

μ PD720201/ μ PD720202

User's Manual: Hardware

USB3.0 HOST CONTROLLER



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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 VDD 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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PREFACE

Readers	This manual is intended for engineers who need to be familiar with the capability of the μ PD720201/ μ PD720202 in order to develop application systems based on it.												
Purpose	The purpose of this manual is to help users understand the hardware capabilities (listed below) of the μ PD720201/ μ PD720202.												
Configuration	<p>This manual consists of the following chapters:</p> <ul style="list-style-type: none">• Overview• Pin function• Register information• Power management• How to connect to external elements• How to access external ROM• FW download interface• Battery charging function												
Guidance	Readers of this manual should already have a general knowledge of electronics, logic circuits, and microcomputers.												
Notation	<p>This manual uses the following conventions:</p> <table><tr><td>Data bit significance:</td><td>High-order bits on the left side; low-order bits on the right side</td></tr><tr><td>Active low:</td><td>XXXXB (Pin and signal names are suffixed with B.)</td></tr><tr><td>Note:</td><td>Explanation of an indicated part of text</td></tr><tr><td>Caution:</td><td>Information requiring the user's special attention</td></tr><tr><td>Remark:</td><td>Supplementary information</td></tr><tr><td>Numerical value:</td><td>Binary ... xxxx or xxxxb Decimal ... xxxx Hexadecimal ... xxxh</td></tr></table>	Data bit significance:	High-order bits on the left side; low-order bits on the right side	Active low:	XXXXB (Pin and signal names are suffixed with B.)	Note:	Explanation of an indicated part of text	Caution:	Information requiring the user's special attention	Remark:	Supplementary information	Numerical value:	Binary ... xxxx or xxxxb Decimal ... xxxx Hexadecimal ... xxxh
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Remark:	Supplementary information												
Numerical value:	Binary ... xxxx or xxxxb Decimal ... xxxx Hexadecimal ... xxxh												
Related Document	<p>Use this manual in combination with the following document.</p> <p>The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.</p> <ul style="list-style-type: none">• μPD720201/μPD720202 Data Sheet: R19DS0047E												

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μ PD720201/ μ PD720202
ASSP (USB3.0 HOST CONTROLLER)



R19UH0078EJ0710
Rev. 7.10
Sep 25, 2023

1. Overview

The μ PD720201 and μ PD720202 are Renesas' third generation Universal Serial Bus 3.0 host controllers, which comply with Universal Serial Bus 3.0 Specification, and Intel's eXtensible Host Controller Interface (xHCI). These devices reduce power consumption and offer a smaller package footprint making them ideal for designers who wish to add the USB3.0 interface to mobile computing devices such as laptops and notebook computers.

The μ PD720201 supports up to four USB3.0 SuperSpeed ports and the μ PD720202 supports up to two USB3.0 SuperSpeed ports. The μ PD720201 and μ PD720202 use a PCI Express® Gen 2 system interface bus allowing system designers to easily add up to four (μ PD720201) or two (μ PD720202) USB3.0 SuperSpeed ports to systems containing the PCI Express bus interface. When connected to USB 3.0-compliant peripherals, the μ PD720201 and μ PD720202 can transfer information at clock speeds of up to 5 Gbps. The μ PD720201 and μ PD720202 and USB 3.0 standard are fully compliant and backward compatible with the previous USB2.0 standard. The new USB 3.0 standard supports data transfer speeds of up to ten times faster than those of the previous-generation USB2.0 standard, enabling quick and efficient transfers of large amounts of information.

1.1 Features

- Compliant with Universal Serial Bus 3.0 Specification Revision 1.0, which is released by USB Implementers Forum, Inc
 - Supports the following speed data rates: Low-Speed (1.5 Mbps) / Full-Speed (12 Mbps) / Hi-Speed (480 Mbps) / SuperSpeed (5 Gbps)
 - μ PD720201 supports up to 4 downstream ports for all speeds
 - μ PD720202 supports up to 2 downstream ports for all speeds
 - Supports all USB compliant data transfer types as follows; Control / Bulk / Interrupt / Isochronous transfer
- Compliant with Intel's eXtensible Host Controller Interface (xHCI) Specification Revision 1.0
 - Supports USB debugging capability on all SuperSpeed ports.
- Supports USB legacy function
- Compliant with PCI Express Base Specification Revision 2.0
- Supports Latency Tolerance Reporting ECN of PCI Express Specification
- Supports ExpressCard™ Standard Release 1.0
- Supports PCI Express Card Electromechanical Specification Revision 2.0
- Supports PCI Bus Power Management Interface Specification Revision 1.2
- Supports USB Battery Charging Specification Revision 1.2 and other portable devices
 - DCP mode of BC 1.2
 - CDP mode of BC 1.2
 - China Mobile Phone Chargers
 - EU Mobile Phone Chargers
 - Apple iOS products
- Operational registers are direct-mapped to PCI memory space
- Supports Serial Peripheral Interface (SPI) type ROM for Firmware
- Supports Firmware Download Interface from system BIOS or system software
- System clock: 24 MHz crystal

- Small and low count pin package with improved signal pin assignment for efficient PCB layout
 - μPD720201 adopts 68pin QFN (8 x 8)
 - μPD720202 adopts 48pin QFN (7 x 7)
- 3.3 V and 1.05 V power supply

1.2 Applications

Desktop and Laptop computers, Tablet, Server, PCI Express Card / Express Card, Digital TV, Set-Top-Box, BD Player/Recorder, Media Player, Digital Audio systems, Projector, Multi Function Printer, Storage, Router, NAS, etc

1.3 Ordering Information

Part Number	Package	Packing form	Operating temperature	Remark
μPD720201K8-701-BAC-A	68-pin QFN (8 × 8)	Fraction (any vacancy in the tray and any free space in the carton)	0 to 85 °C	Lead-free product
μPD720202K8-701-BAA-A	48-pin QFN (7 × 7)			
μPD720202K8-701-BAA-M1-A		Full Carton (tray and Carton is packed with every product)		
μPD720201K8-711-BAC-A	68-pin QFN (8 × 8)	Fraction	-40 to 85 °C	Lead-free product
μPD720201K8-711-BAC-M1-A		Full Carton		
μPD720202K8-711-BAA-A	48-pin QFN (7 × 7)	Fraction		
μPD720202K8-711-BAA-M1-A		Full Carton		

Note: μPD720201K8-711-BAC-A & μPD720201K8-711-BAC-M1-A & μPD720202K8-711-BAA-A & μPD720202K8-711-BAA-M1-A should use the FW Download function.

