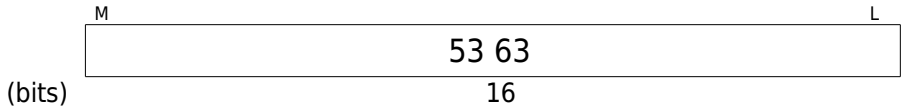
So, the data for our capture was:

Offset	Field	Size	Value	Hex
0	bLength	1	9 (bytes)	0x09
1	bDescriptorType	1	CONFIGURATION descriptor (2)	0x02
2	wTotalLength	2	32 (bytes)	0x0020
4	bNumInterfaces	1	1	0x01
5	bConfigurationValue	1	1	0x01
6	iConfiguration	1	0	0x00
7	bmAttributes	1	Not supported	0x80
8	bMaxPower	2	200 mA	0x64

The CRC observed in the sample capture is:



CRC (in Hex):



Putting it together (PID + 9 bytes of data + CRC):

	Binary (M…L)		Hexadecimal (M…L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00001001	4B	09
02	00000010	00100000	02	20
04	00000000	00000001	00	01
06	00000001	00000000	01	00
08	10000000	01100100	80	64
10	01100011	01010011	63	53

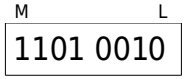
3.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

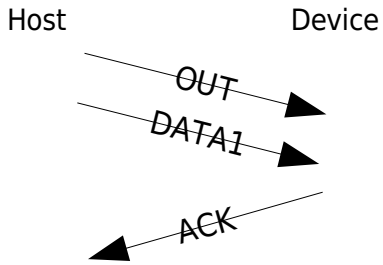
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

3.3 OUT transaction

The OUT transaction has the following three packets:

- OUT packet (->)
- DATA1 packet (->)
- ACK packet (<-)



3.3.1 OUT packet

An OUT packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1000	0111	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

```
11011 0000 000 1010 1110 0001
```

Regrouping in groups of 4-bits:

```
1101 1000 0000 1010 1110 0001
```

Hex values (as a byte):

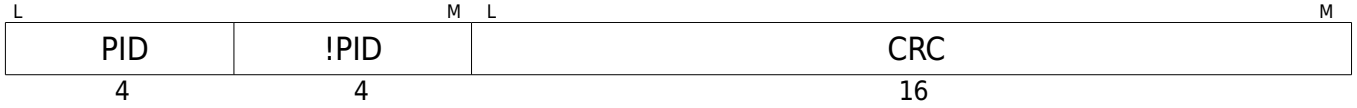
```
D8 0A E1
```

Summary (OUT packet):

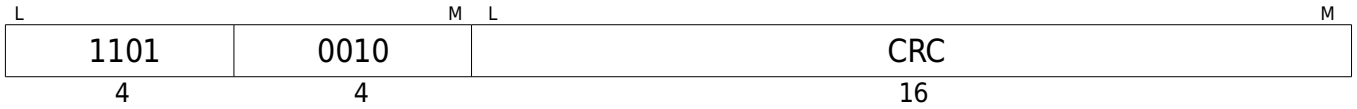
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11100001	00001010	E1	0A
02	11011000		D8	

3.3.2 DATA1 packet

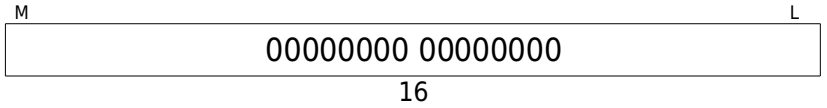
The DATA1 packet has no data. It consists of:



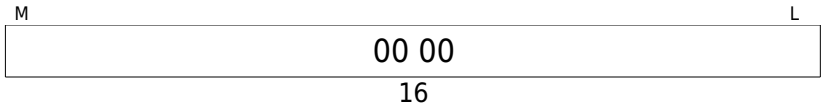
Values:



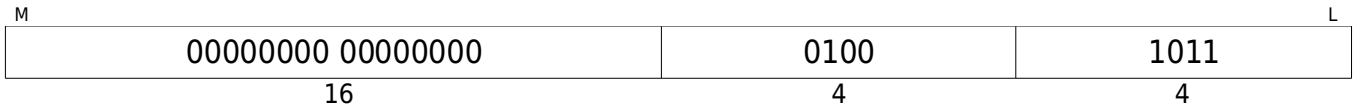
The CRC observed in the sample capture is:



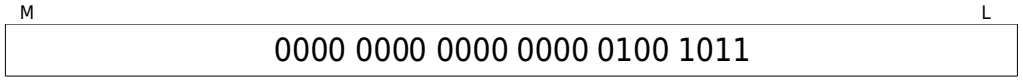
CRC (in Hex):



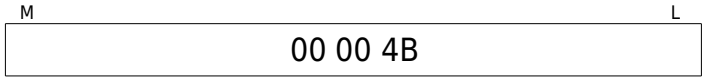
The packet arranged in MSB to LSB order:



In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

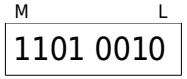
3.3.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

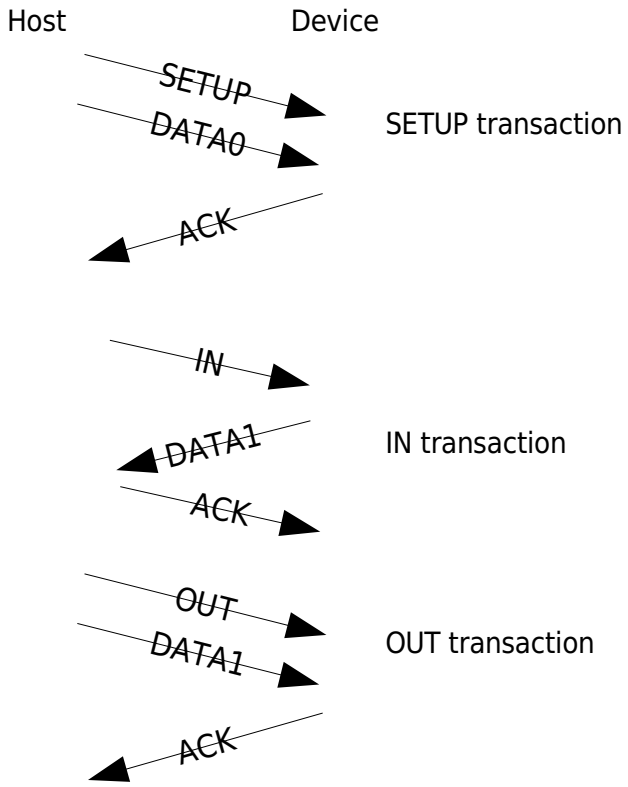
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

4. GetDescriptor (Configuration)

GetDescriptor (Configuration) transfer consists of the following transactions:

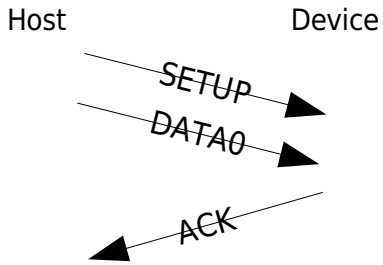
- SETUP transaction (->)
- IN transaction (<-)
- OUT transaction (->)



4.1 SETUP transaction

The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)



4.1.1 SETUP packet

A SETUP packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1011	0100	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

```
11011 0000 000 1010 0010 1101
```

Regrouping in groups of 4-bits:

```
1101 1000 0000 1010 0010 1101
```

Hex values:

```
D 8 0 A 2 D
```

Regrouping as a byte:

M L

D8 0A 2D

Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00001010	2D	0A
02	11011000		D8	

4.1.2 DATA0 packet

A DATA0 packet consists of:

	PID	!PID	SETUP Data	CRC
(bits)	4	4	64	16

	1100	0011	SETUP Data	CRC
(bits)	4	4	64	16

The PID arranged in MSB to LSB order:

	1100	0011
(bits)	4	4

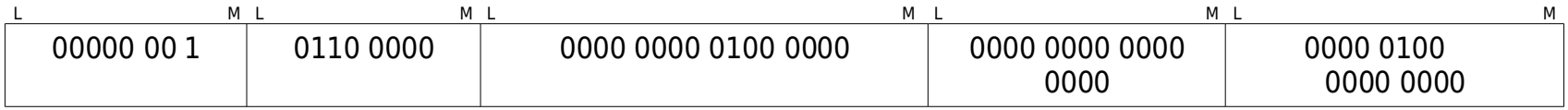
Hex values (PID):

C 3

Since this is for a SETUP packet, the data consists of 8 bytes. The format is:

	bmRequestType	bRequest	wValue	wIndex	wLength
(bytes)	1	1	2	2	2

The 8 bytes for SETUP details are as follows (in decimal):



bmRequestType:

D7: Data transfer direction
1 = Device-to-host

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

bRequest:

GET_DESCRIPTOR request code is 6.

wValue:

Descriptor type is CONFIGURATION, the value is 2. Descriptor index is 0.

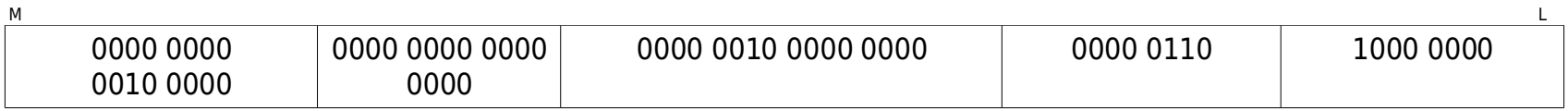
wIndex:

Value is zero.

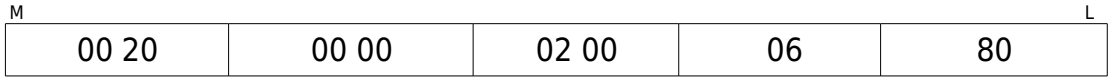
wLength:

Size of descriptor data, which is 32 bytes.

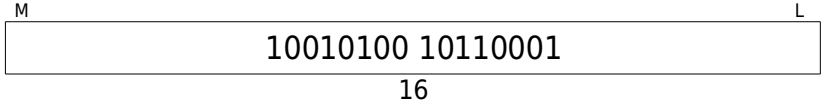
Putting it in MSB to LSB order:



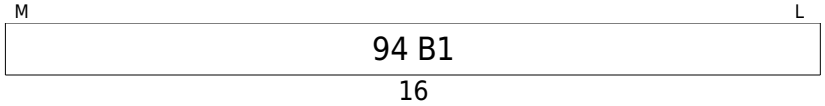
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



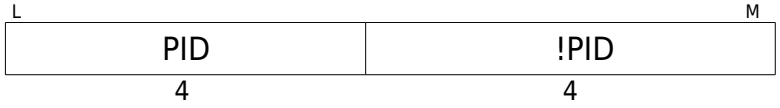
Putting it all (PID + SETUP DATA + CRC) together,

Summary (DATA0 packet):

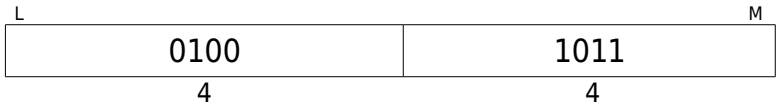
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	10000000	C3	80
02	00000110	00000000	06	00
04	00000010	00000000	02	00
06	00000000	00100000	00	20
08	00000000	10110001	00	B1
10	10010100		94	

4.1.3 ACK packet

An ACK packet consists of:

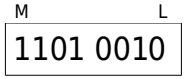


Values:



USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

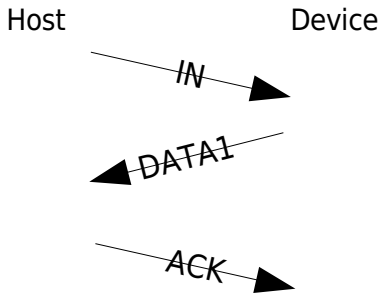
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

