

## USB 2.0 HOST CONTROLLER



The μPD720100A complies with the Universal Serial Bus Specification Revision 2.0 and Open Host Controller Interface Specification for full-/low-speed signaling and Intel's Enhanced Host Controller Interface Specification for high-speed signaling and works up to 480 Mbps. The μPD720100A is integrated three host controller cores with PCI interface and USB 2.0 transceivers into a single chip.

Detailed function descriptions are provided in the following user's manual. Be sure to read the manual before designing.  
**μPD720100A User's Manual: S15534E**

### FEATURES

- Compliant with Universal Serial Bus Specification Revision 2.0 (Data Rate 1.5/12/480 Mbps)
- Compliant with Open Host Controller Interface Specification for USB Rev 1.0a
- Compliant with Enhanced Host Controller Interface Specification for USB Rev 0.95
- PCI multi-function device consists of two OHCI host controller cores for full-/low-speed signaling and one EHCI host controller core for high-speed signaling.
- Root hub with five (max.) downstream facing ports which are shared by OHCI and EHCI host controller core
- All downstream facing ports can handle high-speed (480 Mbps), full-speed (12 Mbps), and low-speed (1.5 Mbps) transaction.
- Configurable number of downstream facing ports (2 to 5)
- 32-bit 33 MHz host interface compliant to PCI Specification release 2.2.
- Supports PCI Mobile Design Guide Revision 1.1.
- Supports PCI-Bus Power Management Interface Specification release 1.1.
- PCI Bus bus-master access
- System clock is generated by 30 MHz X'tal or 48 MHz clock input.
- Operational registers direct-mapped to PCI memory space
- Legacy support for all downstream facing ports. Legacy support features allow easy migration for motherboard implementation.
- 3.3 V power supply, PCI signal pins have 5 V tolerant circuit.

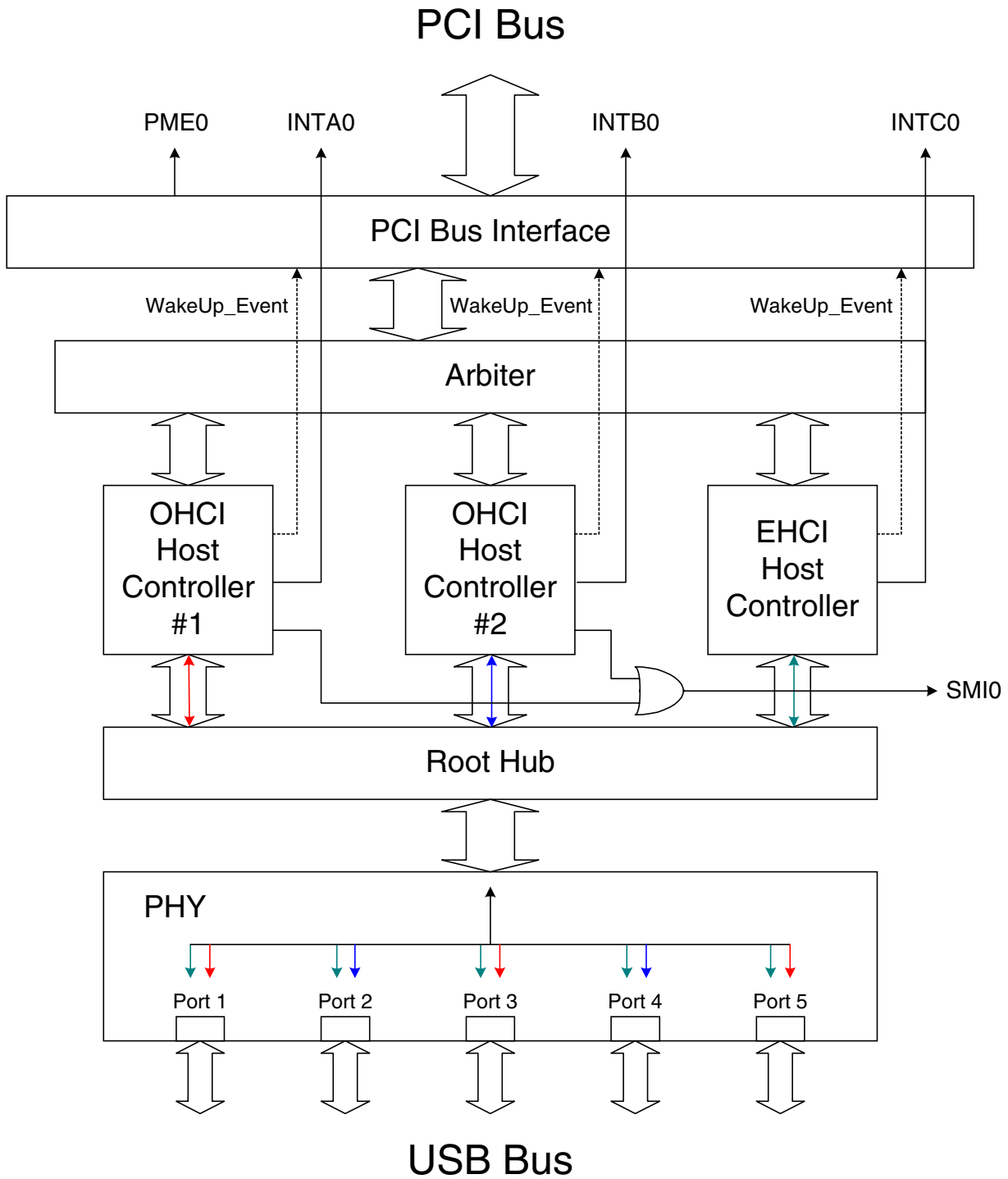
### ORDERING INFORMATION

Part Number	Package	Remark
μPD720100AGM-8ED	160-pin plastic LQFP (Fine pitch) (24 × 24)	
μPD720100AGM-8EY	160-pin plastic LQFP (Fine pitch) (24 × 24)	
★ μPD720100AGM-8EY-A	160-pin plastic LQFP (Fine pitch) (24 × 24)	Lead-free product
μPD720100AS1-2C	176-pin plastic FBGA (15 × 15)	
★ μPD720100AS1-2C-A	176-pin plastic FBGA (15 × 15)	Lead-free product

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Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.

BLOCK DIAGRAM



PCI Bus Interface	:handles 32-bits 33 MHz PCI Bus master and target function which comply with PCI specification release 2.2. The number of enabled ports are set by bit in configuration space.
Arbiter	:arbitrates among two OHCI Host controller cores and one EHCI Host controller core.
OHCI Host Controller #1	:handles full- (12 Mbps)/low-speed (1.5 Mbps) signaling at port 1, 3, and 5.
OHCI Host Controller #2	:handles full- (12 Mbps)/low-speed (1.5 Mbps) signaling at port 2 and 4.
EHCI Host Controller	:handles high- (480 Mbps) signaling at port 1, 2, 3, 4, and 5.
Root Hub	:handles USB hub function in Host controller and controls connection (routing) between Host controller core and port.
PHY	:consists of high-speed transceiver, full-/low-speed transceiver, serializer, deserializer, etc
INTA0	:is the PCI interrupt signal for OHCI Host Controller #1.
INTB0	:is the PCI interrupt signal for OHCI Host Controller #2.
INTC0	:is the PCI interrupt signal for EHCI Host Controller.
SMIO	:is the interrupt signal which is specified by Open Host Controller Interface Specification for USB Rev 1.0a. The SMI signal of each OHCI Host Controller appears at this signal.
PME0	:is the interrupt signal which is specified by PCI-Bus Power Management Interface Specification release 1.1. Wakeup signal of each host controller core appears at this signal.

PIN CONFIGURATION

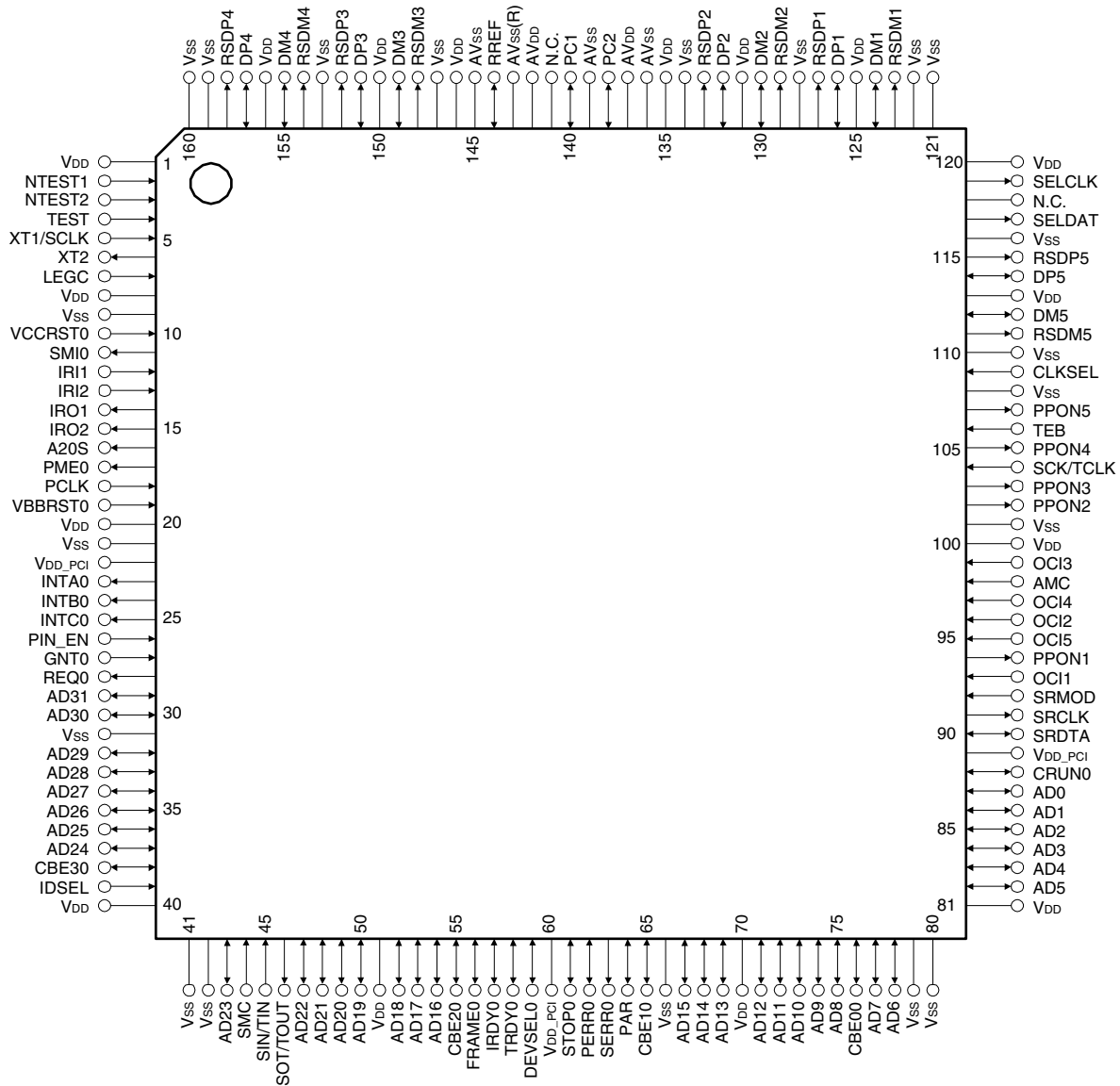
- 160-pin plastic LQFP (Fine pitch) (24 × 24)

