

### Features

- Single 5V operation
- Low power
- Status report capability
- Single IEEE-1284 compatible printer port
- Software programmable printer mode selects
- Microsoft compatible
- Internal power-on reset
- 2KV in-circuit ESD protection for lower cost of external components
- Operation over the extended USB bus voltage range (4.0 to 5.5V)
- Available in 48-pin QFP package

### Applications

- Monitoring equipment
- Printer server
- Portable backup units
- Printer interface

### Ordering Information

#### Commercial Grade

MCS7705CQ	48-QFP	0° C to +70° C
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### General Description

The MCS7705 controller provides bridging between the Universal Serial Bus (USB) input and an IEEE-1284 bi-directional parallel port. This device contains all the necessary logic to communicate with the host computer via the USB bus.

In addition, the MCS7705 contains a 3.3V regulator and operates in bus-powered mode.

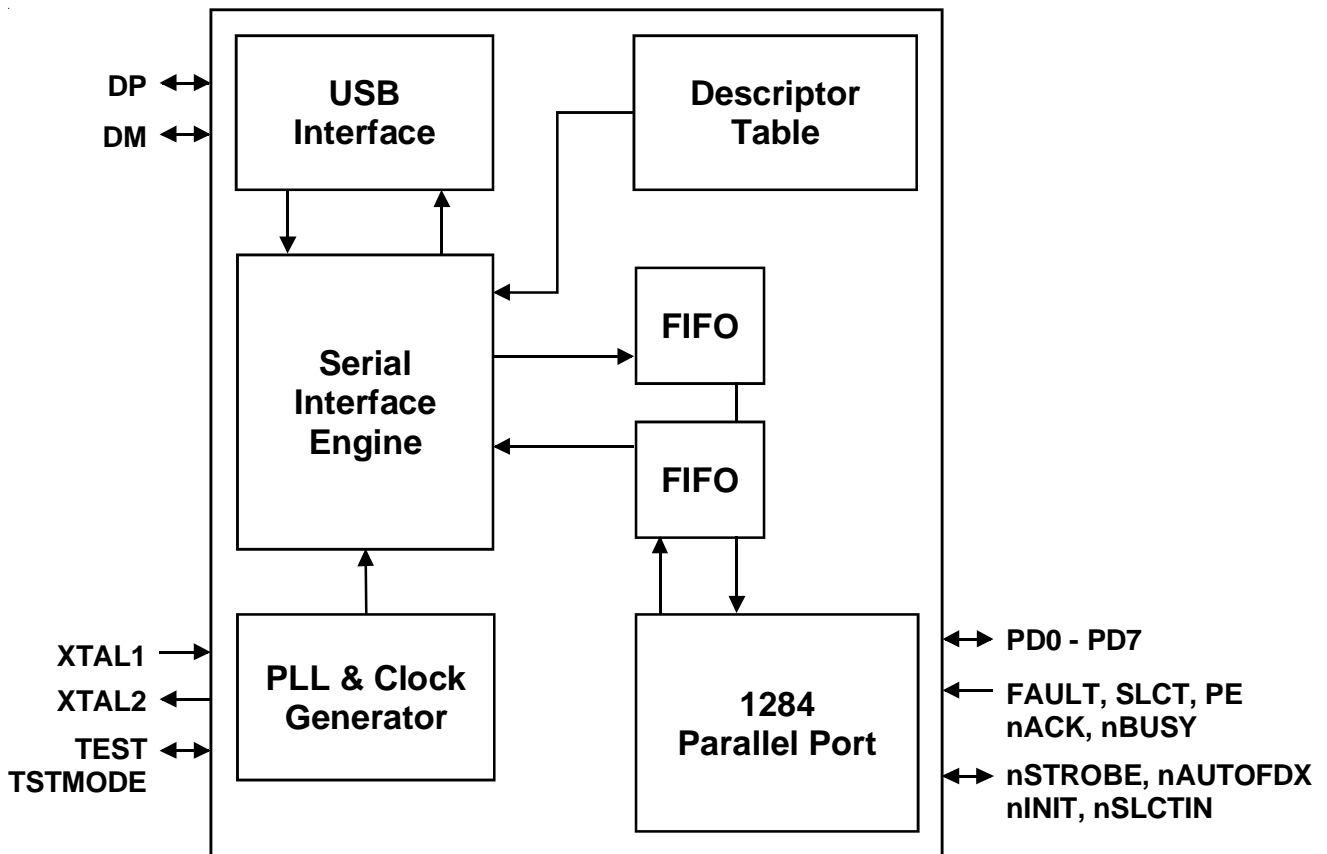
The MCS7705 has a reduced frequency (6MHz) crystal oscillator. This combination of features allows significant cost savings in system design along with straightforward implementation of serial port functionality into PC peripherals using the host's USB port.

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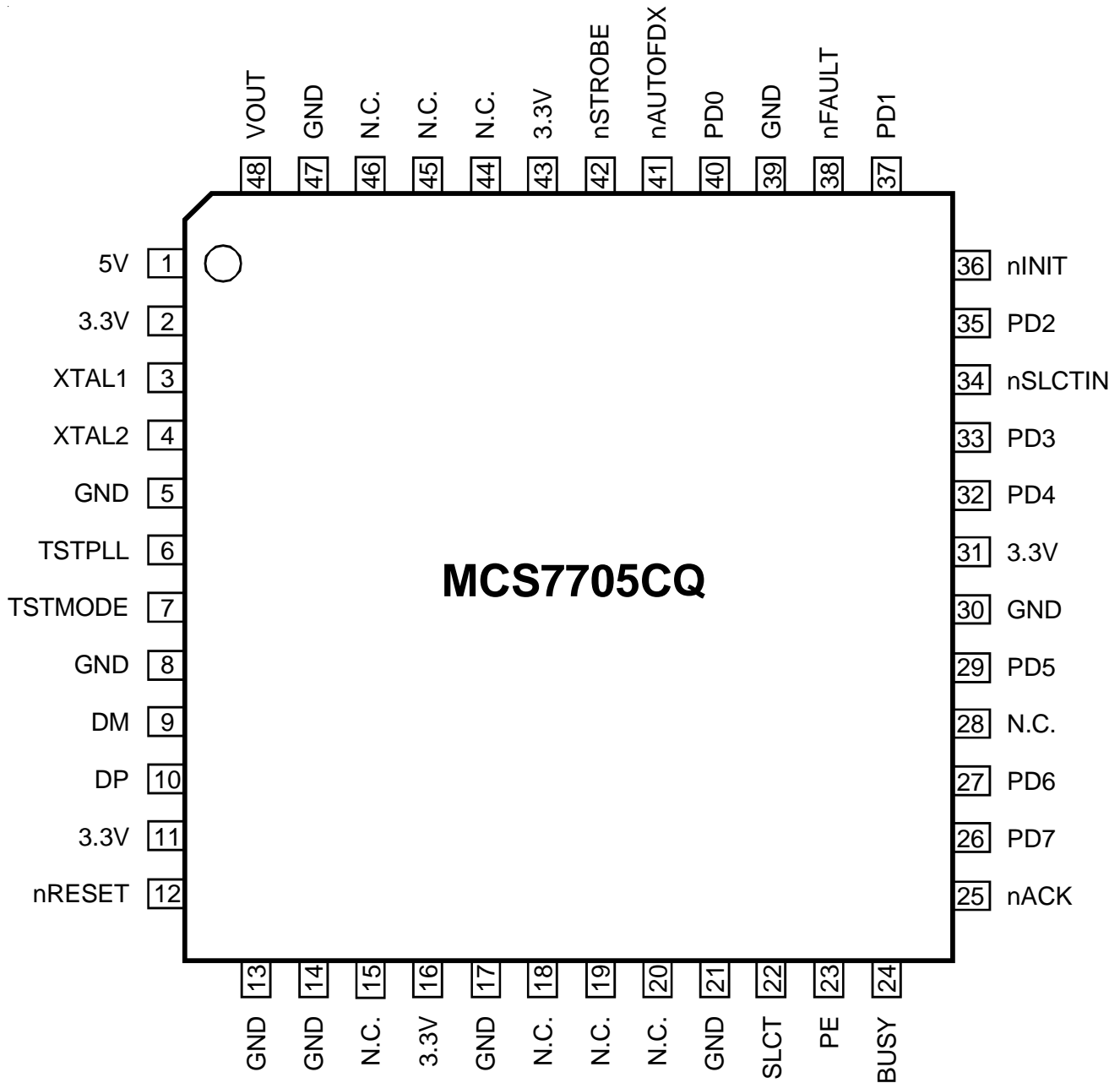
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MCS7705 Block Diagram