μPD720201K8-711-BAC-A & μPD720201K8-711-BAC-M1-A & μPD720202K8-711-BAA-A & μPD720202K8-711-BAA-M1-A should do not support the External ROM (Serial Peripheral Interface (SPI) type ROM).

μPD720201 & μPD720202 should download the firmware from the External ROM (-701 versions only) or by FW download function after Power on Reset.

Regarding External ROM & FW Download function, refer to “6.How to Access External ROM” & “7. FW Download Interface”.

1.4 Block Diagram

Figure 1-1. μPD720201 Block Diagram

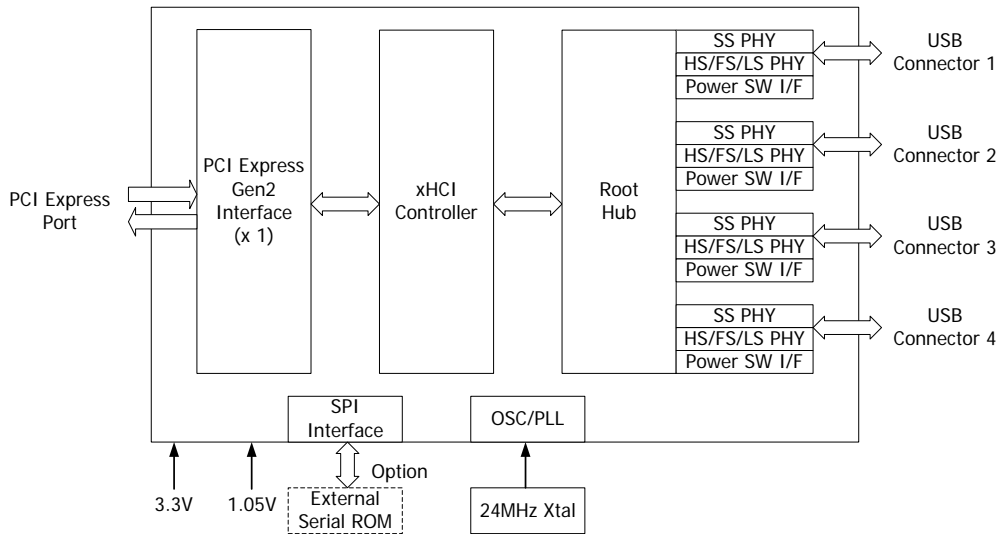
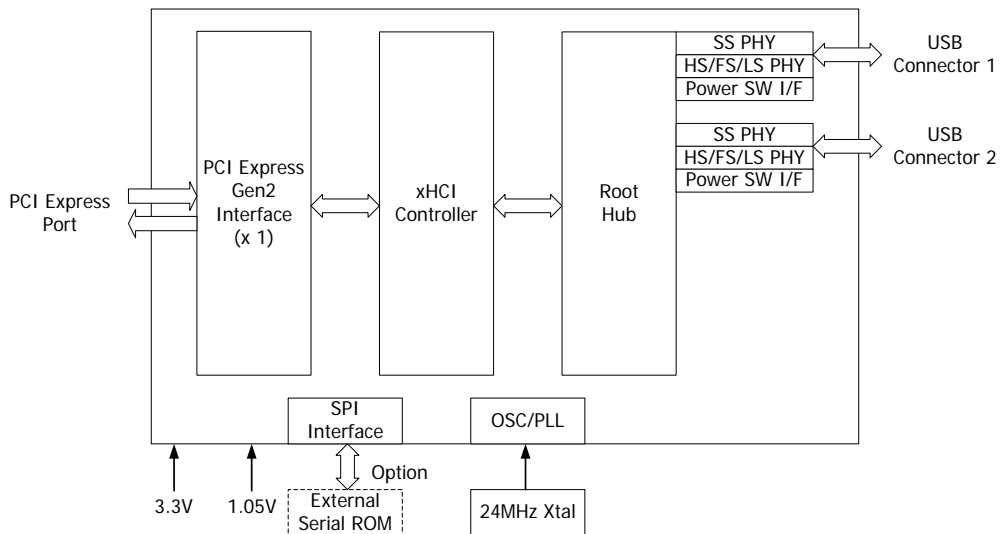