μPD720100AGM-8ED

μPD720100AGM-8EY

★ μPD720100AGM-8EY-A

Top View



Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name
1	V <sub>DD</sub>	41	V <sub>SS</sub>	81	V <sub>DD</sub>	121	V <sub>SS</sub>
2	NTEST1	42	V <sub>SS</sub>	82	AD5	122	V <sub>SS</sub>
3	NTEST2	43	AD23	83	AD4	123	RSDM1
4	TEST	44	SMC	84	AD3	124	DM1
5	XT1/SCLK	45	SIN/TIN	85	AD2	125	V <sub>DD</sub>
6	XT2	46	SOT/TOUT	86	AD1	126	DP1
7	LEGC	47	AD22	87	AD0	127	RSDP1
8	V <sub>DD</sub>	48	AD21	88	CRUN0	128	V <sub>SS</sub>
9	V <sub>SS</sub>	49	AD20	89	V <sub>DD_PCI</sub>	129	RSDM2
10	VCCRST0	50	AD19	90	SRDTA	130	DM2
11	SMI0	51	V <sub>DD</sub>	91	SRCLK	131	V <sub>DD</sub>
12	IRI1	52	AD18	92	SRMOD	132	DP2
13	IRI2	53	AD17	93	OCI1	133	RSDP2
14	IRO1	54	AD16	94	PPON1	134	V <sub>SS</sub>
15	IRO2	55	CBE20	95	OCI5	135	V <sub>DD</sub>
16	A20S	56	FRAME0	96	OCI2	136	AV <sub>SS</sub>
17	PME0	57	IRDY0	97	OCI4	137	AV <sub>DD</sub>
18	PCLK	58	TRDY0	98	AMC	138	PC2
19	VBBRST0	59	DEVSEL0	99	OCI3	139	AV <sub>SS</sub>
20	V <sub>DD</sub>	60	V <sub>DD_PCI</sub>	100	V <sub>DD</sub>	140	PC1
21	V <sub>SS</sub>	61	STOP0	101	V <sub>SS</sub>	141	N.C.
22	V <sub>DD_PCI</sub>	62	PERR0	102	PPON2	142	AV <sub>DD</sub>
23	INTA0	63	SERR0	103	PPON3	143	AV <sub>SS</sub> (R)
24	INTB0	64	PAR	104	SCK/TCLK	144	RREF
25	INTC0	65	CBE10	105	PPON4	145	AV <sub>SS</sub>
26	PIN_EN	66	V <sub>SS</sub>	106	TEB	146	V <sub>DD</sub>
27	GNT0	67	AD15	107	PPON5	147	V <sub>SS</sub>
28	REQ0	68	AD14	108	V <sub>SS</sub>	148	RSDM3
29	AD31	69	AD13	109	CLKSEL	149	DM3
30	AD30	70	V <sub>DD</sub>	110	V <sub>SS</sub>	150	V <sub>DD</sub>
31	V <sub>SS</sub>	71	AD12	111	RSDM5	151	DP3
32	AD29	72	AD11	112	DM5	152	RSDP3
33	AD28	73	AD10	113	V <sub>DD</sub>	153	V <sub>SS</sub>
34	AD27	74	AD9	114	DP5	154	RSDM4
35	AD26	75	AD8	115	RSDP5	155	DM4
36	AD25	76	CBE00	116	V <sub>SS</sub>	156	V <sub>DD</sub>
37	AD24	77	AD7	117	SELDAT	157	DP4
38	CBE30	78	AD6	118	N.C.	158	RSDP4
39	IDSEL	79	V <sub>SS</sub>	119	SELCLK	159	V <sub>SS</sub>
40	V <sub>DD</sub>	80	V <sub>SS</sub>	120	V <sub>DD</sub>	160	V <sub>SS</sub>

**Remark** AV<sub>SS</sub> (R) should be used to connect RREF through 1 % precision reference resistor of 9.1 k $\Omega$ .

- 176-pin plastic FBGA (15 × 15)

μPD720100AS1-2C

★ μPD720100AS1-2C-A

**Bottom View**

	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	17		
30	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	46	16	
29	88	141	142	143	144	145	146	147	148	149	150	151	152	153	104	47	15	
28	87	140					171	172	173					154	105	48	14	
27	86	139													155	106	49	13
26	85	138													156	107	50	12
25	84	137													157	108	51	11
24	83	136	170									174	158	109	52	10		
23	82	135	169									175	159	110	53	9		
22	81	134	168									176	160	111	54	8		
21	80	133													161	112	55	7
20	79	132													162	113	56	6
19	78	131													163	114	57	5
18	77	130					167	166	165					164	115	58	4	
17	76	129	128	127	126	125	124	123	122	121	120	119	118	117	116	59	3	
16	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	2	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		1	
U	T	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A		

Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name
1	V <sub>SS</sub>	45	V <sub>DD</sub>	89	SELCLK	133	PPON1
2	V <sub>SS</sub>	46	NTEST1	90	V <sub>SS</sub>	134	OCI4
3	SMC	47	NANDTEST	91	RSDM1	135	V <sub>SS</sub>
4	AD20	48	TEST	92	RSDP1	136	SCK/TCLK
5	AD18	49	V <sub>SS</sub>	93	DM2	137	PPON5
6	CBE20	50	IRI1	94	RSDP2	138	V <sub>SS</sub>
7	DEVSELO	51	IRO2	95	AV <sub>SS</sub>	139	V <sub>DD</sub>
8	V <sub>DD_PCI</sub>	52	VBBRST0	96	PC2	140	RSDP5
9	SERR0	53	V <sub>DD</sub>	97	AV <sub>SS</sub>	141	V <sub>DD</sub>
10	V <sub>SS</sub>	54	INTA0	98	DM3	142	DP1
11	AD14	55	PIN_EN	99	DP3	143	V <sub>SS</sub>
12	AD11	56	REQ0	100	RSDM4	144	V <sub>DD</sub>
13	CBE00	57	AD29	101	DP4	145	V <sub>SS</sub>
14	AD6	58	AD25	102	V <sub>SS</sub>	146	AV <sub>DD</sub>
15	V <sub>SS</sub>	59	CBE30	103	V <sub>SS</sub>	147	N.C.
16	AD5	60	N.C.	104	V <sub>DD</sub>	148	RREF
17	N.C.	61	IDSEL	105	NTEST2	149	V <sub>SS</sub>
18	AD3	62	V <sub>SS</sub>	106	LEGC	150	V <sub>DD</sub>
19	V <sub>DD_PCI</sub>	63	AD23	107	VCCRST0	151	V <sub>SS</sub>
20	SRMOD	64	AD22	108	IRI2	152	DM4
21	OCI5	65	AD19	109	A20S	153	XT1/SCLK
22	OCI3	66	AD17	110	PCLK	154	XT2
23	V <sub>DD</sub>	67	FRAME0	111	INTC0	155	V <sub>DD</sub>
24	PPON3	68	TRDY0	112	AD31	156	SMI0
25	TEB	69	CBE10	113	V <sub>SS</sub>	157	IRO1
26	V <sub>SS</sub>	70	AD13	114	AD27	158	PME0
27	DM5	71	AD12	115	AD24	159	V <sub>SS</sub>
28	V <sub>SS</sub>	72	AD9	116	V <sub>DD</sub>	160	INTB0
29	N.C.	73	AD7	117	SIN/TIN	161	GNT0
30	N.C.	74	V <sub>SS</sub>	118	SOT/TOUT	162	AD30
31	V <sub>SS</sub>	75	V <sub>SS</sub>	119	AD21	163	AD28
32	N.C.	76	V <sub>DD</sub>	120	V <sub>DD</sub>	164	AD26
33	DM1	77	AD4	121	AD16	165	V <sub>SS</sub>
34	RSDM2	78	AD0	122	IRDY0	166	V <sub>DD</sub>
35	DP2	79	SRDTA	123	STOP0	167	PERR0
36	V <sub>DD</sub>	80	OCI1	124	PAR	168	V <sub>SS</sub>
37	AV <sub>SS</sub>	81	OCI2	125	AD15	169	V <sub>SS</sub>
38	PC1	82	AMC	126	V <sub>DD</sub>	170	PPON2
39	AV <sub>SS</sub> (R)	83	PPON4	127	AD10	171	V <sub>SS</sub>
40	V <sub>DD</sub>	84	CLKSEL	128	AD8	172	V <sub>SS</sub>
41	RSDM3	85	RSDM5	129	AD2	173	AV <sub>DD</sub>
42	RSDP3	86	DP5	130	AD1	174	V <sub>SS</sub>
43	N.C.(V <sub>DD</sub> )	87	SELDAT	131	CRUN0	175	V <sub>DD</sub>
44	RSDP4	88	V <sub>DD</sub>	132	SRCLK	176	V <sub>DD_PCI</sub>

**Remarks 1.** Pin 43 can be opened. But this signal is connected to pin 45 in the package. Should not be connected to GND.