48-Pin QFP Package



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Pin Name	Pin	Type	Description
XTAL1	3	I	Crystal oscillator input or external clock input pin (6MHz). This signal input is used in conjunction with XTAL2 to form a feedback circuit for the internal timing. Two external capacitors (10pF) connected from each side of the XTAL1 and XTAL2 to GND are required to form a crystal oscillator
XTAL2	4	O	Crystal oscillator output. See XTAL1 description.
TSTPLL	6	I	Test mode (active low, internal pull-up) input. When this pin is tied to GND, the internal PLL is bypassed and external 48MHz clock is used as reference clock.
TSTMODE	7	I	Internal test mode (internal pull-up). When this pin is tied to GND, the internal test mode is enabled.
DM	9	I/O	Upstream USB port differential data minus (D-), analog.
DP	10	I/O	Upstream USB port differential data plus (D+), analog.
nRESET	12	I	System reset. Resets all internal register, sequencers, and signals to a consistent state. Connect to 5V pin for power-on reset to use the internal reset circuit.
SLCT	22	I	Peripheral/printer selected (internal pull-up). This pin is set to high by peripheral/printer when it is selected.
PE	23	I	Paper empty (internal pull-up). This pin is set to high by peripheral/printer when printer paper is empty.
BUSY	24	I	Peripheral/printer busy (internal pull-up). This pin is set to high by peripheral/printer, when printer or peripheral is not ready to accept data.
nACK	25	I	Peripheral/printer data acknowledge (internal pull-up). This pin is set to low by peripheral/printer to indicate a successful data transfer has taken place.
PD7	26	I/O	Parallel port data bit 7.
PD6	27	I/O	Parallel port data bit 6.
PD5	29	I/O	Parallel port data bit 5.
PD4	32	I/O	Parallel port data bit 4.
PD3	33	I/O	Parallel port data bit 3.
nSLCTIN	34	I/O	Peripheral/printer select (open-drain). Selects the peripheral/printer when it is set to low.
PD2	35	I/O	Parallel port data bit 2.
nINIT	36	I/O	Initialize the peripheral/printer (open drain). When set to low, peripheral/printer starts it's initialization routine.
PD1	37	I/O	Parallel port data bit 1.
nFAULT	38	I	Peripheral/printer data error (internal pull-up). This pin is set to low by peripheral/printer during error condition.
PD0	40	I/O	Parallel port data bit 0.

Pin Name	Pin	Type	Description
nAUTOFDX	41	I/O	Peripheral/printer auto feed (open-drain). Continuous autofed paper is selected when this pin is set to low.
nSTROBE	42	I/O	Peripheral/printer data strobe (open drain). On the rising edge of the nSTROBE, data is latched into printer port.
VOUT	48	PWR	+3.3V Voltage regulator output.
GND	5, 8, 13, 14, 17 21, 30, 39, 47	PWR	Power and signal ground.
3.3V	2, 11, 16 31, 43	PWR	Device supply input. All should be connected to VOUT pin. VOUT voltage is gated by nRESET.
5V	1	PWR	Main power input. Connect to USB VBUS or local VDD.

Note: All names with “n” prefix are active low.

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### USB Description

#### General

The MCS7705 acts as a USB hub until a device is connected to one of its serial ports. At that time the serial port appears in the system. All standard USB requests received from the host are processed on-board without the need of firmware intervention. The MCS7705 supports bus-powered operation only.

#### Analog Transceivers

The on-chip transceivers are connected directly to USB cables through external series resistors. They transmit and receive serial data at both full-speed (12Mbit/s) and low-speed (1.5Mbit/s) data rates. Slew rates are automatically adjusted according to the speed of the device connected and lie within the range defined in the *USB Specification Rev. 1.1*.

#### Serial Interface Engine

This engine implements the complete USB protocol layer including: serial conversion, synchronization pattern recognition, CRC checking/generation, bit (de)stuffing, packet identifier (PID) verification/generation, address recognition and handshake evaluation/generation.

#### Bit clock recovery

The bit clock recovery circuit recovers the clock from the incoming USB data stream using 4X over sampling. It is able to track in the presence of jitter and frequency drift as specified by the *USB Specification Rev. 1.1*.

#### 3.3V source

A 5V to 3.3V DC-DC regulator is integral to the chip relieving the need for a +3.3V source. It supplies the analog transceivers and internal logic and can be used to supply the 1.5k $\Omega$  pull-up resistor on the DP line of the upstream connection.

#### PLL clock multiplier

An integral Phase-Locked Loop (PLL) performs 6 to 48MHz clock multiplication and requires no external components except the crystal. This allows for the use of low-cost 6MHz crystals which reduces high frequency radiated Electro-Magnetic Interference (EMI).

#### Endpoint descriptions

##### General

The MCS7705 has two endpoints; Endpoint 0 (control) and Endpoint 1 (interrupt) described in this table:

Function	Ports	Endpoint Identifier	Transfer Type	Direction (to/from host)	Max. Packet Size (bytes)
Hub	0: upstream 1: downstream	0	control	OUT	8
		1	interrupt	IN	8
				IN	1

### Hub control endpoint 0

Endpoint 0 is used by the host to configure the device and to perform generic USB status and control access. The MCS7705 hub supports these USB descriptor information through its control endpoint 0, which can handle transfers of 8 bytes maximum:

- Device descriptor
- Configuration descriptor
- Interface descriptor
- Endpoint descriptor
- Hub descriptor

### Hub interrupt endpoint 1

Endpoint 1 is used by the MCS7705 hub to provide status change information to the host. This endpoint can be accessed only by sending the Set Configuration command after the hub has been configured by the host. The host polls it once every 255ms by sending an IN token. If the hub has detected no change in the port status it returns a NAK (Not Acknowledge) response to this request, otherwise it sends the Status Change byte defined in the following table:

Bit	Symbol	Description
0	Hub SC	a logic 1 indicates a status change on the hub's upstream port
1	Port 1 SC	a logic 1 indicates a status change on downstream port 1, this port is used to connect to the on-board serial devices.
2	reserved	not used
3	reserved	not used
4	reserved	not used
5	reserved	not used
6	reserved	not used
7	reserved	not used

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## Host Requests

The MCS7705 handles all standard USB requests from the host via control endpoint 0. The control endpoint can handle a maximum of 8 bytes per transfer.

