NEC

MOS INTEGRATED CIRCUIT

μPD720110

USB2.0 Hub Controller

(Ver 0.91a)

The μPD720110 is a USB 2.0 hub device that complies with the Universal Serial Bus (USB) Specification Revision 2.0 and works up to 480Mbps. USB2.0 compliant transceivers are integrated for all upstream and downstream ports. The μPD720110 works backward compatible either when any one of downstream ports are connected to an USB 1.1 compliant device, or when the upstream port is connected to a USB 1.1 compliant host.

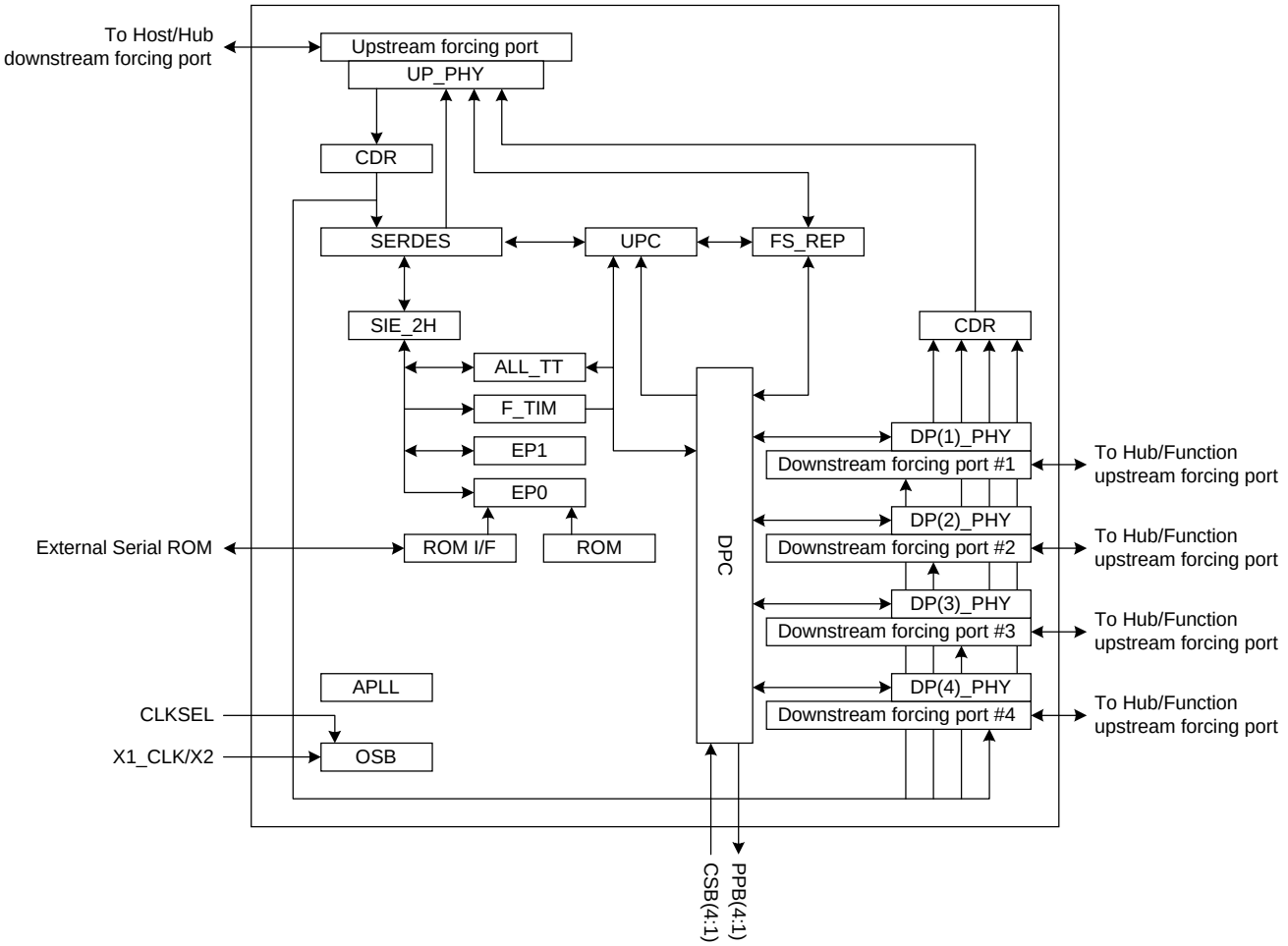
FEATURES

- Compliant with Universal Serial Bus Specification Revision 2.0(Data Rate 1.5/12/480Mbps)
- High-speed or Full-speed packet protocol sequencer for Endpoint 0/1
- 4 (max.) downstream facing ports
- All downstream facing ports can handle high-speed (480 Mbps), full-speed (12 Mbps), and low-speed (1.5 Mbps) transaction.
- Supports split transaction to handle full-speed and low-speed transaction at downstream facing ports when Hub controller is working at high-speed mode.
- One Transaction Translator per Hub and supports 4 concurrent non-periodic transactions
- Supports self-powered mode only
- Supports Over-current detection and Individual / Gang power control
- Supports configurable vendor ID and product ID with external Serial ROM
- Supports “non-removable” attribution on individual port
- System clock is generated by 30 MHz X’tal, 30 MHz clock input, or 48 MHz clock input.
- HS detection indicator output
- 3.3 V Power supply

ORDERING INFORMATION

Part number	Package
μPD720110GC-8EA	100-pin plastic LQFP (Fine pitch) (14 x 14 mm)

BLOCK DIAGRAM



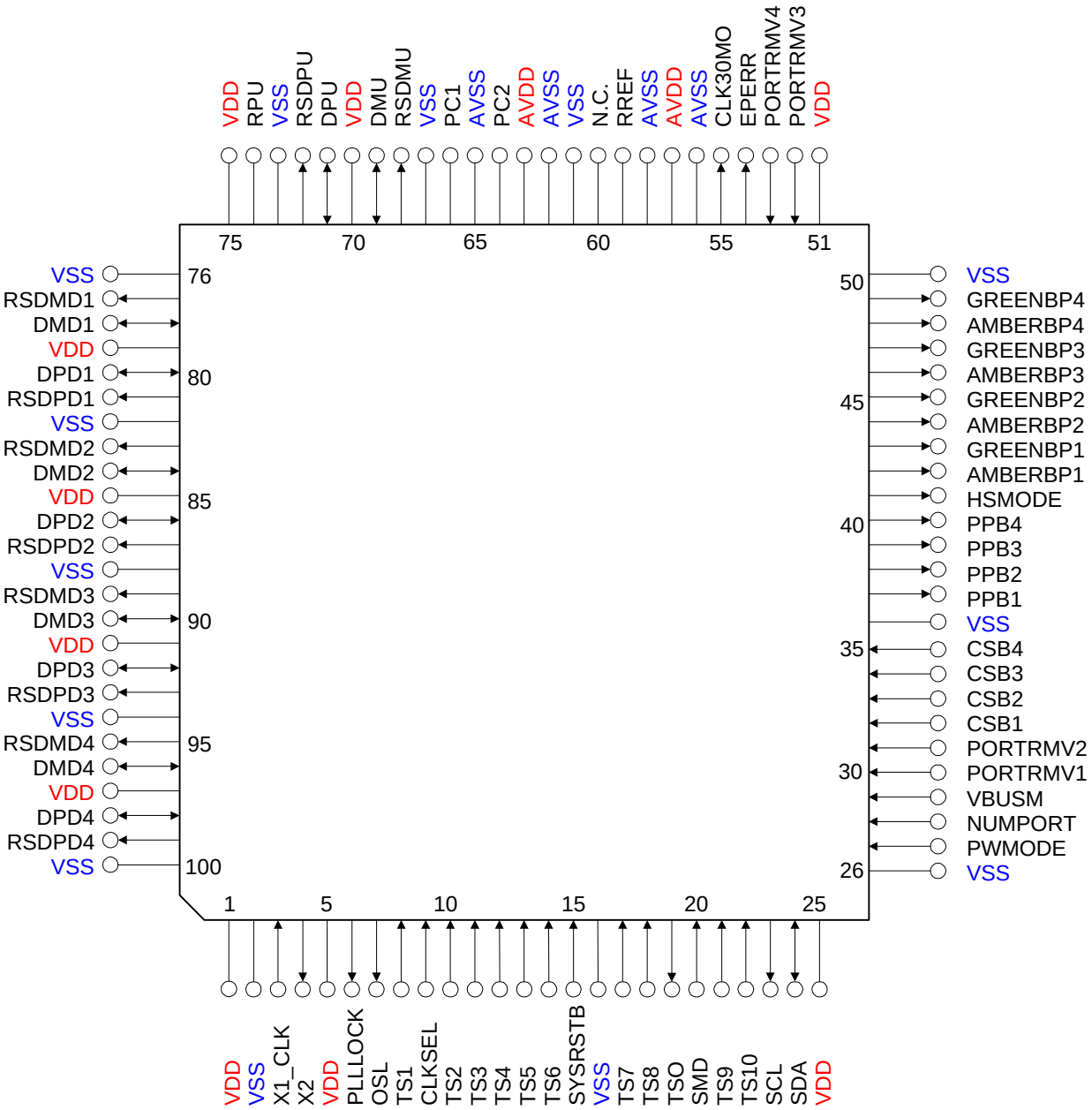
APLL	: generates all clocks of Hub.
ALL_TT	: translates the high-speed transactions (split transactions) for full/low-speed device to full/low-speed transactions. ALL_TT buffers the data transfer from either upstream or downstream direction. For OUT transaction, ALL_TT buffers data from upstream port and sends it out to the downstream facing ports after speed conversion from high-speed to full/low-speed. For IN transaction, ALL_TT buffers data from downstream ports and sends it out to the upstream facing ports after speed conversion from full/low-speed to high-speed.
CDR	: Data & clock recovery circuit
DPC	: Downstream Port Controller handles Port Reset / Enable / Disable / Suspend / Resume
DP(n)_PHY	: Downstream transceiver supports high-speed (480 Mbps), full-speed (12 Mbps), and low-speed (1.5 Mbps) transaction
EP0	: Endpoint 0 controller
EP1	: Endpoint 1 controller
F_TIM (Frame Timer)	: manages hub's synchronization by using micro-SOF which is received at upstream port, and generates SOF packet when full/low-speed device is attached to downstream facing port.
FS_REP	: full/low-speed repeater is enabled when μPD720110 is worked at full-speed mode
OSB	: Oscillator Building Block
ROM	: contains default Descriptors
ROM I/F	: is interface for external Serial ROM which contains user-defined Descriptors
SERDES	: Serializer and Deserializer
SIE_2H	: Serial Interface Engine (SIE) controls USB2.0 and 1.1 protocol sequencing.
UP_PHY	: Upstream Transceiver supports high-speed (480 Mbps), full-speed (12 Mbps) transaction
UPC	: Upstream Port Controller handles Suspend / Resume

PIN CONFIGURATION

- **100-pin plastic LQFP (Fine pitch) (14 x 14 mm)**

μPD720110GC-8EA

Top view



PKG	NAME	PKG	NAME	PKG	NAME	PKG	NAME
1	VDD	26	VSS	51	VDD	76	VSS
2	VSS	27	PWMODE	52	PORTRMV3	77	RSDMD1
3	X1_CLK	28	NUMPORT	53	PORTRMV4	78	DMD1
4	X2	29	VBUSM	54	EPERR	79	VDD
5	VDD	30	PORTRMV1	55	CLK30MO	80	DPD1
6	PLLLOCK	31	PORTRMV2	56	AVSS	81	RSDPD1
7	OSL	32	CSB1	57	AVDD	82	VSS
8	TS1	33	CSB2	58	AVSS	83	RSDMD2
9	CLKSEL	34	CSB3	59	RREF	84	DMD2
10	TS2	35	CSB4	60	N.C.	85	VDD
11	TS3	36	VSS	61	VSS	86	DPD2
12	TS4	37	PPB1	62	AVSS	87	RSDPD2
13	TS5	38	PPB2	63	AVDD	88	VSS
14	TS6	39	PPB3	64	PC2	89	RSDMD3
15	SYSRSTB	40	PPB4	65	AVSS	90	DMD3
16	VSS	41	HSMODE	66	PC1	91	VDD
17	TS7	42	AMBERBP1	67	VSS	92	DPD3
18	TS8	43	GREENBP1	68	RSDMU	93	RSDPD3
19	TSO	44	AMBERBP2	69	DMU	94	VSS
20	SMD	45	GREENBP2	70	VDD	95	RSDMD4
21	TS9	46	AMBERBP3	71	DPU	96	DMD4
22	TS10	47	GREENBP3	72	RSDPU	97	VDD
23	SCL	48	AMBERBP4	73	VSS	98	DPD4
24	SDA	49	GREENBP4	74	RPU	99	RSDPD4
25	VDD	50	VSS	75	VDD	100	VSS

PIN INFORMATION

Pin Name	I/O	Buffer Type	Active Level	Function
X1_CLK	I	Input		System clock input or Oscillator In
X2	O	Output		Oscillator Out
SYSRSTB	I	5V tolerant Input	Low	Asynchronous chip Reset
CLK30MO	O(I/O)	Output		30 MHz Clock Output
CLKSEL	I	Input		Clock select signal
RPU	A	Analog		External 1.5kohm pull-up resistor control
DPD(4:1)	B	USB high speed D+I/O		Downstream high-speed data D+
DPU	B	USB high speed D+I/O		Upstream high-speed data D+
DMD(4:1)	B	USB high speed D–I/O		Downstream high-speed data D-
DMU	B	USB high speed D–I/O		Upstream high-speed data D-
RSDPD(4:1)	O	USB full-speed D+ O		Downstream full-speed data D+ and R_S resistor terminal
RSDPU	O	USB full-speed D+ O		Upstream full-speed data D+ and R_S resistor terminal
RSDMD(4:1)	O	USB full-speed D– O		Downstream full-speed data D- and R_S resistor terminal
RSDMU	O	USB full-speed D– O		Upstream full-speed data D- and R_S resistor terminal
RREF	A	Analog		Reference resistor
PC1	A	Analog		Capacitor for PLL
PC2	A	Analog		Capacitor for PLL
CSB(4:1)	I(I/O)	5V tolerant Input	Low	Port's overcurrent status input
PPB(4:1)	O	5V tolerant N-ch Open Drain	Low	Port's power supply control output
NUMPORT	I	Input		Number of available ports
PWMODE	I	Input		Power mode select
VBUSM	I	Input		VBus monitor
PORTRMV(2:1)	I	Input		Removable/Non-removable select
PORTRMV(4:3)	I(I/O)	Input		Removable/Non-removable select
OSL	O(I/O)	Output	High	Indication for suspend state
HSMODE	O	Output	High	Indication for high-speed operation
AMBERBP(4:1)	O	Output	Low	Indication for downstream port status with amber colored LED.
GREENBP(4:1)	O	Output	Low	Indication for downstream port status with green colored LED.
SCL	O(I/O)	Output		Serial ROM Clock Out
SDA	I/O	I/O with 5 kΩ Pull up R		Serial ROM Data
SMD	I	Input		Serial ROM Input Enable
EPERR	O(I/O)	Output		Indication for Serial ROM error
PLLLOCK	O(I/O)	Output		Indication when PLL is locked
TS(1)	I	Input with 12 kΩ Pull down R		Test signal
TS(10:2)	I	Input		Test signal
TSO	I/O	I/O		Test signal
VDD				VDD
AVDD				VDD for analog circuit
VSS				VSS
AVSS				VSS for analog circuit
N.C.				Not connect

Remarks 1. "5V tolerant" means that the buffer is 3V buffer with 5V tolerant circuit.

2. The signal marked as "(I/O)" in the above table operates as I/O signals during testing. However, they do not need to be considered in normal use.

Contents

1 Pin Functions

The pin type describes a signal either as analog, power, input, or I/O (bi-directional).