**2.** AV<sub>SS</sub> (R) should be used to connect RREF through 1 % precision reference resistor of 9.1 k $\Omega$ .

1. PIN INFORMATION

(1/2)

Pin Name	I/O	Buffer Type	Active Level	Function
AD (31 : 0)	I/O	5 V PCI I/O		PCI "AD [31 : 0]" signal
CBE (3 : 0)0	I/O	5 V PCI I/O		PCI "C/BE [3 : 0]" signal
PAR	I/O	5 V PCI I/O		PCI "PAR" signal
FRAME0	I/O	5 V PCI I/O		PCI "FRAME#" signal
IRDY0	I/O	5 V PCI I/O		PCI "IRDY#" signal
TRDY0	I/O	5 V PCI I/O		PCI "TRDY#" signal
STOP0	I/O	5 V PCI I/O		PCI "STOP#" signal
IDSEL	I	5 V PCI Input		PCI "IDSEL" signal
DEVSEL0	I/O	5 V PCI I/O		PCI "DEVSEL#" signal
REQ0	O	5 V PCI Output		PCI "REQ#" signal
GNT0	I	5 V PCI Input		PCI "GNT#" signal
PERR0	I/O	5 V PCI I/O		PCI "PERR#" signal
SERR0	O	5 V PCI N-ch Open Drain		PCI "SERR#" signal
INTA0	O	5 V PCI N-ch Open Drain	Low	PCI "INTA#" signal
INTB0	O	5 V PCI N-ch Open Drain	Low	PCI "INTB#" signal
INTC0	O	5 V PCI N-ch Open Drain	Low	PCI "INTC#" signal
PCLK	I	5 V PCI Input		PCI "CLK" signal
VBBRST0	I	5 V PCI Input	Low	Hardware Reset for Chip
CRUN0	I/O	5 V PCI I/O		PCI "CLKRUN#" signal
PME0	O	5 V PCI N-ch Open Drain	Low	PCI "PME#" signal
VCCRST0	I	5 V tolerant Input	Low	RESET for Power Management
SMI0	O	5 V tolerant N-ch Open Drain	Low	System management interrupt output
PIN_EN	I	5 V tolerant Input	High	PCI Interface enable
XT1/SCLK	I	Input		System clock input or Oscillator In
XT2	O	Output		Oscillator Out
DP (5 : 1)	I/O	USB high speed D+I/O		USB's high speed D+ signal
DM (5 : 1)	I/O	USB high speed D-I/O		USB's high speed D- signal
RSDP (5 : 1)	O	USB full speed D+ O		USB's full speed D+ signal
RSDM (5 : 1)	O	USB full speed D- O		USB's full speed D- signal
OCI (5 : 1)	I (I/O)	5 V tolerant Input	Low	USB Root Hub Port's overcurrent status input
PPON (5 : 1)	O (I/O)	5 V tolerant Output	High	USB Root Hub Port's power supply control output
LEGC	I (I/O)	Input	High	Legacy support switch
IRI1	I (I/O)	5 V tolerant Input	High	INT input from keyboard
IRI2	I (I/O)	5 V tolerant Input	High	INT input from mouse
IRO1	O	5 V tolerant Output	High	INT output from keyboard
IRO2	O	5 V tolerant Output	High	INT output from mouse
A20S	O	5 V tolerant 3-state Output		GateA20 State output



(2/2)

Pin Name	I/O	Buffer Type	Active Level	Function
RREF	A	Analog		Reference resistor
PC1	A	Analog		Capacitor for PLL
PC2	A	Analog		Capacitor for PLL
NTEST(2:1)	I	Input with 12 k $\Omega$ Pull down R	High	Test pin
SMC	I	Input with 50 k $\Omega$ Pull down R	High	Scan mode control
SIN/TIN	I	Input with 50 k $\Omega$ Pull down R		Scan input or RAM BIST input
SOT/TOUT	O	Output		Scan output or RAM BIST output
TEB	I	Input with 50 k $\Omega$ Pull down R	High	BIST enable
AMC	I	Input with 50 k $\Omega$ Pull down R	High	ATG mode control
SCK/TCLK	I	Input with 50 k $\Omega$ Pull down R		Scan clock or RAM BIST clock
CLKSEL	I	Input with 50 k $\Omega$ Pull down R		Clock select signal
TEST	I	Input with 50 k $\Omega$ Pull down R	High	Test Control
NANDTEST	I	Input with 50 k $\Omega$ Pull down R	High	NAND Tree Test enable
SELDAT	O	Output		Test signal
SELCLK	O	Output		Test signal
SRCLK	O	Output		Serial ROM Clock Out
SRDTA	I/O	I/O		Serial ROM Data
SRMOD	I	Input with 50 k $\Omega$ Pull down R	High	Serial ROM Input Enable
AV <sub>DD</sub>				V <sub>DD</sub> for Analog circuit
V <sub>DD</sub>				V <sub>DD</sub>
V <sub>DD_PCI</sub>				5 V (5 V PCI) or 3.3 V (3.3 V PCI)
AV <sub>SS</sub>				V <sub>SS</sub> for Analog circuit
V <sub>SS</sub>				V <sub>SS</sub>
N.C.				Not connect

- Remarks**
1. "5 V tolerant" means that the buffer is 3 V buffer with 5 V tolerant circuit.
  2. "5 V PCI" indicates a PCI buffer, which complies with the 3 V PCI standard, has a 5 V tolerant circuit. It does not indicate a buffer that fully complies with 5 V PCI standard. However, this function can be used for evaluating the operation of a device on a 5V add-in card.
  3. 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.

## 2. ELECTRICAL SPECIFICATIONS

### 2.1 Buffer List

- 3 V input buffer with Pull down resistor  
NTEST1, NTEST2, TEST, SMC, SIN/TIN, SRMOD, AMC, SCK/TCLK, CLKSEL, TEB
- 3 V output buffer  
SOT/TOUT ( $I_{OL} = 9 \text{ mA}$ ), SRCLK ( $I_{OL} = 3 \text{ mA}$ )
- 3 V bi-directional buffer  
LEGC ( $I_{OL} = 9 \text{ mA}$ ), SRDTA ( $I_{OL} = 3 \text{ mA}$ )
- 3 V Oscillator interface  
XT1/SCLK, XT2
- 5 V input buffer  
VCCRST0, PIN\_EN
- 5 V  $I_{OL} = 12 \text{ mA}$  N-ch Open Drain buffer  
SMI0, PME0, INTA0, INTB0, INTC0, SERR0
- 5 V  $I_{OL} = 6 \text{ mA}$  3-state Output buffer  
A20S
- 5 V  $I_{OL} = 12 \text{ mA}$  3-state Output buffer  
IRO1, IRO2
- 5 V PCI Input buffer with enable (OR type)  
PCLK, VBBRST0, GNT0, IDSEL
- 5 V PCI  $I_{OL} = 12 \text{ mA}$  3-state Output buffer  
REQ0
- ★ • 5 V PCI  $I_{OL} = 9 \text{ mA}$  bi-directional buffer with input enable (OR-type)  
AD(31:0), CBE(3:0)0, PAR, FRAME0, IRDY0, TRDY0, STOP0, DEVSEL0, PERR0, CRUN0, IRI(1:2),  
PPON(1:5), OCI(1:5)
- USB interface  
DP(1:5), DM(1:5), RSDP(1:5), RSDM(1:5), PC1, PC2, RREF, SELDAT, SELCLK

Above, “5 V” refers to a 3-V buffer with 5-V tolerant circuit. 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  $V_{DD}$  voltage. Similarly, “5 V PCI” above refers to a PCI buffer that has a 5-V tolerant circuit, which meets the 3-V PCI standard; it does not refer to a PCI buffer that meets the 5-V PCI standard.

2.2 Terminology

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.
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.

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.

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.
Input leakage current	$I_i$	Indicates the current that flows when the input voltage is supplied to the input pin.
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.

2.3 Electrical Specifications

Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating	Unit
Power supply voltage	V <sub>DD</sub>		-0.5 to +4.6	V
	AV <sub>DD</sub>		-0.5 to +4.6	V
	V <sub>DD_PCI</sub>		-0.5 to +6.0	V
Input voltage, 5 V buffer	V <sub>I</sub>	3.0 V ≤ V <sub>DD</sub> ≤ 3.6 V V <sub>I</sub> < V <sub>DD</sub> + 3.0 V	-0.5 to +6.6	V
Input voltage, 3.3 V buffer	V <sub>I</sub>	3.0 V ≤ V <sub>DD</sub> ≤ 3.6 V V <sub>I</sub> < V <sub>DD</sub> + 0.5 V	-0.5 to +4.6	V
Output voltage, 5 V buffer	V <sub>O</sub>	3.0 V ≤ V <sub>DD</sub> ≤ 3.6 V V <sub>O</sub> < V <sub>DD</sub> + 3.0 V	-0.5 to +6.6	V
Output voltage, 3.3 V buffer	V <sub>O</sub>	3.0 V ≤ V <sub>DD</sub> ≤ 3.6 V V <sub>O</sub> < V <sub>DD</sub> + 0.5 V	-0.5 to +4.6	V
Operating temperature	T <sub>A</sub>		0 to +70	°C
Storage temperature	T <sub>stg</sub>		-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.