## Host Requests

This table shows the supported standard USB requests. Some are unsupported. All others will receive a response with a STALL packet.

**Note:** the USB data transmission order is Least Significant Bit (LSB) first. In the following tables multi-byte variables are displayed least significant byte first.

**Table 1: Standard USB Requests**

Request Name	bmRequestType Byte 0 [7:0] (bin)	bRequest byte 1 (hex)	wValue byte 2, 3 (hex)	wIndex byte 4, 5 (hex)	wLength byte 6, 7 (hex)	Data
<b>Address</b> Set Address	X000 0000	05	address**	00,00	00,00	none
<b>Configuration</b> Get Configuration	1000 0000	08	00,00	00,00	01,00	configuration value = 01H
Set Configuration0	X000 0000	09	00,00	00,00	00,00	none
Set Configuration1	X000 0000	09	01,00	00,00	00,00	none
<b>Descriptor</b> Get Configuration Descriptor	1000 0000	06	00,02	00,00	length***	configuration interface and endpoint descriptors
Get Device Descriptor	1000 0000	06	00,01	00,00	length***	device descriptor
<b>Feature</b> Clear Feature (REMOTE_WAKEUP)	X000 0000	01	01,00	00,00	00,00	none
Clear Endpoint (1) Feature (HALT/STALL)	X000 0010	01	00,00	81,00	00,00	none
<b>Status</b> Get Device Status	1000 0000	00	00,00	00,00	02,00	device status
Get Interface Status	1000 0001	00	00,00	00,00	02,00	zero
Get Endpoint (0) Status	1000 0010	00	00,00	00/80,00*	02,00	endpoint 0 status
Get Endpoint (1) Status	1000 0010	00	00,00	81,00	02,00	endpoint 1 status
<b>Unsupported</b> Set Descriptor	0000 0000	07	XX,XX	XX,XX	XX,XX	descriptor STALL
Get Interface	1000 0001	0A	00,00	XX,XX	01,00	STALL
Set Interface	X000 0001	0B	XX,XX	XX,XX	00,00	STALL
Sync Frame	1000 0010	0C	00,00	XX,XX	02,00	STALL

\* The MSB specifies endpoint direction: 0 = OUT, 1 = IN. Either value is accepted.

\*\* Device address: 0 to 127

\*\*\* Returned value in bytes

### Hub Specific Requests

In this table, the supported hub specific requests are listed. Some unsupported requests are shown also to show responses if they are made.

**Table 2: Hub Requests**

Request Name	bmRequestType Byte 0 [7:0] (bin)	bRequest byte 1 (hex)	wValue byte 2, 3 (hex)	wIndex byte 4, 5 (hex)	wLength byte 6, 7 (hex)	Data
<b>Descriptor</b> Get Hub Descriptor	1010 0000	06	00,00/29*	00,00	length,00	hub descriptor length=bytes
<b>Feature</b> Clear Hub Feature (C_LOCAL_POWER)	X010 0000	01	00,00	00,00	00,00	none
Clear Port Feature (feature selectors)	X010 0011	01	feature,00	port**,00	00,00	none feature see next table
Set Port Feature (feature selectors)	x010 0011	03	feature,00	port**,00	00,00	none feature see next table
<b>Status</b> Get Hub Status	1010 0000	00	00,00	00,00	04,00	hub status and status change field
Get Port Status	1010 0011	00	00,00	port**,00	04,00	port status
<b>Unsupported</b> Get Bus Status	1010 0011	02	00,00	port**,00	01,00	STALL
Clear Hub Feature (C_OVER_CURRENT)	X010 0000	01	01,00	00,00	00,00	STALL
Set Hub Descriptor	0010 0000	07	XX,XX	00,00	3E,00	STALL
Set Hub Feature (C_LOCAL_POWER)	X010 0000	03	00,00	00,00	00,00	STALL
Set Hub Feature	X010 0000	03	01,00	00,00	00,00	STALL

\* USB 1.0 specifies 00H; USB 1.1 specifies 29H

\*\* Downstream port identifier: 1

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**Table 3: Port Feature Selectors**

Feature Selector Name	Value (hex)	Set Feature	Clear Feature
PORT_CONNECTION	00	not used	not used
PORT_ENABLE	01	not used	disables port
PORT_SUSPEND	02	suspends port	resumes port
PORT_OVERCURRENT	03	not used	not used
PORT_RESET	04	resets and enables port	not used
PORT_POWER	08	power up port	power down port
PORT_LOW_SPEED	09	not used	not used
C_PORT_CONNECTION	10	not used	clears port connection change bit
C_PORT_ENABLE	11	not used	clears port enable bit
C_PORT_SUSPEND	12	not used	clears port suspend change bit
C_PORT_OVERCURRENT	13	not used	clears port overcurrent change bit
C_PORT_RESET	14	not used	clears port reset change bit

## Descriptors

The MCS7705 hub controller supports these standard USB descriptors:

- Device
- Configuration
- Interface
- Endpoint
- Hub

**Table 4: Device Descriptors**

Offset (bytes)	Field Name	Size (bytes)	Value (hex)	Comments
0	bLength	1	12	descriptor length = 18 bytes
1	bDescriptorType	1	01	type = DEVICE
2	bcdUSB	2	10,01	USB Specification Rev. 1.1
4	bDeviceClass	1	09	HUB_CLASSCODE
5	bDeviceSubClass	1	00	n/a
6	bDeviceProtocol	1	00	n/a
7	bMaxPacketSize0	1	08	packet size = 8 bytes
8	idVendor	2	10,97	the MosChip vendor ID (9710)
10	idProduct	2	05,77	the MCS7705 product ID
12	bcdDevice	2	01,01	device release 1.1; this value represents the silicon rev.
14	iManufacturer	1	00	no manufacturer string
15	iProduct	1	00	no product string
16	iSerialNumber	1	00	no serial number string
17	bNumConfigurations	1	01	one configuration

**Table 5: Configuration Descriptors**

Offset (bytes)	Field Name	Size (bytes)	Value (hex)	Comments
0	bLength	1	09	descriptor length = 9 bytes
1	bDescriptorType	1	02	type – CONFIGURATION
2	wTotalLength	2	22,00	total length of configuration, interface, endpoint descriptors and hub descriptors (34 bytes)
4	bNumInterfaces	1	01	one interface
5	bConfiguration	1	01	configuration value = 1
6	iConfiguration	1	00	no configuration string
7	bmAttributes	1	E0	not supported
8	MaxPower	1	A0	bus-powered with remote wake-up
			32	100mA default

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**Table 6: Interface Descriptors**

Offset (bytes)	Field Name	Size (bytes)	Value (hex)	Comments
0	bLength	1	09	descriptor length = 9 bytes
1	bDescriptorType	1	04	type = INTERFACE
2	bInterfaceNumber	1	00	n/a
3	bAlternateSetting	1	01	no alternate setting
4	bNumEndpoints	1	01	status change (interrupt) endpoint
5	bInterfaceClass	1	09	HUB_CLASSCODE
6	bInterfaceSubClass	1	00	n/a
7	bInterfaceProtocol	1	00	no class-specific protocol
8	bInterface	1	00	no interface string