Figure 1-2. μPD720202 Block Diagram

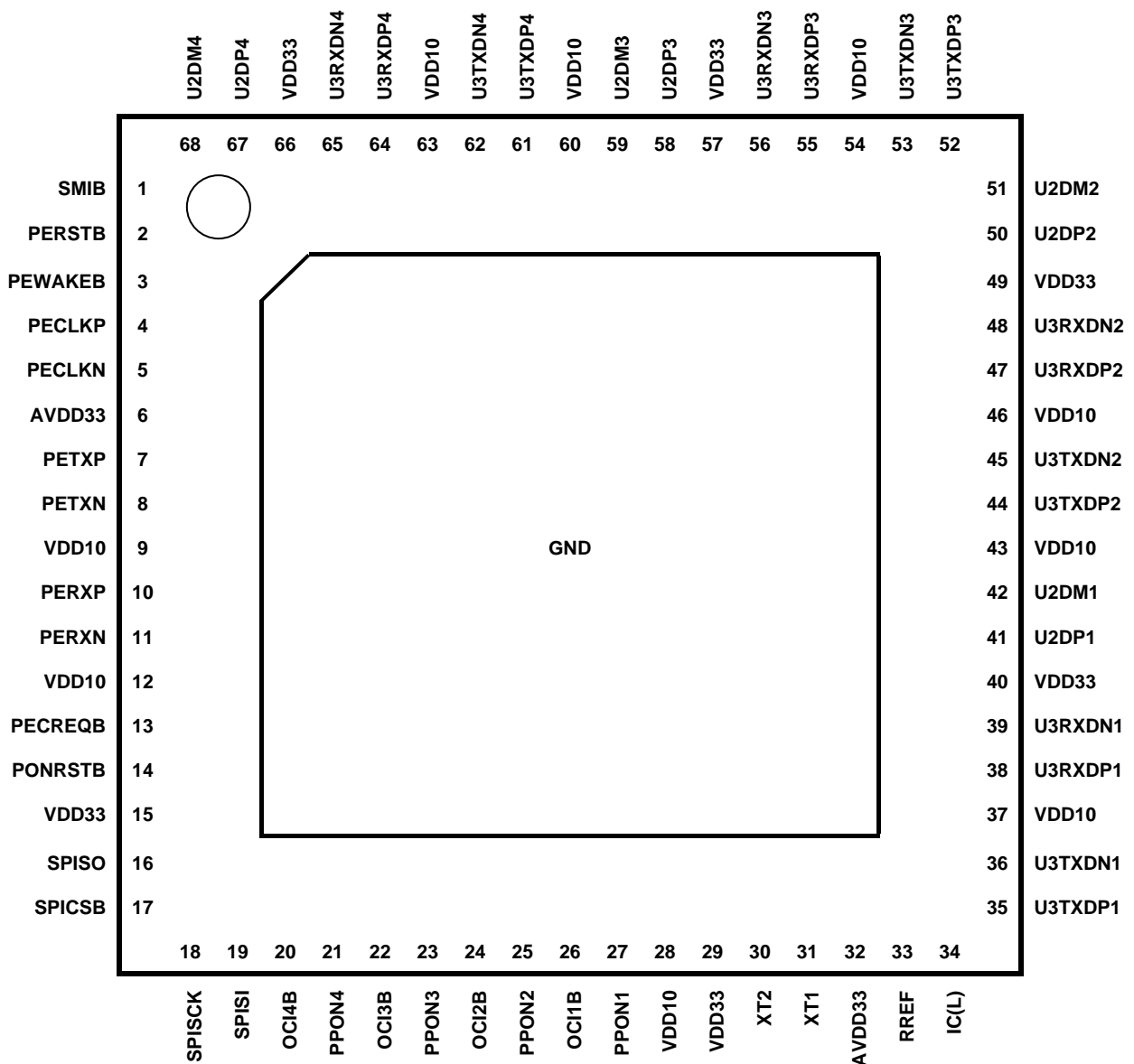


PCI Express Gen2 Interface	Complies with PCI Express Gen2 interface, with 1 lane. This block includes both the link and PHY layers.
xHCI Controller	Handles all support required for USB 3.0, SuperSpeed and Hi-/Full-/Low-Speed. This block includes the register interface from the system.
Root hub	Hub function in host controller.
SS PHY	For SuperSpeed Tx/Rx
HS/FS/LS PHY	For Hi-/Full-/Low-Speed Tx/Rx
Power SW I/F	Connected to external power switch for port power control and over current detection.
SPI Interface	Connected to external serial ROM. When system BIOS or system software does not support FW download function, the external serial ROM is required.
OSC	Internal oscillator block.

1.5 Pin Configuration (TOP VIEW)

- 68-pin QFN (8 × 8)
 μPD720201K8-701-BAC-A
 μPD720201K8-711-BAC-A
 μPD720201K8-711-BAC-M1-A

Figure 1-3. Pin Configuration of μPD720201



• 48-pin QFN (7 x 7)

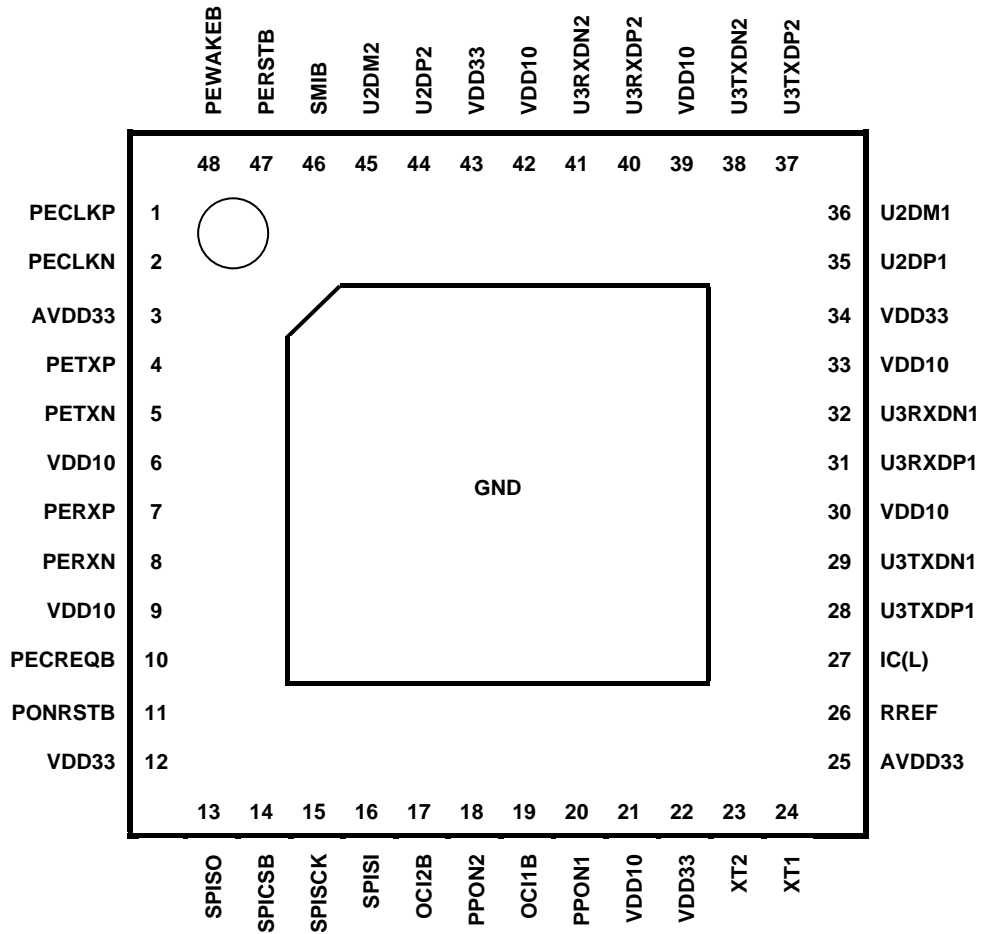
μPD720202K8-701-BAA-A

μPD720202K8-701-BAA-M1-A

μPD720202K8-711-BAA-A

μPD720202K8-711-BAA-M1-A

Figure 1-4. Pin Configuration of μPD720202



2. Pin Function

This section describes each pin functions.