Recommended Operating Ranges

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Operating voltage	V <sub>DD</sub>		3.0	3.3	3.6	V
	AV <sub>DD</sub>		3.0	3.3	3.6	V
	V <sub>DD_PCI</sub>	In 3.3 V PCI	3.0	3.3	3.6	V
		In 5 V PCI	4.75	5.0	5.25	V
High-level input voltage	V <sub>IH</sub>					
3.3 V High-level input voltage		2.0		V <sub>DD</sub>	V	
5.0 V High-level input voltage		2.0		5.5	V	
Low-level input voltage	V <sub>IL</sub>					
3.3 V Low-level input voltage		0		0.8	V	
5.0 V Low-level input voltage		0		0.8	V	

DC Characteristics (V<sub>DD</sub> = 3.0 to 3.6 V, T<sub>A</sub> = 0 to +70°C)

Control Pin Block

Parameter	Symbol	Condition	MIN.	MAX.	Unit
Off-state output current	I <sub>oz</sub>	V <sub>O</sub> = V <sub>DD</sub> or V <sub>SS</sub>		±10	μA
Output short circuit current	I <sub>os</sub> <sup>Note</sup>			-250	mA
Low-level output current	I <sub>oL</sub>				
3.3 V Low-level output current		V <sub>OL</sub> = 0.4 V	9.0		mA
3.3 V Low-level output current		V <sub>OL</sub> = 0.4 V	3.0		mA
5.0 V Low-level output current		V <sub>OL</sub> = 0.4 V	12.0		mA
5.0 V Low-level output current		V <sub>OL</sub> = 0.4 V	6.0		mA
High-level output current	I <sub>oH</sub>				
3.3 V High-level output current		V <sub>OH</sub> = 2.4 V	-9.0		mA
3.3 V High-level output current		V <sub>OH</sub> = 2.4 V	-3.0		mA
5.0 V High-level output current		V <sub>OH</sub> = 2.4 V	-2.0		mA
5.0 V High-level output current		V <sub>OH</sub> = 2.4 V	-2.0		mA
Input leakage current	I <sub>i</sub>				
3.3 V buffer		V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>		±10	μA
3.3 V buffer with 50 kΩ PD		V <sub>I</sub> = V <sub>DD</sub>		191	μA
5.0 V buffer		V <sub>I</sub> = V <sub>DD</sub> or V <sub>SS</sub>		±10	μA

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

PCI Interface Block

Parameter	Symbol	Condition	MIN.	MAX.	Unit
High-level input voltage	V <sub>ih</sub>		2.0	5.25	V
Low-level input voltage	V <sub>il</sub>		0	0.8	V
Low-level output current	I <sub>oL</sub>	V <sub>OL</sub> = 0.4 V	12.0		mA
High-level output current	I <sub>oH</sub>	V <sub>OH</sub> = 2.4 V	-2.0		mA
Input high leakage current	I <sub>ih</sub>	V <sub>in</sub> = 2.7		70	μA
Input low leakage current	I <sub>il</sub>	V <sub>in</sub> = 0.5		-70	μA
PME0 leakage current	I <sub>off</sub>	V <sub>O</sub> < 3.6 V V <sub>CC</sub> off or floating		1	μA

**USB Interface Block**

Parameter	Symbol	Conditions	MIN	MAX	Unit
Serial Resistor between DP (DM) and RSDP (RSDM).	R <sub>s</sub>		35.64	36.36	Ω
Output pin impedance	Z <sub>HSDRV</sub>	Includes R <sub>s</sub> resistor	40.5	49.5	Ω
<b>Input Levels for Low-/full-speed:</b>					
High-level input voltage (drive)	V <sub>IH</sub>		2.0		V
High-level input voltage (floating)	V <sub>IHZ</sub>		2.7	3.6	
Low-level input voltage	V <sub>IL</sub>			0.8	V
Differential input sensitivity	V <sub>DI</sub>	(D+) - (D-)	0.2		V
Differential Common mode Range	V <sub>CM</sub>	Includes V <sub>DI</sub> range	0.8	2.5	V
<b>Output Levels for Low-/full-speed:</b>					
High-level output voltage	V <sub>OH</sub>	R <sub>L</sub> of 14.25 kΩ to GND	2.8	3.6	V
Low-level output voltage	V <sub>OL</sub>	R <sub>L</sub> of 1.425 kΩ to 3.6 V	0.0	0.3	V
SE1	V <sub>OSE1</sub>		0.8		V
Output signal crossover point voltage	V <sub>CRS</sub>		1.3	2.0	V
<b>Input Levels for High-speed:</b>					
High-speed squelch detection threshold (differential signal)	V <sub>HSSQ</sub>		100	150	mV
High-speed disconnect detection threshold (differential signal)	V <sub>HSDSC</sub>		525	625	mV
High-speed data signaling common mode voltage range	V <sub>HSCM</sub>		-50	+500	mV
High-speed differential input signaling level	See Figure 2-4.				
<b>Output Levels for High-speed:</b>					
High-speed idle state	V <sub>HSOI</sub>		-10.0	+10	mV
High-speed data signaling high	V <sub>HSOH</sub>		360	440	mV
High-speed data signaling low	V <sub>H SOL</sub>		-10.0	+10	mV
Chirp J level (different signal)	V <sub>CHIRPJ</sub>		700	1100	mV
Chirp K level (different signal)	V <sub>CHIRPK</sub>		-900	-500	mV

Figure 2-1. Differential Input Sensitivity Range for Low-/full-speed

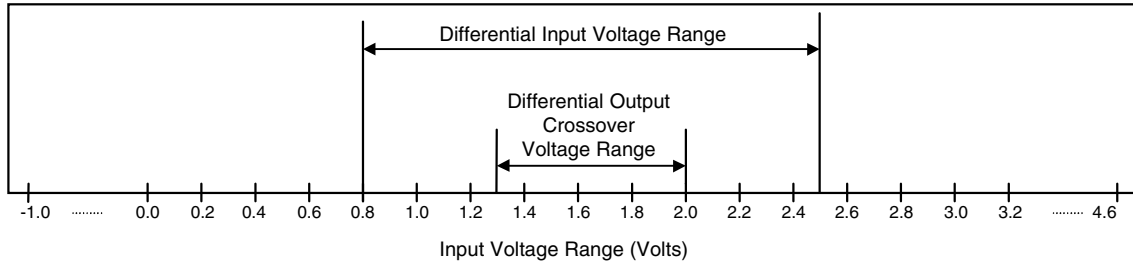


Figure 2-2. Full-speed Buffer  $V_{OH}/I_{OH}$  Characteristics for High-speed Capable Transceiver

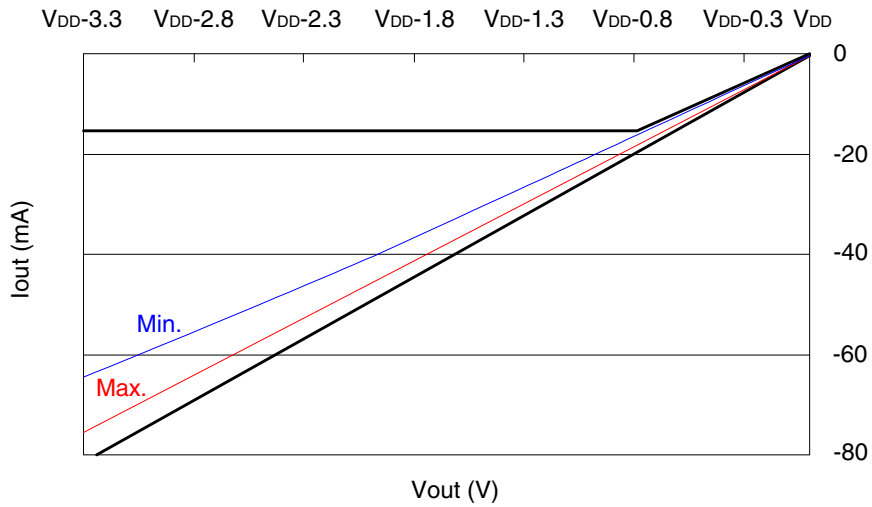


Figure 2-3. Full-speed Buffer  $V_{OL}/I_{OL}$  Characteristics for High-speed Capable Transceiver

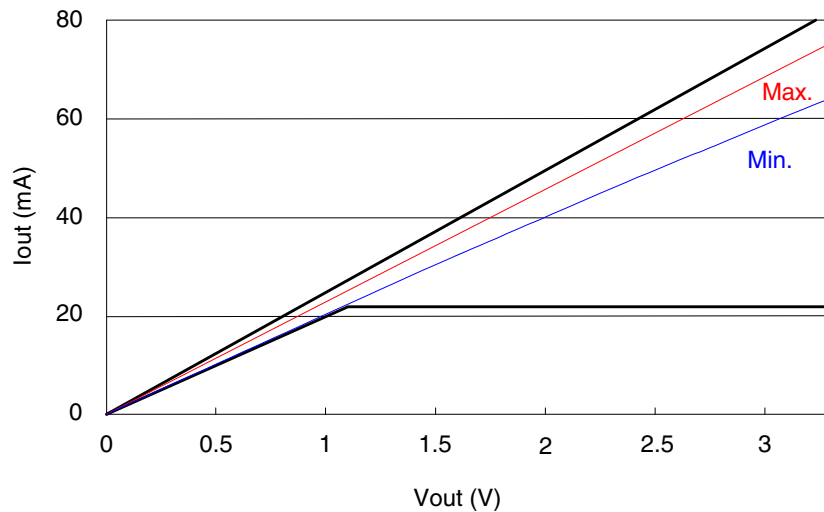


Figure 2-4. Receiver Sensitivity for Transceiver at DP/DM

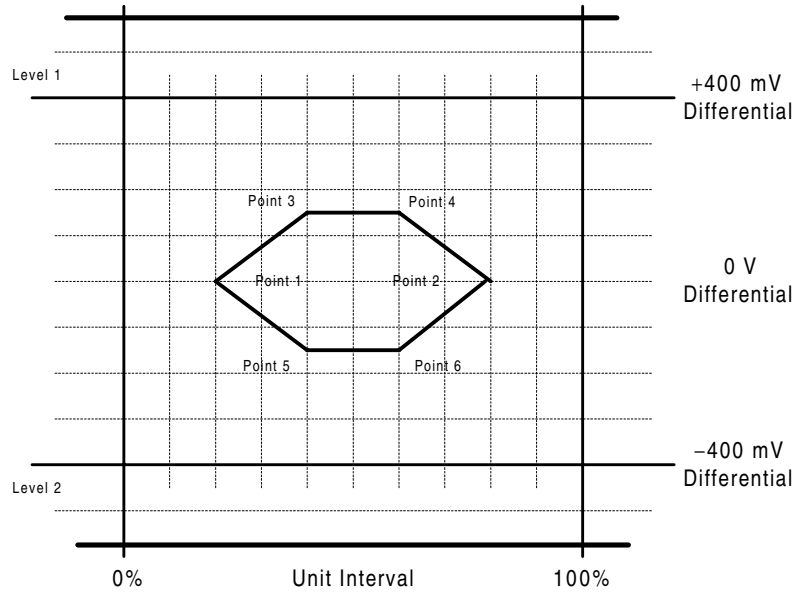
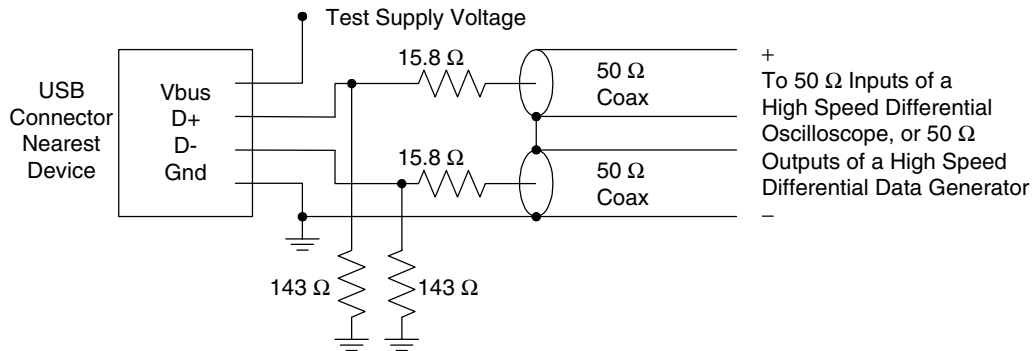