1.1 Power supply

Pin	Pin No.	Direction	Function
VDD	1, 5, 25, 51, 70, 75, 79, 85, 91, 97	Power	+3.3 V power supply
AVDD	57, 63	Power	+3.3 V power supply for analog circuit
VSS	2, 16, 26, 36, 50, 61, 67, 73, 76, 82, 88, 94,100	Power	Ground
AVSS	56, 58, 62, 65	Power	Ground for analog circuit
N.C.	60	-	No Connection

1.2 Analog signaling

Pin	Pin No.	Direction	Function
RREF	59	Analog	RREF must be connected a 1% precision reference resistor of 9.1 kΩ. The other side of resistor must be connected to local ground.
PC1	66	Analog	PC1 is used for PLL function. Should be left open on circuit board.
PC2	64	Analog	PC2 is used for PLL function. Should be left open on circuit board.

1.3 System clock & reset

Pin	Pin No.	Direction	Function
X1_CLK	3	I	System clock input or Oscillator input Apply 30-MHz / 48-MHz clock input or connect to 30-MHz X'tal. Clock frequency is selected by "CLKSEL" signal.
X2	4	O	If 30-MHz / 48-MHz clock input is applied to X1_CLK, this signal must be opened. Otherwise, connect to 30-MHz X'tal. Clock frequency is selected by "CLKSEL" signal.
CLK30MO	55	O	Clock output from APLL
PLLLOCK	6	O	APLL Locked indication 0: APLL is not locked 1: APLL is locked
SYSRSTB	15	I	Asynchronous active low reset signaling

Remarks 1. No power-on-reset circuit is included on this chip, so the system designer has to make sure that this chip is properly reset before start of operation.

2. Clock outputs appear even before PLL is locked.

1.4 USB interface

Pin	Pin No.	Direction	Function
RPU	74	Analog	This signal should be connected to 1.5 kΩ pull-up resister. RPU is controlled by VBUSM pin.
DPD(4 : 1)	98, 92, 86, 80	I/O	USB's downstream facing port D+ high-speed signal Shared with DMDx pins having the same numbers.
RSDPD(4 : 1)	99, 93, 87, 81	O	USB's downstream facing port D+ full-speed signal Connected to DPDx through 36 Ω 1% precision Rs resistor.
DMD(4 : 1)	96, 90, 84, 78	I/O	USB's dwonstream facing port D– high-speed signal Shared with DPDx pins having the same numbers.
RSDMD(4 : 1)	95, 89,83, 77	O	USB's downstream facing port D– full-speed signal Connected to DMDx through 36 Ω 1% precision Rs resistor.
DPU	71	I/O	USB's upstream facing port D+ high-speed signal Shared with DMU pin.
RSDPU	72	O	USB's upstream facing port D+ full-speed signal Connected to DPU through 36 Ω 1% precision Rs resistor.
DMU	69	I/O	USB's upstream facing port D– high-speed signal Shared with DPU pin.
RSDMU	68	O	USB's upstream facing port D– full-speed signal Connected to DMU through 36 Ω 1% precision Rs resistor.
CSB (4 : 1)	35, 34, 33, 32	I	Pin for inputting the overcurrent status of the downstream facing ports 1: No overcurrent condition detected. 0: Overcurrent condition detected.
PPB (4 : 1)	40, 39, 38, 37	O	Power supply control output for downstream facing ports 1: Power supply OFF 0: Power supply ON

1.5 USB Hub interface

Pin	Pin No.	Direction	Function
PWMODE	27	I	Only self-powered Hub is available. Should be tied to “low” on circuit board.
NUMPORT	28	I	Available port number select 0: 4 downstream facing ports 1: 3 downstream facing ports
VBUSM	29	I	Control RPU which connects to 1.5 k ohm pull-up resister. 0: 1.5 k ohm pull-up resister, which is connected to RPU, is disabled. 1: 1.5 k ohm pull-up resister, which is connected to RPU, is enabled.
PORTRMV(4 : 1)	53, 52, 31, 30	I	Attribute of device removable setting 0: Device is removable 1: Device is non-removable as compound device These signals are invalid when SMD is set to “high”.
AMBERBP(4 : 1)	48, 46, 44, 42	O	Indicates downstream facing port status by using amber colored LED. These should connected to amber colored LED at default descriptor setting. The meaning of amber colored LED describes at section 3.6. 0: Port is in error condition. 1: Port is not in error condition.
GREENBP(4 : 1)	49, 47, 45, 43	O	Indicates downstream facing port status by using green colored LED. These should connected to green colored LED at default descriptor setting. The meaning of green colored LED describes at section 3.6. 0: Port is in fully operational. 1: Port is not in fully operational.
HSMODE	41	O	Indicates that μPD720100 is working under high-speed mode. 0: High-speed operating mode 1: Full-speed operating mode
OSL	7	O	Indicates that μPD720100 is under suspend state. 1: Under suspend state 0: Not under suspend state

1.6 System interface

Pin	Pin No.	Direction	Function
CLKSEL	9	I	Clock signal select 1: X1_CLK must be applied 48-MHz clock input . 0 (Default): X1_CLK must be connected to 30-MHz X'tal or must be applied with 30-MHz clock .
SCL	23	O	External Serial ROM Clock Out
SDA	24	I/O	External Serial ROM Data
SMD	20	I	External Serial ROM Input Enable 0 (Default): External Serial ROM inactive and port attribute control pins are active. 1: External Serial ROM active and port attribute control pins are inactive.
EPERR	54	O	Indicates error detection when initializing external Serial ROM 0: Error detected 1: No error

Chip clock type	CLKSEL	On board setting
Use 48 MHz clock input	1	48 MHz clock signal supply to X1_CLK on board
Use 30 MHz clock input	0	30 MHz clock signal supply to X1_CLK on board
Use 30 MHz Oscillator	0	30 MHz X'tal connects between X1_CLK and X2. Also, the capacitor and some other element must be required.

1.7 Test signals

Pin	Pin No.	Direction	Caution
TS(10:1)	22, 21, 18, 17, 14, 13, 12, 11, 10, 8	I	Should be tied to "low" on circuit board.
TSO	19	O	Should be left open on circuit board.

2 Descriptors information

This chapter describes the descriptors which are implemented in hub controller. μPD720110 has following descriptors. Host reads these descriptors by using Get Descriptor request.

- Device Descriptor
- Device Qualifier Descriptor
- Configuration Descriptor
- Interface Descriptor
- Endpoint Descriptor
- Other Speed Configuration Descriptor
- Hub Class-specific Descriptor
- String Descriptor

The hub returns different descriptors based on whether it is operating at high-speed or full-speed. The following section shows descriptor set for full-speed operation and high-speed operation.

Some values of Descriptor can be changed by pin configuration or using external serial ROM. And also, There is Mask ROM option which supports customized String Descriptor.

2.1 Descriptors under full-speed mode

2.1.1 Device Descriptor

The hub returns Device descriptor by GET_DESCRIPTOR (Device) request.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	12h				
1	bDescriptorType	01h				
2	bcdUSB	0200h				
4	bDeviceClass	09h				
5	bDeviceSubClass	00h				
6	bDeviceProtocol	00h				
7	bMaxPacketSize0	40h	Max 64Byte for EP0			
8	idVendor	0409h	"NEC"		Available	Available
10	idProduct	0058h	"USB 2.0 Hub Controller"		Available	Available
12	bcdDevice	0100h	"1.00"		Available	Available
14	iManufacturer	01h				Available
15	iProduct	02h				Available
16	iSerialNumber	00h				Available
17	bNumConfigurations	01h				

2.1.2 Device_Qualifier Descriptor

The hub returns Device_Qualifier descriptor by GET_DESCRIPTOR (Device_Qualifier) request. GET_DESCRIPTOR (Device_Qualifier) request is issued by USB2.0 host controller when the hub is operating at full-speed mode.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	0Ah				
1	bDescriptorType	06h				
2	bcdUSB	0200h				
4	bDeviceClass	09h				
5	bDeviceSubClass	00h				
6	bDeviceProtocol	01h	Single TT			
7	bMaxPacketSize0	40h	Max 64Byte for EP0			
8	bNumConfigurations	01h				
9	bReserved	00h				

2.1.3 Configuration Descriptor

The hub returns Configuration descriptor by GET_DESCRIPTOR (Configuration) request.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	09h				
1	bDescriptorType	02h				
2	wTotalLength	0019h	Total 25 Byte			
4	bNumberInterface	01h				
5	bConfigurationValue	01h				
6	iConfiguration	00h				Available
7	bmAttribute	E0h	Self-Powered			
8	bMaxPower	32h			Available	Available

2.1.4 Interface Descriptor which is combined with Configuration Descriptor

The hub returns Configuration descriptor followed by Interface descriptor.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	09h				
1	bDescriptorType	04h				
2	bInterfaceNumber	00h				
3	bAlternateSetting	00h				
4	bNumEndpoints	01h				
5	bInterfaceClass	09h				
6	bInterfaceSubClass	00h				
7	bInterfaceProtocol	00h				
8	iInterface	00h				Available

2.1.5 Endpoint Descriptor which is combined with Configuration Descriptor

The hub returns Configuration/Interface descriptor followed by Endpoint descriptor.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	07h				
1	bDescriptorType	05h				
2	bEndpointAddress	81h	EP1, IN direction			
3	bmAttribute	03h	Interrupt Endpoint			
4	wMaxPacketSize	0001h	Max 1Byte			
6	bInterval	FFh				

2.1.6 Other_Speed_Configuration Descriptor

The hub returns Other_Speed_Configuration descriptor by GET_DESCRIPTOR (Other_Speed_Configuration) request. GET_DESCRIPTOR (Other_Speed_Configuration) request is issued by USB2.0 host controller when the hub is operating at full-speed mode.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	09h				
1	bDescriptorType	07h				
2	wTotalLength	0019h	Total 25 Byte			
4	bNumberInterface	01h				
5	bConfigurationValue	01h				
6	iConfiguration	00h				Available
7	bmAttribute	E0h	Self-Powered			
8	bMaxPower	32h			Available	Available

2.1.7 Interface Descriptor which is combined with Other_Speed_Configuration Descriptor

The hub returns Other_Speed_Configuration descriptor followed by Interface descriptor.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	09h				
1	bDescriptorType	04h				
2	bInterfaceNumber	00h				
3	bAlternateSetting	00h				
4	bNumEndpoints	01h				
5	bInterfaceClass	09h				
6	bInterfaceSubClass	00h				
7	bInterfaceProtocol	00h	Single TT			
8	iInterface	00h				Available

2.1.8 Endpoint Descriptor which is combined with Other_Speed _Configuration Descriptor

The hub returns Other_Speed_Configuration/Interface descriptor followed by Endpoint descriptor.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	07h				
1	bDescriptorType	05h				
2	bEndpointAddress	81h	EP1, IN direction			
3	bmAttribute	03h	Interrupt Endpoint			
4	wMaxPacketSize	0001h	Max 1Byte			
6	bInterval	0Ch				

2.1.9 String Descriptors

The hub returns String descriptors by GET_DESCRIPTOR (String) request. Following descriptors are included in μPD720110 as default setting.

String_Index0

Index	Field Name	Value	Description
0	bLength	04h	
1	bDescriptorType	03h	"String"
2	wLANGID	0409h	“US English”

String_Index1 (for “Manufacture” at default setting)

Index	Field Name	Value	Description
0	bLength	20h	
1	bDescriptorType	03h	"String"
2-	bString	“NEC Corporation” describes with UNICODE	

String_Index2 (for “Product” at default setting)

Index	Field Name	Value	Description
0	bLength	2Ch	
1	bDescriptorType	03h	"String"
2-	bString	“USB2.0 Hub Controller” describes by UNICODE	

String descriptors can be provided up to 6 indexes in Mask ROM option. The total length of String descriptors is limited by the size of Mask ROM. And it should be less than 390 bytes.

2.2 Descriptors under high-speed mode

2.2.1 Device Descriptor

The hub returns Device descriptor by GET_DESCRIPTOR (Device) request.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	12h				
1	bDescriptorType	01h				
2	bcdUSB	0200h				
4	bDeviceClass	09h				
5	bDeviceSubClass	00h				
6	bDeviceProtocol	01h	Single TT			
7	bMaxPacketSize0	40h	Max 64Byte for EP0			
8	idVendor	0409h	"NEC"		Available	Available
10	idProduct	0058h	"USB 2.0 Hub Controller"		Available	Available
12	bcdDevice	0100h	"1.00"		Available	Available
14	iManufacturer	01h				Available
15	iProduct	02h				Available
16	iSerialNumber	00h				Available
17	bNumConfigurations	01h				

2.2.2 Device_Qualifier Descriptor

The hub returns Device_Qualifier descriptor by GET_DESCRIPTOR (Device_Qualifier) request.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	BLength	0Ah				
1	BDescriptorType	06h				
2	bcdUSB	0200h				
4	bDeviceClass	09h				
5	bDeviceSubClass	00h				
6	bDeviceProtocol	00h				
7	bMaxPacketSize0	40h	Max 64Byte for EP0			
8	bNumConfigurations	01h				
9	bReserved	00h				

2.2.3 Configuration Descriptor

The hub returns Configuration descriptor by GET_DESCRIPTOR (Configuration) request.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	09h				
1	bDescriptorType	02h				
2	wTotalLength	0019h	Total 25 Byte			
4	bNumberInterface	01h				
5	bConfigurationValue	01h				
6	iConfiguration	00h				Available
7	bmAttribute	E0h	Self-Powered			
8	bMaxPower	32h			Available	Available

2.2.4 Interface Descriptor which is combined with Configuration Descriptor

The hub returns Configuration descriptor followed by Interface descriptor.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	09h				
1	bDescriptorType	04h				
2	bInterfaceNumber	00h				
3	bAlternateSetting	00h				
4	bNumEndpoints	01h				
5	bInterfaceClass	09h				
6	bInterfaceSubClass	00h				
7	bInterfaceProtocol	00h	Single TT			
8	iInterface	00h				Available

2.2.5 Endpoint Descriptor which is combined with Configuration Descriptor

The hub returns Configuration/Interface descriptor followed by Endpoint descriptor.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	07h				
1	bDescriptorType	05h				
2	bEndpointAddress	81h	EP1, IN direction			
3	bmAttribute	03h	Interrupt Endpoint			
4	wMaxPacketSize	0001h	Max 1Byte			
6	bInterval	0Ch				

2.2.6 Other_Speed_Configuration Descriptor

The hub returns Other_Speed_Configuration descriptor by GET_DESCRIPTOR (Other_Speed_Configuration) request.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	09h				
1	bDescriptorType	07h				
2	wTotalLength	0019h	Total 25 Byte			
4	bNumberInterface	01h				
5	bConfigurationValue	01h				
6	iConfiguration	00h				Available
7	bmAttribute	E0h	Self-Powered			
8	bMaxPower	32h			Available	Available

2.2.7 Interface Descriptor which is combined with Other_Speed_Configuration Descriptor

The hub returns Other_Speed_Configuration descriptor followed by Interface descriptor.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	09h				
1	bDescriptorType	04h				
2	bInterfaceNumber	00h				
3	bAlternateSetting	00h				
4	bNumEndpoints	01h				
5	bInterfaceClass	09h				
6	bInterfaceSubClass	00h				
7	bInterfaceProtocol	00h				
8	iInterface	00h				Available

2.2.8 Endpoint Descriptor which is combined with Other_Speed _Configuration Descriptor

The hub returns Other_Speed_Configuration/Interface descriptor followed by Endpoint descriptor.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bLength	07h				
1	bDescriptorType	05h				
2	bEndpointAddress	81h	EP1, IN direction			
3	bmAttribute	03h	Interrupt Endpoint			
4	wMaxPacketSize	0001h	Max 1Byte			
6	bInterval	FFh				

2.2.9 String Descriptors

The hub returns String descriptors by GET_DESCRIPTOR (String) request. Following descriptors are included in μPD720110 as default setting.