**Table 7: Endpoint Descriptors**

Offset (bytes)	Field Name	Size (bytes)	Value (hex)	Comments
0	bLength	1	07	descriptor length = 7 bytes
1	bDescriptorType	1	05	type = ENDPOINT
2	bEndpointAddress	1	81	endpoint1, direction: IN
3	bmAddress	1	03	interrupt endpoint
4	wMaxPacketSize	2	01,00	packet size = 1 byte
6	bInterval	1	FF	polling interval (255ms)

**Table 8: Hub Descriptors**

Offset (bytes)	Field Name	Size (bytes)	Value (hex)	Comments
0	bDescLength	1	09	descriptor length = 9 bytes
1	bDescriptorType	1	29	type = HUB
2	bNbrPorts	1	04	number of active ports
3	wHubCharacteristics	2	09,00	individual power switching**, over current protection active
			00,00	reserved
5	bPwrOn2PwrGood	1	32	100ms
6	bHubContrCurrent	1	64	maximum hub controller current (100mA)
7	DeviceRemovable	1	02	non-removable device on port 1
8	PortPwrCtrlMask	1	1E	n/a

\*\* Power management status reported on an individual basis, compliant with *USB Specification Rev. 1.1*

## Hub Responses

This section defines the hub responses caused by USB host requests.

### Get Device Status

The hub returns two (2) bytes for this request.

**Table 9: Get Device Status Responses**

Bit #	Function	Value	Description
0	power	0 1	bus-powered not supported
1	remote wake-up	0 1	no remote wake-up remote wake-up enabled
2-15	reserved		

### Get Configuration

The hub returns a single (1) byte for this request.

**Table 10: Get Configuration Responses**

Bit #	Function	Value	Description
0	configuration value	0 1	device not configured device configured
1-7	reserved		

### Get Interface Status

The hub returns two (2) bytes for this request.

**Table 11: Get Interface Status Responses**

Bit #	Function	Value	Description
0-15	reserved	0	n/a

### Get Port Status

The hub returns four (4) bytes for this request. The first two bytes contain the port status bits (wPortStatus). The last two bytes contain the port status change bits (wPortChange). See each in the tables below.

**Table 12: Get Port Status Responses (wPortStatus)**

Bit #	Function	Value	Description
0	current connect status	0	no device present
		1	device present on this port
1	port enabled/disabled	0	port disabled
		1	port enabled
2	suspend	0	port not suspended
		1	port suspended
3	over current indicator	0	no over current condition
		1	over current condition detected
4	reset	0	reset not asserted
		1	reset asserted
5-7	reserved	0	n/a
8	port power	0	port powered off
		1	port power is on
9	speed of dev attached	0	full-speed device attached
		1	low-speed device attached
10-15	reserved	0	n/a

**Table 13: Get Port Status Responses (wPortChange)**

Bit #	Function	Value	Description
0	connect status change	0	no change in current connect status
		1	current connect status changed
1	port enabled/disabled change	0	no port error
		1	port disabled by a port error
2	suspend change	0	no change in suspend status
		1	resume complete
3	over current indicator change	0	no change in over current status
		1	over current indicator changed
4	reset change	0	no change in reset status
		1	reset complete
5-15	reserved	0	n/a

### Get Configuration Descriptor

The hub returns 34 bytes containing the configuration descriptor (9 bytes, see table 5), the interface descriptor (9 bytes, see table 6), the endpoint descriptor (7 bytes, see table 7) and hub descriptor (9 bytes, see table 8).

### Get Device Descriptor

The hub returns 18 bytes containing the device descriptor, see table 4.

### Get Hub Descriptor

The hub returns 9 bytes containing the hub descriptor, see table 8.

### Hub Power Mode

USB hubs are bus-powered.

**Bus-powered** — Bus-powered hubs obtain all power from the host or an upstream self-powered hub. The maximum current is 100mA per downstream port. Current limiting and reporting of overcurrent conditions are both optional.

### Voltage Drop Requirements

#### Bus-powered Hubs

Bus-powered hubs are guaranteed to receive a supply voltage of 4.5V at the upstream port connector.

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## Parallel Port Description

### Parallel Port Register Description

#### Data Register

Data register is cleared at initialization by RESET. During a write operation, the Data register latches the contents of the data bus with the rising edge of the nIOW input. The contents of this register are buffered and output onto the PD7-PD0 ports. During a read operation PD7-PD0 ports are buffered and output to the host CPU on the falling edge of the nIOR input.

#### Device Status Register

The contents of this register are latched for the duration of an nIOR cycle. The bits of the status port are defined as follows.

#### DSR Bit-0:

0 = Normal.

1 = 10 $\mu$ s timeout (EPP mode only). Cleared by writing 1 into DSR register or consecutive reads (after the first read) always returns "0".

#### DSR Bit-1:

Not used, set to "0".

#### DSR Bit-2:

0 = nACK input pin is at low state (INT follows the nACK pin), when SPP mode is selected. Normal (no interrupt) when PS/2 mode is selected.

1 = Normal (no interrupt). In standard mode operation, INT is active (interrupt is generated on the rising edge of the nACK). It is cleared when DSR is read.

#### DSR Bit-3:

0 = Printer reports error condition.

1 = Normal operation.

#### DSR Bit-4:

0 = Printer is off line.

1 = Printer is on line.

#### DSR Bit-5:

0 = Normal operation

1 = Paper end/empty is detected

#### DSR Bit-6:

0 = State of the nACK pin (ACK = low).

1 = State of the nACK pin (ACK = high).

#### DSR Bit-7:

0 = nBUSY pin is high, printer is not ready to take data.

1 = nBUSY pin is low, printer is read to take data.

### Device Control Register

#### DCR Bit-0:

0 = Sets the nSTROBE pin to high.

1 = Sets the nSTROBE pin to low. PD7-PD0 data are latched into printer

#### DCR Bit-1:

0 = Sets the nAUTOFD pin to high. Printer generates auto line feed after each line is printed.

1 = Sets the nAUTOFD pin to low. No auto feed function.

#### DCR Bit-2:

0 = Sets the INIT pin to high.

1 = Sets the INIT pin to low. Peripheral/printer starts its initialization routine.

#### DCR Bit-3:

0 = Sets the nSLCTIN pin to high. Selects the printer.

1 = Sets the nSLCTIN pin to low. Printer is not selected.

#### DCR Bit-4:

0 = Disables printer interrupt function. nACK pin has no effect on the INT pin.

1 = Enables printer interrupt function. The INT follows the nACK input pin during standard mode, latches high on the rising edge of the nACK, when PS/2 mode is selected.

#### DCR Bit-5:

0 = PD7-PD0 pins are output mode.

1 = PD7-PD0 pins are input mode.

#### DCR Bits 7-6:

Not used, set to "0".

### Config-A Register

Configuration A register (read only). Reading this regis-

ter returns 10010100. Writing to this register has no effect and the data is ignored.

### Config-B Register

Configuration B register. This register allows software to control the selecting of interrupts. A read-write implementation implies a “software-configurable” device. Reading this register returns the configured interrupt and interrupt pin state. If a value is not set to 000 (the jumper-default) then it is assumed that the value in the register is correct and software will use the default interrupt.