2.1 Power supply

Table 2-1. Power Supply

Pin Name	720201 Pin No.	720202 Pin No.	I/O Type	Function
VDD33	15, 29, 40, 49, 57, 66	12, 22, 34, 43	Power	+3.3 V power supply
VDD10	9, 12, 28, 37, 43, 46, 54, 60, 63	6, 9, 21, 30, 33, 39, 42	Power	+1.05 V power supply.
AVDD33	6, 32	3, 25	Power	+3.3 V power supply for analog circuit.
GND	GND PAD	GND PAD	Power	Connect to ground.
IC(L)	34	27	I	Test pin. Connect to ground.

2.2 Analog Signal

Table 2-2. Analog Signal

Pin Name	720201 Pin No.	720202 Pin No.	I/O Type	Active Level	Function
RREF	33	26	USB2	–	Reference resistor connection.

2.3 System clock

Table 2-3. System Clock

Pin Name	720201 Pin No.	720202 Pin No.	Type	Active Level	Function
XT1	31	24	I (OSC)	–	Oscillator in Connect to 24 MHz crystal. *
XT2	30	23	O (OSC)	–	Oscillator out Connect to 24 MHz crystal. *

Note 1: An external modular oscillator cannot be used instead of a crystal, due to aggressive clock management in reduced power states.

2.3.1 System Interface signal

Table 2-4. System Interface Signal

Pin Name	720201 Pin No.	720202 Pin No.	I/O Type	Active Level	Function
PONRSTB	14	11	I (3.3 V Schmitt Input)	Low	Power on reset signal. When supporting wakeup from D3cold, this signal should be pulled high with system auxiliary power supply.
SMIB	1	46	O (3.3 V Output)	Low	System management Interrupt signal. This is controlled with the USB Legacy Support Control/Status register.

2.3.2 PCI Express Interface

Table 2-5. PCI Express Interface

Pin Name	720201 Pin No.	720202 Pin No.	I/O Type	Active Level	Function
PECLKP	4	1	I (PCIE)	–	PCI Express 100 MHz Reference Clock.
PECLKN	5	2	I (PCIE)	–	PCI Express 100 MHz Reference Clock.
PETXP	7	4	O (PCIE)	–	PCI Express Transmit Data+.
PETXN	8	5	O (PCIE)	–	PCI Express Transmit Data-.
PERXP	10	7	I (PCIE)	–	PCI Express Receive Data+.
PERXN	11	8	I (PCIE)	–	PCI Express Receive Data-.
PERSTB	2	47	I (3.3 V Input)	Low	PCI Express “PERST#” signal.
PEWAKEB	3	48	O (Open Drain)	Low	PCI Express “WAKE#” signal. This signal is used for remote wakeup mechanism, and requests the recovery of power and reference clock input.
PECREQB	13	10	O (Open Drain)	Low	PCI Express “CLKREQ#” signal. This signal is used to request run/stop of reference clock.

2.3.3 USB Interface

Table 2-6. USB Interface

Pin Name	720201 Pin No.	720202 Pin No.	I/O Type	Active Level	Function
U3TXDP1	35	28	O (USB3)	–	USB3.0 Transmit data D+ signal for SuperSpeed
U3TXDN1	36	29	O (USB3)	–	USB3.0 Transmit data D- signal for SuperSpeed
U3RXDP1	38	31	I (USB3)	–	USB3.0 Receive data D+ signal for SuperSpeed
U3RXDN1	39	32	I (USB3)	–	USB3.0 Receive data D- signal for SuperSpeed
U2DP1	41	35	I/O (USB2)	–	USB2.0 D+ signal for Hi-/Full-/Low-Speed
U2DM1	42	36	I/O (USB2)	–	USB2.0 D– signal for Hi-/Full-/Low-Speed
OCI1B	26	19	I (3.3 V Input)	Low	Over-current status input signal. 0: Over-current condition is detected 1: No over-current condition is detected
PPON1	27	20	O (3.3 V Output)	High	USB port power supply control signal. 0: Power supply OFF 1: Power supply ON
U3TXDP2	44	37	O (USB3)	–	USB3.0 Transmit data D+ signal for SuperSpeed
U3TXDN2	45	38	O (USB3)	–	USB3.0 Transmit data D- signal for SuperSpeed
U3RXDP2	47	40	I (USB3)	–	USB3.0 Receive data D+ signal for SuperSpeed
U3RXDN2	48	41	I (USB3)	–	USB3.0 Receive data D- signal for SuperSpeed
U2DP2	50	44	I/O (USB2)	–	USB2.0 D+ signal for Hi-/Full-/Low-Speed
U2DM2	51	45	I/O (USB2)	–	USB2.0 D– signal for Hi-/Full-/Low-Speed
OCI2B	24	17	I (3.3 V Input)	Low	Over-current status input signal. 0: Over-current condition is detected 1: No over-current condition is detected
PPON2	25	18	O (3.3 V Output)	High	USB port power supply control signal. 0: Power supply OFF 1: Power supply ON