Figure 2-5. Receiver Measurement Fixtures



Pin Capacitance

Parameter	Symbol	Condition	MIN.	MAX.	Unit
Input capacitance	$C_I$	$V_{DD} = 0\text{ V}$ , $T_A = 25^\circ\text{C}$ $f_c = 1\text{ MHz}$ Unmeasured pins returned to 0 V	6	8	pF
Output capacitance	$C_O$		10	12	pF
I/O capacitance	$C_{IO}$		10	12	pF
PCI input pin capacitance	$C_{in}$			8	pF
PCI clock input pin capacitance	$C_{clk}$		6	8	pF
PCI IDSEL input pin capacitance	$C_{IDSEL}$			8	pF



**Power Consumption**

Parameter	Symbol	Condition	TYP.	Unit
Power Consumption	P <sub>WD0-0</sub>	The power consumption under the state without suspend. Device state = D0, All the ports does not connect to any function. <sup>Note 1</sup>	168.0	mA
	P <sub>WD0-2</sub>	The power consumption under the state without suspend. Device state = D0, The number of active ports is 2. <sup>Note 2</sup> Full- or low-speed device(s) is (are) on the port. High-speed device(s) is (are) on the port.	186.2	mA
			301.6	mA
	P <sub>WD0-3</sub>	The power consumption under the state without suspend. Device state = D0, The number of active ports is 3. <sup>Note 2</sup> Full- or low-speed device(s) is (are) on the port. High-speed device(s) is (are) on the port.	195.3	mA
			368.4	mA
	P <sub>WD0-4</sub>	The power consumption under the state without suspend. Device state = D0, The number of active ports is 4. <sup>Note 2</sup> Full- or low-speed device(s) is (are) on the port. High-speed device(s) is (are) on the port.	204.4	mA
			435.2	mA
	P <sub>WD0-5</sub>	The power consumption under the state without suspend. Device state = D0, The number of active ports is 5. <sup>Note 2</sup> Full- or low-speed device(s) is (are) on the port. High-speed device(s) is (are) on the port.	213.5	mA
			502.0	mA
	P <sub>WD0-S</sub>	The power consumption under suspend state. Device state = D0, The internal clock is stopped. <sup>Note 3</sup>	136.2	mA
	P <sub>WD0-C</sub>	The power consumption under suspend state during PCI clock is stopped by CRUN0. Device state = D0, The internal clock is stopped. <sup>Note 3</sup>	113.0	mA
	P <sub>WD1</sub>	Device state = D1, Analog PLL output is stopped. <sup>Note 3, 4</sup>	24.7	mA
P <sub>WD2</sub>	Device state = D2, Analog PLL output is stopped. <sup>Note 3, 4</sup>	10.9	mA	
P <sub>WD3H</sub>	Device state = D3 <sub>not</sub> , PIN_EN = High Analog PLL output is stopped. <sup>Note 3, 4</sup>	10.9	mA	
P <sub>WD3C</sub>	Device state = D3 <sub>cold</sub> , PIN_EN = Low Oscillator output is stopped. <sup>Note 3, 4, 5</sup>	650	μA	

- Notes**
1. When any device is not connected to all the ports of HC, the power consumption for HC does not depend on the number of active ports.
  2. The number of active ports is set by the value of Port No field in PCI configuration space EXT register.
  3. For the condition of clock stop, see **μPD720100A User's Manual 7.3 Control for System Clock Operation**.
  4. When the device state = D1, PCI clock is defined as it is running. When the device state = D2 or D3, PCI clock is defined as it is stopped.
  5. If 48 MHz oscillator clock-in is used, power consumption for oscillator block + HC chip will be more than 15 mA.

**System Clock Ratings**

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Clock frequency	f <sub>CLK</sub>	X'tal	-500 ppm	30	+500 ppm	MHz
		Oscillator block	-500 ppm	48	+500 ppm	MHz
Clock Duty cycle	t <sub>DUTY</sub>		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.

AC Characteristics (V<sub>DD</sub> = 3.0 to 3.6 V, T<sub>A</sub> = 0 to +70°C)

PCI Interface Block

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
PCI clock cycle time	t <sub>cyc</sub>		30		ns
PCI clock pulse, high-level width	t <sub>high</sub>		11		ns
PCI clock pulse, low-level width	t <sub>low</sub>		11		ns
PCI clock, rise slew rate	S <sub>cr</sub>	0.2 V <sub>DD</sub> to 0.6 V <sub>DD</sub>	1	4	V/ns
PCI clock, fall slew rate	S <sub>cf</sub>	0.2 V <sub>DD</sub> to 0.6 V <sub>DD</sub>	1	4	V/ns
PCI reset active time (vs. power supply stability)	t <sub>rst</sub>		1		ms
PCI reset active time (vs. CLK Start)	t <sub>rst-clk</sub>		100		μs
Output float delay time (vs. RST0↓)	t <sub>rst-off</sub>			40	ns
PCI reset rise slew rate	S <sub>rr</sub>		50		mV/ns
PCI bus signal output time (vs. PCLK↑)	t <sub>val</sub>		2	11	ns
PCI point-to-point signal output time (vs. PCLK↑)	t <sub>val</sub> (ptp)	REQ0	2	12	ns
Output delay time (vs. PCLK↑)	t <sub>on</sub>		2		ns
Output float delay time (vs. PCLK↑)	t <sub>off</sub>			28	ns
Input setup time (vs. PCLK↑)	t <sub>su</sub>		7		ns
Point-to-point input setup time (vs. PCLK↑)	t <sub>su</sub> (ptp)	GNT0	10		ns
Input hold time	t <sub>h</sub>		0		ns

USB Interface Block

(1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
<b>Low Source Electrical Characteristics</b>					
★ Rise time (10% - 90%)	t <sub>LR</sub>	C <sub>L</sub> = 200 pF – 600 pF, R <sub>s</sub> = 36 Ω	75	300	ns
★ Fall time (90% - 10%)	t <sub>LF</sub>	C <sub>L</sub> = 200 pF – 600 pF, R <sub>s</sub> = 36 Ω	75	300	ns
Differential Rise and Fall Time matching	t <sub>LRFM</sub>	(t <sub>LR</sub> /t <sub>LF</sub> )	80	125	%
Low-speed Data Rate	t <sub>LDRATHS</sub>	Average bit rate	1.49925	1.50075	Mbps
Source Jitter Total (including frequency tolerance):					
To Next Transition	t <sub>DDJ1</sub>		-25	+25	ns
For Paired Transitions	t <sub>DDJ2</sub>		-14	+14	ns
Source Jitter for Differential Transition to SE0 transition	t <sub>LDEOP</sub>		-40	+100	ns
Receiver Jitter:					
To Next Transition	t <sub>UJR1</sub>		-152	+152	ns
For Paired Transitions	t <sub>UJR2</sub>		-200	+200	ns
Source SE0 interval of EOP	t <sub>LEOPT</sub>		1.25	1.50	μs
Receiver SE0 interval of EOP	t <sub>LEOPR</sub>		670		ns
Width of SE0 interval during differential transition	t <sub>FST</sub>			210	ns
<b>Full-speed Source Electrical Characteristics</b>					
Rise time (10% - 90%)	t <sub>FR</sub>	C <sub>L</sub> = 50 pF, R <sub>s</sub> = 36 Ω	4	20	ns
Fall time (90% - 10%)	t <sub>FF</sub>	C <sub>L</sub> = 50 pF, R <sub>s</sub> = 36 Ω	4	20	ns
Differential Rise and Fall Time matching	t <sub>FRFM</sub>	(t <sub>FR</sub> /t <sub>FF</sub> )	90	111.11	%
Full-speed Data Rate	t <sub>FDRATHS</sub>	Average bit rate	11.9940	12.0060	Mbps
Frame Interval	t <sub>FRAME</sub>		0.9995	1.0005	ms
Consecutive Frame Interval Jitter	t <sub>RFI</sub>	No clock adjustment		42	ns
Source Jitter Total (including frequency tolerance):					
To Next Transition	t <sub>DJ1</sub>		-3.5	+3.5	ns
For Paired Transitions	t <sub>DJ2</sub>		-4.0	+4.0	ns
Source Jitter for Differential Transition to SE0 transition	t <sub>FDEOP</sub>		-2	+5	ns
Receiver Jitter:					
To Next Transition	t <sub>JR1</sub>		-18.5	+18.5	ns
For Paired Transitions	t <sub>JR2</sub>		-9	+9	ns
Source SE0 interval of EOP	t <sub>FEOPT</sub>		160	175	ns
Receiver SE0 interval of EOP	t <sub>FEOPR</sub>		82		ns
Width of SE0 interval during differential transition	t <sub>FST</sub>			14	ns