4.2 IN transaction

The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)



4.2.1 IN packet

A IN packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1001	0110	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

11011 0000 000 1010 0110 1001

Regrouping in groups of 4-bits:

1101 1000 0000 1010 0110 1001

Hex values (as a byte):

D8 0A 69

Summary (IN packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00001010	69	0A
02	11011000		D8	

4.2.2 DATA1 packet

A DATA1 packet for GetDescriptor (Configuration) provides the 32 bytes of data. It consists of:

	L … M	L … M	
	PID	!PID	Data	CRC
(bits)	4	4	256	16

Values:

	L … M	L … M	
	1101	0010	Data	CRC
(bits)	4	4	256	16

========== BEGIN ==========
Standard Interface Descriptor

Table 9-12: Standard Interface Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	Number	Length of this descriptor (bytes)
1	bDescriptorType	1	Constant	INTERFACE descriptor type
2	bInterfaceNumber	1	Number	Number of this interface
3	bAlternateSetting	1	Number	Used to select this alternate setting for the interface identified in the prior field
4	bNumEndpoints	1	Number	Number of endpoints for this interface (excluding endpoint zero). If zero, it uses only endpoint zero.
5	bInterfaceClass	1	Number	Class code (by USB-IF)
6	bInterfaceSubClass	1	Number	Subclass code (by USB-IF)
7	bInterfaceProtocol	1	Protocol	Protocol code (by USB-IF)
8	iInterface	1	Index	Index of string descriptor describing this interface

Table 9-13: Standard Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	Number	Length of this descriptor (bytes)
1	bDescriptorType	1	Constant	ENDPOINT descriptor type
2	bEndpointAddress	1	Endpoint	Bit:7 Direction 0 = OUT endpoint 1 = IN endpoint Bit: 6...4 Reserved (set to zero) Bit: 3...0 Endpoint number
3	bmAttributes	1	Bitmap	Bit: 7...6 Reserved (set to zero) Bit: 5...4 Usage type 00 = Data endpoint 01 = Feedback endpoint 10 = Implicit feedback data endpoint 11 = Reserved Bit: 3...2 Synchronization type 00 = No synchronization 01 = Asynchronous 10 = Adaptive 11 = Synchronous Bit: 1...0: Transfer type 00 = Control 01 = Isochronous 10 = Bulk 11 = Interrupt
4	wMaxPacketSize	2	Number	Bit: 15...13 Reserved (set to zero) Bit: 12...11 Additional transaction per microframe 00 = None 01 = 1 additional 10 = 2 additional 11 = Reserved Bit: 10...0 Maxium packet size
6	bInterval	1	Number	Interval for polling endpoint for data transfers. Expressed in frames or microframes.

Reference: Chapter 9: USB Device Framework, pages 268-271
========== *END* ==========

So, the data for our capture was one configuration descriptor, one interface descriptor and two endpoint descriptors:

Configuration descriptor (9 bytes):

Offset	Field	Size	Value	Hex
0	bLength	1	9 (bytes)	0x09
1	bDescriptorType	1	CONFIGURATION descriptor (2)	0x02
2	wTotalLength	2	32 (bytes)	0x0020
4	bNumInterfaces	1	1	0x01
5	bConfigurationValue	1	1	0x01
6	iConfiguration	1	0	0x00
7	bmAttributes	1	Not supported	0x80
8	bMaxPower	2	200 mA	0x64

Interface descriptor (9 bytes):

Offset	Field	Size	Value	Hex
0	bLength	1	9 (bytes)	0x09
1	bDescriptorType	1	INTERFACE descriptor (4)	0x04
2	bInterfaceNumber	1	0	0x00
3	bAlternateSetting	1	0	0x00
4	bNumEndpoints	1	2	0x02
5	bInterfaceClass	1	Mass Storage(08)	0x08
6	bInterfaceSubClass	1	SCSI transparent command set(06)	0x06
7	bInterfaceProtocol	1	Bulk-Only Transport(50)	0x50
8	iInterface	1	0	0x00

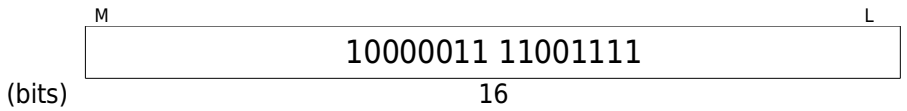
Endpoint descriptor (7 bytes):

Offset	Field	Size	Value	Hex
0	bLength	1	7 (bytes)	0x07
1	bDescriptorType	1	ENDPOINT descriptor (5)	0x05
2	bEndpointAddress	1	IN endpoint (D7), first endpoint (D0)	0x81
3	bmAttributes	1	Data endpoint (D5...D4), No synchronization (D3...D2), Bulk transfer type (D1...D0)	0x02
4	wMaxPacketSize	2	512 bytes	0x0200
6	bInterval	1	0	0x00

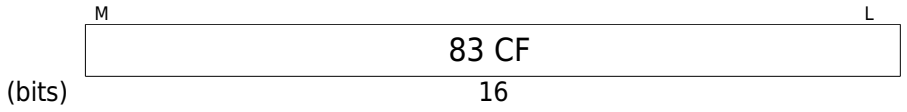
Endpoint descriptor (7 bytes):

Offset	Field	Size	Value	Hex
0	bLength	1	7 (bytes)	0x07
1	bDescriptorType	1	ENDPOINT descriptor (5)	0x05
2	bEndpointAddress	1	OUT endpoint (D7), second endpoint (D0)	0x01
3	bmAttributes	1	Data endpoint (D5...D4), No synchronization (D3...D2), Bulk transfer type (D1...D0)	0x02
4	wMaxPacketSize	2	512 bytes	0x0200
6	bInterval	1	1	0x01

The CRC observed in the sample capture is:



CRC (in Hex):



Putting it together (PID + 32 bytes of data + CRC):

	Binary (M...L)				Hex			
	Offset				Offset			
Offset	0	1			0			1
00	01001011	00001001	00000010	00100000	4B	09	02	20
04	00000000	00000001	00000001	00000000	00	01	01	00
08	10000000	01100100	00001001	00000100	80	64	09	04
12	00000000	00000000	00000010	00001000	00	00	02	08
16	00000110	01010000	00000000	00000111	06	50	00	07
20	00000101	10010001	00000010	00000000	05	81	02	00
24	00000010	00000000	00000111	00000101	02	00	07	05
28	00000001	00000010	00000000	00000010	01	02	00	02
32	00000001	11001111	10010011		01	CF	83	

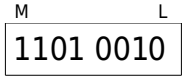
4.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

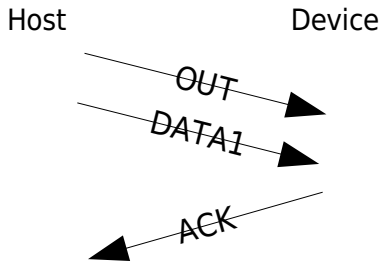
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

4.3 OUT transaction

The OUT transaction has the following three packets:

- OUT packet (->)
- DATA1 packet (->)
- ACK packet (<-)



4.3.1 OUT packet

An OUT packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1000	0111	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

```
11011 0000 000 1010 1110 0001
```

Regrouping in groups of 4-bits:

```
1101 1000 0000 1010 1110 0001
```

Hex values (as a byte):

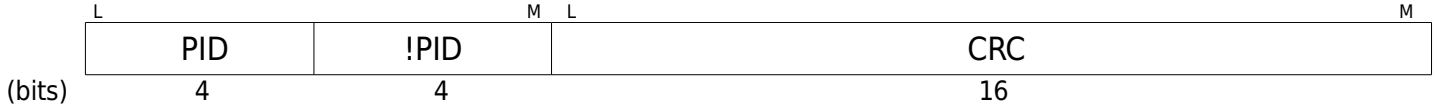
```
D8 0A E1
```

Summary (OUT packet):

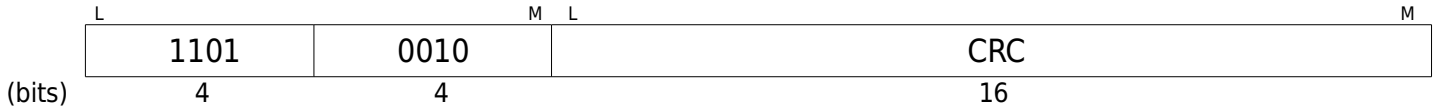
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11100001	00001010	E1	0A
02	11011000		D8	

4.3.2 DATA1 packet

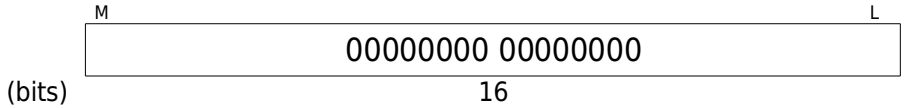
The DATA1 packet has no data. It consists of:



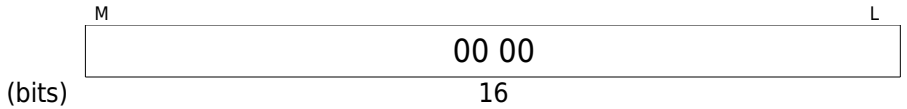
Values:



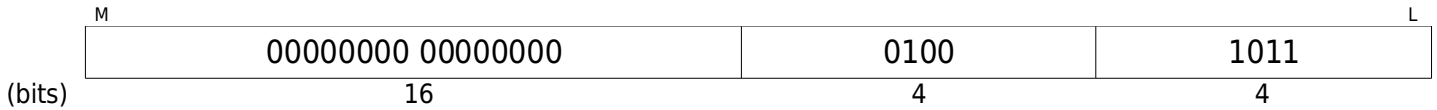
The CRC observed in the sample capture is:



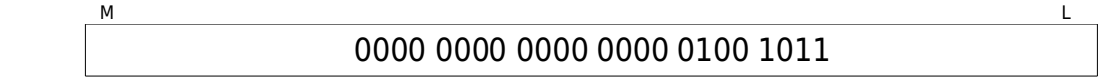
CRC (in Hex):



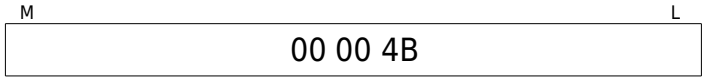
The packet arranged in MSB to LSB order:



In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

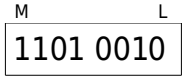
4.3.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

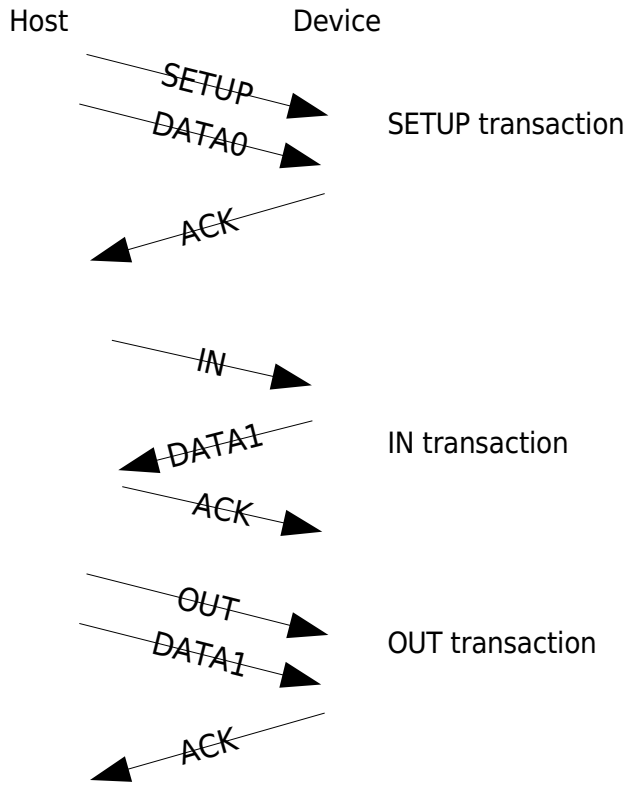
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