Pin Name	720201 Pin No.	720202 Pin No.	I/O Type	Active Level	Function
U3TXDP3	52	–	O (USB3)	–	USB3.0 Transmit data D+ signal for SuperSpeed
U3TXDN3	53	–	O (USB3)	–	USB3.0 Transmit data D- signal for SuperSpeed
U3RXDP3	55	–	I (USB3)	–	USB3.0 Receive data D+ signal for SuperSpeed
U3RXDN3	56	–	I (USB3)	–	USB3.0 Receive data D- signal for SuperSpeed
U2DP3	58	–	I/O (USB2)	–	USB2.0 D+ signal for Hi-/Full-/Low-Speed
U2DM3	59	–	I/O (USB2)	–	USB2.0 D- signal for Hi-/Full-/Low-Speed
OCI3B	22	–	I (3.3 V Input)	Low	Over-current status input signal. 0: Over-current condition is detected 1: No over-current condition is detected
PPON3	23	–	O (3.3 V Output)	High	USB port power supply control signal. 0: Power supply OFF 1: Power supply ON
U3TXDP4	61	–	O (USB3)	–	USB3.0 Transmit data D+ signal for SuperSpeed
U3TXDN4	62	–	O (USB3)	–	USB3.0 Transmit data D- signal for SuperSpeed
U3RXDP4	64	–	I (USB3)	–	USB3.0 Receive data D+ signal for SuperSpeed
U3RXDN4	65	–	I (USB3)	–	USB3.0 Receive data D- signal for SuperSpeed
U2DP4	67	–	I/O (USB2)	–	USB2.0 D+ signal for Hi-/Full-/Low-Speed
U2DM4	68	–	I/O (USB2)	–	USB2.0 D- signal for Hi-/Full-/Low-Speed
OCI4B	20	–	I (3.3V Input)	Low	Over-current status input signal. 0: Over-current condition is detected 1: No over-current condition is detected
PPON4	21	–	O (3.3V Output)	High	USB port power supply control signal. 0: Power supply OFF 1: Power supply ON

Note 1: The SuperSpeed signals (U3TXDPx, U3TXDNx, U3RXDPx, U3RXDNx) and Hi-/Full-/Low-signals (U2DPx, U2DMx) of μPD720201 and μPD720202 shall be connected to the same USB connector.

Note 2: The Timing of PPONx assertion is changed from μPD720200. The PPONx of μPD720200A, μPD720201 and μPD720202 are asserted after the software sets Max Device Slots Enable (MaxSlotsEn) field in Configure (CONFIG) register or Host Controller Reset (HCRST) flag in USBCMD register. On μPD720200, the PPON (2:1) are asserted immediately after the PCIe Reset.

2.3.4 SPI Interface

Table 2-7. SPI Interface

Pin Name	720201 Pin No.	720202 Pin No.	Type	Active Level	Function
SPISCK	18	15	O (3.3 V output)	–	SPI serial flash ROM clock signal. When the external serial ROM is not mounted, this signal should be pulled down through a pull-down resistor.
SPICSB	17	14	O (3.3 V output)	–	SPI serial flash ROM chip select signal. When the external serial ROM is not mounted, this signal should be pulled down through a pull-down resistor.
SPISI	19	16	O (3.3 V output)	–	SPI serial flash ROM slave input signal. When the external serial ROM is not mounted, this signal should be pulled down through a pull-down resistor.
SPISO	16	13	I (3.3 V Input)	–	SPI serial flash ROM slave output signal. This signal should be pulled up through a pull-up resistor in all cases.

3. Register Information

The μPD720201 and μPD720202 are implemented with the eXtensible Host Controller (xHCI) core that handles all speeds required for USB 3.0, SuperSpeed and Hi-/Full-/Low-Speed. The following sections show PCI configuration space and Memory Mapped I/O register information for the xHCI host controller. The number of valid ports is specified by “HCSPARAMS1” register in the Host Controller Capability Registers.

3.1 Register Attributes

The following notation is used to describe register access attributes.

Table 3-1. Register and Register Bit-Field Types

Register Attribute	Description
HwInit	Hardware Initialized: Register bits are initialized by firmware or hardware mechanisms such as pin strapping or serial external ROM. Bits are read-only after initialization and may only be reset with a HCRST.
RO	Read-only: Register bits are read-only and cannot be altered by software. Register bits are permitted to be initialized by hardware and firmware mechanisms such as pin strapping or serial external ROM.
RWO	Read-Write-once: Register bits can be written only once after power up. After the first write, the bits become read only.
RW	Read-Write: Register bits are read-write and are permitted to be either Set or Cleared by software to the desired state. Note that individual bits in some read/write registers may be Read-Only.
RW1C	Write-1-to-clear status: Register bits indicate status when read. A set bit indicating a status event may be cleared by writing a '1'. Writing a '0' to RW1C bits has no effect.
RW1S	Write-1-to-set status: Register bits indicate status when read. A clear bit may be set by writing a '1'. Writing a '0' to RW1S bits has no effect.
RWS	Sticky-Read-Write: Register bits are read-write and are Set or Cleared by software to the desired state. Bits are only initialized or modified by hot reset. Where noted, registers that consume AUX power shall preserve sticky register values when AUX power consumption is enabled. In these cases, registers are not initialized or modified by hot, warm, or cold reset.
RW1CS	Sticky-Write-1-to clear status: Register bits indicate status when read. A set bit indicating a status event may be cleared by writing '1'. Writing a '0' to RW1CS bits has no effect. Bits are not initialized or modified by hot reset. Where noted, registers that consume AUX power shall preserve sticky register values when AUX power consumption is enabled. In these cases, registers are not initialized or modified by hot, warm, or cold reset.
Rsvd	Reserved: Reserved for future implementation. Rsvd registers or memory shall be treated as read-only by system software. Rsvd registers shall return '0' when read. Software shall ignore the value read from these bits.

3.2 PCI Configuration Space

The configuration registers are accessed in order to set up hardware resources, device characteristics or operations, etc. in PCI Express. The following sections describe the PCI Configuration Space, which is the address space for the configuration registers. For more detailed description, see the **PCI Express Base Specification Revision 2.0**.

3.2.1 PCI Type 0 Configuration Space Header

Table 3-2. PCI Type 0 Configuration Space Header

31	23	15	7	Offset
24	16	8	0	
Device ID		Vendor ID		00h
Status		Command		04h
Class Code			Revision ID	08h
BIST	Header Type	Latency Timer	Cache Line Size	0Ch
Base Address Register #0				10h
Base Address Register #1				14h
Reserved				18h~28h
Subsystem ID		Subsystem Vendor ID		2Ch
Reserved				30h
Reserved			Cap_Ptr	34h
Reserved				38h
Max_Lat	Min_Gnt	Interrupt Pin	Interrupt Line	3Ch
Reserved				40h~4Ch
PMC		Next_Ptr	Cap_ID	50h
Reserved		PMSC		54h
Reserved				58h~5Ch
Reserved		FLADJ	SBRN	60h
Reserved				64h~6Ch
Reserved	FW Version		Reserved	6Ch
Message Control		Next_Ptr	Cap_ID	70h
MSI Address				74h
MSI Upper Address				78h
Reserved		MSI Data		7Ch
MSI Mask Bits				80h
MSI Pending Bits				84h
Reserved				88h~8Ch
Message Control		Next_Ptr	Cap_ID	90h
Table Offset , Table BIR				94h
PBA Offset , PBA BIR				98h
Reserved				9Ch
PCI Express Capability		Next_Ptr	Cap_ID	A0h