#### Config-B Bit-7:

Not used, set to “0”.

#### Config-B Bit-6:

0 = Configured printer interrupt pin is low.  
1 = Configured printer interrupt pin is high.

#### Config-B Bit 7-0:

Interrupt pin select register.

### Extended Control Register (ECR)

This register controls the mode selection and DMA operation.

Bit-7	Bit-6	Bit-5	Operating Mode
0	0	0	SPP
0	0	1	PS/2
0	1	0	PPF (FIFO mode)
0	1	1	ECP
1	0	0	EPP
1	0	1	Not used
1	1	0	FIFO test
1	1	1	Config A/B enable

### Mode changes

After hardware reset, PS/2 mode is selected as default mode. It is required to select mode 000 or 001 between any other mode configuration.

### Mode “000”

#### SPP/Centronics/Compatible Mode

Forward direction only. The direction bit is forced to “0” and PD7-PD0 are set to output direction. The MCS7717 is under software control. This mode defines the protocol used by most PCs to transfer data to a printer. It is commonly called the “Centronics” mode and is the method utilized with the standard parallel port. Data is placed on the PD7-PD0 port, the printer status is checked via DSR register. If no error condition is flagged and printer is not busy, software toggles the nSTROBE pin to latch the PD7-PD0 data into printer. This operating cycle continues when printer/peripheral issues data acknowledge signal (pulses the ACK and nBUSY pin).

#### Nibble Mode

The nibble mode is the most common way to get reverse channel data from a printer or peripheral. This mode is usually combined with the Centronics mode or a proprietary forward channel mode to create a bi-directional channel. In this mode printer status bits are used as nibble bits.

#### Bits order for nibble mode

Pins	Data Bits
nBUSY	Bit-7
PE	Bit-6
SLCT	Bit-5
nFAULT	Bit-4
nBUSY	Bit-3
PE	Bit-2
SLCT	Bit-1
nFAULT	Bit-0

### Mode “001”

#### PS/2, Byte Mode

The byte mode protocol is used to transfer bi-directional data via PD7-PD0 ports without FIFO utilization. The direction of the port is controlled with DIR bit in DCR register. PS/2-byte use SPP protocol for data transfer.

#### DCR Bit-5:

0 = PD7-PD0 pins are out put mode.  
1 = PD7-PD0 pins are input mode.

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## Mode “010”

### FIFO output Mode

In this mode, bytes written to the FIFO are transmitted automatically using the SPP/Centronics standard protocol.

## Mode “011”

### Extended Capability Port “ECP” Mode

The ECP provides an advanced mode for communication with printer or peripherals. Like EPP protocol, ECP provides 16 byte FIFO for a high performance bi-directional communication path between the host adapter and the peripheral. The ECP protocol provides the following cycle types in both the forward and reverse direction.

- Data cycle
- Command cycles
- Run-Length counts (RLE)
- Channel address

The RLE feature enables real time data compression that can achieve compression ratios up to 64:1. This is particularly useful for printers and peripherals that are transferring large raster images that have large strings of identical data. In order for the RLE mode to be enabled, both the host and peripheral must support it. Channel addressing is intended to address multiple logical devices within single physical device like Modem/FAX/Printer in one physical package.

## Mode “100”

### Enhanced Parallel Port “EPP” Mode

In EPP mode, nSLCTIN (address strobe) and nAUTOFD (data strobe) are automatically generated while nSTROBE indicates a write or read cycle. Additional I/O addresses are defined for data and address access and when these locations are used, handshaking is performed automatically.

## Mode “110”

### FIFO test Mode

In this mode, the FIFO can be written and read in any direction, but no data will be transmitted on the PD7-PD0 ports. Whatever, data is in the FIFO may be displayed on the PD7-PD0 ports.

## ECR Bit-4:

Error Interrupt Enable.

0 = Enables nFAULT interrupt. nFAULT pin is used as source of interrupt.

1 = Disables nFAULT interrupt (nACK is used as source of interrupt).

## ECR Bit-3:

0 = normal operating mode.

## ECR Bit-2:

1 = Disables service interrupt.

0 = Enables one of the following 3 cases of interrupts. One of the 3 service interrupts has occurred, service interrupt bit will be set to a “1” by hardware. Writing this bit to a “1” will not cause an interrupt.

Port Direction (DCR Bit-5 = 0), this bit will be set to “1” whenever there are write interrupt threshold (4 characters) or more bytes free in the FIFO. The chip generates an interrupt when this condition is occurred and service interrupt is cleared to “0”.

Port Direction (DCR Bit-5 = 1), this bit will be set to “1” whenever there are read interrupt threshold (12 characters) or more bytes to be read from the FIFO. The chip generates an interrupt when this condition is occurred and service interrupt is cleared to “0”.

## ECR Bit-1:

0 = One or more empty location in FIFO is available.

1 = FIFO full.

## ECR Bit-0:

0 = One or more data in FIFO.

1 = FIFO empty.

### Master rest conditions

Register	BIT-7	BIT-6	BIT-5	BIT-4	BIT-3	BIT-2	BIT-1	BIT-0
RHR	0	0	0	0	0	0	0	0
THR	X	X	X	X	X	X	X	X
IER	0	0	0	0	0	0	0	0
FCR	0	0	0	0	0	0	0	0
IIR	0	0	0	0	0	0	0	1
LCR	0	0	0	0	0	0	0	0
MCR	0	0	0	0	0	0	0	0
LSR	0	1	1	0	0	0	0	0
MSR	X	X	X	X	0	0	0	0
SPR	0	0	0	0	0	0	0	0
DPR	X	X	X	X	X	X	X	X
DSR	0	1	1	1	1	0	0	0
DCR	0	0	0	0	0	0	0	0
EPP	0	0	0	0	0	0	0	0
C-FIFO	0	0	0	0	0	0	0	0
CONF-A	1	0	0	1	0	1	0	0
CONF-B	0	X	0	0	0	0	0	0
ECR	0	0	0	0	0	0	0	1

### Absolute Maximum Ratings

Supply Voltage	6 Volts
Voltage at any pin	GND – 0.5 to VCC +0.5
Storage Temperature	-60° C to 150° C
Package Dissipation	95mW
Electrostatic Discharge Voltage (human body model; device only) (I <sub>L1</sub> < 1μA)**	±1500 Volts
Latch up current (V <sub>I</sub> < 0; or V <sub>I</sub> > V <sub>CC</sub> )	100mA

\*\* Equivalent to discharging a 100pF capacitor through a 1.5kΩ resistor

### Recommended Operating Conditions

Supply Voltage	4.0 to 5.5 Volts
Input Voltage (I/O)	0 to 5.5 Volts
Input Voltage to analog I/O pins (DP, DM)	0 to 3.6 Volts
Open Drain Output Pull-up Voltage	0 to 3.3 Volts
Ambient Operating Temperature (free air)	0° C to 70° C

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**Table 15: Static Characteristics – Supply Pins**

V<sub>CC</sub> = 4.0V to 5.5V; V<sub>GND</sub> = 0V; T<sub>amb</sub> = 0 to +70° C; unless otherwise specified

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V <sub>reg(3.3)</sub>	regulated supply voltage		3.0**	3.3	3.6	V
I <sub>CC</sub>	operating supply current		-	18	-	mA
I <sub>CC(susp)</sub>	suspend supply current	1.5kΩ pull-up on upstream port (DP)	-	-	270	μA
		no pull-up on upstream port (DP)	-	-	80	μA

\*\* In 'suspend' mode the minimum voltage is 2.7V.