String_Index0

Index	Field Name	Value	Description
0	bLength	04h	
1	bDescriptorType	03h	"String"
2	wLANGID	0409h	“US English”

String_Index1 (for “Manufacture” at default setting)

Index	Field Name	Value	Description
0	bLength	20h	
1	bDescriptorType	03h	"String"
2-	bString	“NEC Corporation” describes with UNICODE	

String_Index2 (for “Product” at default setting)

Index	Field Name	Value	Description
0	bLength	2Ch	
1	bDescriptorType	03h	"String"
2-	bString	“USB2.0 Hub Controller” describes by UNICODE	

String descriptors can be provided up to 6 indexes in Mask ROM option. The total length of String descriptors is limited by the size of Mask ROM. And it should be less than 390 bytes.

2.3 Class Specified – Hub Class Descriptor

The hub returns Hub Class descriptors by GetHubDescriptor request.

Index	Field Name	Value	Description	Pin configuration	Serial ROM	Mask ROM
0	bDescLength	09h				
1	bDescriptorType	29h	"Hub Class"			
2	bNbrPorts	04h 03h	4 downstream facing ports 3 downstream facing ports	NUMPORT=0 NUMPORT=1	Available	Available
3	wHubCharacteristics	01b(D1:D0)	Individual port power switching		Available	Available **Note 2**
		0b(D2) 1b(D2)	Not compound device Compound device	All PORTRMVx=0 One of PORTRMVx=1		
		01b(D4:D3)	Individual overcurrent detection			
		01b(D6:D5)	TT Think Time is 16 FS bit time			
		1b(D7)	Support PORT_INDICATOR **Note 1**			
5	bPwrOn2PwrGood	32h				
6	bHubContrCurrent	C8h	Hub's Current is "200mA"			
7	bDeviceRemovable	0b(D0)	Reserved		Available	Available
		0b(D1) 1b(D1)	Device is removable Device is not removable	PORTRMV1=0 PORTRMV1=1		
		0b(D2) 1b(D2)	Device is removable Device is not removable	PORTRMV2=0 PORTRMV2=1		
		0b(D3) 1b(D3)	Device is removable Device is not removable	PORTRMV3=0 PORTRMV3=1		
		0b(D4) 1b(D4)	Device is removable Device is not removable	PORTRMV4=0 PORTRMV4=1		
8	bPortPwrCtrlMask	FFh				

Note 1: Port_Indicator should support at default setting. It is possible to omit Port_Indicator by using Serial ROM or Mask ROM version.

2: Mask ROM option can not support Ganged power switching and Global overcurrent detection. So, Both [D1:D0] bits and [D4:D3] bits of wHubCharacteristics field must be set to "01". Also, [D6:D5] bits of wHubCharacteristics field must be set to "01" to indicate that TT Think time is16 FS bit time. If you use external Serial ROM, Ganged power switching and Global overcurrent detection can be selected.

3 USB Requests information

When μPD720110 is connecting to downstream facing port of USB2.0 host controller or USB2.0 Hub, it is operating at high-speed mode. At that time, μPD720110 uses USB2.0 high-speed protocols to communicate with other devices on the bus. On the other hand, When μPD720110 is connecting to downstream facing port of USB1.x host controller or USB1.x Hub, it is operating at full-speed mode. At that time, μPD720110 uses USB2.0 full-speed protocols to communicate with other devices on the bus.

- Handles setup transactions for Endpoint 0 which are controlled hub itself.
- Repeats setup transactions to other devices.
- Handles interrupt transactions for Endpoint 1 which are retrieved the status change
- Repeats interrupt transactions to other devices.
- Repeats bulk transactions to other devices.
- Repeats isochronous transactions to other devices.
- Translate split transactions for USB1.X device which is attached to the downstream facing port.
- Repeats split transactions to USB2.0 hub which is attached to the downstream facing port.

This section describes requests which are supported by μPD720110 default descriptor setting. Please refer Chapter 9 and 11 in USB specification rev. 2.0 in further detail.

3.1 Standard Requests

μPD720110 supports all standard requests except for SET_DESCRIPTOR() and SYNCH_FRAME(). Following table shows the standard requests at the default descriptor setting.

Request	bmRequestType	bRequest	wValue	wIndex	wLength	Return
CLEAR_FEATURE (Device :Remote Wakeup)	00000000b	01h	0001h	0000h	0000h	None
CLEAR_FEATURE (Endpoint 0 Halt)	00000010b	01h	0000h	0000h / 0080h	0000h	None
CLEAR_FEATURE (Endpoint 1 Halt)	00000010b	01h	0000h	0081h	0000h	None
GET_CONFIGURATION	10000000b	08h	0000h	0000h	0001h	Current configuration value
GET_DESCRIPTOR (Device)	10000000b	06h	0100h	0000h	0012h **Note 1**	Device descriptor
GET_DESCRIPTOR (Configuration)	10000000b	06h	0200h	0000h	0019h **Note 1**	Configuration / Interface / Endpoint descriptors
GET_DESCRIPTOR (String_Index0) **Note 2**	10000000b	06h	0300h	0409h / 0000h	0004h **Note 1**	String descriptor index0
GET_DESCRIPTOR (String_Index1) **Note 2**	10000000b	06h	0301h	0409h	0020h **Note 1**	String descriptor index1
GET_DESCRIPTOR (String_Index2) **Note 2**	10000000b	06h	0302h	0409h	002Ch **Note 1**	String descriptor index2
GET_DESCRIPTOR (Device_Qualifier)	10000000b	06h	0600h	0000h	000Ah **Note 1**	Device_Qualifier
GET_DESCRIPTOR (Other_Speed_Configuration)	10000000b	06h	0700h	0000h	0019h **Note 1**	Other_Speed_ Configuration
GET_INTERFACE	10000001b	0Ah	0000h	0000h	0001h	00h
GET_STATUS (Device)	10000000b	00h	0000h	0000h	0002h	Device status
GET_STATUS (Interface)	10000001b	00h	0000h	0000h	0002h	0000h
GET_STATUS (Endpoint 0)	10000010b	00h	0000h	0000h / 0080h	0002h	Endpoint 0 status
GET_STATUS (Endpoint 1)	10000010b	00h	0000h	0081h	0002h	Endpoint 1 status
SET_ADDRESS	00000000b	05h	0000h – 007Fh	0000h	0000h	None

Request	bmRequestType	bRequest	wValue	wIndex	wLength	Return
SET_CONFIGURATION	00000000b	09h	0000h / 0001h	0000h	0000h	None
SET_FEATURE (Device :Remote Wakeup)	00000000b	03h	0001h	0000h	0000h	None
SET_FEATURE (Endpoint 0 Halt)	00000010b	03h	0000h	0000h / 0080h	0000h	None
SET_FEATURE (Endpoint 1 Halt)	00000010b	03h	0000h	0081h	0000h	None
SET_FEATURE (Test_J)	00000000b	03h	0002h	0100h	0000h	None
SET_FEATURE (Test_K)	00000000b	03h	0002h	0200h	0000h	None
SET_FEATURE (Test_SE0_NAK)	00000000b	03h	0002h	0300h	0000h	None
SET_FEATURE (Test_Packet)	00000000b	03h	0002h	0400h	0000h	None
SET_FEATURE (Test_Force_Enable)	00000000b	03h	0002h	0500h	0000h	None
SET_INTERFACE	00000001b	0Bh	0000h	0000h	0000h	None

Note 1: The wLength field specifies the number of bytes to return. If the descriptor is longer than the wLength field, only the initial bytes of the descriptor are return. If the descriptor is shorter than the wLength field, the device indicates the end of the control transfer by sending a short packet when further data is requested.

2: String descriptors can be provided up to 6 indexes in Mask ROM option. Get Descriptor String will also supports up to 6 indexes (Index0 – Index5) of String descriptor. At that time, the wIndex and the wLength will be changed by the value of String descriptors.

3.2 Class-Specific Requests

μPD720110 supports all class-specific requests except for SetHubDescriptor() and GetBusState().

Following table shows the class-specific requests at the default descriptor setting.

Request	bmRequestType	bRequest	wValue	wIndex	wLength	Return
ClearHubFeature (C_HUB_OVER _CURRENT)	00100000b	01h	0001h	0000h	0000h	None
ClearPortFeature (PORT_ENABLE)	00100011b	01h	0001h	0001h – 0004h	0000h	None
ClearPortFeature (PORT_SUSPEND)	00100011b	01h	0002h	0001h – 0004h	0000h	None
ClearPortFeature (PORT_POWER)	00100011b	01h	0008h	0001h – 0004h	0000h	None
ClearPortFeature (PORT_INDICATOR)	00100011b	01h	0016h	**Note 1**	0000h	None
ClearPortFeature (C_PORT_CONNECTION)	00100011b	01h	0010h	0001h – 0004h	0000h	None
ClearPortFeature (C_PORT_RESET)	00100011b	01h	0014h	0001h – 0004h	0000h	None
ClearPortFeature (C_PORT_ENABLE)	00100011b	01h	0011h	0001h – 0004h	0000h	None
ClearPortFeature (C_PORT_SUSPEND)	00100011b	01h	0012h	0001h – 0004h	0000h	None
ClearPortFeature (C_PORT_OVER_CURRENT)	00100011b	01h	0013h	0001h – 0004h	0000h	None
GetHubDescriptor	10100000b	06h	2900h	0000h	0009h **Note 2**	Hub descriptor
GetHubStatus	10100000b	00h	0000h	0000h	0004h	Hub status and change indicators. Refer section 3.4
GetPortStatus	10100011b	00h	0000h	0001h – 0004h	0004h	Port status and change indicators. Refer section 3.5
SetPortFeature (PORT_RESET)	00100011b	03h	0004h	0001h – 0004h	0000h	None
SetPortFeature (PORT_SUSPEND)	00100011b	03h	0002h	0001h – 0004h	0000h	None
SetPortFeature (PORT_POWER)	00100011b	03h	0008h	0001h – 0004h	0000h	None

Request	bmRequestType	bRequest	wValue	wIndex	wLength	Return
SetPortFeature (PORT_TEST: Test_J)	00100011b	03h	0015h	0011h – 0014h	0000h	None
SetPortFeature (PORT_TEST: Test_K)	00100011b	03h	0015h	0021h – 0024h	0000h	None
SetPortFeature (PORT_TEST: Test_SE0_NAK)	00100011b	03h	0015h	0031h – 0034h	0000h	None
SetPortFeature (PORT_TEST: Test_Packet)	00100011b	03h	0015h	0041h – 0044h	0000h	None
SetPortFeature (PORT_TEST: Test_Force_Enable)	00100011b	03h	0015h	0051h – 0054h	0000h	None
SetPortFeature (PORT_INDICATOR)	00100011b	03h	0016h	**Note 1**	0000h	None
ClearTTBuffer	00100011b	08h	**Note 3**	0001h	0000h	None
GetTTState	10100011b	0Ah	0000h	0001h	08D0h	TT state
ResetTT	00100011b	09h	0000h	0001h	0000h	None
StopTT	00100011b	0Bh	0000h	0001h	0000h	None

Note 1: The high byte of the wIndex field is the selector identifying the specific indicator. And the low byte of the wIndex field shows port number. Refer section 3.6 in detail.

Table 3-1 Port Indicators Selector Code

Value	Port Indicator Color	Port Indicator Mode
0h	Default	Automatic
1h	Amber	Manual
2h	Green	
3h	Off	
4-FFh	Reserved	Reserved

2: The wLength field specifies the number of bytes to return. If the descriptor is longer than the wLength field, only the initial bytes of the descriptor are return. If the descriptor is shorter than the wLength field, the device indicates the end of the control transfer by sending a short packet when further data is requested.

3: The wValue for ClearTTBuffer is as follows.

Table 3-2 wValue for ClearTTBuffer

Bits	Field
3..0	Endpoint Number
10..4	Device Address
12..11	Endpoint Type
14..13	Reserved, must be zero
15	Direction, 1 = IN, 0 = OUT

3.3 The response for each transaction

According to USB specification rev. 2.0, the device behavior in some states and conditions is not specified. The section describes the response of μPD720110 in each state and condition to clarify μPD720110's behavior at default descriptor setting.

Request	Condition				
	Default state	**Address state**	**Configured state**	**Endpoint 0 halted**	**Invalid wValue**
Standard Requests					
CLEAR_FEATURE					
Device	STALL *	Treat request	Treat request	Treat request	STALL
Endpoint 0	STALL *	Treat request	Treat request	Treat request	STALL
Endpoint 1	STALL *	STALL	Treat request	Treat request	STALL
GET_CONFIGURATION	STALL *	Return data	Return data	STALL	STALL *
GET_DESCRIPTOR **Note 1**					
Device	Return data	Return data	Return data	STALL	STALL
Configuration	Return data	Return data	Return data	STALL	STALL
String **Note 2**	Return data	Return data	Return data	STALL	STALL
Device Qualifier	Return data	Return data	Return data	STALL	STALL
Other Speed Configuration	Return data	Return data	Return data	STALL	STALL
GET_INTERFACE	STALL *	STALL	Return data	STALL	STALL *
GET_STATUS					
Device	STALL *	Return data	Return data	Return data	STALL *
Interface	STALL *	STALL	Return data	Return data	STALL *
Endpoint 0	STALL *	Return data	Return data	Return data	STALL *
Endpoint 1	STALL *	STALL	Return data	Return data	STALL *
SET_ADDRESS	Treat request	Treat request	STALL *****	STALL	STALL *
SET_CONFIGURATION	STALL *	Treat request	Treat request	STALL	STALL
SET_FEATURE					
Device	STALL *	Treat request	Treat request	Treat request	STALL
Endpoint 0	STALL *	Treat request	Treat request	Treat request	STALL
Endpoint 1	STALL *	STALL	Treat request	Treat request	STALL
TEST_MODE in HS mode	Treat request	Treat request	Treat request	Treat request	STALL
TEST_MODE in FS mode	STALL	STALL	STALL	STALL	STALL
SET_INTERFACE	STALL *	STALL	Treat request	STALL	STALL
Other Standard Requests	STALL	STALL	STALL	STALL	STALL

Request	Condition				
	Default state	Address state	Configured state	Endpoint 0 halted	Invalid wValue
Class-specific Requests					
ClearHubFeature					
C_HUB_OVER_CURRENT	No response *	No response *	Treat request	Treat request	STALL
ClearPortFeature	No response *	No response *	Treat request	Treat request	STALL
GetHubDescriptor **Note 1, 3**	Return data *	Return data *	Return data	Return data	STALL
GetHubStatus	No response *	No response *	Return data	Return data	STALL
GetPortStatus	No response *	No response *	Return data	Return data	STALL
SetPortFeature **Note 4**					
Except for *TEST_MODE*	No response *	No response *	Treat request	Treat request	STALL
TEST_MODE in HS mode	No response *	No response *	Treat request	Treat request	STALL
TEST_MODE in FS mode	STALL	STALL	STALL	STALL	STALL
ClearTTBuffer					
In HS mode	No response *	No response *	Treat request	Treat request	**Note 5**
In FS mode	STALL	STALL	STALL	STALL	STALL
GetTTState **Note 1**					
In HS mode	No response *	No response *	Return data	Return data	STALL
In FS mode	STALL	STALL	STALL	STALL	STALL
ResetTT					
In HS mode	No response *	No response *	Treat request	Treat request	STALL
In FS mode	STALL	STALL	STALL	STALL	STALL
StopTT					
In HS mode	No response *	No response *	Treat request	Treat request	STALL
In FS mode	STALL	STALL	STALL	STALL	STALL
Other Class-specific Requests	STALL	STALL	STALL	STALL	STALL
Normal transaction					
Interrupt for Endpoint 1	-	-	Return data	Return data	-

Request	Condition		
	Invalid wIndex	Invalid wLength	Endpoint 1 halted
Standard Requests			
CLEAR_FEATURE			
Device	STALL	STALL *	-
Endpoint 0	STALL	STALL *	-
Endpoint 1	STALL	STALL *	-
GET_CONFIGURATION	STALL *	STALL *	-
GET_DESCRIPTOR **Note 1**			
Device	STALL	-	-
Configuration	STALL	-	-
String **Note 2**	STALL	-	-
Device Qualifier	STALL	-	-
Other Speed Configuration	STALL	-	-
GET_INTERFACE	STALL	STALL *	-
GET_STATUS			
Device	STALL *	STALL *	-
Interface	STALL	STALL *	-
Endpoint 0	STALL	STALL *	-
Endpoint 1	STALL	STALL *	-
SET_ADDRESS	STALL *	STALL *	-
SET_CONFIGURATION	STALL *	STALL *	-
SET_FEATURE			
Device	STALL	STALL *	-
Endpoint 0	STALL	STALL *	-
Endpoint 1	STALL	STALL *	-
TEST_MODE in HS mode	STALL *	STALL *	-
TEST_MODE in FS mode	STALL	STALL	-
SET_INTERFACE	STALL	STALL *	-
Other Standard Requests	STALL	STALL	-
Class-specific Requests			
ClearHubFeature	STALL	STALL	-
ClearPortFeature	STALL	STALL	-
GetHubDescriptor **Note 1, 3**	STALL	-	-
GetHubStatus	STALL	STALL	-
GetPortStatus	STALL	STALL	-
SetPortFeature **Note 4**			
Except for *TEST_MODE*	STALL	STALL	-
TEST_MODE in HS mode	STALL	STALL	-
TEST_MODE in FS mode	STALL	STALL	-
ClearTTBuffer			
In HS mode	STALL	STALL	-
In FS mode	STALL	STALL	-
GetTTState **Note 1**			
In HS mode	STALL	-	-
In FS mode	STALL	STALL	-
ResetTT			
In HS mode	STALL	STALL	-
In FS mode	STALL	STALL	-
StopTT			
In HS mode	STALL	STALL	-
In FS mode	STALL	STALL	-
Other Class-specific Requests	STALL	STALL	-
Normal transaction			
Interrupt for Endpoint 1	-	-	STALL

Remarks 1: * indicates that “Not Specified” describes in USB specification rev. 2.0.