5. GetDescriptor (String Language IDs)

GetDescriptor (String Language IDs) transfer consists of the following transactions:

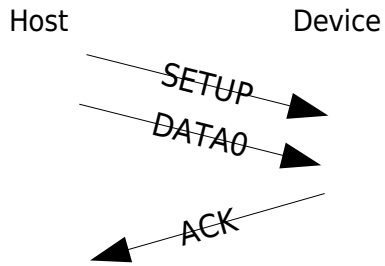
- SETUP transaction (->)
- IN transaction (<-)
- OUT transaction (->)



5.1 SETUP transaction

The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)



5.1.1 SETUP packet

A SETUP packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1011	0100	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

```
11011 0000 000 1010 0010 1101
```

Regrouping in groups of 4-bits:

```
1101 1000 0000 1010 0010 1101
```

Hex values:

```
D 8 0 A 2 D
```

Regrouping as a byte:

M L

D8 0A 2D

Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00001010	2D	0A
02	11011000		D8	

5.1.2 DATA0 packet

A DATA0 packet consists of:

	PID	!PID	SETUP Data	CRC
(bits)	4	4	64	16

	1100	0011	SETUP Data	CRC
(bits)	4	4	64	16

The PID arranged in MSB to LSB order:

	1100	0011
(bits)	4	4

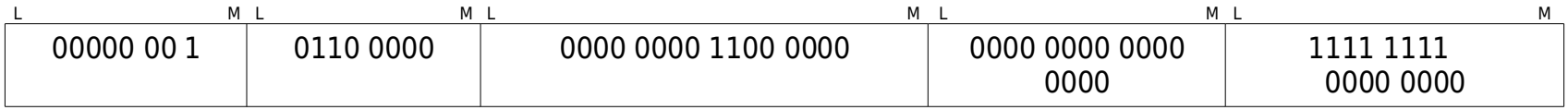
Hex values (PID):

C 3

Since this is for a SETUP packet, the data consists of 8 bytes. The format is:

	bmRequestType	bRequest	wValue	wIndex	wLength
(bytes)	1	1	2	2	2

The 8 bytes for SETUP details are as follows (in decimal):



bmRequestType:

D7: Data transfer direction
1 = Device-to-host

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

bRequest:

GET_DESCRIPTOR request code is 6.

wValue:

Descriptor type is STRING, the value is 3. Descriptor index is 0.

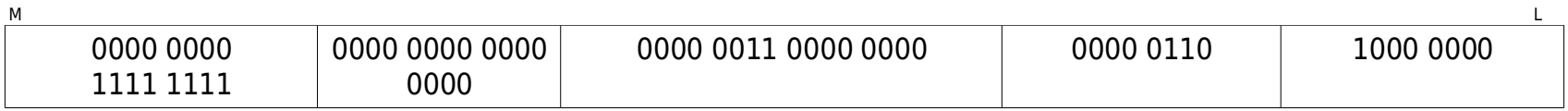
wIndex:

Value is zero.

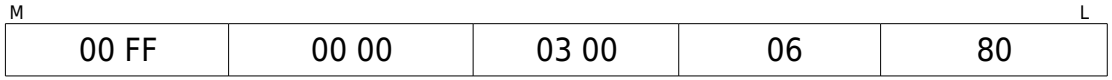
wLength:

Size of descriptor data, which is 255 bytes.

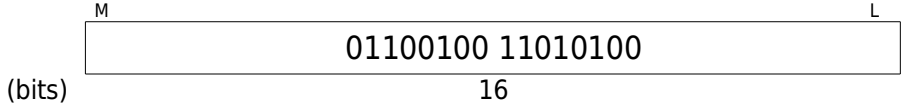
Putting it in MSB to LSB order:



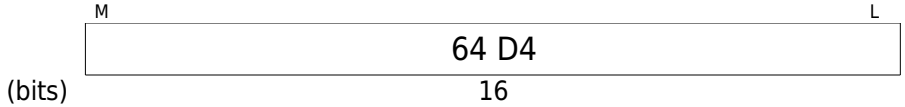
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



Putting it all (PID + SETUP DATA + CRC) together,

Summary:

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	10000000	C3	80
02	00000110	00000000	06	00
04	00000011	00000000	03	00
06	00000000	11111111	00	FF
08	00000000	11010100	00	D4
10	01100100		64	

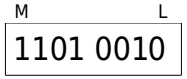
5.1.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

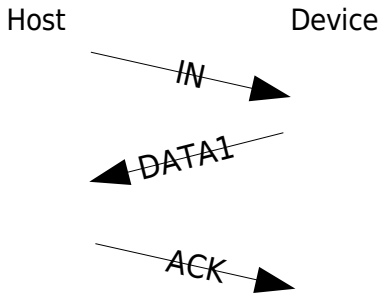
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

5.2 IN transaction

The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)



5.2.1 IN packet

A IN packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1001	0110	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

11011 0000 000 1010 0110 1001

Regrouping in groups of 4-bits:

1101 1000 0000 1010 0110 1001

Hex values (as a byte):

D8 0A 69

Summary (IN packet):

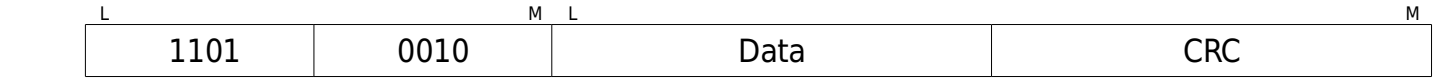
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00001010	69	0A
02	11011000		D8	

5.2.2 DATA1 packet

A DATA1 packet for GetDescriptor (String Language IDs) provides the 4 bytes of data. It consists of:

(bits)	4	4	32	16

Values:



(bits)	4	4	32	16

========== *BEGIN* ==========
String Descriptor Zero

Table 9-15: String Descriptor Zero, Specifying Languages Supported by the Device

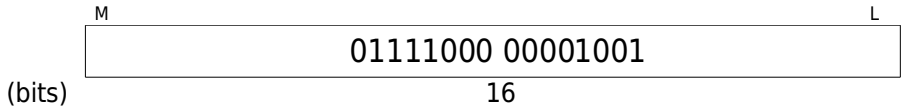
Offset	Field	Size	Value	Description
0	bLength	1	N+2	Length of this descriptor (bytes)
1	bDescriptorType	1	Constant	STRING descriptor type
2	wLANGID[0]	2	Number	LANGID code zero
...	...	...	...	...
N	wLANID[x]	2	Number	LANGID code x

Reference: Chapter 9: USB Device Framework, pages 273-274
========== *END* ==========

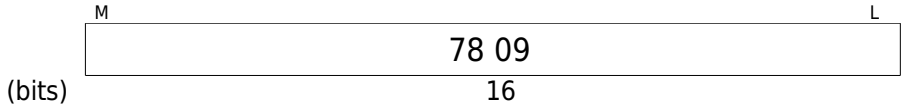
So, the data for our capture was:

Offset	Field	Size	Value	Hex
0	bLength	1	4 bytes	0x04
1	bDescriptorType	1	STRING descriptor	0x03
2	wLANGID[0]	2	English (US)	0x0409

The CRC observed in the sample capture is:



CRC (in Hex):



Putting it together (PID + 4 bytes of data + CRC):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000100	4B	04
02	00000011	00001001	03	09
04	00000100	00001001	04	09
06	01111000		78	

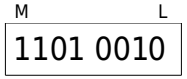
5.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

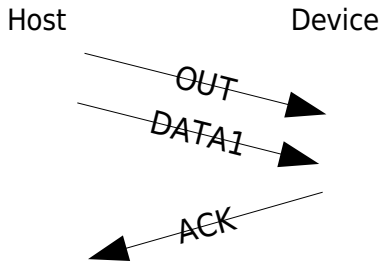
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

5.3 OUT transaction

The OUT transaction has the following three packets:

- OUT packet (->)
- DATA1 packet (->)
- ACK packet (<-)



5.3.1 OUT packet

An OUT packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1000	0111	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

```
11011 0000 000 1010 1110 0001
```

Regrouping in groups of 4-bits:

```
1101 1000 0000 1010 1110 0001
```

Hex values (as a byte):

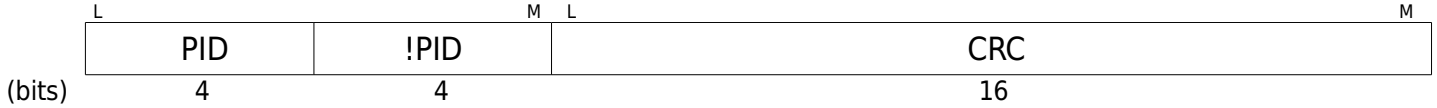
```
D8 0A E1
```

Summary (OUT packet):

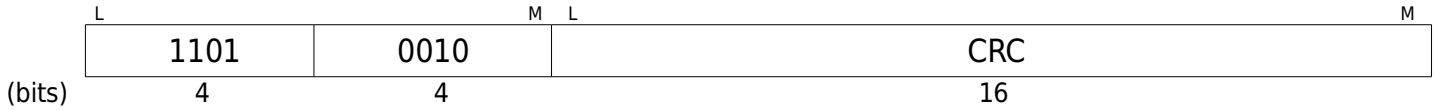
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11100001	00001010	E1	0A
02	11011000		D8	

5.3.2 DATA1 packet

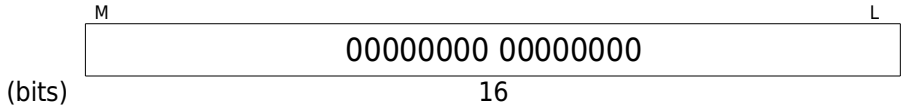
The DATA1 packet has no data. It consists of:



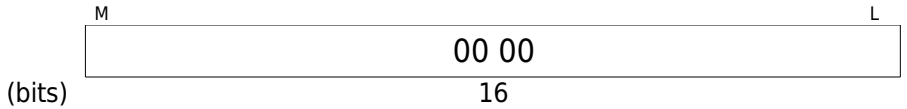
Values:



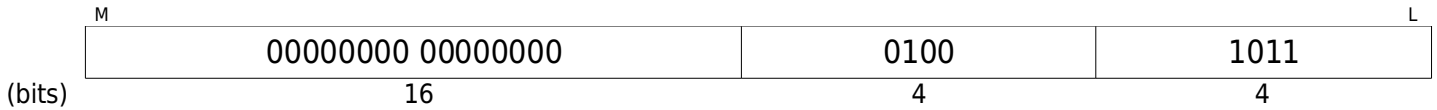
The CRC observed in the sample capture is:



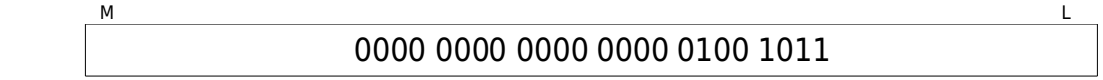
CRC (in Hex):



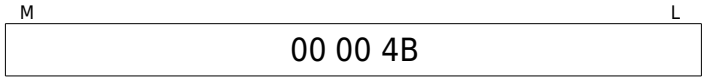
The packet arranged in MSB to LSB order:



In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

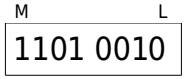
5.3.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