Device Capability		A4h
Device Status	Device Control	A8h
Link Capability		ACh
Link Status	Link Control	B0h
Reserved		B4h~C3h
Device Capability 2		C4h
Device Status 2	Device Control 2	C8h
Link Capability 2		CCh
Link Status 2	Link Control 2	D0h
Reserved		D4h~DBh
PHY Control 0		DCh
PHY Control 1		E0h
PHY Control 2		E4h
Host Controller Configuration		E8h
External ROM Information		ECh
External ROM Configuration		F0h
External ROM Write Control & Status	FW Download Control & Status	F4h
DATA 0		F8h
DATA 1		FCh
Advanced Error Reporting Enhanced Capability Header		100h
Uncorrectable Error Status Register		104h
Uncorrectable Error Mask Register		108h
Uncorrectable Error Severity Register		10Ch
Correctable Error Status Register		110h
Correctable Error Mask Register		114h
Advanced Error Capabilities and Control Register		118h
Header Log 1		11Ch
Header Log2		120h
Header Log3		124h
Header Log4		128h
Device Serial Number Enhanced Capability Header		140h
Serial Number Register (Lower DW)		144h
Serial Number Register (Upper DW)		148h
LTR Extended Capability Header		150h
Max No-Snoop Latency Register	Max Snoop Latency Register	154h

3.2.1.1 Vendor ID Register

Table 3-3. Vendor ID Register (Offset Address: 00h)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Vendor ID	RO	1912h	This is a 16-bit value.

3.2.1.2 Device ID Register

Table 3-4. Device ID Register (Offset Address: 02h)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Device ID	RO	0014h (μPD720201) 0015h (μPD720202)	This is a 16-bit value. 0014h is assigned to μPD720201 and 0015h is assigned to μPD720202.

3.2.1.3 Command Register

Table 3-5. Command Register (Offset Address: 04h)

Bits	Field	Read/Write	Value (Default)	Comment
0	I/O Space	RO	0b	No support I/O space
1	Memory Space	RW	0b	Controls response to memory access 0: Memory access disable 1: Memory access enable
2	Bus Master	RW	0b	Controls the ability of a PCI Express Endpoint to issue Memory Read/Write Requests. When Set, the PCI Express Function is allowed to issue Memory Requests.
3	Special Cycles	RO	0b	Does not apply to PCI Express.
4	Memory Write and Invalidate Enable	RO	0b	Does not apply to PCI Express.
5	VGA palette snoop	RO	0b	Does not apply to PCI Express.
6	Parity Error response	RW	0b	This bit controls the logging of poisoned TLPs in the Master Data Parity Error bit in the Status register.
7	Wait cycle control	RO	0b	Does not apply to PCI Express.
8	SERR# enable	RW	0b	When Set, this bit enables reporting of Non-fatal and Fatal errors detected by the Function to the Root Complex.

Bits	Field	Read/Write	Value (Default)	Comment
9	Fast back-to-back enable	RO	0b	Does not apply to PCI Express.
10	Interrupt Disable	RW	0b	Controls the ability of a PCI Express Function to generate INTx interrupts. When Set, Functions are prevented from asserting INTx interrupts.
15 : 11	Rsvd	-	-	Reserved.

3.2.1.4 Status Register

Table 3-6. Status Register (Offset Address: 06h)

Bits	Field	Read/Write	Value (Default)	Comment
2 : 0	Rsvd	-	-	Reserved.
3	Interrupt Status	RO	0b	Shows Interrupt Status. When "Interrupt Disable" bit in PCI Command Register is set to 0b, the register shows the Interrupt Status. When "Interrupt Disable" is set to 1b; the register is invalid.
4	Capabilities List	RO	1b	Indicates the presence of an Extended Capability list item.
5	66 MHz capable	RO	0b	Does not apply to PCI Express.
6	Rsvd	-	-	Reserved.
7	Fast back-to-back capable	RO	0b	Does not apply to PCI Express.
8	Master Data Parity Error	RW1C	0b	This bit is set if the Parity Error Response bit in the Command register is 1b and either of the following two conditions occurs: - Receive a Completion marked poisoned - Poison a write Request. If the Parity Error Response bit is 0b, this bit is never set.
10 : 9	DEVSEL timing	RO	00b	Does not apply to PCI Express.
11	Signaled target abort	RW1C	0b	This bit is set when a function completes a posted or non-posted request as a completer abort error.
12	Received target abort	RW1C	0b	This bit is set when a requester receives a completion with completer abort completion status.

Bits	Field	Read/Write	Value (Default)	Comment
13	Received master abort	RW1C	0b	This bit is set when a requester receives a completion with unsupported request completion status.
14	Signaled system error	RW1C	0b	This bit is set when a function sends an ERR_FATAL or ERR_NONFATAL Message, and the SERR# Enable bit in the Command register is 1b.
15	Detected parity error	RW1C	0b	This bit is set by a function whenever it receives a Poisoned TLP, regardless of the state the Parity Error Response bit in the Command register.

3.2.1.5 Revision ID Register

Table 3-7. Revision ID Register (Offset Address: 08h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Revision ID	RO	03h(μPD720201) 02h(μPD720202)	Revision ID.

3.2.1.6 Class Code Register

Table 3-8. Class Code Register (Offset Address: 09h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Programming Interface	RO	30h	USB3.0 host controller.
15 : 8	Sub Class	RO	03h	Universal Serial Bus.
23 : 16	Base Class	RO	0Ch	Serial Bus Controllers.

3.2.1.7 Cache Line Size Register

Table 3-9. Cache Line Size Register (Offset Address: 0Ch)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Cache Line Size	RW	0h	Cache Line Size. This field is implemented as a read-write field for legacy compatibility purposes but has no effect on this device behavior.

3.2.1.8 Latency Timer Register

Table 3-10. Latency Timer Register (Offset Address: 0Dh)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Latency Timer	RO	0h	Does not apply to PCI Express.