2: The requests, which are defined in USB specification rev. 2.0 additionally, are undefined in full-speed mode. So, μPD720110 will return STALL handshake for these requests when it is operating in full-speed mode.

3: When μPD720110’s upstream facing port is in *TEST_MODE*, μPD720110 can not response for any request.

4: In high-speed mode, 4 additional requests for Transaction translator are provided.

Request	Function
ClearTTBuffer	Clears the state of a Transaction Translator (TT) bulk/control buffer after it has been left in a busy state due to high-speed errors. After successful completion of this request, the buffer can again be used by the TT with high-speed split transaction for full/low-speed transactions to attached full-/low-speed device.
GetTTState	Returns Internal state of TT for debugging purposes after StopTT request is completed.
ResetTT	Returns the TT in hub to a known state.
StopTT	Stops the normal execution of the TT to retrieve internal state of TT via GetTTState request for debugging purposes.

Note 1: The wLength field specifies the number of bytes to return. If the descriptor (or internal state of TT) is longer than the wLength field, only the initial bytes of the descriptor (or internal state of TT) are return. If the descriptor (or internal state of TT) is shorter than the wLength field, the device indicates the end of the control transfer by sending a short packet when further data is requested.

2: String descriptors can be provided up to 6 indexes in Mask ROM option. Get Descriptor String will also supports up to 6 indexes (Index0 – Index5) of String descriptor. If μPD720110 is not supporting String descriptor, it will return STALL handshake for this request.

3: The hub is not configured, the hub’s response to GetHubDescriptor request is undefined in USB specification. μPD720110 will return data for the GetHubDescriptor request even in default or address state. At that time, it will not decode wValue field for GetHubDescriptor request and ignore that field.

4: When the downstream facing port is in *TEST_MODE*, μPD720110 returns ACK handshake for another SetPortFeature (*TEST_MODE*), but it discards that request. When the downstream facing port is in *TEST_MODE*, μPD720110 does not response for SetFeature (*TEST_MODE*). When the port is not in Disable, Disconnect, or Suspend State, μPD720110 returns STALL handshake for SetPortFeature (*TEST_MODE*).

5: μPD720110 decodes only bit14 and bit 13 for wValue field of ClearTTBuffer request. If wValue[14:13] is not matched “00b”, μPD720110 will return STALL handshake. On the other hands, If wValue[14:13] is matched “00b” , μPD720110 will return ACK handshake. At that time, If the buffer for device address and endpoint number which is contained in wValue does not exits, this request will ignored.

3.4 Hub Status Field and Hub Change Field

The section describes the value which is returned for GetHubStatus request. These fields may be set by SetHubFeature request and cleared by ClearHubFeature request.

Table 3-3 Hub Status Field, *wHubStatus*

Bit	Description
0	**Local Power Source:** This is the source of the local power supply. This is always 0 during power supply for hub is active. 0 = Local power supply good
1	**Over-current Indicator:** reporting on a hub basis 0 = No over-current condition currently exists 1 = A hub over-current condition exists
2-15	**Reserved** These bits return 0 when read.

Table 3-4 Hub Change Field, *wHubChange*

Bit	Description
0	**Local Power Status Change:** (C_HUB_LOCAL_POWER) 0 = No change has occurred to Local Power Status
1	**Over-Current Indicator Change:** (C_HUB_OVER_CURRENT) This field indicates if a change has occurred in the Over-current indicator field in *wHubStatus*. 0 = No change has occurred to the Over-Current Indicator 1 = Over-Current Indicator has changed
2-15	**Reserved** These bits return 0 when read.

3.5 Port Status Field and Port Change Field

The section describes the value which is returned for GetPortStatus request. These fields may be set by SetPortFeature request and cleared by ClearPortFeature request.

Table 3-5 Port Status Field, *wPortStatus*

Bit	Description
0	**Current Connect Status:** (PORT_CONNECTION) 0 = No device is present. 1 = A device is present on this port.
1	**Port Enabled/Disabled:** (PORT_ENABLE) 0 = Port is disabled. 1 = Port is enabled.
2	**Suspend:** (PORT_SUSPEND) 0 = Not suspended. 1 = Suspended or resuming.
3	**Over-current Indicator:** reporting on a per-port basis (PORT_OVER_CURRENT) 0 = All no over-current condition exists on this port. 1 = An over-current condition exists on this port.
4	**Reset:** (PORT_RESET) 0 = Reset signaling not asserted. 1 = Reset signaling asserted.

Bit	Description
5-7	**Reserved** These bits return 0 when read.
8	**Port Power:** (PORT_POWER) 0 = This port is in the Powered-off state. 1 = This port is not in the Powered-off state.
9	**Low Speed Device Attached:** (PORT_LOW_SPEED) 0 = Full-speed or High-speed device attached to this port. (determined by bit 10) 1 = Low-speed device attached to this port.
10	**High Speed Device Attached:** (PORT_HIGH_SPEED) 0 = Full-speed device attached to this port. 1 = High-speed device attached to this port.
11	**Port Test Mode:** (PORT_TEST) 0 = This port is not in the Port Test Mode. 1 = This port is in Port Test Mode.
12	**Port Indicator Control**: (PORT_INDICATOR) 0 = Port indicator displays default colors. 1 = Port indicator displays software controlled color.
13-15	**Reserved** These bits return 0 when read.

Table 3-6 Port Change Field, *wPortChange*

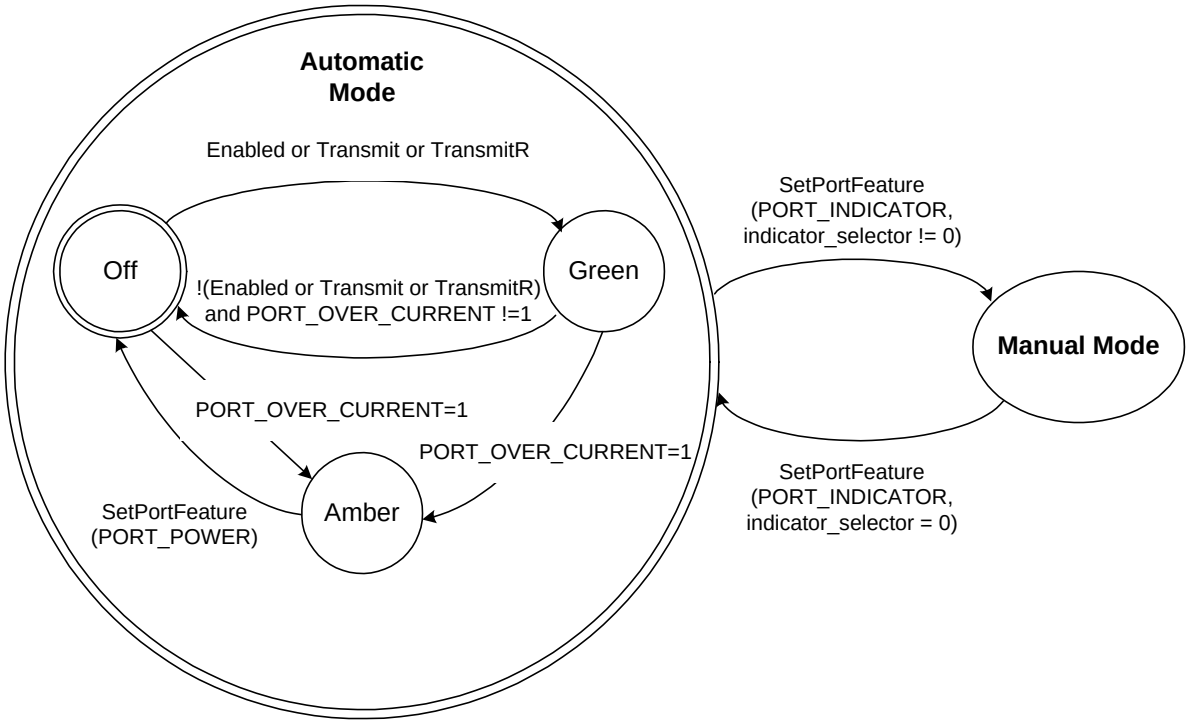
Bit	Description
0	**Connect Status Change:** (C_PORT_CONNECTION) This field indicates if a change has occurred in the Current Connect Status field in *wPortStatus.* 0 = No change has occurred to Current Connect status. 1 = Current Connect status has changed.
1	**Port Enable/Disable Change:** (C_PORT_ENABLE) This field is set to one when a port is disabled because of a Port_Error condition.
2	**Suspend Change:** (C_PORT_SUSPEND) This field indicates a change in the host-visible suspend state of the attached device. It indicates the device has transitioned out of the Suspend state. This field is set only when the entire resume process has completed. 0 = No change. 1 = Resume complete.
3	**Over-Current Indicator Change:** (C_PORT_OVER_CURRENT) This field indicates if a change has occurred in the Over-current Indicator field in *wPortStatus.* 0 = No change has occurred to Over-Current Indicator. 1 = Over-Current Indicator has changed.
4	**Reset Change:** (C_PORT_RESET) This field is set when reset processing on this port is complete. 0 = No change. 1 = Reset complete.
5-15	**Reserved** These bits return 0 when read.

3.6 PORT_INDICATOR

Each downstream facing port of a hub can support an optional status indicator. The presence of indicators for downstream facing ports is specified by bit 7 of the *wHubCharacteristics* field of the hub class descriptor. They should be supported under default setting of μPD720110. They can be omitted by setting of external Serial ROM or Mask ROM option.

The indicator provides two colors: Green and Amber. A combination of hardware and software control is used to inform the user of the current status of the port or the device attached to the port, and to guide the user through problem resolution. Colors and blinking are used to provide information to the user. A hub must automatically control the color of the indicator as specified in Figure 3-1.

Figure 3-1 USB upstream port connection



In **Automatic Mode**, Amber colored LED indicates to detect over current condition on the port. And Green colored LED indicates that the port is in Enabled, Transmit, or TransmitR. In **Manual Mode**, the color of a port indicator (Amber, Green, or Off) is set by a system software USB Hub class request.

The following table defines port state as understood by the user:

Table 3-7 Indicator Colors and Port Status

Color	Port State
Off	Suspended, Disconnected, Disabled, or Not Configured
Amber	Error condition
Green	Fully operational
Blinking Off/Green	Software Attention
Blinking Off/Amber	Hardware Attention
Blinking Green/Amber	Reserved

The specific indicator mode is specified in the SetPortFeature(PORT_INDICATOR) request by the Port Indicator selector. As shown in Table 3-8, If the Port Indicator Selector is not “0”, Port Indicator will be put into **Manual Mode**. The GetPortStatus (PORT_INDICATOR) provides no standard mechanism to report a specific indicator mode, therefore system software must track which indicator mode was used.

Table 3-8 Port Indicator Selectors

Value	Indicator Mode Description
0	Default as **Automatic Mode**
1	Amber
2	Green
3	Off
4-FFH	Reserved

For example, this feature should be used to require user intervention when host software detects following error conditions on a port.

- A high power device is plugged into a low power port.
- A defective device is plugged into a port (Babble conditions, excessive errors, etc.).
- An overcurrent condition occurs which causes software or hardware to set the indicator.

And many error conditions can be resolved if the user moves a device from one port to another that has the proper capabilities.

A typical scenario is when a user plugs a high power device in to a bus-powered hub. If there is an available high power port, then the user can be directed to move the device from the low-power port to the high power port.

1. Host software would cycle the PORT_INDICATOR feature of the low power port to blink the indicator and display a message to the user to unplug the device from the port with the blinking indicator.
2. Using the C_PORT_CONNECTION status change feature host software can determine when the user physically removed the device from the low power port.
3. Host software would next issue a ClearPortFeature(PORT_INDICATOR) to the low power port (restoring the default color), begin cycling the PORT_INDICATOR of the high power port, and display a message telling the user to plug the device into to port with the blinking indicator.
4. Using the C_PORT_CONNECTION status change feature host software can determine when the user physically inserted the device onto the high power port.

Host software must cycle the PORT_INDICATOR feature to blink the current color at approximately 0.5Hz rate with a 30-50% duty cycle.

4 External Serial ROM Interface

This chapter describes how to use external Serial ROM. This chip has the interface to connect external Serial ROM to load a part of USB descriptors instead of internal ROM.

When SMD is set to “high”, the external Serial ROM for USB descriptors is enabled. At that case, when the power supply for the chip will be turned on, all data presented in the external Serial ROM will be loaded, it will be used instead of a part of Internal ROM. All data, which should be written in external Serial ROM, occupies 17 bytes (8 bits X 17 words) and the format is as shown in Table 4-1.

As described in Chapter 2, the hub returns different descriptors based on whether it is operating at high-speed or full-speed. The following table indicates the allocation of data in Serial ROM based on full-speed operation. When the hub is operating at high-speed, hub will swap fields of Configuration Descriptor and fields of Other_Speed_Configuration Descriptor automatically.

Table 4-1 external Serial ROM code format.