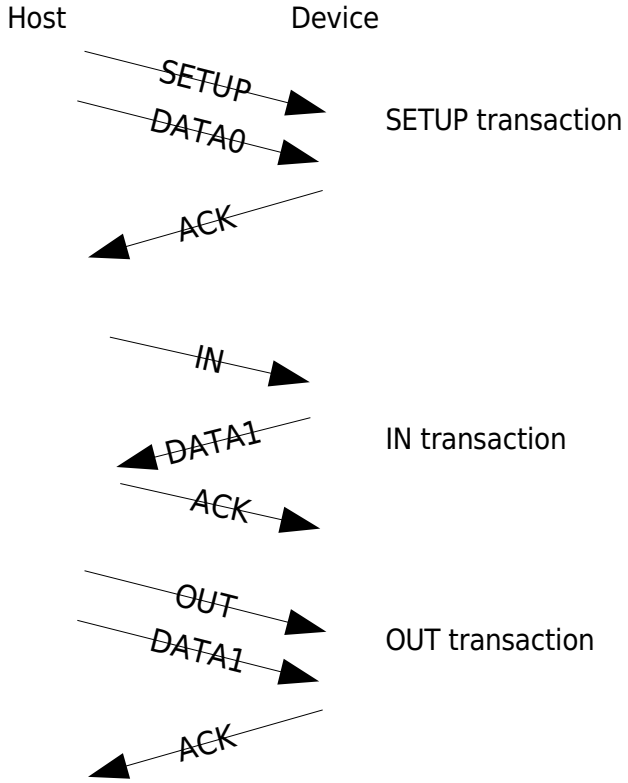
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

6. GetDescriptor (String 2)

GetDescriptor (String 2) transfer consists of the following transactions:

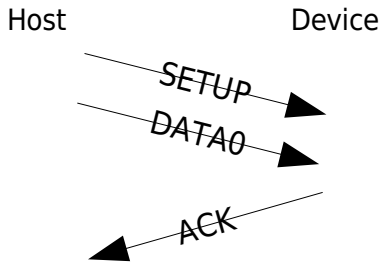
* SETUP transaction (->)
* IN transaction (<-)
* OUT transaction (->)



6.1 SETUP transaction

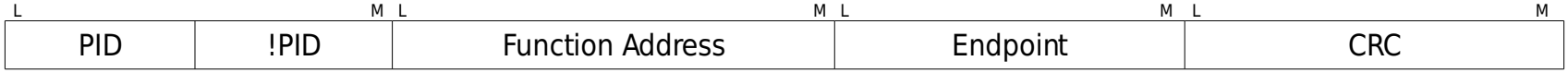
The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)

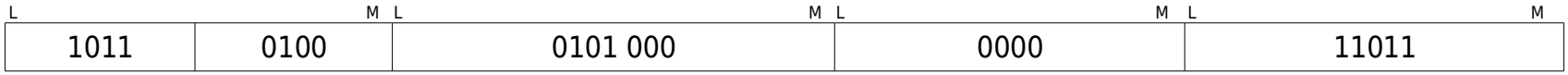


6.1.1 SETUP packet

A SETUP packet consists of:

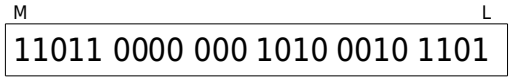


Values:

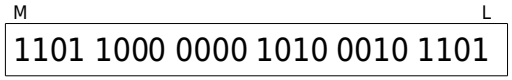


USB is little-endian. LSB goes out of the wire, first.

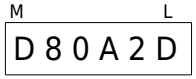
Displaying from MSB to LSB:



Regrouping in groups of 4-bits:



Hex values:



Regrouping as a byte:

M L

D8 0A 2D

Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00001010	2D	0A
02	11011000		D8	

6.1.2 DATA0 packet

A DATA0 packet consists of:

	PID	!PID	SETUP Data	CRC
(bits)	4	4	64	16

	1100	0011	SETUP Data	CRC
(bits)	4	4	64	16

The PID arranged in MSB to LSB order:

	1100	0011
(bits)	4	4

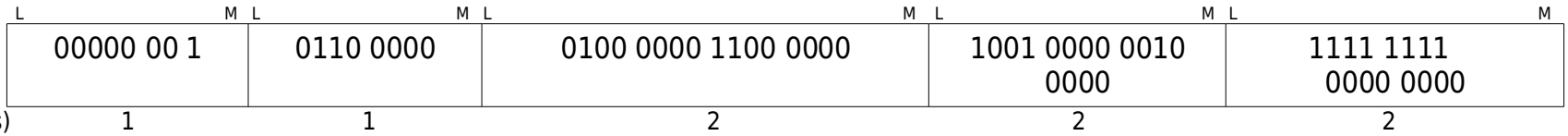
Hex values (PID):

C 3

Since this is for a SETUP packet, the data consists of 8 bytes. The format is:

	bmRequestType	bRequest	wValue	wIndex	wLength
(bytes)	1	1	2	2	2

The 8 bytes for SETUP details are as follows (in decimal):



bmRequestType:

D7: Data transfer direction
1 = Device-to-host

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

bRequest:

GET_DESCRIPTOR request code is 6.

wValue:

Descriptor type is STRING, the value is 3. Descriptor index is 2.

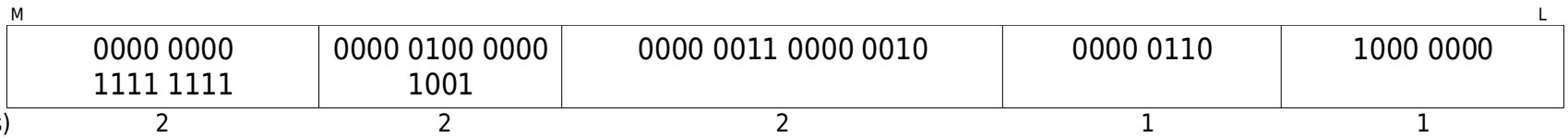
wIndex:

Language ID is English (US). The value is 0x0409.

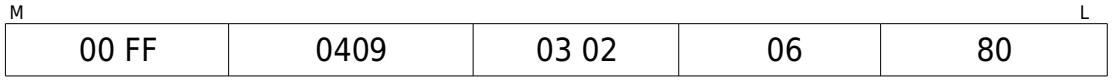
wLength:

Size of descriptor data, which is 255 bytes.

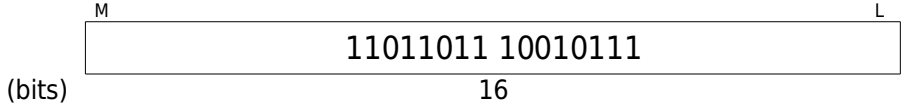
Putting it in MSB to LSB order:



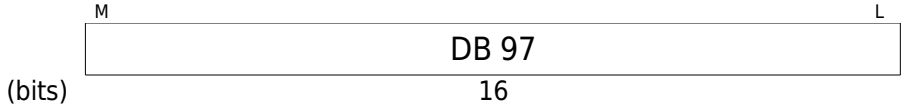
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



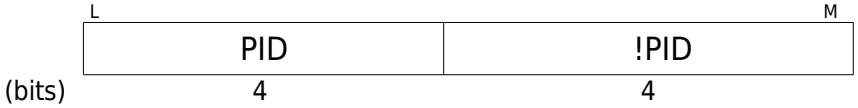
Putting it all (PID + SETUP DATA + CRC) together,

Summary (DATA0 packet):

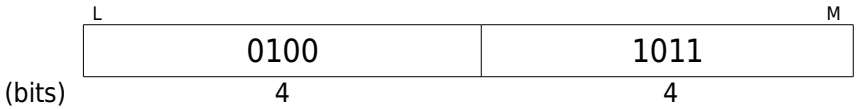
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	10000000	C3	80
02	00000110	00000010	06	02
04	00000011	00001001	03	09
06	00000100	11111111	04	FF
08	00000000	10010111	00	97
10	11011011		DB	

6.1.3 ACK packet

An ACK packet consists of:

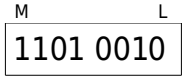


Values:



USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

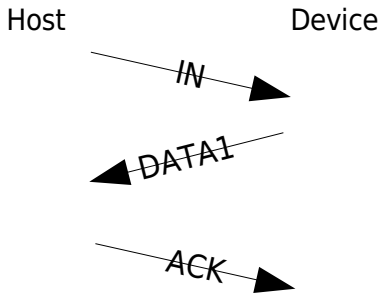
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

6.2 IN transaction

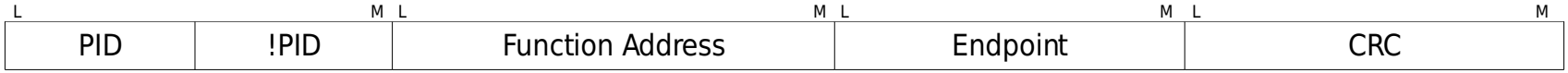
The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)

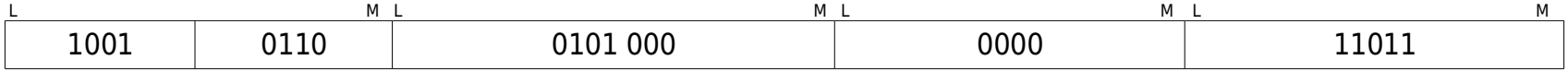


6.2.1 IN packet

A IN packet consists of:

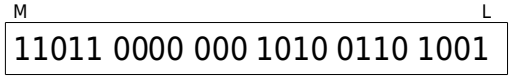


Values:

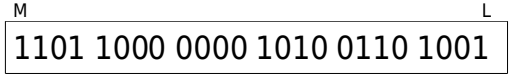


USB is little-endian. LSB goes out of the wire, first.

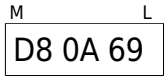
Displaying from MSB to LSB:



Regrouping in groups of 4-bits:



Hex values (as a byte):

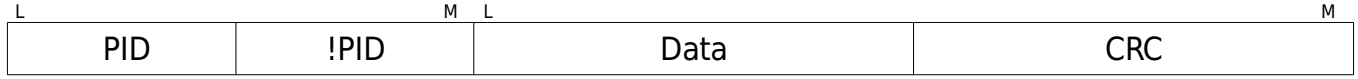


Summary (IN packet):

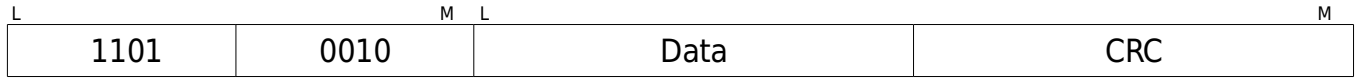
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00001010	69	0A
02	11011000		D8	

6.2.2 DATA1 packet

A DATA1 packet for GetDescriptor (String 2) provides 24 bytes of data for this device. It consists of:



Values:



========== *BEGIN* ==========
UNICODE String Descriptor

Table 9-16: UNICODE String Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	N+2	Length of this descriptor (bytes)
1	bDescriptorType	1	Constant	STRING descriptor type
2	bString	N	Number	UNICODE encoded string

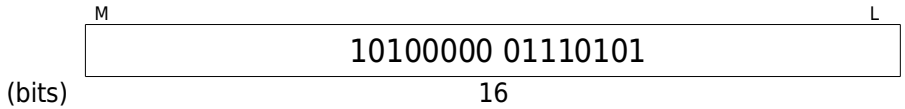
- The string is not NULL-terminated.
- The string length is computed by subtracting two from the value of the first byte in the descriptor.