(2/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
<b>High-speed Source Electrical Characteristics</b>					
Rise time (10% - 90%)	t <sub>HSR</sub>		500		ps
Fall time (90% - 10%)	t <sub>HSF</sub>		500		ps
Driver waveform	See Figure 2-6.				
High-speed Data Rate	t <sub>HSDRAT</sub>		479.760	480.240	Mbps
Microframe Interval	t <sub>HSFRAM</sub>		124.9375	125.0625	μs
Consecutive Microframe Interval Difference	t <sub>HSRFI</sub>			4 high-speed	Bit times
Data source jitter	See Figure 2-6.				
Receiver jitter tolerance	See Figure 2-4.				
<b>Hub event Timings</b>					
Time to detect a downstream facing port connect event	t <sub>DCNN</sub>		2.5	2000	μs
Time to detect a disconnect event at a downstream facing port:	t <sub>DDIS</sub>		2.0	2.5	μs
Duration of driving resume to a downstream port	t <sub>DRSMON</sub>	Nominal	20		ms
Time from detecting downstream resume to rebroadcast.	t <sub>URSM</sub>			1.0	ms
Inter-packet Delay for packets traveling in same direction for high-speed	t <sub>HSIPDSD</sub>		88		Bit times
Inter-packet Delay for packets traveling in opposite direction for high-speed	t <sub>HSIPDOD</sub>		8		Bit times
Inter-packet delay for root hub response for high-speed	t <sub>HSRSPDP1</sub>			192	Bit times
Time for which a Chirp J or Chirp K must be continuously detected during Reset handshake	t <sub>FILT</sub>		2.5		μs
Time after end of device Chirp K by which hub must start driving first Chirp K	t <sub>WTDCH</sub>			100	μs
Time for which each individual Chirp J or Chirp K in the chirp sequence is driven downstream during reset	t <sub>DCHBIT</sub>		40	60	μs
Time before end of reset by which a hub must end its downstream chirp sequence	t <sub>DCHSE0</sub>		100	500	μs

Figure 2-6. Transmit Waveform for Transceiver at DP/DM

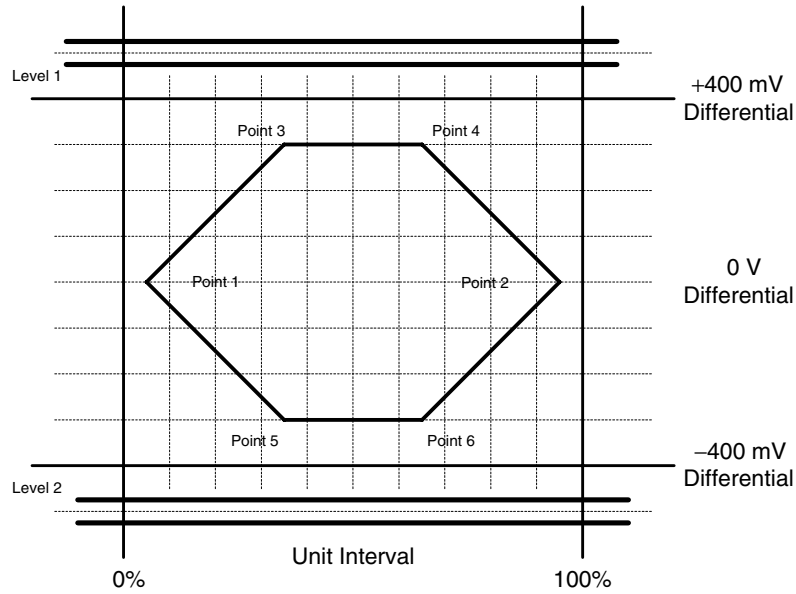
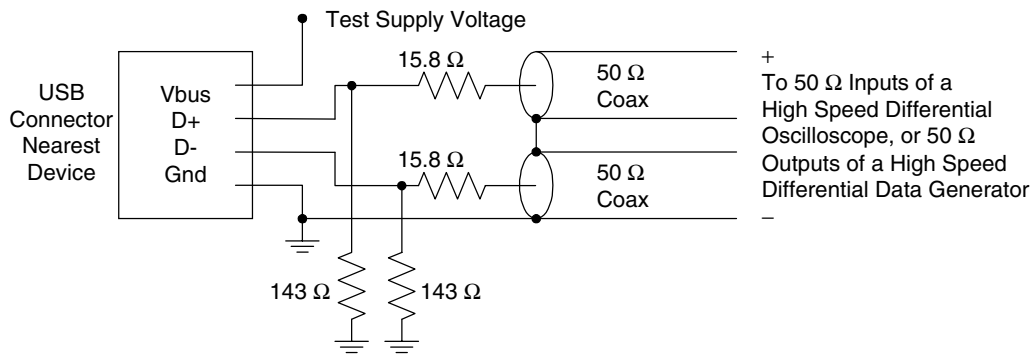
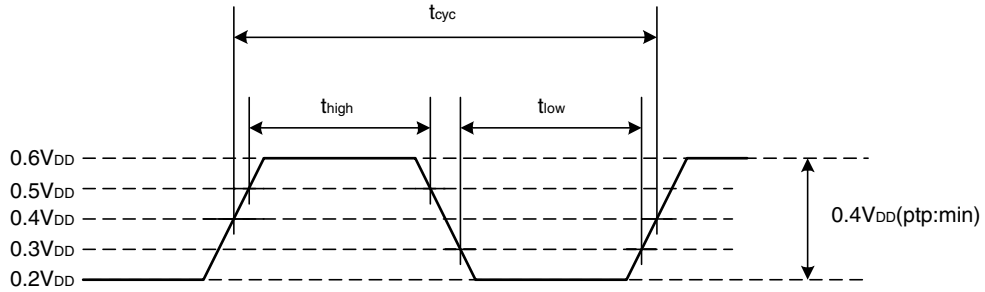