ROM Address	Description	Semantics	Default value
00h	Vendor ID	Lower byte of idVender field in Device Descriptor	09h
01h	Vendor ID	Upper byte of idVender field in Device Descriptor	04h
02h	Product ID	Lower byte of idProduct field in Device Descriptor	58h
03h	Product ID	Upper byte of idProduct field in Device Descriptor	00h
04h	Device release number in binary-coded decimal	Lower byte of bcdDevice field in Device Descriptor	00h
05h	Device release number in binary-coded decimal	Upper byte of bcdDevice field in Device Descriptor	01h
06h	Configuration characteristics D7: Reserved (set to one) D6: Self-powered D5: Remote Wakeup D4...0: Reserved (reset to zero This chip supports only self-powered mode, D6 should be set to one. Hub should supports remote wakeup, D5 should be set to one.	bmAttributes field in Configuration Descriptor	E0h **Note**
07h	Maximum power consumption of the USB device from the bus in this specific configuration when the device is fully operational. Expressed in 2 mA units (i.e., 50 = 100 mA).	MaxPower field in Configuration Descriptor	32h
08h	Configuration characteristics D7: Reserved (set to one) D6: Self-powered D5: Remote Wakeup D4...0: Reserved (reset to zero This chip supports only self-powered mode, D6 should be set to one. Hub should supports remote wakeup, D5 should be set to one.	bmAttributes field in Other Speed Configuration Descriptor	E0h **Note**

ROM Address	Description	Semantics	Default value
09h	Maximum power consumption of the USB device from the bus in this specific configuration when the device is fully operational. Expressed in 2 mA units (i.e., 50 = 100 mA).	MaxPower field in Other Speed Configuration Descriptor	32h
0Ah	Number of downstream facing ports that this hub supports	bNbrPorts field in Hub Descriptor	04h
0Bh	D1...D0: Logical Power Switching Mode 00: Ganged power switching (all ports' power at once) 01: Individual port power switching 1X: Reserved. D2: Identifies a Compound Device 0: Hub is not part of a compound device 1: Hub is part of a compound device D4...D3: Over-current Protection Mode 00: Global Over-current Protection. 01: Individual Port Over-current Protection. 1X: No Over-current Protection. Can not select this setting for this chip. D6...D5: TT Think Time 01: TT requires at most 16 FS bit times These bits must be set to "01". D7: Port Indicators Supported 0: Port Indicators are not supported on its downstream facing ports and the PORT_INDICATOR request has no effect. 1: Port Indicators are supported on its downstream facing ports and the PORT_INDICATOR request controls the indicators	Lower byte of wHubCharacteristics field in Hub Descriptor	A9h
0Ch	Reserved (set to one)	Upper byte of wHubCharacteristics field in Hub Descriptor	00h **Note**
0Dh	Time (in 2ms intervals) from the time the power-on sequence begins on a port until power is good on that port.	bPwrOn2PwrGood field in Hub Descriptor	32h
0Eh	Maximum current requirements of the Hub Controller electronics in mA.	bHubContrCurrent field in Hub Descriptor	C8h
0Fh	Indicates if a port has a removable device attached. This field is reported on byte-granularity. Within a byte, if no port exists for a given location, the field representing the port characteristics returns 0. Bit value definition: 0B - Device is removable 1B - Device is non-removable Bit Allocation Bit 0: Reserved for future use Bit 1: Port 1 Bit 2: Port 2 Bit 3: Port 3 Bit 4: Port 4 Bit 5-15: No port exists (set to zero)	Device Removale field in Hub Descriptor	00h
10h	-	bPortPwrCtrlMask field in Hub Descriptor	FFh **Note**

Note : These values of fields should be fixed. Please use default value for these fields.

Timing chart for expected external serial ROM with I2C interface is as follows.

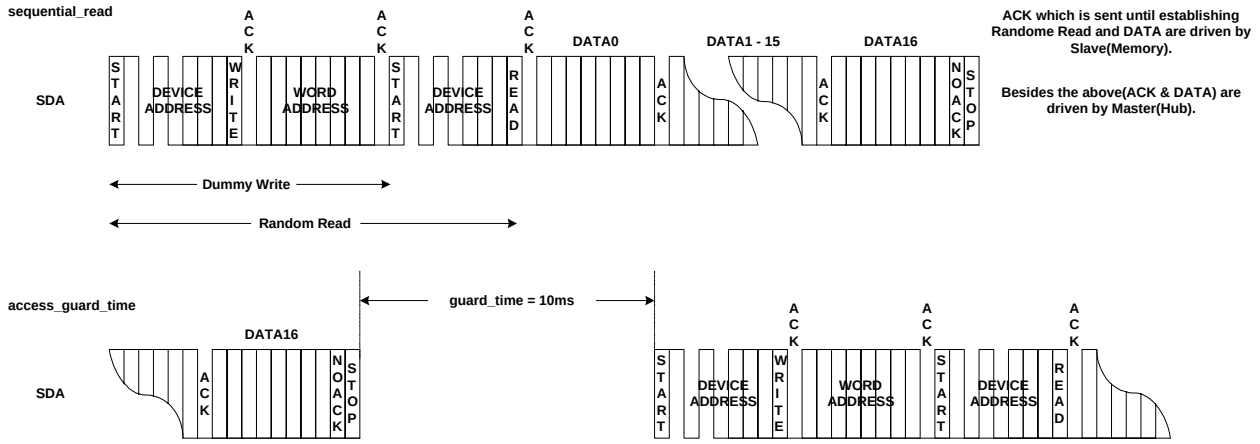


Figure 4-1 I2C timing chart

μPD720110 does not have Serial ROM writing capability. The appropriate serial ROM writer should be required to write the user defined descriptor field in external Serial ROM.

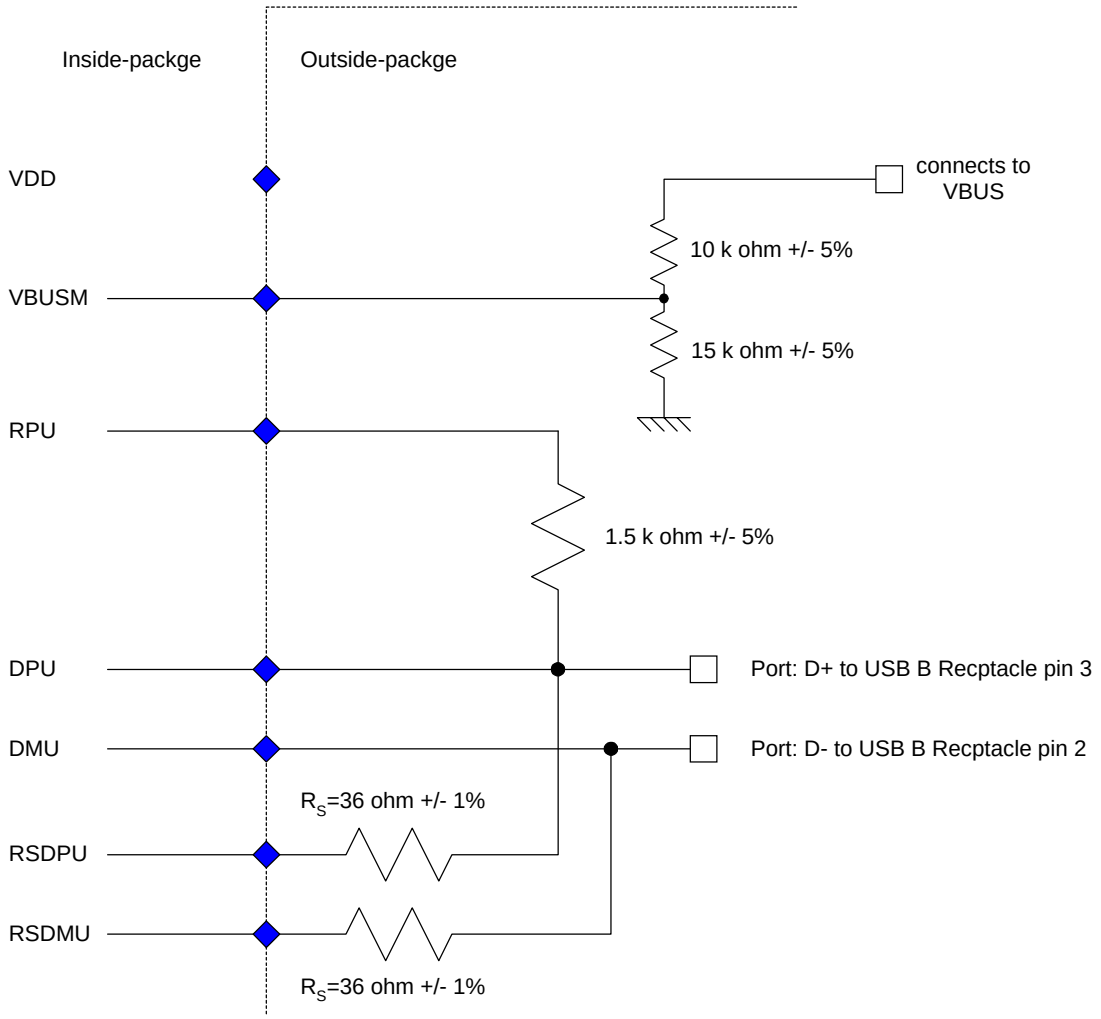
The setting of the external Serial ROM is higher priority than the pin configuration. If the external Serial ROM is enabled, the pin configuration will be ignored. Following table shows the influence by the setting of Serial ROM and pin configuration

Pin name	Description	Internal ROM is enabled.	External Serial ROM is enabled.
NUMPORT	Control number of active downstream facing ports	The setting of NUMPORT reflects to the value of bNbrPorts field in Hub descriptor.	Ignore setting of NUMPORT. The value of bNbrPorts field in Hub descriptor is loaded by external serial ROM.
PORTRMVx	Control None-removable device setting for active downstream facing ports	The setting of PORTRMVx reflects to the value of DeviceRemovable field and wHubCharacteristics (D2) in Hub descriptor.	Ignore setting of PORTRMVx. The value of DeviceRemovable field and wHubCharacteristics (D2) field in Hub descriptor are loaded by external serial ROM.

5 How to connect to external discrete components

5.1 USB upstream port connection

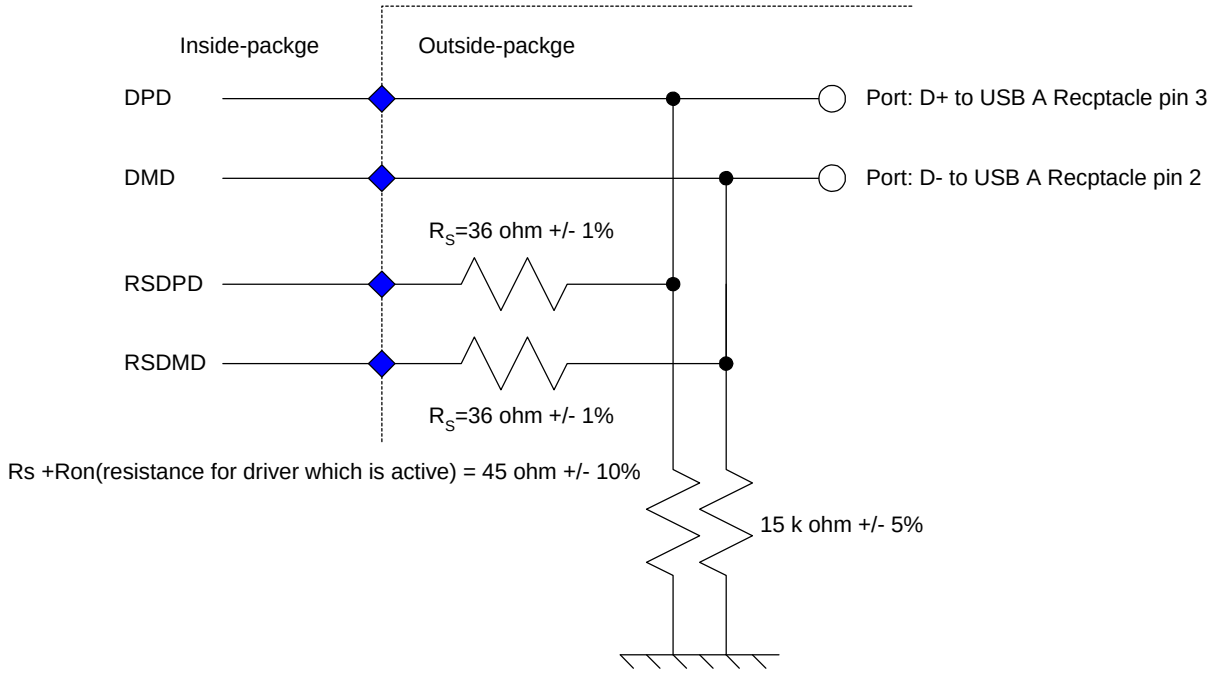
Figure 5-1 USB upstream port connection



Rs +Ron(resistance for driver which is active) = 45 ohm +/- 10%

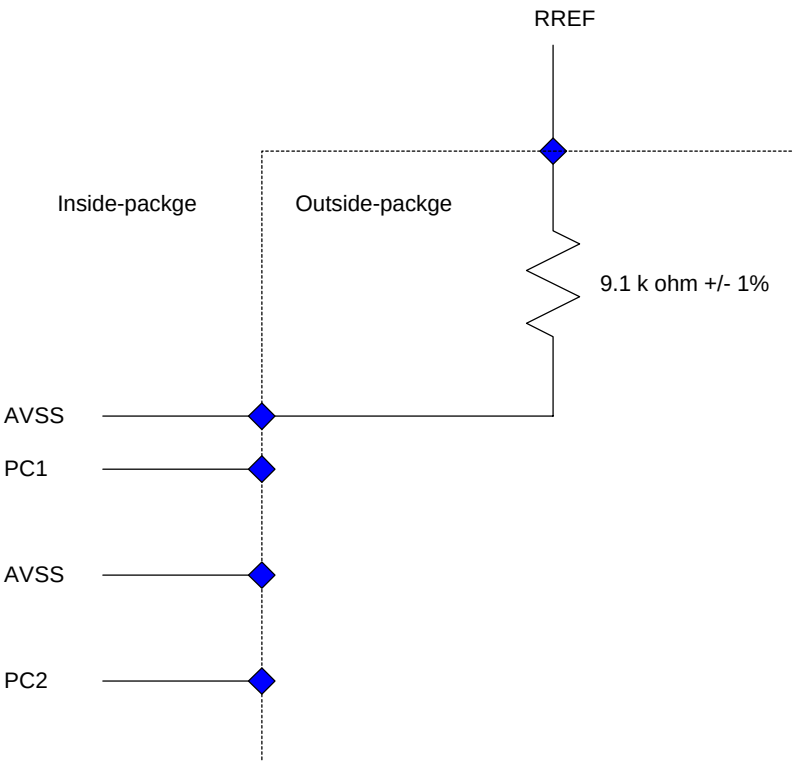
5.2 USB downstream port connection

Figure 5-2 USB downstream port connection



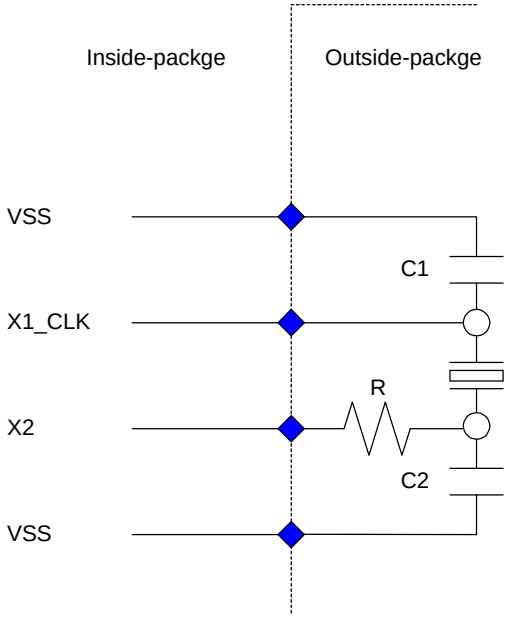
5.3 PLL capacitor connection

Figure 5-3 PLL capacitor & RREF connection



5.4 X'tal connection

Figure 5-4 X'tal connection



Following table shows the external parameters for AT-49 30MHz.

Table 5-1 External parameters

Vender	X'tal	R	C1	C2
KDS	AT-49 30.000 MHz	150 Ω	12 pF	12 pF

If you use AT-49 30MHz on your board, please contact to KDS to get the best external parameters on your board.