Reference: Chapter 9: USB Device Framework, page 274
========== *END* ==========

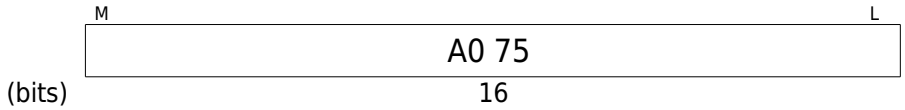
So, the data for our capture was:

Offset	Field	Size	Value	Hex
0	bLength	1	24 bytes	0x18
1	bDescriptorType	1	STRING descriptor	0x03
2	bString	2	C	0x0043
4	bString	2	r	0x0072
6	bString	2	u	0x0075
8	bString	2	z	0x007A
10	bString	2	e	0x0065
12	bString	2	r	0x0072
14	bString	2	<space>	0x0020
16	bString	2	M	0x004D
18	bString	2	i	0x0069
20	bString	2	n	0x006E
22	bString	2	i	0x0069

The CRC observed in the sample capture is:



CRC (in Hex):



Putting it together (PID + 24 bytes of data + CRC):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00011000	4B	18
02	00000011	01000110	03	43
04	00000000	01110010	00	72
06	00000000	01110101	00	75
08	00000000	01111010	00	7A
10	00000000	01100101	00	65
12	00000000	01110010	00	72
14	00000000	00100000	00	20
16	00000000	01001101	00	4D
18	00000000	01101001	00	69
20	00000000	01101110	00	6E
22	00000000	01101001	00	69
24	00000000	01110101	00	75
26	10100000		A0	

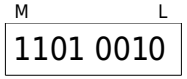
6.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

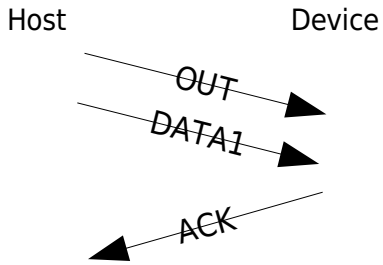
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

6.3 OUT transaction

The OUT transaction has the following three packets:

- OUT packet (->)
- DATA1 packet (->)
- ACK packet (<-)



6.3.1 OUT packet

An OUT packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1000	0111	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

```
11011 0000 000 1010 1110 0001
```

Regrouping in groups of 4-bits:

```
1101 1000 0000 1010 1110 0001
```

Hex values (as a byte):

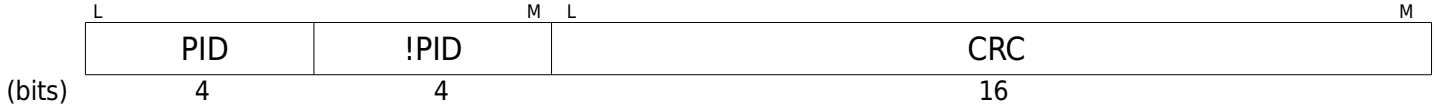
```
D8 0A E1
```

Summary (OUT packet):

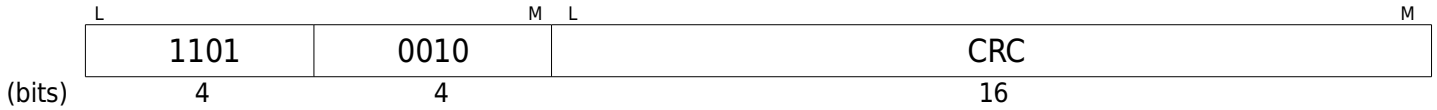
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11100001	00001010	E1	0A
02	11011000		D8	

6.3.2 DATA1 packet

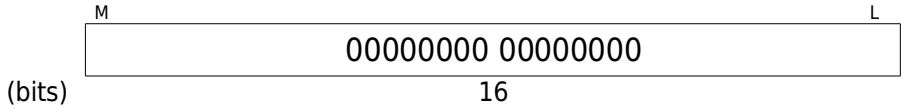
The DATA1 packet has no data. It consists of:



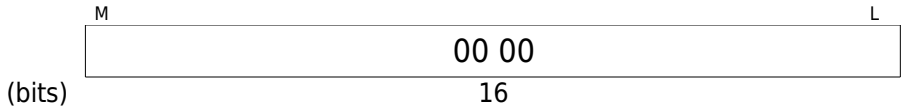
Values:



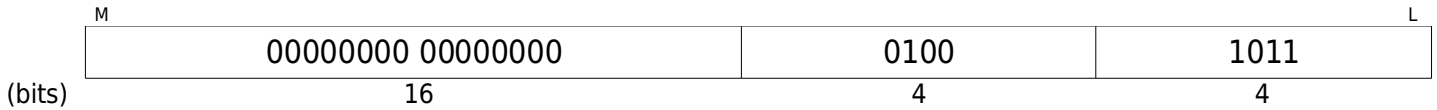
The CRC observed in the sample capture is:



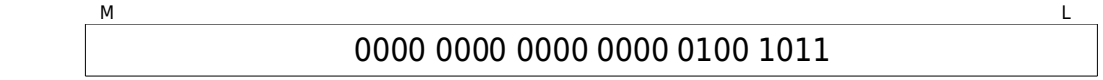
CRC (in Hex):



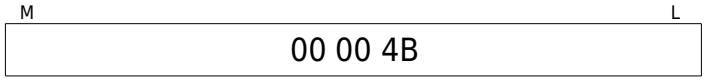
The packet arranged in MSB to LSB order:



In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

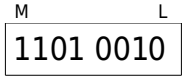
6.3.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

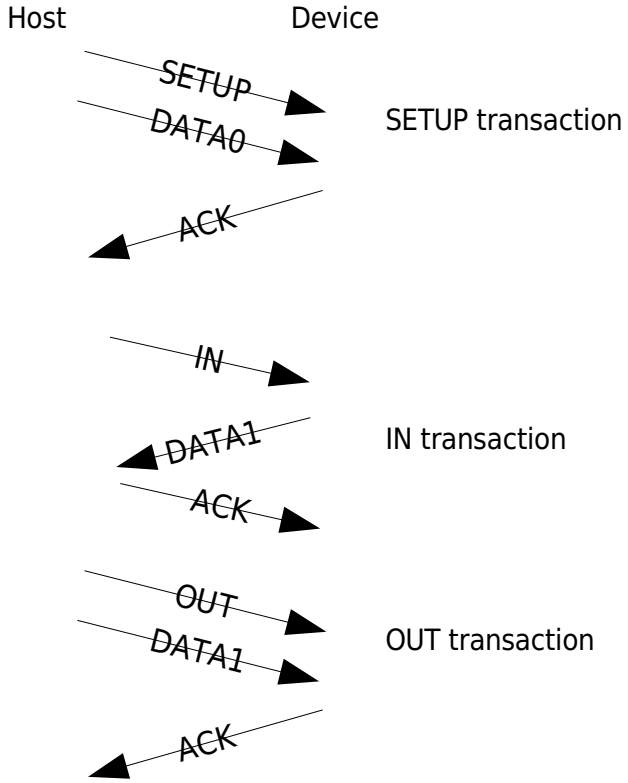
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

7. GetDescriptor (String 1)

GetDescriptor (String 1) transfer consists of the following transactions:

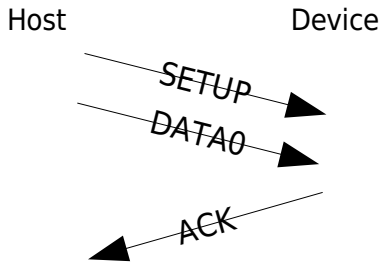
* SETUP transaction (->)
* IN transaction (<-)
* OUT transaction (->)



7.1 SETUP transaction

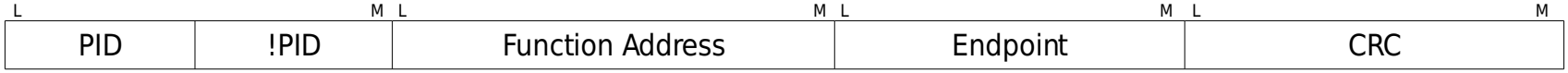
The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)



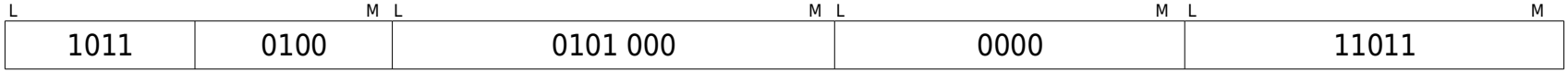
7.1.1 SETUP packet

A SETUP packet consists of:



(bits)	4	4	7	4	5

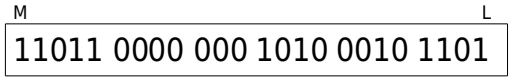
Values:



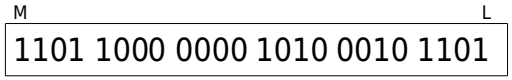
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

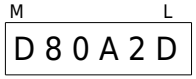
Displaying from MSB to LSB:



Regrouping in groups of 4-bits:



Hex values:



Regrouping as a byte:

M L

D8 0A 2D

Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00001010	2D	0A
02	11011000		D8	

7.1.2 DATA0 packet

A DATA0 packet consists of:

	PID	!PID	SETUP Data	CRC
(bits)	4	4	64	16

	1100	0011	SETUP Data	CRC
(bits)	4	4	64	16

The PID arranged in MSB to LSB order:

	1100	0011
(bits)	4	4

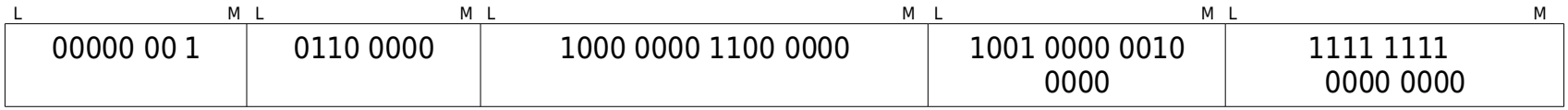
Hex values (PID):

C 3

Since this is for a SETUP packet, the data consists of 8 bytes. The format is:

	bmRequestType	bRequest	wValue	wIndex	wLength
(bytes)	1	1	2	2	2

The 8 bytes for SETUP details are as follows (in decimal):



bmRequestType:

D7: Data transfer direction
1 = Device-to-host

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

bRequest:

GET_DESCRIPTOR request code is 6.

wValue:

Descriptor type is STRING, the value is 3. Descriptor index is 1.

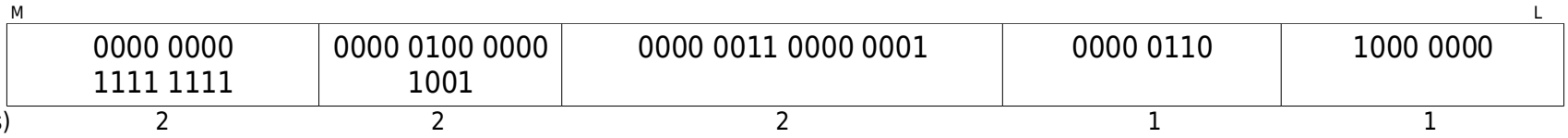
wIndex:

Language ID is English (US). The value is 0x0409.

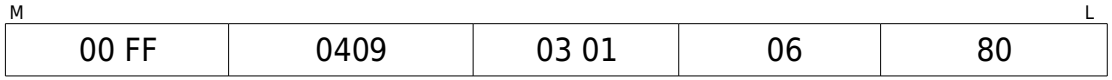
wLength:

Size of descriptor data, which is 255 bytes.