3.2.1.9 Header Type Register

Table 3-11. Header Type Register (Offset Address: 0Eh)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Header Type	RO	0h	Header Type 0.

3.2.1.10 BIST Register

Table 3-12. BIST Register (Offset Address: 0Fh)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	BIST	RO	0h	BIST is not supported.

3.2.1.11 Base Address Register #0

Table 3-13. Base Address Register #0 (Offset Address: 10h)

Bits	Field	Read/Write	Value (Default)	Comment
0	Memory space Indicator	RO	0b	Operational registers are mapped to main memory space.
2 : 1	Type	RO	10b	Base register is 64bits wide and can be mapped anywhere in the 64-bit address space.
3	Prefetchable	RO	0b	Prefetch is disabled.
12 : 4	Base address (LSB)	RO	0h	Operational registers require 8Kbyte address space.
31 : 13	Base address (MSB)	RW	0h	Indicates the high-order 19 bits of the base address in the Operational registers.

3.2.1.12 Base Address Register #1

Table 3-14. Base Address Register #1 (Offset Address: 14h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Base address	RW	0h	Indicates the high-order 32 bits of the base address in the Operational registers.

3.2.1.13 Subsystem Vendor ID Register

Table 3-15. Subsystem Vendor ID Register (Offset Address: 2Ch)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Subsystem Vendor ID	RWO	0000h	This is written by BIOS or loaded from an External Serial Rom. After the first write, this register bits become read only. This register is initialized to default value by the assertion of PONRSTB.

3.2.1.14 Subsystem ID Register

Table 3-16. Subsystem ID Register (Offset Address: 2Eh)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Subsystem ID	RWO	0000h	This is written by BIOS or loaded from an External Serial ROM. After the first write, this register bits become read only. This register is initialized to default value by the assertion of PONRSTB.

3.2.1.15 Capabilities Pointer Register

Table 3-17. Capabilities Pointer Register (Offset Address: 34h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Capabilities Pointer	RO	50h	Capability Pointer.

3.2.1.16 Interrupt Line Register

Table 3-18. Interrupt Line Register (Offset Address: 3Ch)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Interrupt Line	RW	0h	Interrupt line's route

3.2.1.17 Interrupt Pin Register

Table 3-19. Interrupt Pin Register (Offset Address: 3Dh)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Interrupt Pin	RO	01h	Routing to INTA#

3.2.1.18 Min_Gnt Register

Table 3-20. Min_Gnt Register (Offset Address: 3Eh)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Min_Gnt	RO	0h	Does not apply PCI Express.

3.2.1.19 Max_LAT Register

Table 3-21. Max_Lat Register (Offset Address: 3Fh)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Max_Lat	RO	0h	Does not apply PCI Express.

3.2.1.20 Serial Bus Release Number Register (SBRN)

This register contains the release of the Universal Serial Bus Specification with which this Universal Serial Bus Host Controller module is compliant.

Table 3-22. SBRN Register (Offset Address: 60h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Serial Bus Specification Release Number	RO	30h	Serial Bus Release Number Register. This register indicates the release number of the USB with which this controller is compliant.

3.2.1.21 Frame Length Adjustment Register (FLADJ)

This register is the Auxiliary Power well. This feature is used to adjust any offset from the clock source that generates the clock that drives the SOF counter. When a new value is written into these six bits, the length of the frame is adjusted for all USB buses implemented by an xHC. Its initial programmed value is system dependent based on the accuracy of hardware USB clock and is initialized by system software (typically the BIOS). This register should only be modified when the HCHalted (HCH) bit in the USBSTS register is '1'. Changing the value of this register while the host controller is operating yield undefined results.

Table 3-23. FLADJ Register (Offset Address: 61h)

Bits	Field	Read/Write	Value (Default)	Comment														
5 : 0	Frame Length Timing Value	RWS	20h	<p>Each decimal value change to this register corresponds to 16 Hi-Speed bit times. The SOF cycle time (number of SOF counter clock periods to generate a SOF microframe length) is equal to 59488 + value in this field. The default vale is decimal 32 (20h), which gives an SOF cycle time of 60000.</p> <table border="0"> <tr> <td>Frame Length</td> <td>FLADJ Value</td> </tr> <tr> <td>59488</td> <td>0</td> </tr> <tr> <td>...</td> <td></td> </tr> <tr> <td>59984</td> <td>31</td> </tr> <tr> <td>60000</td> <td>32</td> </tr> <tr> <td>...</td> <td></td> </tr> <tr> <td>60496</td> <td>63</td> </tr> </table>	Frame Length	FLADJ Value	59488	0	...		59984	31	60000	32	...		60496	63
Frame Length	FLADJ Value																	
59488	0																	
...																		
59984	31																	
60000	32																	
...																		
60496	63																	
7 : 6	Rsvd	-	-	Reserved.														

3.2.2 PCI Power Management Capabilities

3.2.2.1 Capabilities List Register

Table 3-24. Capabilities List Register (Offset Address: 50h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Cap_ID	RO	01h	ID for PCI Power Management reg.
15 : 0	Next_Ptr	RO	70h	Next Capability Pointer.

3.2.2.2 Power Management Capabilities Register (PMC)

Table 3-25. PMC Register (Offset Address: 52h)