KDS's Home page: http://www.kdsj.co.jp

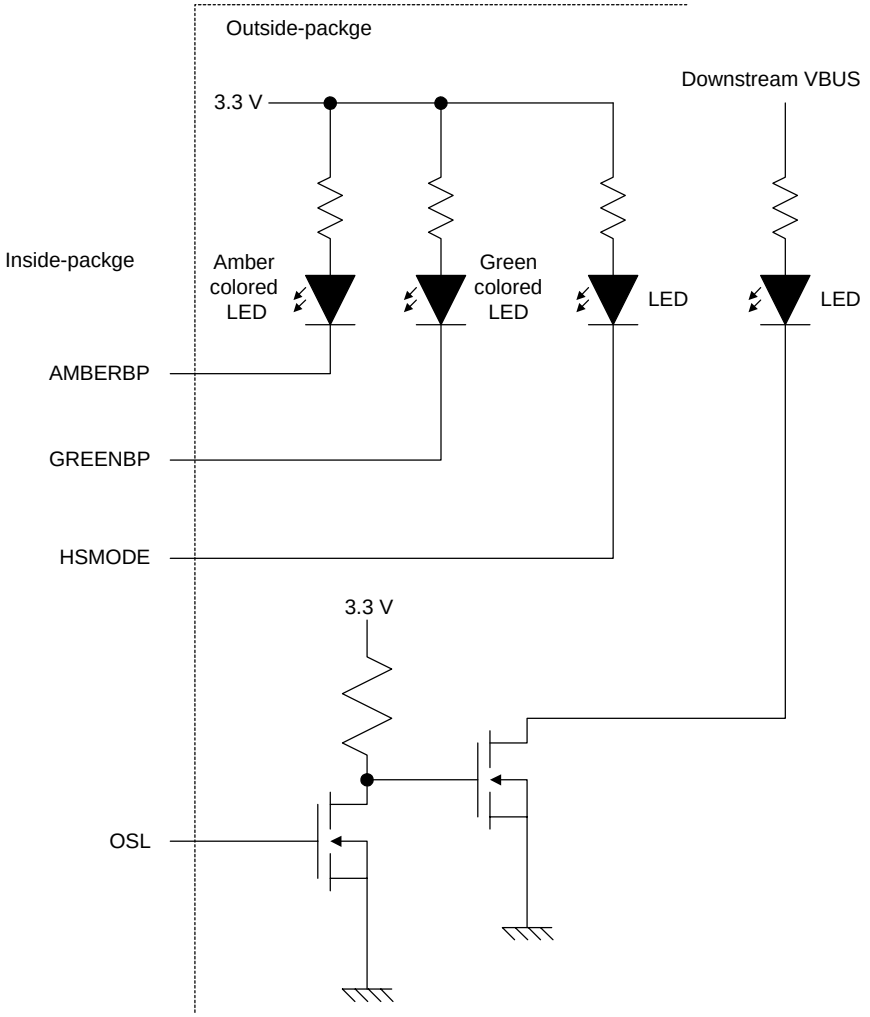
Caution When you use an oscillator circuit, please keep following points.

- **Keep the wiring length as short as possible.**
- **Do not cross the wiring with the other signal lines.**
- **Do not route the wring near a signal line through which a high fluctuating current flows.**
- **Always keep the ground point of the oscillator capacitor to the same potential as V_{SS}.**
- **Do not ground the capacitor to a ground pattern in which a high current flows.**
- **Do not fetch signals from the oscillator.**

5.5 LED connection

Port_Indicator(AMBERBPx,GREENBPx) should support at default setting. At that case, Amber colored LED should be connected each AMBERBPx and Green colored LED should be connected each GREENBPx. It is possible to omit Port_Indicator to set appropriate value to wHubCharacteristics field in Hub Class descriptor by using Serial ROM or Mask ROM version. When Port_Indicator can be omitted, AMBERBPx and GREENBPx can be left open. HSMODE is optional signal to indicate that a hub is operating at high-speed. If not need to indicate operating speed, HSMODE can be left open. OSL is also optional signal to indicate that a hub is in suspend state. If not need to indicate suspend state, OSL can be left open.

Figure 5-5 LED connection



5.6 Handling Unused Pins

To realize 3 ports hub controller implementation, please handle unused pins as shown below.

Pin	Direction	Connection Method
NUMPORT	I	Tied to "High".
DPD4	I/O	Tied to "low".
DMD4	I/O	Tied to "low".
RSDPD4	O	No Connection (Open)
RSDMD4	O	No Connection (Open)
CSB4	I	“H” clamp
PPB4	O	No Connection (Open)

6 Electrical Specifications

6.1 Buffer List

- 5 V schmitt buffer
  SYSRSTB, CSB(4:1)
- 3.3 V Oscillator block
  X1_CLK, X2
- 3.3 V input buffer
  CLKSEL, TS(10:1), SMD, PWMODE, NUMPORT, VBUSM, PORTRMV(4:1)
- 3.3 V IOL = 6 mA Output buffer
  PLLLOCK, OSL, TSO, SCL, CLK30MO
- 3.3 V IOL = 12 mA Output buffer
  EPERR
- 3.3 V IOL = 6 mA schmitt I/O buffer with 5 kΩ pull-up resister.
  SDA
- 5 V IOL = 12 mA Output buffer
  HSMODE, AMBERBP(4:1), GREENBP(4:1)
- 5 V IOL = 12 mA N-ch Open Drain buffer
  PPB(4:1),
- USB2.0 interface
  RPU, DPU, DMU, RSDPU, RSDMU, DPD(4:1), DMD(4:1), RSDPD(4:1), RSDMD(4:1),RREF, PC1, PC2

Above, “5 V” refers to a 3-V buffer that is 5-V tolerant (has 5-V maximum voltage). Therefore, it is possible to have a 5-V connection for an external bus, but the output level will be only up to 3 V, which is the VDD voltage.

6.2 Terminology

Table 6-1 Terms Used in Absolute Maximum Ratings

Parameter	Symbol	Meaning
Power supply voltage	V_{DD}	Indicates voltage range within which damage or reduced reliability will not result when power is applied to a V_{DD} pin.
Input voltage	V_I	Indicates voltage range within which damage or reduced reliability will not result when power is applied to an input pin.
Output voltage	V_O	Indicates voltage range within which damage or reduced reliability will not result when power is applied to an output pin.
Output current	I_O	Indicates absolute tolerance values for DC current to prevent damage or reduced reliability when a current flow out of or into an output pin.
Operating temperature	T_A	Indicates the ambient temperature range for normal logic operations.
Storage temperature	T_{stg}	Indicates the element temperature range within which damage or reduced reliability will not result while no voltage or current are applied to the device.

Table 6-2 Terms Used in Recommended Operating Range

Parameter	Symbol	Meaning
Power supply voltage	V_{DD}	Indicates the voltage range for normal logic operations occur when V_{SS} = 0V.
High-level input voltage	V_{IH}	Indicates the voltage, which is applied to the input pins of the device, is the voltage indicates that the high level states for normal operation of the input buffer. * If a voltage that is equal to or greater than the “MIN.” value is applied, the input voltage is guaranteed as high level voltage.
Low-level input voltage	V_{IL}	Indicates the voltage, which is applied to the input pins of the device, is the voltage indicates that the low level states for normal operation of the input buffer. * If a voltage that is equal to or lesser than the “MAX.” value is applied, the input voltage is guaranteed as low level voltage.
Hysteresys voltage	V_H	Indicates the differential between the positive trigger voltage and the negative trigger voltage.

Table 6-3 Terms Used in DC Characteristics

Parameter	Symbol	Meaning
Off-state output leakage current	I_{OZ}	Indicates the current that flows from the power supply pins when the rated power supply voltage is applied when a 3-state output has high impedance.
Output short circuit current	I_{OS}	Indicates the current that flows when the output pin is shorted(to GND pins) when output is at high-level.
Low-level output current	I_{OL}	Indicates the current that flows to the output pins when the rated low-level output voltage is being applied.
High-level output current	I_{OH}	Indicates the current that flows from the output pins when the rated high-level output voltage is being applied.

6.3 Absolute Maximum Ratings

Table 6-4 Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating	Unit
Power supply voltage	V_{DD}		-0.5 to +4.6	V
Input voltage				
3.3V Input voltage	V_I	$V_O < V_{DD}+0.5$	-0.5 to +4.6	V
5.0V Input voltage		$V_I < V_{DD}+3.0$	-0.5 to +6.6	V
Output voltage				
3.3V Output voltage	V_O	$V_O < V_{DD}+0.5$	-0.5 to +4.6	V
5.0V Output voltage		$V_O < V_{DD}+3.0$	-0.5 to +6.6	V
Operating temperature	T_A		0 to +70	°C
Storage temperature	T_{stg}		-65 to +150	°C

Caution: Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameters. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

The ratings and conditions indicated for DC characteristics and AC characteristics represent the quality assurance range during normal operation.

6.4 Recommended Operating Ranges

Table 6-5 Recommended Operating Ranges

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Power supply voltage	V_{DD}		3.0	3.3	3.6	V
High-level input voltage						
3.3V High-level input voltage	V_{IH}		2.0		V_{DD}	V
5.0V High-level input voltage			2.0		5.5	V
Low-level input voltage						
3.3V Low-level input voltage	V_{IL}		0		0.8	V
5.0V Low-level input voltage			0		0.8	V
Hysteresys voltage	V_H		0.3		1.5	V
Input rise time for SYSRSTB	T_r	0.3V to 2.7V			10	ms

6.5 DC Characteristics

Table 6-6 DC Characteristics

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Off-state output leakge current	I_{OZ}	$V_O = V_{DD}$or GND			±10	μA
Output short circuit current	I_{OS} Note1				-250	mA
Low-level outpt current						
3.3V Low-level outpt current	I_{OL}	V_{OL} = 0.4 V	6			mA
3.3V Low-level outpt current		V_{OL} = 0.4 V	12			mA
5.0V Low-level outpt current		V_{OL} = 0.4 V	12			mA
High-level outpt current						
3.3V High-level outpt current	I_{OH}	V_{OH} = 2.4 V	-6			mA
3.3V High-level outpt current		V_{OH} = 2.4 V	-12			mA
5.0V High-level outpt current		V_{OH} = 2.4 V	-2			mA

Note 1 : The output short circuit time is one second or less and is only for one pin on the LSI.

Table 6-7 DC Characteristics (USB Interface Block)

Parameter	Symbol	Conditions	MIN	MAX	Unit
Serial Resistor between DPx (DMx) and RSDPx(RSDMx).	R_S		35.64	36.36	ohm
Output pin impedance	Z_{HSDRV}	Includes R_S resister	40.5	49.5	ohm
Bus Pull-up Resister on Upstream Facing Port	R_{PU}		1.425	1.575	kohm
Bus Pull-down Resister on Downstream Facing Port	R_{PD}		14.25	15.75	kohm
Termination voltage for upstream facing port pullup(full-speed)	V_{TERM}		3.0	3.6	V
Input Levels for Low-/full-speed:					
High-level input voltage(drive)	V_{IH}		2.0		V
High-level input voltage(floating)	V_{IHZ}		2.7	3.6	
Low-level input voltage	V_{IL}			0.8	V
Differential input sensitivity	V_{DI}	$\lvert(D+) - (D-)\rvert$	0.2		V
Differential Common mode Range	V_{CM}	Includes VDI range	0.8	2.5	V
Output Levels for Low-/full-speed:					
High-level output voltage	V_{OH}	RL of 14.25 kΩ to GND	2.8	3.6	V
Low-level output voltage	V_{OL}	RL of 1.425 kΩ to 3.6 V	0.0	0.3	V
SE1	V_{OSE1}		0.8		V
Output signal crossover point voltage	V_{CRS}		1.3	2.0	V

Parameter	Symbol	Conditions	MIN	MAX	Unit
Input Levels for High-speed:					
High-speed squelch detection threshold (differential signal)	V_{HSSQ}		100	150	mV
High-speed disconnect detection threshold (differential signal)	V_{HSDSC}		525	625	mV
High-speed data signaling common mode voltage range	V_{HSCM}		-50	500	mV
High-speed differential input signaling level	See Figure 6-4.				
Output Levels for High-speed:					
High-speed idle state	V_{HSOI}		-10.0	10	mV
High-speed data signaling high	V_{HSOH}		360	440	mV
High-speed data signaling low	V_{HSOL}		-10.0	10	mV
Chirp J level(different signal)	V_{CHIRPJ}		700	1100	mV
Chirp K level(different signal)	V_{CHIRPK}		-900	-500	mV

Figure 6-1. Differential Input Sensitivity Range for Low-/full-speed

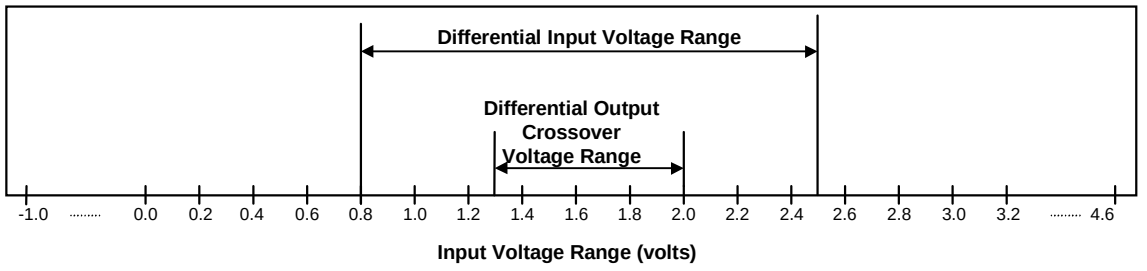


Figure 6-2. Full-speed Buffer Voh/Ioh Characteristics for High-speed Capable Transceiver

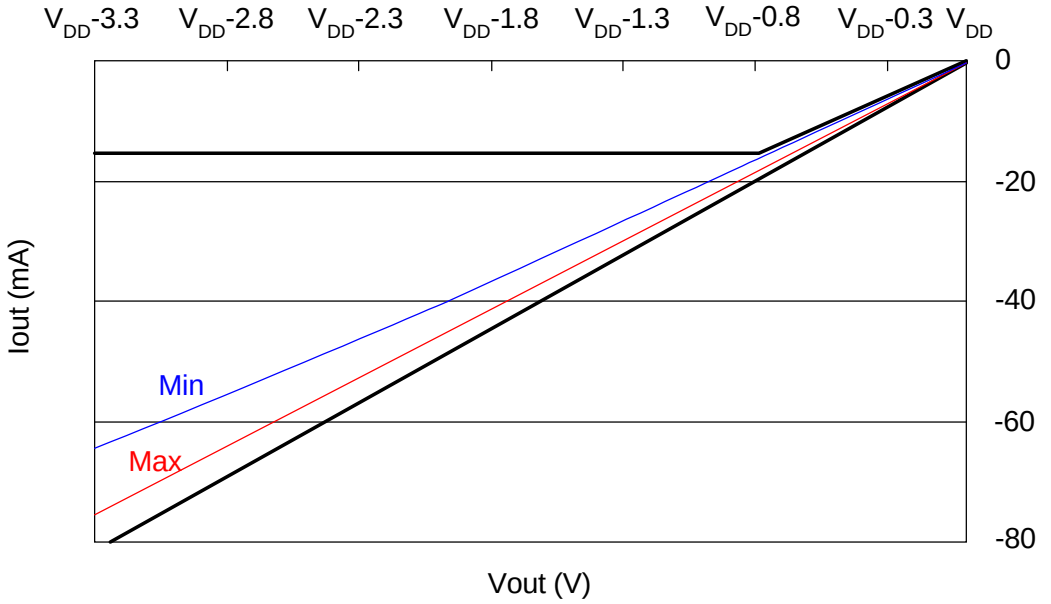


Figure 6-3. Full-speed Buffer Vol/Iol Characteristics for High-speed Capable Transceiver

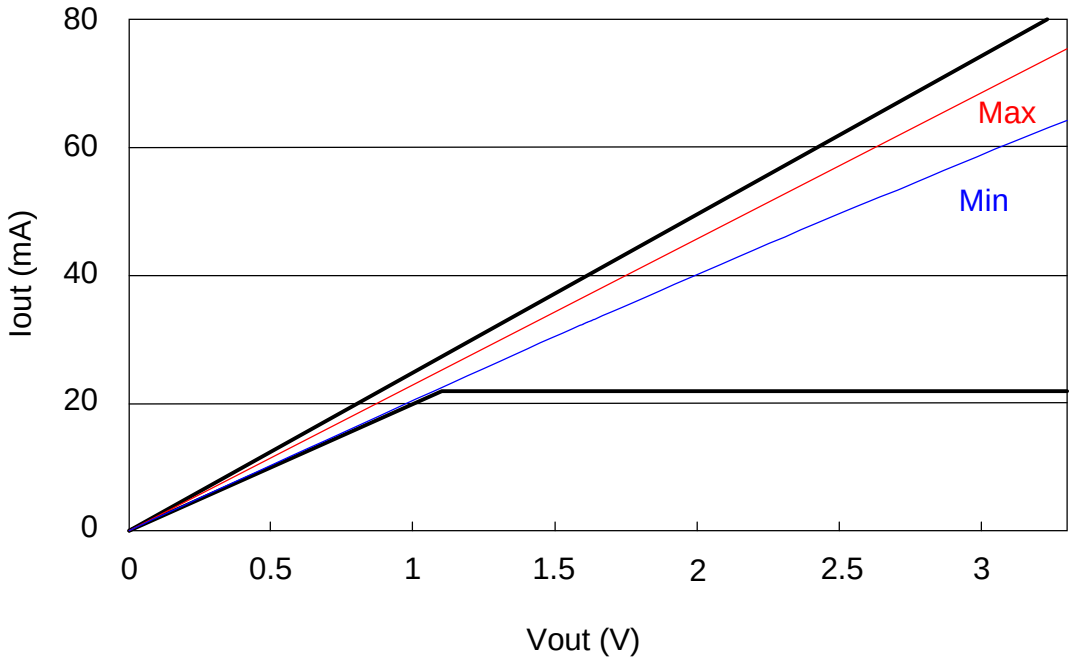


Figure 6-4. Receiver sensitivity for transceiver at DP/DM.