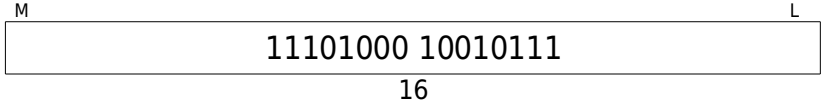
Putting it in MSB to LSB order:



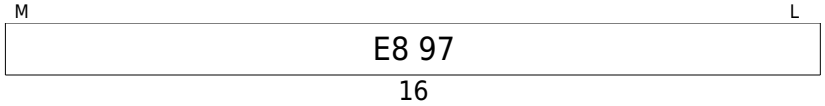
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



Putting it all (PID + SETUP DATA + CRC) together,

Summary (DATA0 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	10000000	C3	80
02	00000110	00000010	06	01
04	00000011	00001001	03	09
06	00000100	11111111	04	FF
08	00000000	10010111	00	97
10	11101000		E8	

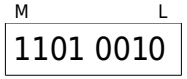
7.1.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

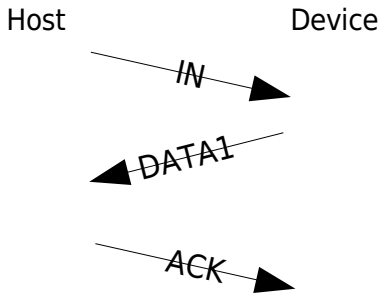
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

7.2 IN transaction

The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)



7.2.1 IN packet

A IN packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1001	0110	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

11011 0000 000 1010 0110 1001

Regrouping in groups of 4-bits:

1101 1000 0000 1010 0110 1001

Hex values (as a byte):

D8 0A 69

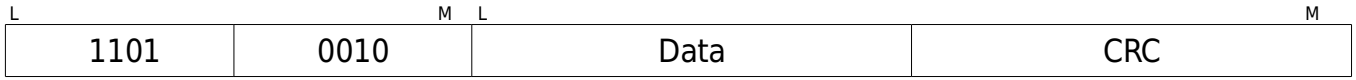
Summary (IN packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00001010	69	0A
02	11011000		D8	

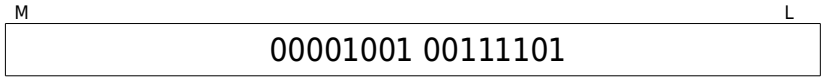
7.2.2 DATA1 packet

A DATA1 packet for GetDescriptor (String 1) provides 40 bytes of data for this device. It consists of:

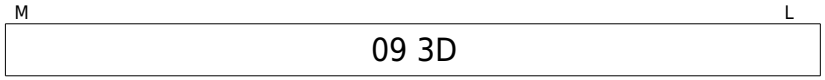
Values:



The CRC observed in the sample capture is:



CRC (in Hex):



So, the data for our capture was:

Offset	Field	Size	Value	Hex
0	bLength	1	40 bytes	0x28
1	bDescriptorType	1	STRING descriptor	0x03
2	bString	2	S	0x0053
4	bString	2	a	0x0061
6	bString	2	n	0x006E
8	bString	2	d	0x0044
10	bString	2	i	0x0069
12	bString	2	s	0x0073
14	bString	2	k	0x006B
16	bString	2		0x0020
18	bString	2	C	0x0043
20	bString	2	o	0x006F
22	bString	2	r	0x0072
24	bString	2	p	0x0070
26	bString	2	o	0x006F
28	bString	2	r	0x0072
30	bString	2	a	0x0061
32	bString	2	t	0x0074
34	bString	2	i	0x0069
36	bString	2	o	0x006F
38	bString	2	n	0x006E

Putting it together (PID + 40 bytes of data + CRC):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00101000	4B	28
02	00000011	01010011	03	53
04	00000000	01100001	00	61
06	00000000	01101110	00	6E
08	00000000	01100110	00	44
10	00000000	01101001	00	69
12	00000000	01110011	00	73
14	00000000	01101011	00	6B
16	00000000	00100000	00	20
18	00000000	01000011	00	43
20	00000000	01101111	00	6F
22	00000000	01110010	00	72
24	00000000	01110000	00	70
26	00000000	01101111	00	6F
28	00000000	01110010	00	72
30	00000000	01100001	00	61
32	00000000	01110100	00	74
34	00000000	01101001	00	69
36	00000000	01101111	00	6F
38	00000000	01101110	00	6E
40	00000000	00111101	00	3D
42	00001001		09	

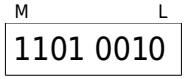
7.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

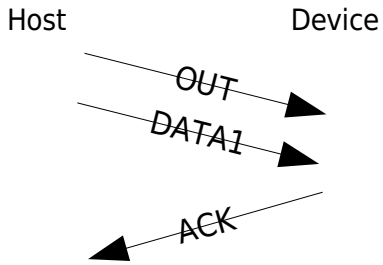
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

7.3 OUT transaction

The OUT transaction has the following three packets:

- OUT packet (->)
- DATA1 packet (->)
- ACK packet (<-)



7.3.1 OUT packet

An OUT packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1000	0111	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

```
11011 0000 000 1010 1110 0001
```

Regrouping in groups of 4-bits:

```
1101 1000 0000 1010 1110 0001
```

Hex values (as a byte):

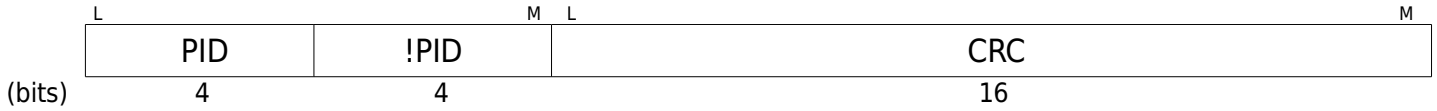
```
D8 0A E1
```

Summary (OUT packet):

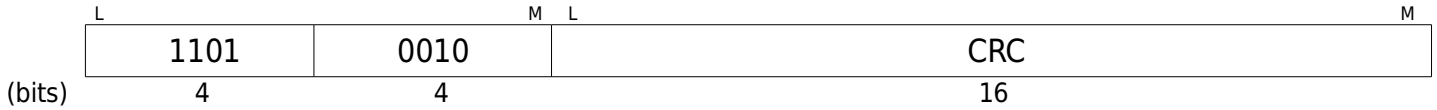
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11100001	00001010	E1	0A
02	11011000		D8	

7.3.2 DATA1 packet

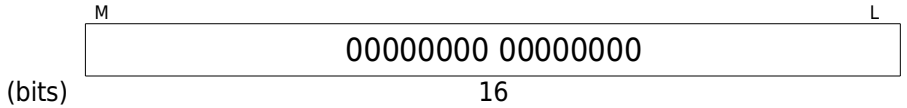
The DATA1 packet has no data. It consists of:



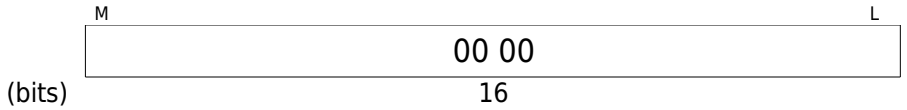
Values:



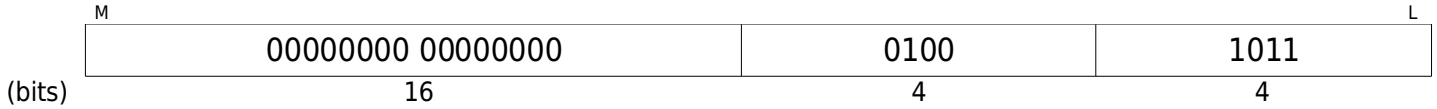
The CRC observed in the sample capture is:



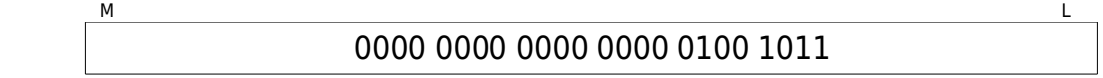
CRC (in Hex):



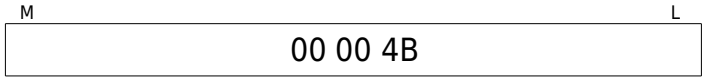
The packet arranged in MSB to LSB order:



In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

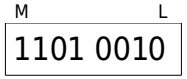
7.3.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

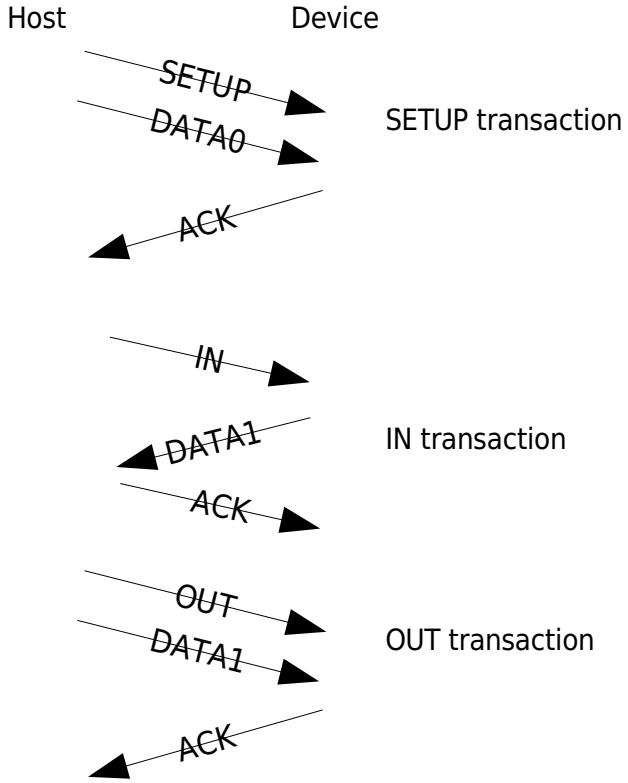
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

8. GetDescriptor (String 3)

GetDescriptor (String 3) transfer consists of the following transactions:

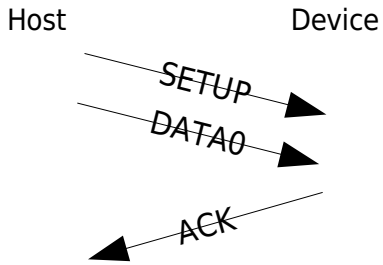
* SETUP transaction (->)
* IN transaction (<-)
* OUT transaction (->)



8.1 SETUP transaction

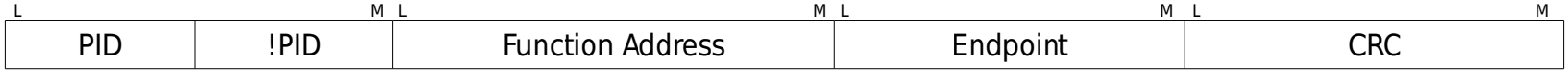
The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)

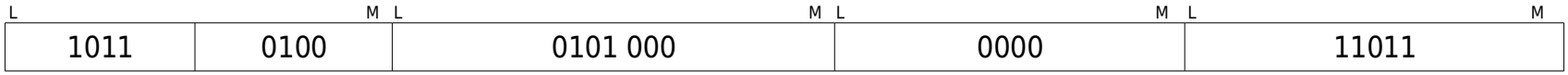


8.1.1 SETUP packet

A SETUP packet consists of:

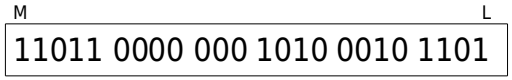


Values:

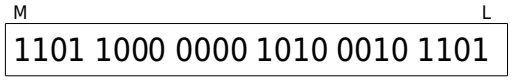


USB is little-endian. LSB goes out of the wire, first.