Figure 2-7. Transmitter Measurement Fixtures

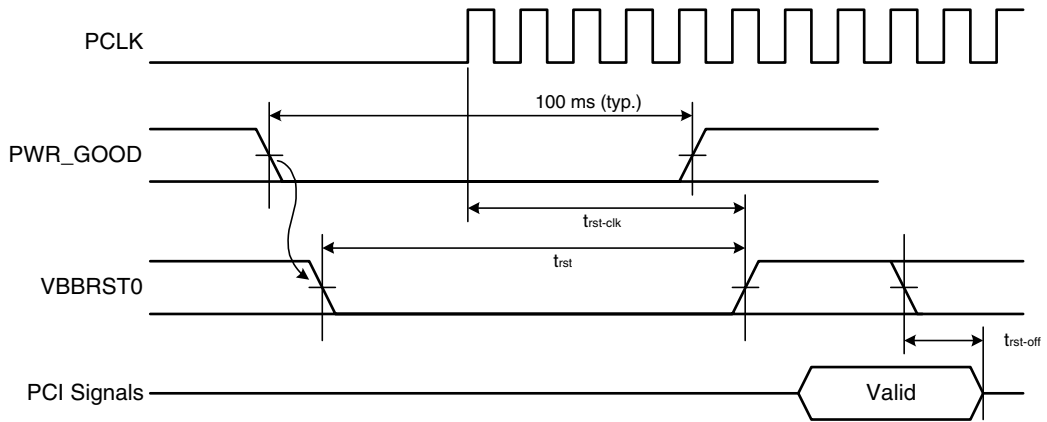


Timing Diagram

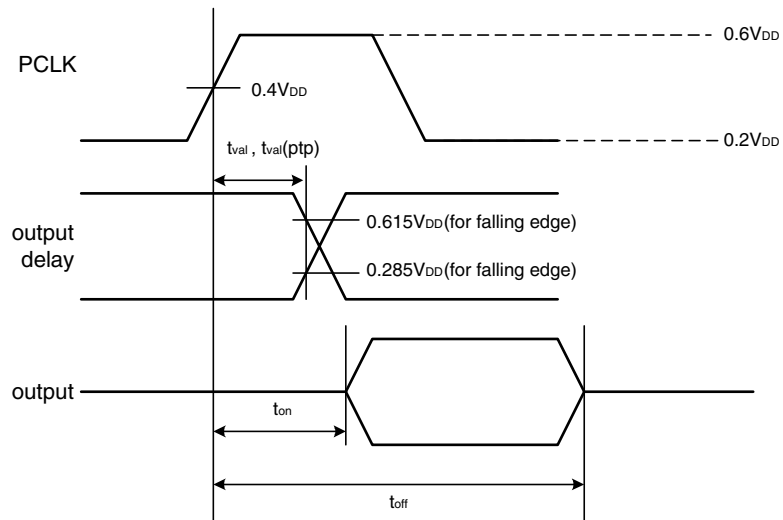
PCI Clock



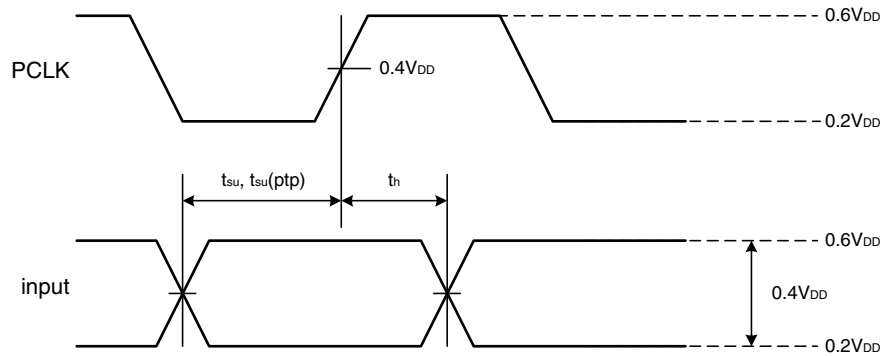
PCI Reset



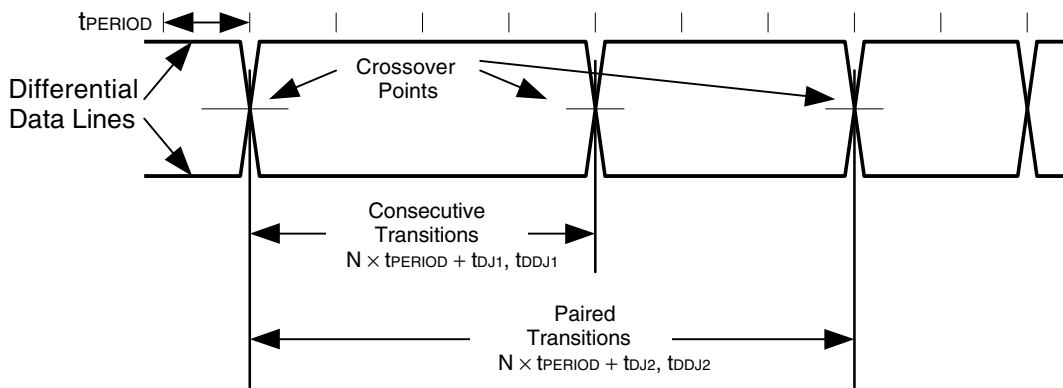
PCI Output Timing Measurement Condition



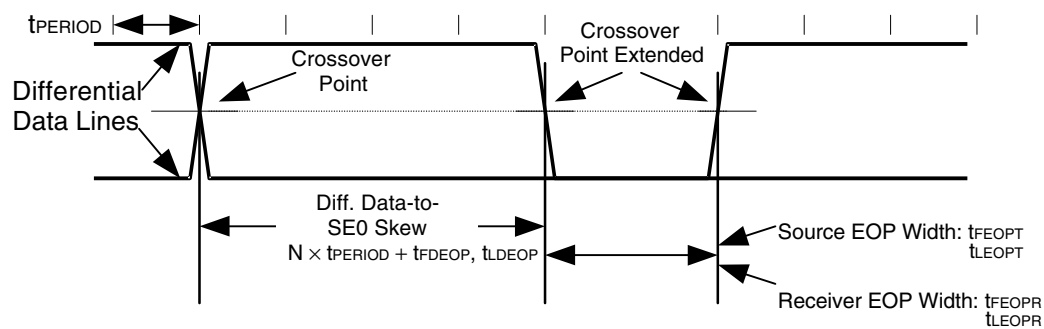
PCI Input Timing Measurement Condition



USB Differential Data Jitter for Low-/full-speed

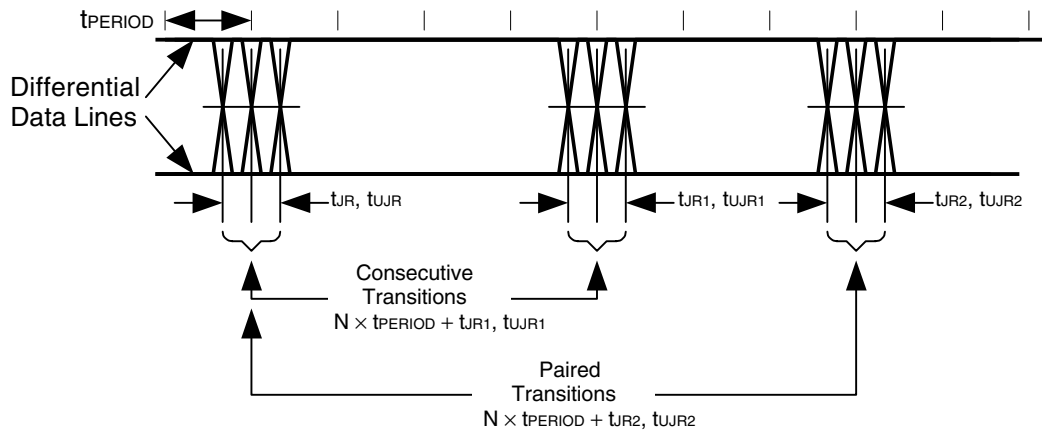


USB Differential-to-EOP Transition Skew and EOP Width for Low-/full-speed

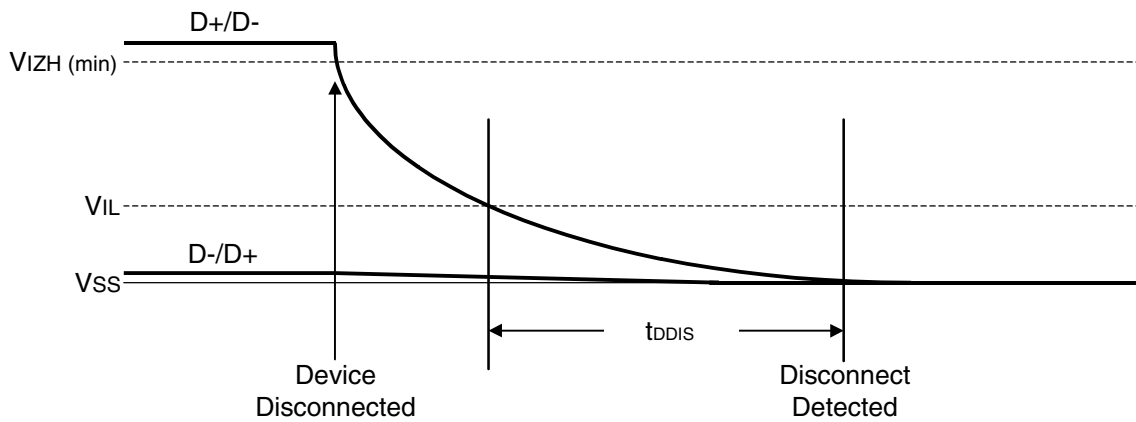




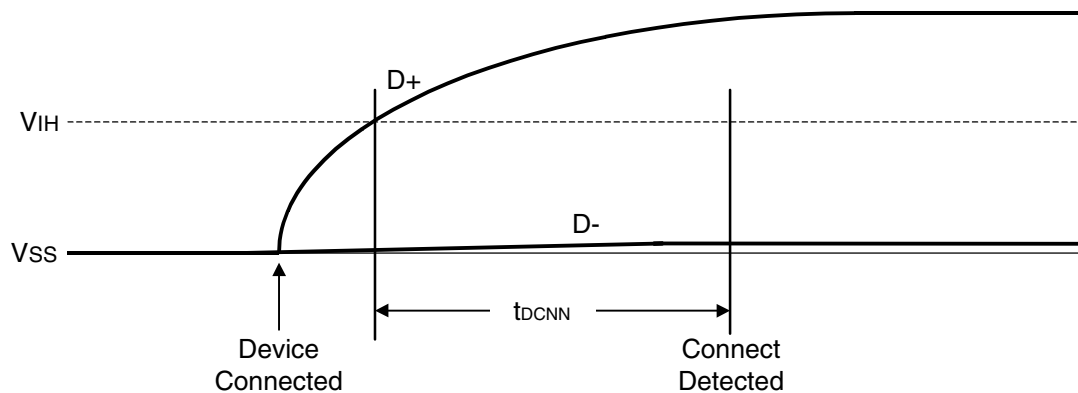
USB Receiver Jitter Tolerance for Low-/full-speed



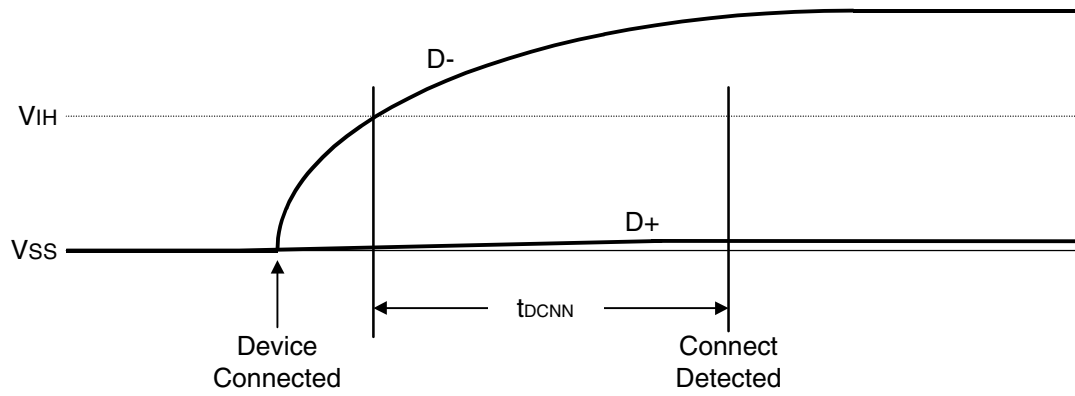
Low-/full-speed Disconnect Detection



Full-/high-speed Device Connect Detection

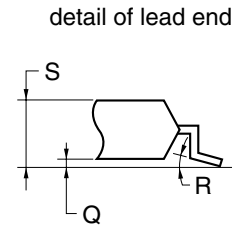
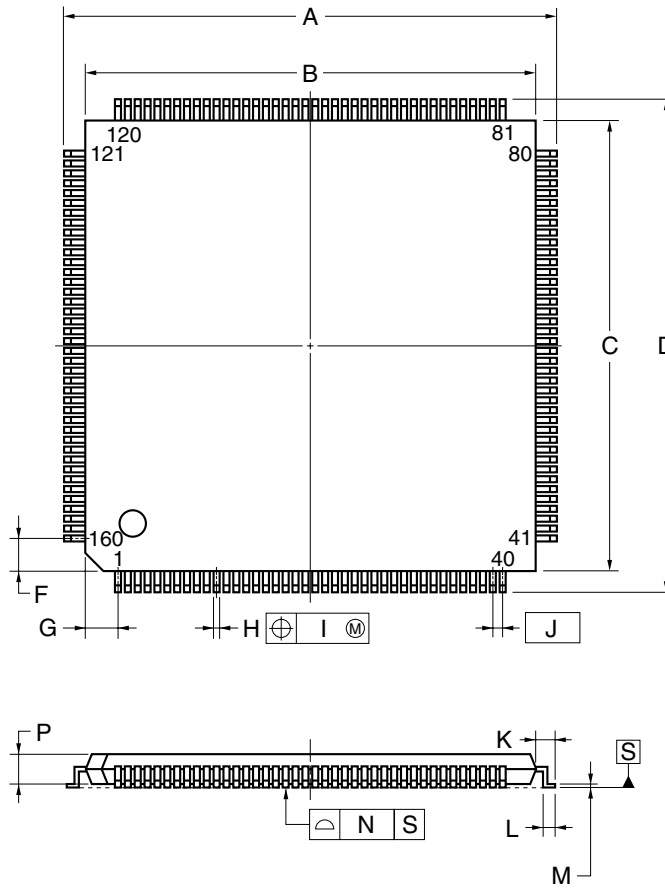


Low-speed Device Connect Detection



3. PACKAGE DRAWING

160-PIN PLASTIC LQFP (FINE PITCH) (24x24)