**Table 16: Static Characteristics – Digital Pins**

V<sub>CC</sub> = 4.0V to 5.5V; V<sub>GND</sub> = 0V; T<sub>amb</sub> = 0 to +70° C; unless otherwise specified

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V <sub>IL</sub>	LOW Level Input Voltage		-	-	0.8	V
V <sub>IH</sub>	HIGH Level Input Voltage		2.0	-	-	V
V <sub>th(LH)</sub>	Positive-going Threshold Voltage		1.4	-	1.9	V
V <sub>th(HL)</sub>	Negative-going Threshold Voltage		0.9	-	1.5	V
V <sub>hys</sub>	Hysteresis Voltage		0.4	-	0.7	V
V <sub>OL</sub>	LOW Level Output Voltage (open drain outputs)	I <sub>oL</sub> = 6mA	-	-	0.4	V
		I <sub>oL</sub> = 20μA	-	-	0.1	V
I <sub>LI</sub>	Input Leakage Current		-	-	±1	μA
I <sub>oZ</sub>	OFF State Output Current		-	-	±1	μA

**Table 17: Static Characteristics – Analog I/O Pins (DP, DM)**

V<sub>CC</sub> = 4.0V to 5.5V; V<sub>GND</sub> = 0V; T<sub>amb</sub> = 0 to +70° C; unless otherwise specified

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V <sub>DI</sub>	differential input sensitivity	V <sub>I(D+)</sub> – V <sub>I(D-)</sub>	0.2	-	-	V
V <sub>CM</sub>	differential common mode voltage	includes V <sub>DI</sub> range	0.8	-	2.5	V
V <sub>IL</sub>	LOW Level Input Voltage		-	-	0.8	V
V <sub>IH</sub>	HIGH Level Input Voltage		2.0	-	-	V
V <sub>OL</sub>	LOW Level Output Voltage	R <sub>L</sub> = 1.5kΩ to 3.6V	-	-	0.3	V
V <sub>OH</sub>	HIGH Level Output Voltage	R <sub>L</sub> = 15kΩ to GND	2.8	-	3.6	V
I <sub>LZ</sub>	OFF-state leakage current		-	-	±10	μA
C <sub>IN</sub>	transceiver capacitance pin to GND		-	-	20	pF
Z <sub>DRV</sub> **	driver output impedance	steady-state drive	28	-	44	Ω
Z <sub>INP</sub>	input impedance		10	-	-	MΩ
V <sub>TERM</sub> ***	termination voltage for upstream port pull-up (RPU)		3.0****	-	3.6	V

\*\* Includes external resistors of 20Ω ±1% on both DP and DM.

\*\*\* This voltage is available at pin V<sub>reg(3.3)</sub>

\*\*\*\* In “suspend” mode the minimum voltage is 2.7V.

**Table 18: Dynamic Characteristics**

V<sub>CC</sub> = 4.0V to 5.5V; V<sub>GND</sub> = 0V; T<sub>amb</sub> = 0 to +70° C; unless otherwise specified

Symbol	Parameter	Condition	Min	Typ	Max	Unit
f <sub>XTAL</sub>	Crystal Frequency		-	6	-	MHz
t <sub>trip</sub>	overcurrent trip response time from nOCn LOW to nPSWn HIGH	see Figure 1**	-	-	15	ms

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**Table 19: Dynamic Characteristics – Analog I/O Pins (DP, DM); Full-speed Mode (Fig 9)**

V<sub>CC</sub> = 4.0V to 5.5V; V<sub>GND</sub> = 0V; T<sub>amb</sub> = 0 to +70° C; unless otherwise specified

Symbol	Parameter	Condition	Min	Typ	Max	Unit
T <sub>FR</sub>	rise time	C <sub>L</sub> = 50pF; 10 to 90% of   V <sub>OH</sub> - V <sub>OL</sub>	4	-	20	ns
t <sub>FF</sub>	fall time	C <sub>L</sub> = 50pF; 10 to 90% of   V <sub>OH</sub> - V <sub>OL</sub>	4	-	20	ns
FRFM	differential rise/fall time matching (t <sub>FR</sub> /t <sub>FF</sub> )		* 90	-	111.11	%
V <sub>CRS</sub>	output signal crossover voltage		*,** 1.3	-	2.0	V
t <sub>DJ1</sub>	source differential jitter for consecutive transitions	see Figure 2	*,** -3.5	-	+3.5	ns
t <sub>DJ2</sub>	source differential jitter for paired transitions	see Figure 2	*,** -4	-	+4	ns
t <sub>FEOPT</sub>	source EOP width	see Figure 3	** 160	-	175	ns
t <sub>FDEOP</sub>	source differential data-to-EOP transition skew	see Figure 3	** -2	-	+5	ns
t <sub>JR1</sub>	receiver data jitter tolerance for consecutive transitions	see Figure 4	** -18.5	-	+18.5	ns
t <sub>JR2</sub>	receiver data jitter tolerance for paired transitions	see Figure 4	** -9	-	+9	ns
t <sub>FEOPR</sub>	receiver SE0 width	accepted as EOP; see Figure 3	** 82	-	-	ns
t <sub>FST</sub>	width of SE0 during differential transition	rejected as EOP; see Figure 5	** -	-	14	ns
t <sub>FHDD</sub>	hub differential data delay (without cable)	see Figure 6; C <sub>L</sub> = 0pF	** -	-	44	ns
t <sub>FSOP</sub>	data bit width distortion after SOP	see Figure 6	** -5	-	+5	ns
t <sub>FEOPD</sub>	hub EOP delay relative to t <sub>HDD</sub>	see Figure 7	** 0	-	15	ns
t <sub>FHESK</sub>	hub EOP output width skew	see Figure 7	** -15	-	+15	ns

\* Excluding the first transition from Idle state.

\*\* Characterized only, not tested. Limits guaranteed by design.

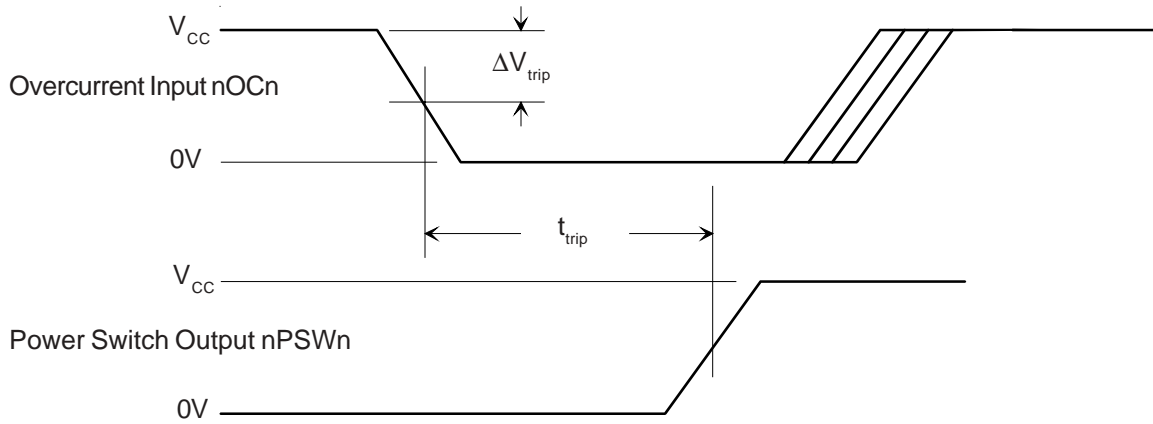
**Table 20: Dynamic Characteristics – Analog I/O Pins (D+, D-); Low-speed Mode (Fig 7)**