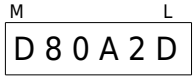
Displaying from MSB to LSB:



Regrouping in groups of 4-bits:



Hex values:



Regrouping as a byte:

M L

D8 0A 2D

Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00001010	2D	0A
02	11011000		D8	

8.1.2 DATA0 packet

A DATA0 packet consists of:

	PID	!PID	SETUP Data	CRC
(bits)	4	4	64	16

	1100	0011	SETUP Data	CRC
(bits)	4	4	64	16

The PID arranged in MSB to LSB order:

	1100	0011
(bits)	4	4

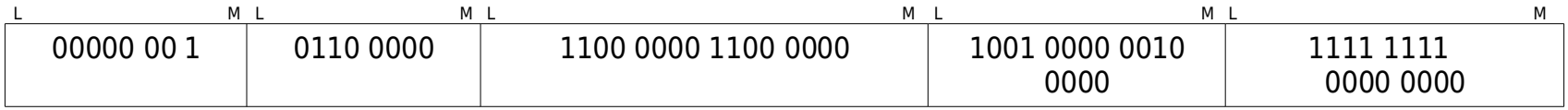
Hex values (PID):

C 3

Since this is for a SETUP packet, the data consists of 8 bytes. The format is:

	bmRequestType	bRequest	wValue	wIndex	wLength
(bytes)	1	1	2	2	2

The 8 bytes for SETUP details are as follows (in decimal):



bmRequestType:

D7: Data transfer direction
1 = Device-to-host

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

bRequest:

GET_DESCRIPTOR request code is 6.

wValue:

Descriptor type is STRING, the value is 3. Descriptor index is 3.

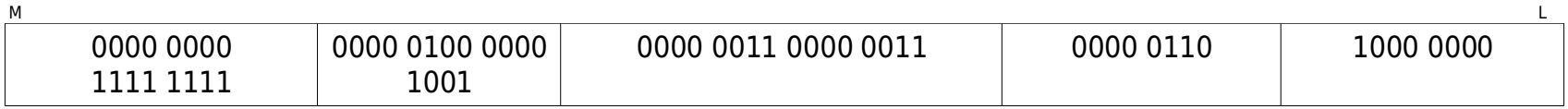
wIndex:

Language ID is English (US). The value is 0x0409.

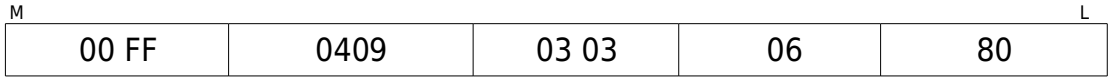
wLength:

Size of descriptor data, which is 255 bytes.

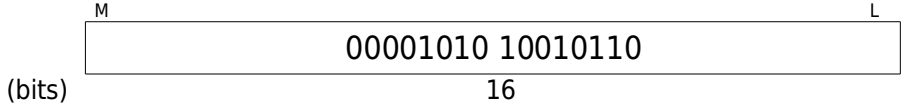
Putting it in MSB to LSB order:



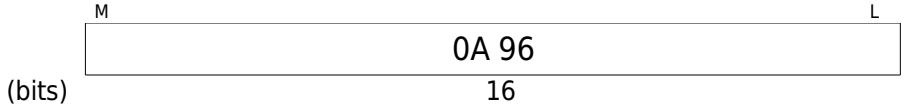
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



Putting it all (PID + SETUP DATA + CRC) together,

Summary (DATA0 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	10000000	C3	80
02	00000110	00000011	06	03
04	00000011	00001001	03	09
06	00000100	11111111	04	FF
08	00000000	10010110	00	96
10	00001010		0A	

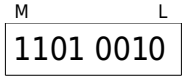
8.1.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

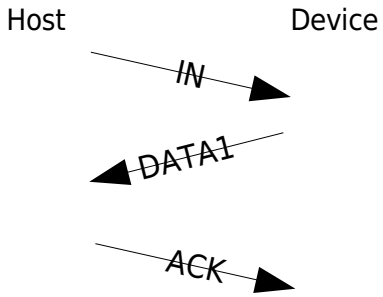
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

8.2 IN transaction

The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)



8.2.1 IN packet

A IN packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1001	0110	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

11011 0000 000 1010 0110 1001

Regrouping in groups of 4-bits:

1101 1000 0000 1010 0110 1001

Hex values (as a byte):

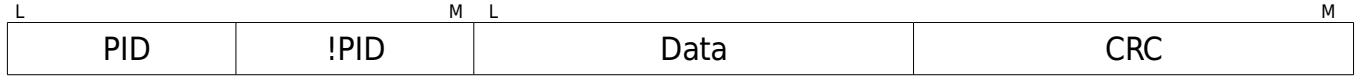
D8 0A 69

Summary (IN packet):

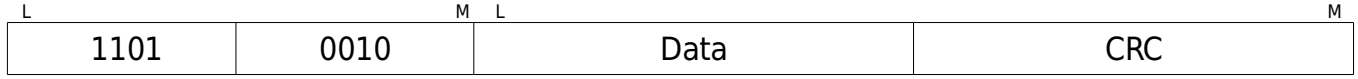
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00001010	69	0A
02	11011000		D8	

8.2.2 DATA1 packet

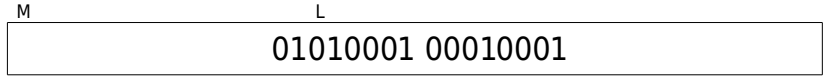
A DATA1 packet for GetDescriptor (String 3) provides 42 bytes of data for this device. It consists of:



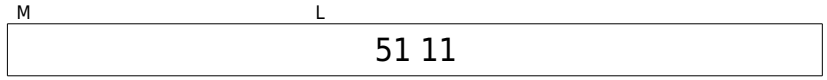
Values:



The CRC observed in the sample capture is:



CRC (in Hex):



So, the data for our capture was:

Offset	Field	Size	Value	Hex
0	bLength	1	42 bytes	0x2A
1	bDescriptorType	1	STRING descriptor	0x03
2	bString	2	S	0x0053
4	bString	2	N	0x004E
6	bString	2	D	0x0044
8	bString	2	K	0x004B
10	bString	2	4	0x0034
12	bString	2	0	0x0030
14	bString	2	E	0x0045
16	bString	2	1	0x0031
18	bString	2	6	0x0036
20	bString	2	4	0x0034
22	bString	2	1	0x0031
24	bString	2	7	0x0037
26	bString	2	5	0x0035
28	bString	2	8	0x0038
30	bString	2	6	0x0036
32	bString	2	0	0x0030
34	bString	2	0	0x0030
36	bString	2	1	0x0031
38	bString	2	0	0x0030
40	bString	2	6	0x0036

Putting it together (PID + 42 bytes of data + CRC):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00101000	4B	2A
02	00000011	01010011	03	53
04	00000000	01001110	00	4E
06	00000000	01000100	00	44
08	00000000	01001011	00	4B
10	00000000	00110100	00	34
12	00000000	00110000	00	30
14	00000000	01000101	00	45
16	00000000	00110001	00	31
18	00000000	00110110	00	36
20	00000000	00110100	00	34
22	00000000	00110001	00	31
24	00000000	00110111	00	37
26	00000000	00110101	00	35
28	00000000	00111000	00	38
30	00000000	00110110	00	36
32	00000000	00110000	00	30
34	00000000	00110000	00	30
36	00000000	00110001	00	31
38	00000000	00110000	00	30
40	00000000	00110110	00	36
42	00000000	00010001	00	11
44	01010001		51	

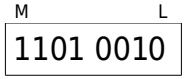
8.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

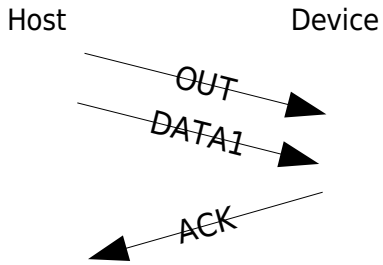
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

8.3 OUT transaction

The OUT transaction has the following three packets:

- OUT packet (->)
- DATA1 packet (->)
- ACK packet (<-)



8.3.1 OUT packet

An OUT packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1000	0111	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

11011 0000 000 1010 1110 0001

Regrouping in groups of 4-bits:

1101 1000 0000 1010 1110 0001

Hex values (as a byte):

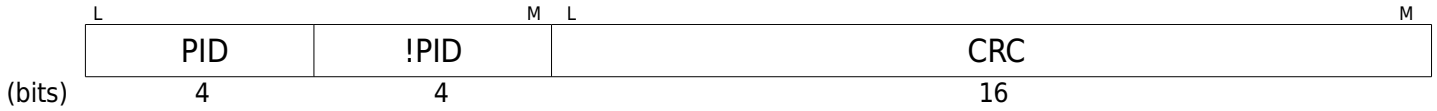
D8 0A E1

Summary (OUT packet):

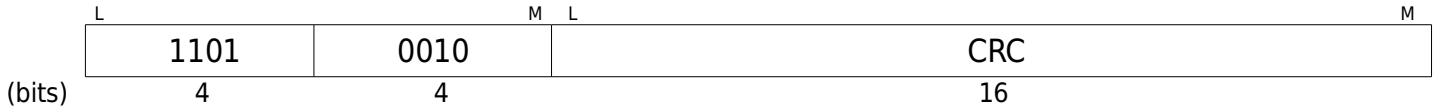
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11100001	00001010	E1	0A
02	11011000		D8	

8.3.2 DATA1 packet

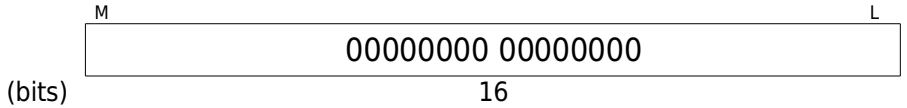
The DATA1 packet has no data. It consists of:



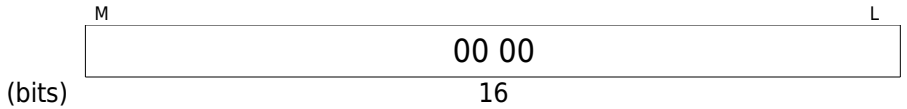
Values:



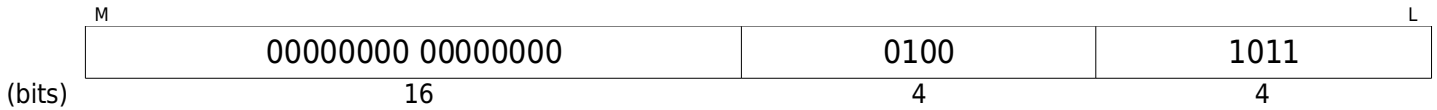
The CRC observed in the sample capture is:



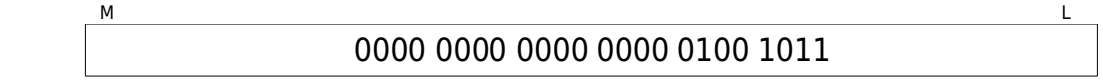
CRC (in Hex):



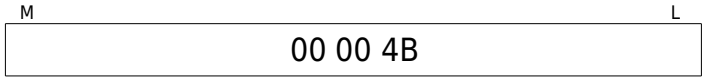
The packet arranged in MSB to LSB order:



In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

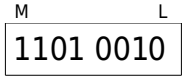
8.3.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

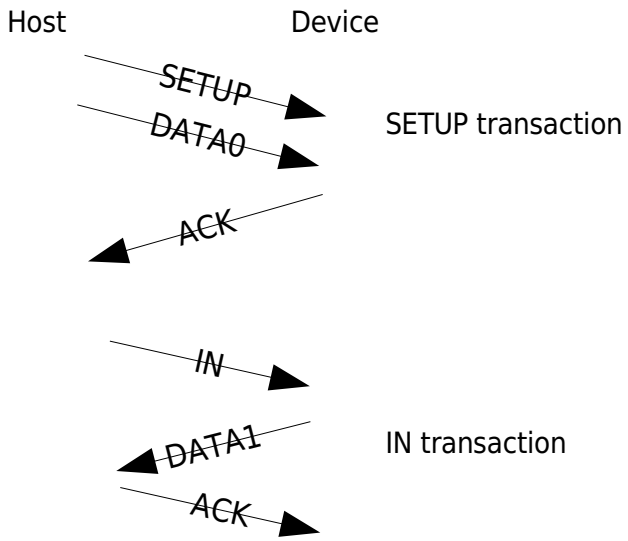
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