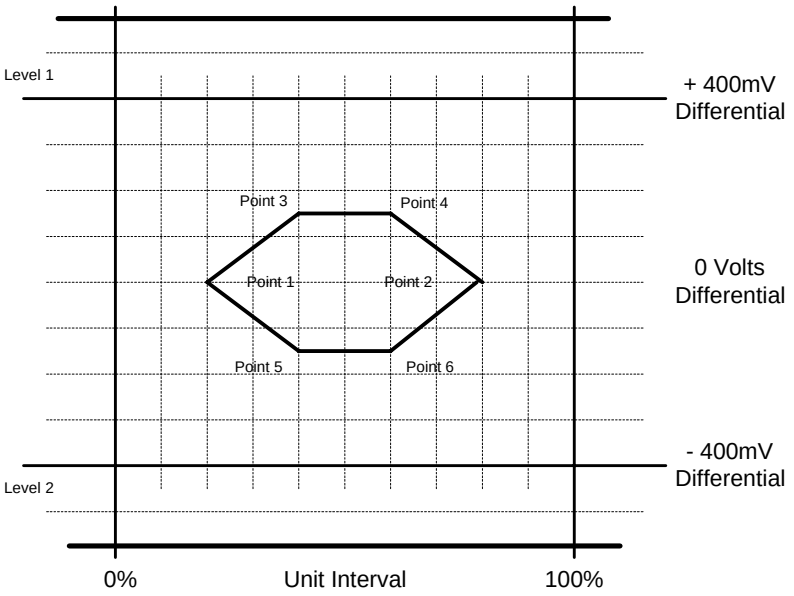
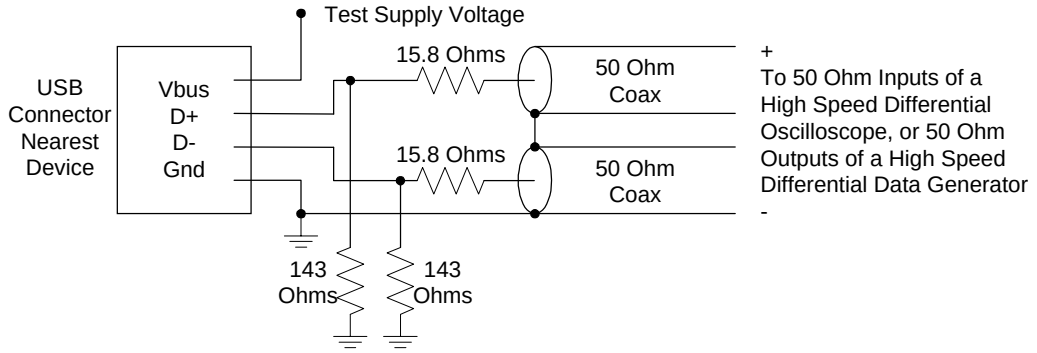


Figure 6-5 Receiver Measurement Fixtures



6.6 Power Consumption

Table 6-8 Power Consumption (30 MHz X'tal)

Parameter	Symbol	Condition	TYP.	Unit
Power Consumption	PW-0	The power consumption under the state without suspend. All the ports does not connect to any function. Note 1		
		Hub controller is operating at full-speed mode.	180	mA
		Hub controller is operating at high-speed mode.	260	mA
	PW-3	The power consumption under the state without suspend. The number of active ports is 3. Note 2		
		Hub controller is operating at full-speed mode.	185	mA
		Hub controller is operating at high-speed mode.	440	mA
	PW-4	The power consumption under the state without suspend. The number of active ports is 4. Note 2		
		Hub controller is operating at full-speed mode.	190	mA
		Hub controller is operating at high-speed mode.	490	mA
	PW_S	The power consumption under suspend state. The internal clock is stopped.		mA

Notes 1. When any device is not connected to all the ports of Hub, the power consumption for Hub does not depend on the number of active ports.

2. The number of active ports is set by NUMPORT pin or external serial ROM.

6.7 System clock specification

Table 6-9 System clock specification

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Clock frequency	f_{CLK}	X'tal	-500 ppm	30	+500 ppm	MHz
		Oscillator block	-500 ppm	48	+500 ppm	MHz
Duty cycle	t_{DUTY}		40	50	60	%

Remarks 1. Recommended accuracy of clock frequency is ± 100 ppm.

2. Required accuracy of X'tal or Oscillator block is including initial frequency accuracy, the spread of X'tal capacitor loading, supply voltage, temperature, and aging, etc.

6.8 AC characteristics (V_{DD}=3.0V to 3.6 T_A=0 to + 70°C)

Table 6-10 AC Characteristics (USB Interface Block)

Parameter	Symbol	Conditions	MIN	MAX	Unit
Low-speed Source Electrical Characteristics					
Rise time (10% - 90%)	T_{LR}	CL = 50 pF – 150 pF, RS = 36 ohm	75	300	ns
Fall time (90 - 10%)	T_{LF}	CL = 50 pF – 150 pF, RS = 36 ohm	75	300	ns
Differential Rise and Fall Time matching	T_{LRFM}	(TLR/TLF)	80	125	%
Low-speed Data Rate	$T_{LDRATHS}$	Average bit rate	1.49925	1.50075	Mb/s
Hub Differential Data Delay	T_{LHDD}			300	ns
Hub Differential Driver Jitter (including cable):					
Downstream facing port					
To Next Transition	T_{LDHJ1}		–45	45	ns
For Paired Transitions	T_{LDHJ2}		–15	15	ns
Upstream facing port					
To Next Transition	T_{LUHJ1}		-45	45	ns
For Paired Transitions	T_{LUHJ2}		-45	45	ns
Data Bit Width Distortion after SE0	T_{LSOP}		-60	60	ns
Hub EOP Delay Relative to THDD	T_{LEOPD}		0	200	ns
Hub EOP Output Width Skew	T_{LHESK}		-300	300	ns

Parameter	Symbol	Conditions	MIN	MAX	Unit
Full-speed Source Electrical Characteristics					
Rise time (10% - 90%)	T_{FR}	CL = 50 pF, RS = 36 ohm	4	20	ns
Fall time (90% - 10%)	T_{FF}	CL = 50 pF, RS = 36 ohm	4	20	ns
Differential Rise and Fall Time matching	T_{FRFM}	(TFR/TFF)	90	111.11	%
Full-speed Data Rate	$T_{FDRATHS}$	Average bit rate	11.9940	12.0060	Mb/s
Frame Interval	T_{FRAME}		0.9995	1.0005	ms
Consecutive Frame Interval Jitter	T_{RFI}	No clock adjustment		42	ns
Source Jitter Total (including frequency tolerance): To Next Transition For Paired Transitions	 T_{DJ1} T_{DJ2}		 –3.5 –4.0	 3.5 4.0	 ns ns
Source Jitter for Differential Transition to SE0 transition	T_{FDEOP}		–2	5	ns
Receiver Jitter: To Next Transition For Paired Transitions	 T_{JR1} T_{JR2}		 –18.5 –9	 18.5 9	 ns ns
Source SE0 interval of EOP	T_{FEOPT}		160	175	ns
Receiver SE0 interval of EOP	T_{FEOPR}		82		ns
Width of SE0 interval during differential transition	T_{FST}			14	ns
Hub Differential Data Delay (without cable)	T_{HDD2}			44	ns
Hub Differential Driver Jitter (including cable): To Next Transition For Paired Transitions	 T_{HDJ1} T_{HDJ2}		 –3 –1	 3 1	 ns ns
Data Bit Width Distortion after SE0	T_{FSOP}		-5	5	ns
Hub EOP Delay Relative to THDD	T_{FEOPD}		0	15	ns
Hub EOP Output Width Skew	T_{FHESK}		-15	15	ns
High-speed Source Electrical Characteristics					
Rise time (10% - 90%)	T_{HSR}		500		ps
Fall time (90 - 10%)	T_{HSF}		500		ps
Driver waveform	See Figure 6-6.				
High-speed Data Rate	T_{HSDRAT}		479.760	480.240	Mb/s
Microframe Interval	T_{HSFRAM}		124.9375	125.0625	μs
Consecutive Microframe Interval Difference	T_{HSRFI}			4 high-speed	Bit times
Data source jitter	See Figure 6-6.				
Receiver jitter tolerance	See Figure 6-4.				

Parameter	Symbol	Conditions	MIN	MAX	Unit
Hub Data Delay (without cable)	T_{HSHDD}			36 high-speed +4 ns	Bit times
Hub Delay Variation Range:	T_{HSHDV}			5 high-speed	Bit times
Hub event Timings					
Time to detect a downstream facing port connect event Awake Hub Suspended Hub	T_{DCNN}		 2.5 2.5	 2000 12000	 μs μs
Time to detect a disconnect event at a hub's downstream facing port	T_{DDIS}		2	2.5	μs
Duration of driving resume to a downstream port; only from a controlling hub	T_{DRSMDN}		20		ms
Time from detecting downstream resume to rebroadcast.	T_{URSM}			1.0	ms
Duration of driving reset to a downstream facing port	T_{DRST}	Only for a SetPortFeature (PORT_RESET) request	10	20	ms
Time to detect a long K from upstream	T_{URLK}		2.5	100	μs
Time to detect a long SE0 from upstream	T_{URLSE0}		2.5	10000	μs
Duration of repeating SE0 upstream (for low-/full-speed repeater)	T_{URPSE0}			23	FS Bit times
Inter-packet Delay (for high-speed) of packets traveling in same direction	$T_{HSIPDSD}$		88		Bit times
Inter-packet Delay (for high-speed) of packets traveling in opposite direction	$T_{HSIPDOD}$		8		Bit times
Inter-packet delay for device/ root hub response w/detachable cable for high-speed	$T_{HSRSPIPD1}$			192	Bit times
Time of which a Chirp J or Chirp K must be continuously detected (filtered) by hub or device during Reset handshake	T_{FILT}		2.5		μs
Time after end of device Chirp K by which hub must start driving first Chirp K in the hub's chirp sequence	T_{WTDCH}			100	μs
Time for which each individual Chirp J or Chirp K in the chirp sequence is driven downstream by hub during reset.	T_{DCHBIT}		40	60	μs
Time before end of reset by which a hub must end its downstream chirp sequence.	T_{DCHSE0}		100	500	μs

Parameter	Symbol	Conditions	MIN	MAX	Unit
Hub event Timings					
Time from internal power good to device pulling D+ beyond V_{IHZ}	T_{SIGATT}			100	ms
Debounce interval provided by USB system software after attach	T_{ATTDB}			100	ms
Maximum duration of suspend averaging interval	$T_{SUSAVGI}$			1	s
Period of idle bus before device can initiate resume	T_{WTRSM}		5		ms
Duration of driving resume upstream	T_{DRSMUP}		1	15	ms
Resume Recovery Time	T_{RSMRCY}	Remote-wakeup is enabled	10		ms
Time to detect a reset from upstream for non high-speed capable devices	T_{DETRST}		2.5	10000	μs
Reset Recovery Time	T_{RSTRCY}			10	ms
Inter-packet Delay for full-speed	T_{IPD}		2		Bit times
Inter-packet delay for device response w/detachable cable for full-speed	$T_{RSPIPD1}$			6.5	Bit times
SetAddress() Completion Time	$T_{DSETADDR}$			50	ms
Time to complete standard request with no data	$T_{DRQCMPLTND}$			50	ms
Time to deliver first and subsequent (except last) data for standard request	$T_{DRETDATA1}$			500	ms
Time to deliver last data for standard request	$T_{DRETDATAN}$			50	ms

Table 6-12 AC characteristics

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
CLK30MO cycle time	t_{C3C}					ns
CLK30MO high level width	t_{C3H}					ns
CLK30MO low level width	t_{C3L}					ns

Figure 6-6 Transmit waveform for transceiver at DP/DM.

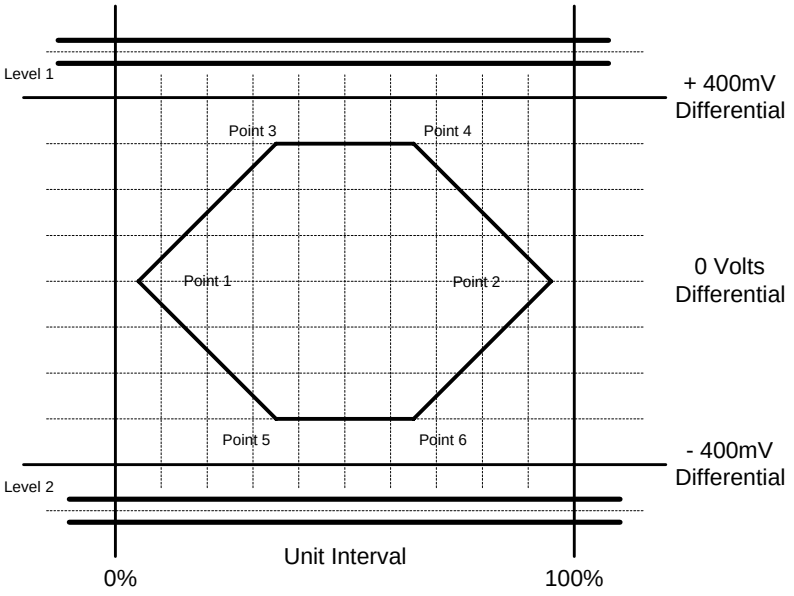
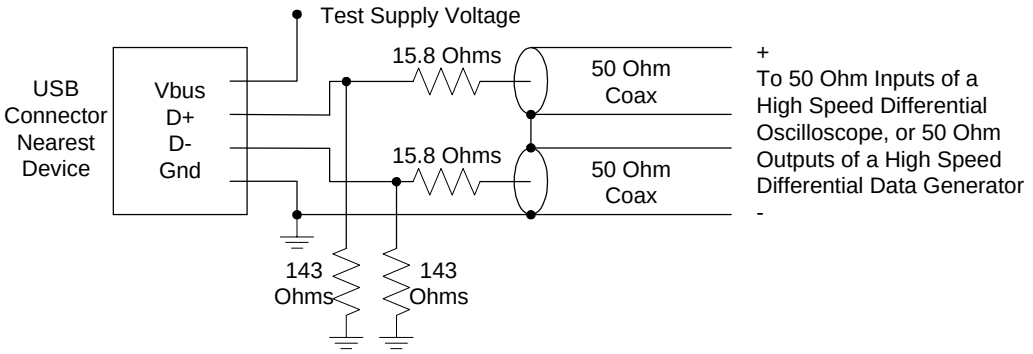