V<sub>CC</sub> = 4.0V to 5.5V; V<sub>GND</sub> = 0V; T<sub>amb</sub> = 0 to +70° C; unless otherwise specified

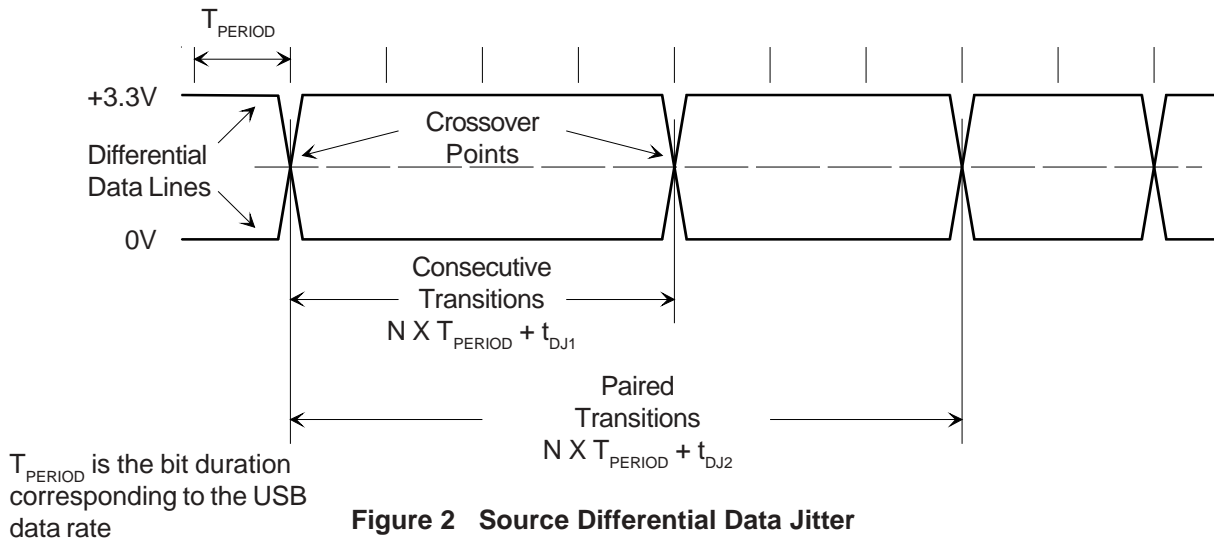
Symbol	Parameter	Condition	Min	Typ	Max	Unit
t <sub>LR</sub>	rise time	C <sub>L</sub> = 200 to 600pF; 10 to 90% of  V <sub>OH</sub> - V <sub>OL</sub>	75	-	300	ns
t <sub>LF</sub>	fall time		75	-	300	ns
LRFM	differential rise/fall time matching (t <sub>LR</sub> /t <sub>LF</sub> )		** 80	-	125	%
V <sub>CRS</sub>	output signal crossover voltage		** ,***1.3	-	2.0	V
t <sub>LHDD</sub>	hub differential data delay	see Figure 6	-	-	300	ns
t <sub>LSOP</sub>	data bit width distortion after SOP	see Figure 6	*** -60	-	+60	ns
t <sub>LEOPD</sub>	hub EOP delay relative to t <sub>HDD</sub>	see Figure 7	*** 0	-	200	ns
t <sub>LHESK</sub>	hub EOP output width skew	see Figure 7	*** -300	-	+300	ns

\*\* Excluding the first transition from Idle state.

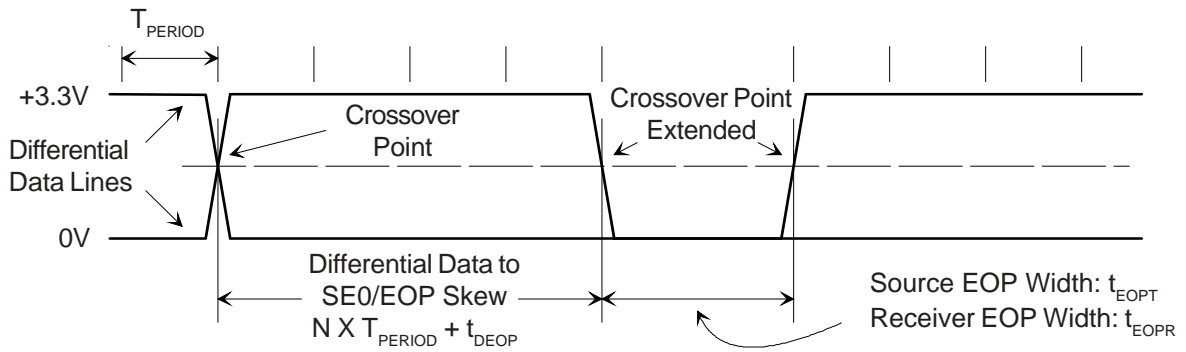
\*\*\* Characterized only, not tested. Limits guaranteed by design.



**Figure 1 Over Current Trip Response Timing**



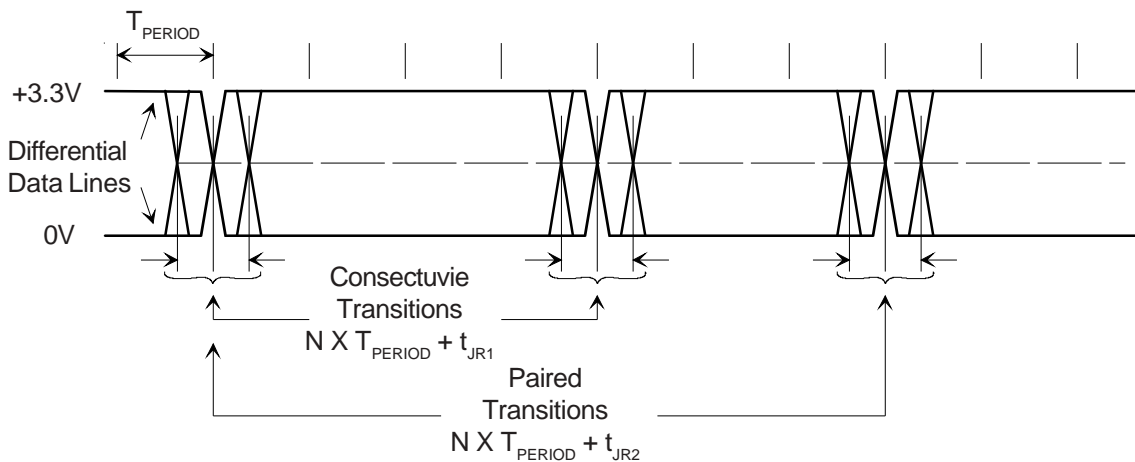
**Figure 2 Source Differential Data Jitter**



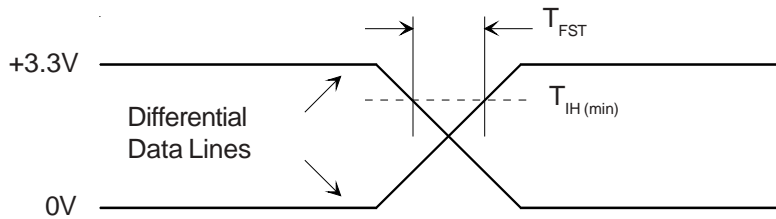
$T_{PERIOD}$  is the bit duration for the USB data rate.