9. SetConfiguration

SetConfiguration transfer consists of the following transactions:

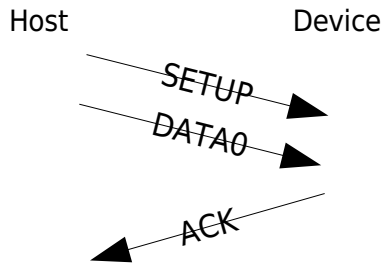
* SETUP transaction (->)
* IN transaction (<-)



9.1 SETUP transaction

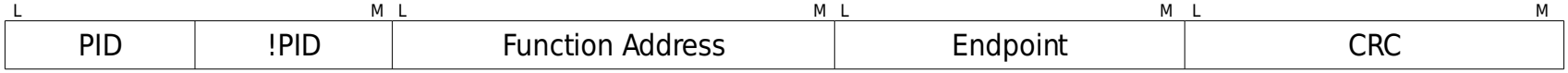
The SETUP transaction has the following three packets:

- SETUP packet (->)
- DATA0 packet (->)
- ACK packet (<-)

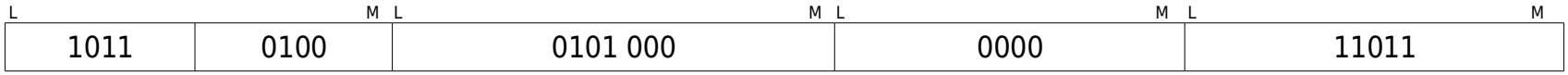


9.1.1 SETUP packet

A SETUP packet consists of:

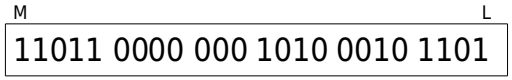


Values:

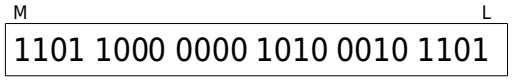


USB is little-endian. LSB goes out of the wire, first.

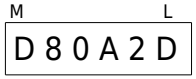
Displaying from MSB to LSB:



Regrouping in groups of 4-bits:



Hex values:



Regrouping as a byte:

M L

D8 0A 2D

Summary (SETUP packet):

Offset	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
	0	1	0	1
00	00101101	00001010	2D	0A
02	11011000		D8	

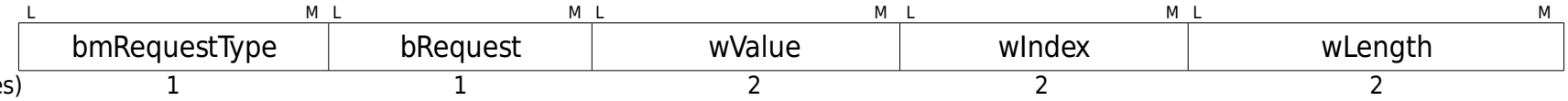
9.1.2 DATA0 packet

A DATA0 packet consists of:

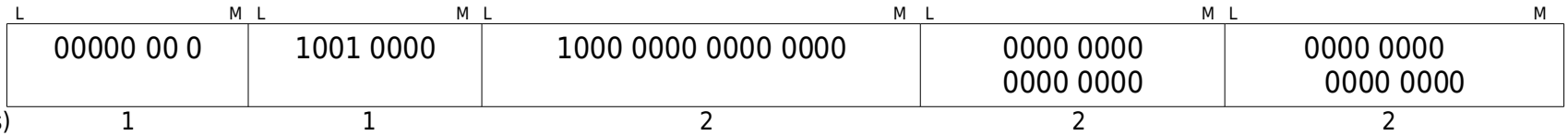
The PID arranged in MSB to LSB order:

Hex values (PID):

So, the SETUP packet consists of:



The 8 bytes for SETUP details are as follows:



bmRequestType:

D7: Data transfer direction
0 = Host-to-device

D6...D5: Type
0 = Standard

D4...D0: Recipient
0 = Device

bRequest:

SET_CONFIGURATION request code is 9.

wValue:

Configuration 1.

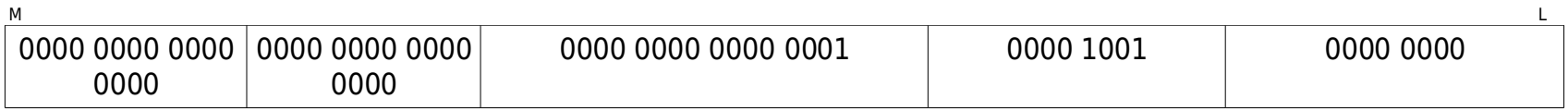
wIndex:

Zero.

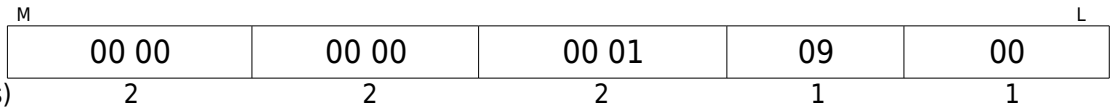
wLength:

Zero.

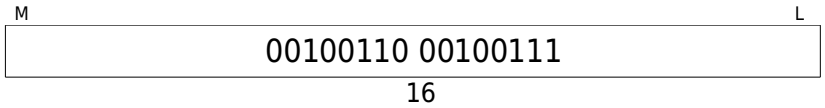
Putting it in MSB to LSB order:



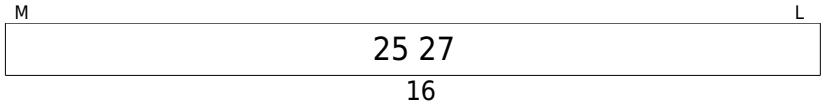
In Hex:



The CRC observed in the sample capture is:



CRC (in Hex):



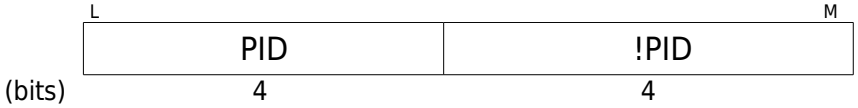
Putting it all (PID + SETUP DATA + CRC) together,

Summary (DATA0 packet):

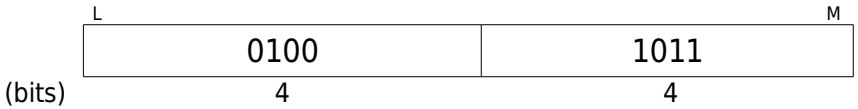
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	11000011	00000000	C3	00
02	00001001	00000001	09	01
04	00000000	00000000	00	00
06	00000000	00000000	00	00
08	00000000	00100111	00	27
10	00100110		25	

9.1.3 ACK packet

An ACK packet consists of:

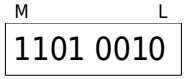


Values:



USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

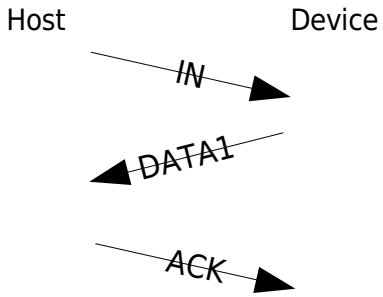
Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

9.2 IN transaction

The IN transaction has the following three packets:

- IN packet (->)
- DATA1 packet (<-)
- ACK packet (->)



9.2.1 IN packet

A IN packet consists of:

	PID	!PID	Function Address	Endpoint	CRC
(bits)	4	4	7	4	5

Values:

	1001	0110	0101 000	0000	11011
(bits)	4	4	7	4	5

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:

11011 0000 000 1010 0110 1001

Regrouping in groups of 4-bits:

1101 1000 0000 1010 0110 1001

Hex values (as a byte):

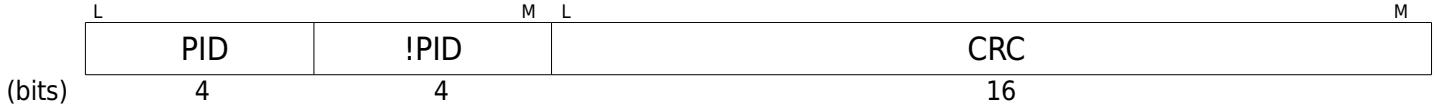
D8 0A 69

Summary (IN packet):

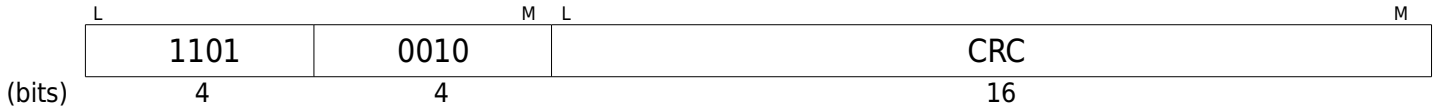
	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01101001	00001010	69	0A
02	11011000		D8	

9.2.2 DATA1 packet

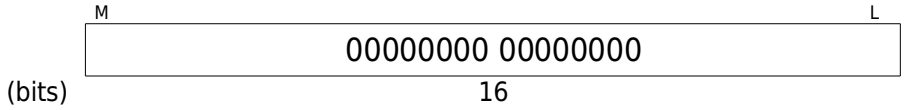
A DATA1 packet for SetAddress has no data. It consists of:



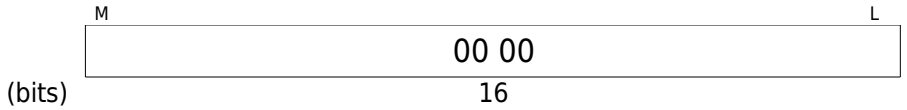
Values:



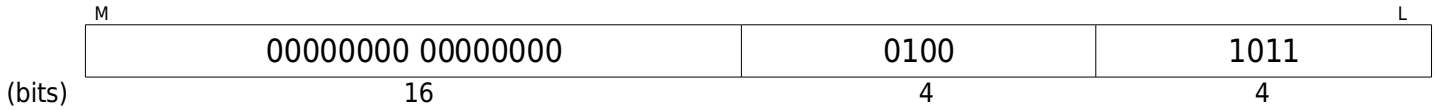
The CRC observed in the sample capture is:



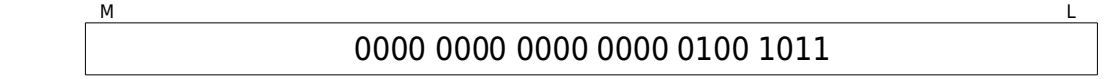
CRC (in Hex):



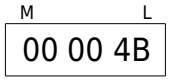
The packet arranged in MSB to LSB order:



In groups of 4 bits:



In Hex,



Summary (DATA1 packet):

	Binary (M...L)		Hexadecimal (M...L)	
	Offset		Offset	
Offset	0	1	0	1
00	01001011	00000000	4B	00
02	00000000		00	

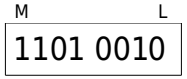
9.2.3 ACK packet

An ACK packet consists of:

Values:

USB is little-endian. LSB goes out of the wire, first.

Displaying from MSB to LSB:



Hex values:

Summary (ACK packet):

	Binary (M...L)	Hexadecimal (M...L)
	Offset	Offset
Offset	0	0
00	11010010	D2

References

[1] Universal Serial Bus Specification. Revision 2.0. April 27, 2000. http://www.usb.org

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