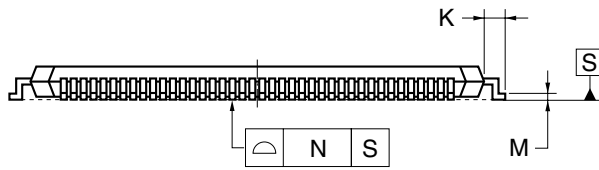
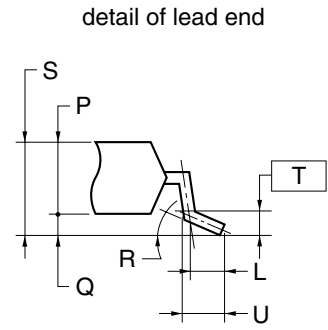
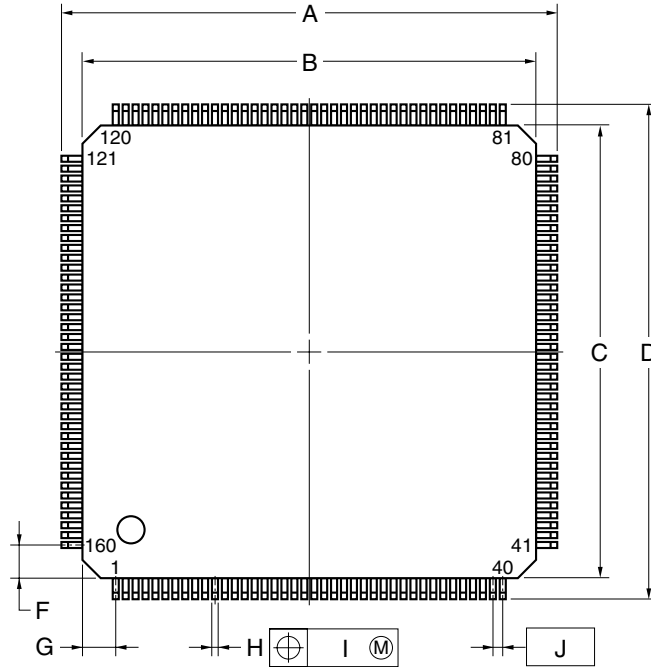
NOTE

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

ITEM	MILLIMETERS
A	26.0±0.2
B	24.0±0.2
C	24.0±0.2
D	26.0±0.2
F	2.25
G	2.25
H	0.22 <sup>+0.05</sup> <sub>-0.04</sub>
I	0.10
J	0.5 (T.P.)
K	1.0±0.2
L	0.5±0.2
M	0.145 <sup>+0.055</sup> <sub>-0.045</sub>
N	0.10
P	1.4±0.1
Q	0.125±0.075
R	3 <sup>+</sup> <sub>-3</sub> °
S	1.7 MAX.

S160GM-50-8ED-3

160-PIN PLASTIC LQFP (FINE PITCH) (24x24)

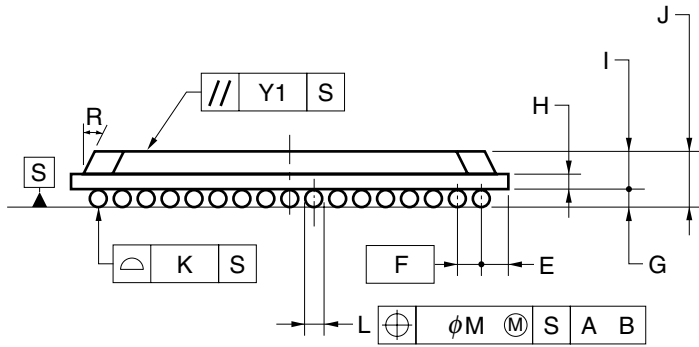
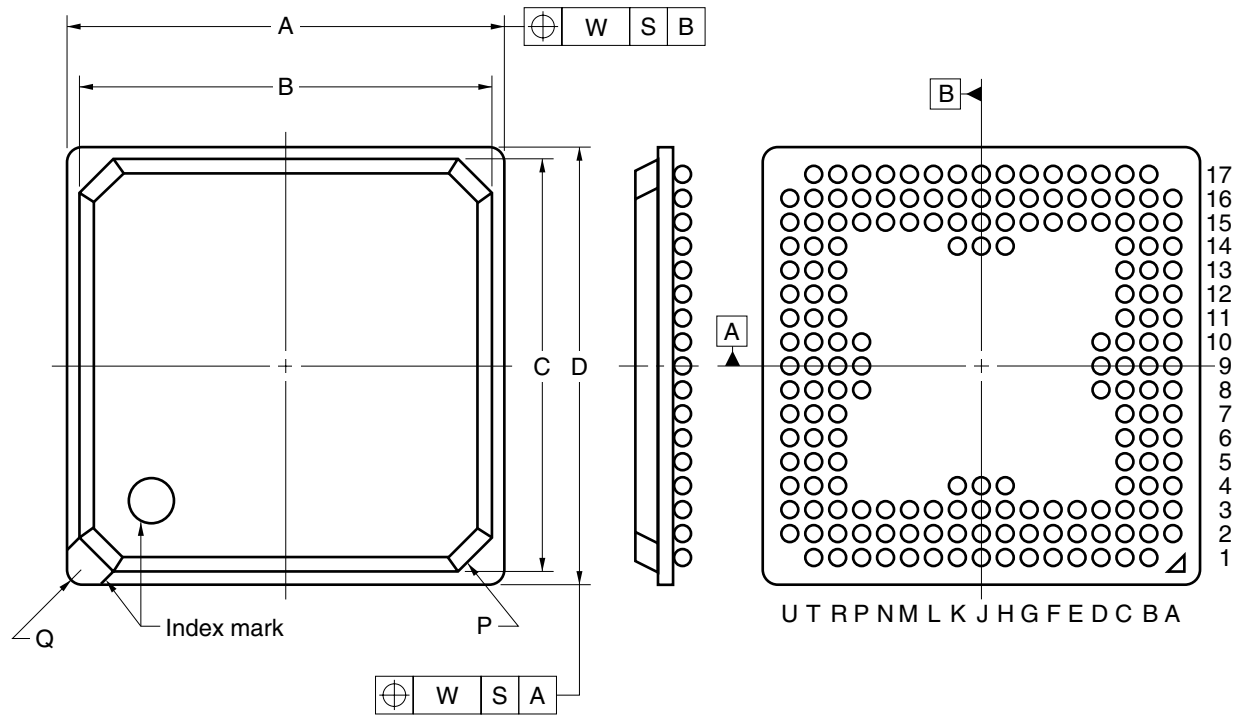


**NOTE**  
 Each lead centerline is located within 0.08 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	26.0±0.2
B	24.0±0.2
C	24.0±0.2
D	26.0±0.2
F	2.25
G	2.25
H	0.22 <sup>+0.05</sup> <sub>-0.04</sub>
I	0.08
J	0.5 (T.P.)
K	1.0±0.2
L	0.5
M	0.17 <sup>+0.03</sup> <sub>-0.07</sub>
N	0.08
P	1.4±0.05
Q	0.10±0.05
R	3° <sup>+4°</sup> <sub>-3°</sub>
S	1.6 MAX.
T	0.25 (T.P.)
U	0.16±0.15

P160GM-50-8EY

176-PIN PLASTIC FBGA (15x15)



ITEM	MILLIMETERS
A	15.00±0.10
B	14.40
C	14.40
D	15.00±0.10
E	1.10
F	0.8 (T.P.)
G	0.35±0.1
H	0.36
I	1.16
J	1.51±0.15
K	0.10
L	$\phi 0.50^{+0.05}_{-0.10}$
M	0.08
P	C1.0
Q	R0.3
R	25°
W	0.20
Y1	0.20

S176S1-80-2C-1

**4. RECOMMENDED SOLDERING CONDITIONS**

The μPD720100A should be soldered and mounted under the following recommended conditions.

For soldering methods and conditions other than those recommended below, contact an NEC Electronics sales representative.

For technical information, see the following website.

Semiconductor Device Mount Manual (<http://www.necel.com/pkg/en/mount/index.html>)

**μPD720100AGM-8ED: 160-pin plastic LQFP (Fine pitch) (24 × 24)**

**μPD720100AGM-8EY: 160-pin plastic LQFP (Fine pitch) (24 × 24)**

Soldering Method	Soldering Conditions	Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Three times or less Exposure limit: 3 days <sup>Note</sup> (after that, prebake at 125°C for 10 hours)	IR35-103-3
Partial heating	Pin temperature: 300°C max., Time: 3 seconds max. (per pin row)	—

**Note** After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

**★ μPD720100AGM-8EY-A: 160-pin plastic LQFP (Fine pitch) (24 × 24) Lead-free product**

Soldering Method	Soldering Conditions	Symbol
Infrared reflow	Package peak temperature: 260°C, Time: 60 seconds max. (at 220°C or higher), Count: Three times or less Exposure limit: 7 days <sup>Note</sup> (after that, prebake at 125°C for 10 hours)	IR60-107-3
Partial heating	Pin temperature: 300°C max., Time: 3 seconds max. (per pin row)	—

**Note** After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

**μPD720100AS1-2C: 176-pin plastic FBGA (15 × 15)**

Soldering Method	Soldering Conditions	Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Three times or less Exposure limit: 7 days <sup>Note</sup> (after that, prebake at 125°C for 10 hours)	IR35-107-3

**Note** After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

**★ μPD720100AS1-2C-A: 176-pin plastic FBGA (15 × 15) Lead-free product**

Soldering Method	Soldering Conditions	Symbol
Infrared reflow	Package peak temperature: 260°C, Time: 60 seconds max. (at 220°C or higher), Count: Three times or less Exposure limit: 7 days <sup>Note</sup> (after that, prebake at 125°C for 10 hours)	IR60-107-3

**Note** After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

## NOTES FOR CMOS DEVICES

**① VOLTAGE APPLICATION WAVEFORM AT INPUT PIN**

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between  $V_{IL}$  (MAX) and  $V_{IH}$  (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between  $V_{IL}$  (MAX) and  $V_{IH}$  (MIN).

**② HANDLING OF UNUSED INPUT PINS**

Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to  $V_{DD}$  or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

**③ PRECAUTION AGAINST ESD**

A 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 when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up 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 benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

**④ STATUS BEFORE INITIALIZATION**

Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

**⑤ POWER ON/OFF SEQUENCE**

In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current.

The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

**⑥ INPUT OF SIGNAL DURING POWER OFF STATE**

Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

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