Full-speed timing: subscript prefix "F" Low-speed timing: subscript prefix "L".

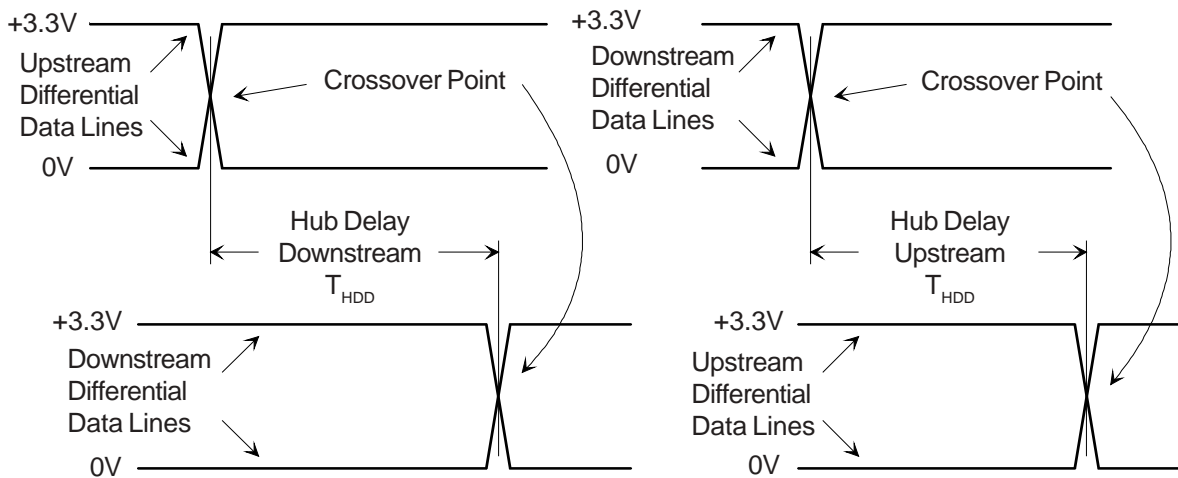
**Figure 3 Source Differential Data-to-EOP Transition Skew and EOP Width**



**Figure 4 Receiver Differential Data Jitter**



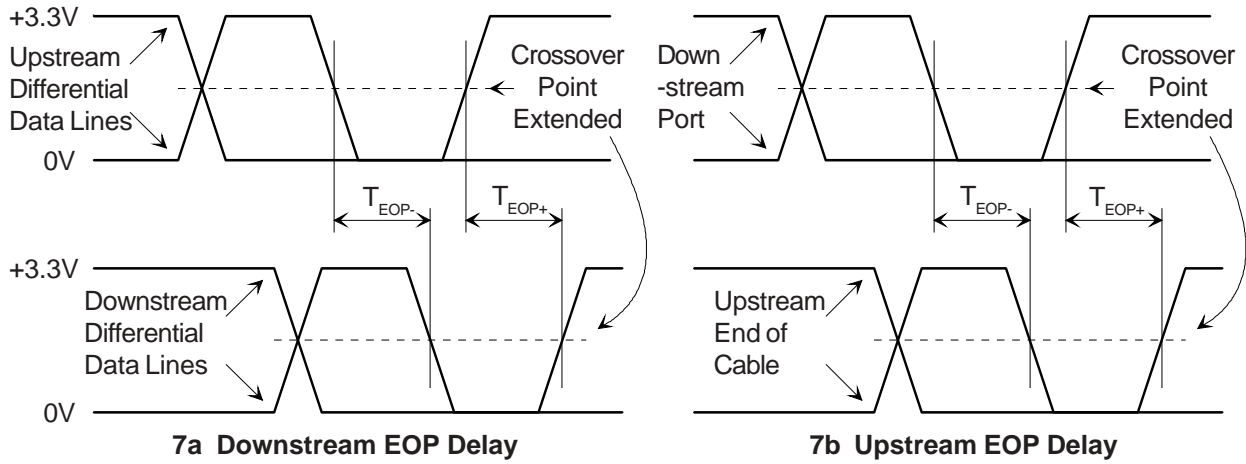
**Figure 5 Receiver SE0 Width Tolerance**



$$\text{SOP Distortion: } t_{\text{SOP}} = t_{\text{HDD}} (\text{next J}) - t_{\text{HDD(SOP)}}$$

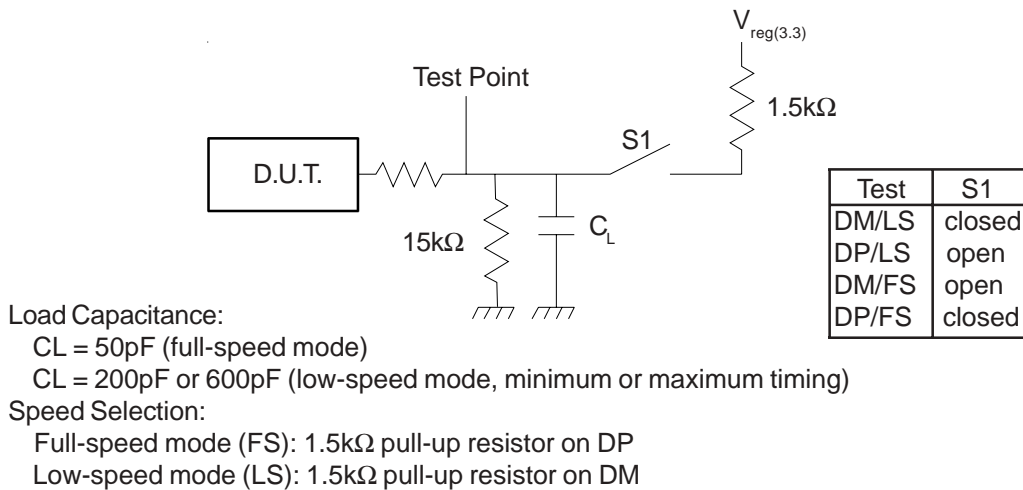
Full-speed timing: subscript prefix "F"    Low-speed timing: subscript prefix "L".

**Figure 6 Hub Differential Data Delay and SOP Distortion**



EOP Delay:  $\max(t_{EOP-}, t_{EOP+})$   
 EOP Delay Relative to  $t_{HDD}$ :  $\max(t_{EOP-}, t_{EOP+})$   
 EOP Skew:  $t_{HESK} = t_{EOP+} - t_{EOP-}$

**Figure 7 Hub EOP Delay and EOP Skew**



**Figure 8 Load Impedance for DP and DM Pins**

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Revision	Notes	Date
1.0	Preliminary Release	7 Nov 2002

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