Figure 6-7 Transmitter Measurement Fixtures



7 Timing Diagram

7.1 Clock Output

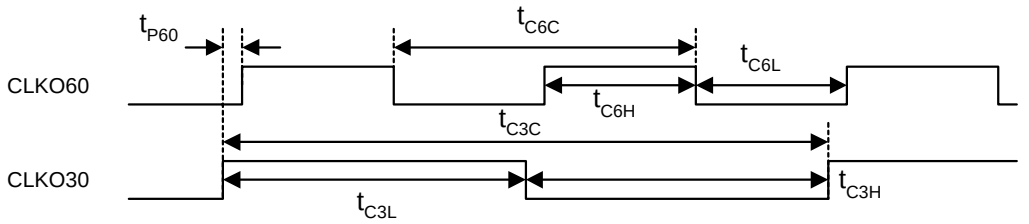


Figure 7-1 Clock output

7.2 Power-on and Connection Events

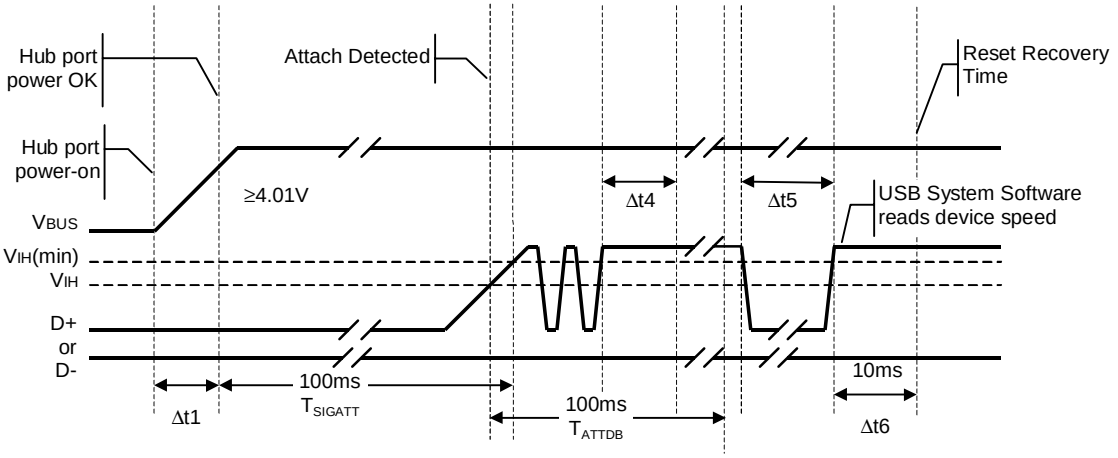


Figure 7-2 Power-on and Connection Events Timing

7.3 USB signals

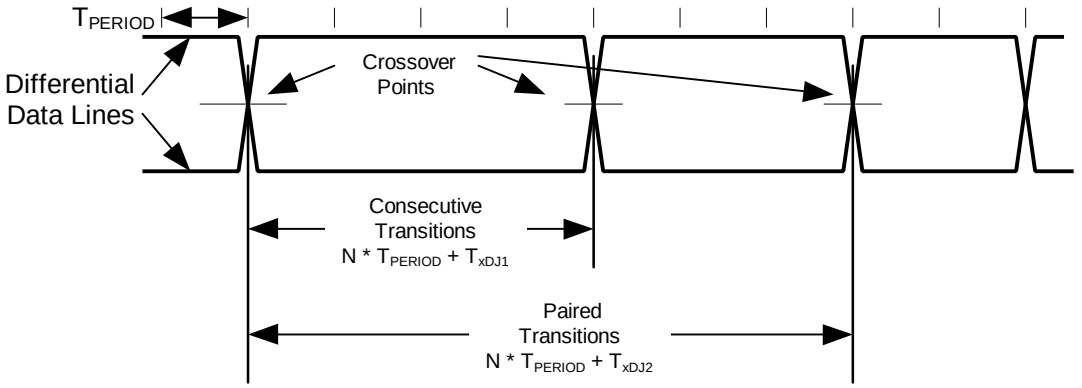


Figure 7-3 USB Differential Data Jitter for full-speed

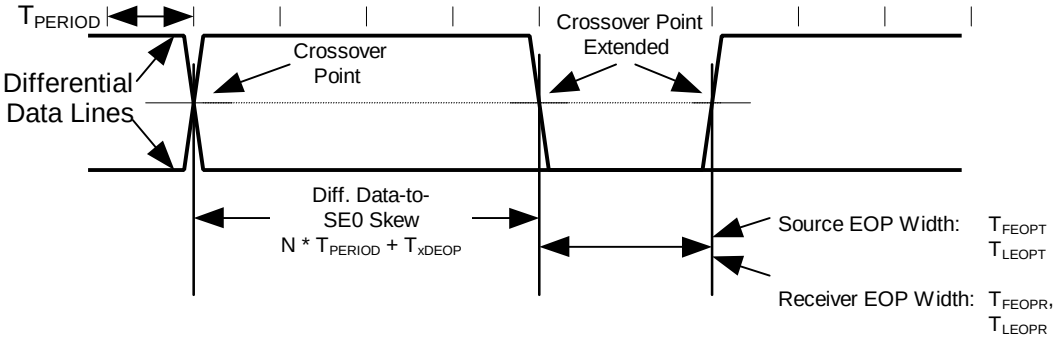


Figure 7-4 USB Differential-to-EOP Transition Skew an EOP width for full-speed

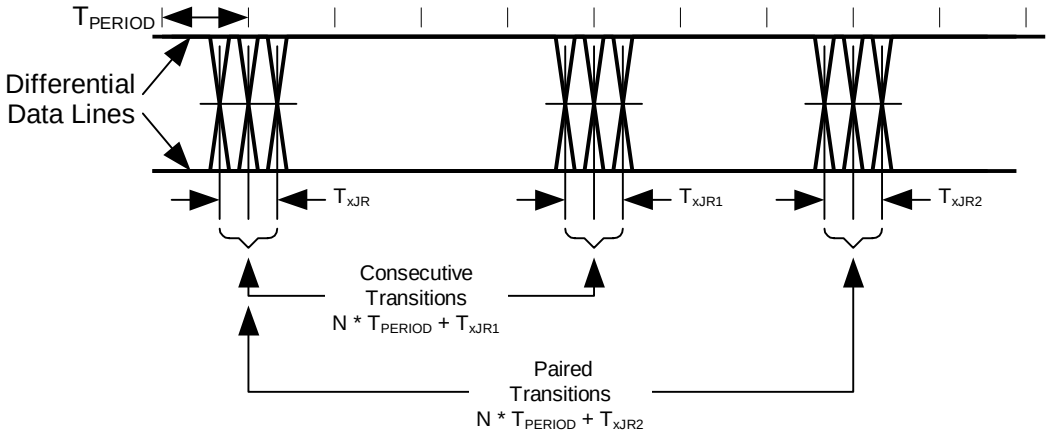
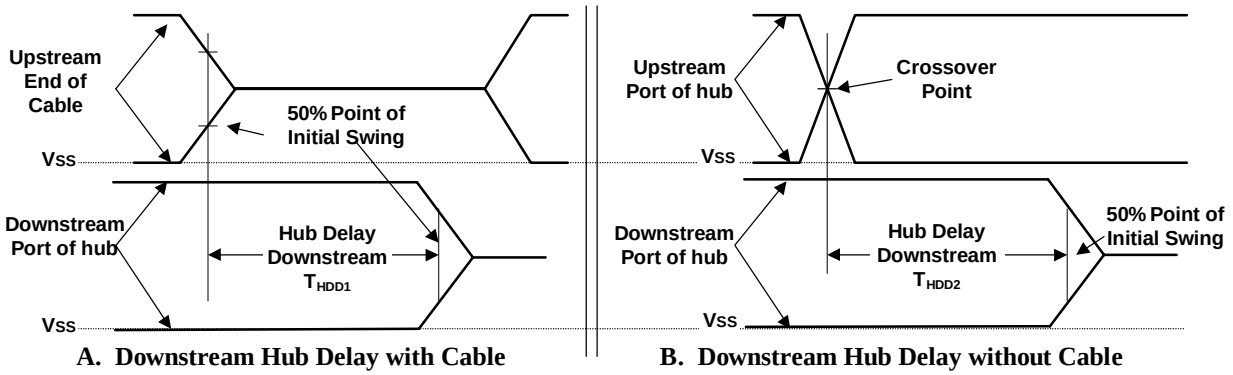
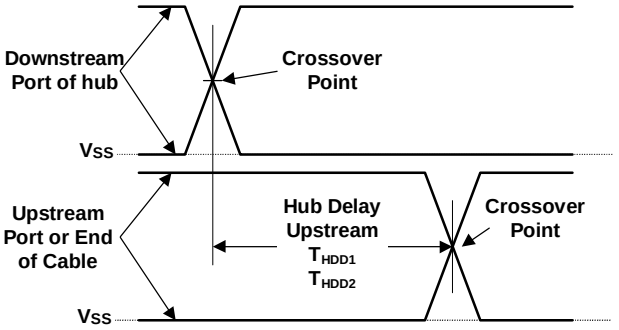


Figure 7-5 USB Receiver Jitter Tolerance for full-speed



A. Downstream Hub Delay with Cable

B. Downstream Hub Delay without Cable



C. Upstream Hub Delay with or without Cable

Hub Differential Jitter:

$T_{HDJ1} = T_{HDDx}(J) - T_{HDDx}(K)$ or $T_{HDDx}(K) - T_{HDDx}(J)$ Consecutive Transitions

$T_{HDJ2} = T_{HDDx}(J) - T_{HDDx}(J)$ or $T_{HDDx}(K) - T_{HDDx}(K)$ Paired Transitions

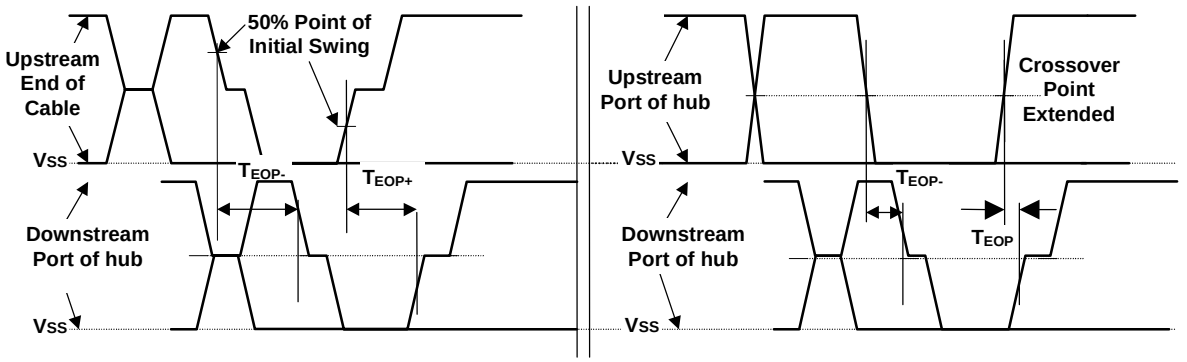
Bit after SOP Width Distortion (same as data jitter for SOP and next J transition):

$T_{FSOP} = T_{HDDx}$(next J) - T_{HDDx}(SOP)

Low-speed timings are determined in the same way for:

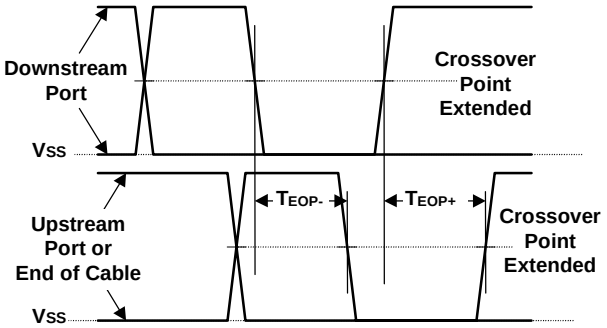
T_{LHDD}, T_{LDHJ1}, T_{LDJH2}, T_{LUHJ1}, T_{LUJH2}, and T_{LSOP}

Figure 7-6 Hub Differential Delay, Differential Jitter, and SOP Distortion



A. Downstream EOP Delay with Cable

B. Downstream EOP Delay without Cable



C. Upstream EOP Delay with or Without Cable

EOP Delay:

$T_{FEOPD} = T_{EOPy} - T_{HDDx}$
(T_{EOPy} means that this equation applies to T_{EOP-} **and** T_{EOP+})

EOP Skew:

$T_{FHESK} = T_{EOP+} - T_{EOP-}$

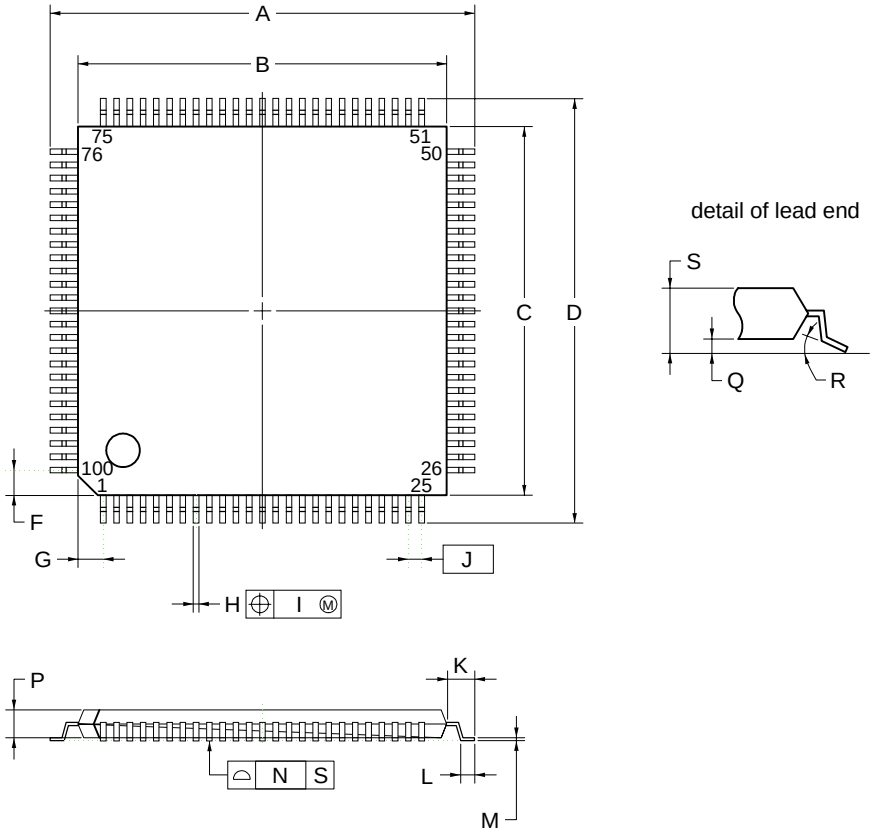
Low-speed timings are determined in the same way for:

T_{LEOPD} **and** T_{LHESK}

Figure 7-7 Hub EOP Delay and EOP Skew

8 Package Drawing

100-PIN PLASTIC TQFP (FINE PITCH) (14x14)



NOTE

Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	16.0±0.2
B	14.0±0.2
C	14.0±0.2
D	16.0±0.2
F	1.0
G	1.0
H	$0.22^{+0.05}_{-0.04}$
I	0.10
J	0.5 (T.P.)
K	1.0±0.2
L	0.5±0.2
M	$0.145^{+0.055}_{-0.045}$
N	0.10
P	1.0±0.1
Q	0.1±0.05
R 3	$^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$
S	1.27 MAX.

S100GC-50-9EU-2

NOTES FOR CMOS DEVICES

1. PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once,

when it has occurred Environmental control must be adequate. When it is dry, humidifiers should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

2. HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently that Bipolar or NMOS devices. Input levels of CMOS device must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specification governing the devices.

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NEC devices are classified into the following three quality grades:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books.

If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.