Bits	Field	Read/Write	Value (Default)	Comment																				
2 : 0	Version	RO	11b	Supports PCI Power Management Interface Specification release 1.2																				
3	PME Clock	RO	0b	Does not apply to PCI Express.																				
4	Rsvd	-	-	Reserved.																				
5	DSI	RO	0b	Does not required Specific Initialization before the generic class device driver is able to use it.																				
8 : 6	Aux_Current	Hwlnit	111b	Indicates current requirement. If the AUXDET in HCConfiguration register is '0b', this field returns a value of "000b" when read. If the AUXDET in HCConfiguration register is '1b', following assignments apply: <table border="0" style="margin-left: 20px;"> <tr> <td style="text-align: right;">Bit</td> <td style="text-align: right;">3.3Vaux</td> </tr> <tr> <td style="text-align: right;"><u>8 7 6</u></td> <td style="text-align: right;"><u>Max. Current Required</u></td> </tr> <tr> <td style="text-align: right;">1 1 1</td> <td style="text-align: right;">375 mA</td> </tr> <tr> <td style="text-align: right;">1 1 0</td> <td style="text-align: right;">320 mA</td> </tr> <tr> <td style="text-align: right;">1 0 1</td> <td style="text-align: right;">270 mA</td> </tr> <tr> <td style="text-align: right;">1 0 0</td> <td style="text-align: right;">220 mA</td> </tr> <tr> <td style="text-align: right;">0 1 1</td> <td style="text-align: right;">160 mA</td> </tr> <tr> <td style="text-align: right;">0 1 0</td> <td style="text-align: right;">100 mA</td> </tr> <tr> <td style="text-align: right;">0 0 1</td> <td style="text-align: right;">55 mA</td> </tr> <tr> <td style="text-align: right;">0 0 0</td> <td style="text-align: right;">0 (self powerd)</td> </tr> </table>	Bit	3.3Vaux	<u>8 7 6</u>	<u>Max. Current Required</u>	1 1 1	375 mA	1 1 0	320 mA	1 0 1	270 mA	1 0 0	220 mA	0 1 1	160 mA	0 1 0	100 mA	0 0 1	55 mA	0 0 0	0 (self powerd)
Bit	3.3Vaux																							
<u>8 7 6</u>	<u>Max. Current Required</u>																							
1 1 1	375 mA																							
1 1 0	320 mA																							
1 0 1	270 mA																							
1 0 0	220 mA																							
0 1 1	160 mA																							
0 1 0	100 mA																							
0 0 1	55 mA																							
0 0 0	0 (self powerd)																							
9	D1_support	RO	0b	No Support.																				
10	D2_support	RO	0b	No Support.																				

Bits	Field	Read/Write	Value (Default)	Comment
15 : 11	PME_support	Hwlnit	X1001b	<p>If the AUXDET in HConfiguration register is set to '1b', bit 15 is set to '1'.</p> <p>This 5-bit field indicates the power states in which the function may send PME Message. A value of 0b for any bit indicates that the function is not capable of sending the PME Message while in that power state.</p> <p>PME Message can be sent from D0 and D3hot.</p>

3.2.2.3 Power Management Status / Control Register (PMSC)

Table 3-26. PMSC Register (Offset Address: 54h)

Bits	Field	Read/Write	Value (Default)	Comment
1 : 0	Power State	RW	0b	<p>This 2-bit field is used both to determine the current power state of a function and to set the function into a new power state. The definition of the field values is given below.</p> <p>00b : D0 11b : D3</p> <p>In case of transitioning from D0 to D3, Run/Stop in USBCMD register should be 0b, and HCHalted in USBSTS register is 1b.</p> <p>If Run/Stop is 1b and HCHalted is 0b and Power State is set from D0 to D3, the behavior of μPD720201/ μPD720202 is undefined.</p>
2	Rsvd	-	-	Reserved.
3	No_Soft_Reset	RO	1b	<p>This bit indicates that devices transitioning from D3hot to D0 do not perform an internal reset. Configuration Context is preserved. Upon transition from D3hot to the D0 Initialized state, no additional operating system intervention is required to preserve Configuration Context beyond writing the Power State bits.</p>
7 : 4	Rsvd	-	-	Reserved.

Bits	Field	Read/Write	Value (Default)	Comment
8	PME Enable	RWS	0b	A '1' enables the function to send PME Message. When '0', PME Message is disabled.
12 : 9	Data Select	RO	0b	No support.
14 : 13	Data Scale	RO	0b	No support.
15	PME Status	RW1CS	0b	This bit is set when the function would send the PME message if enabled to do so. This bit is independent of the state of PME Enable bit. Writing a '1' to this bit will clear it and cause the function to stop sending PME message. Writing a '0' has no effect.

3.2.3 MSI Capabilities

3.2.3.1 Capabilities List Register for MSI

Table 3-27. Capabilities List Register (Offset Address: 70h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Cap_ID	RO	05h	ID for MSI Capability reg.
15 : 8	Next_Ptr	RO	90h	Pointer to the next capabilities list.

3.2.3.2 Message Control for MSI

Table 3-28. Message Control Register (Offset Address: 72h)

Bits	Field	Read/Write	Value (Default)	Comment
0	MSI Enable	RW	0b	If 1 and MSI-X Enable bit is 0, the function is permitted to use MSI.
3 : 1	Multiple Message Capable	RO	11b	Supports 8 request vectors.
6 : 4	Multiple Message Enable	RW	0b	System software writes to this field to indicate the number of allocated vectors.
7	64bit address capable	RO	1b	This is capable of sending 64bit message address.
8	Per-vector masking capable	RO	0b	Does not support MSI per-vector masking.
15 : 9	Rsvd	-	-	Reserved.

3.2.3.3 Message Address for MSI

Table 3-29. Message Address Register (Offset Address: 74h)

Bits	Field	Read/Write	Value (Default)	Comment
1 : 0	Rsvd	-	-	Reserved.
31 : 2	MSI Address	RW	0h	System-specified message address.

3.2.3.4 Message Upper Address for MSI

Table 3-30. Message Upper Address Register (Offset Address: 78h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	MSI Upper Address	RW	0h	System-specified message address.

3.2.3.5 Message Data for MSI

Table 3-31. Message Data Register (Offset Address: 7Ch)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	MSI Data	RW	0h	System-specified message data.

3.2.3.6 Mask Bits for MSI

Table 3-32. Mask Bits Register (Offset Address: 80h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	MSI Mask bits	RW	0h	For each Mask bit that is set, the function is prohibited from sending the associated message.

3.2.3.7 Pending Bits for MSI

Table 3-33. Pending Bits Register (Offset Address: 84h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	MSI Pending bits	RO	0h	Does not support MSI Pending bits.

3.2.4 MSI-X Capabilities

3.2.4.1 Capabilities List Register for MSI-X

Table 3-34. Capabilities List Register (Offset Address: 90h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Cap_ID	RO	11h	ID for MSI-X Capability reg.
15 : 8	Next_Ptr	RO	A0h	Pointer to the next capabilities list.

3.2.4.2 Message Control for MSI-X

Table 3-35. Message Control Register (Offset Address: 92h)

Bits	Field	Read/Write	Value (Default)	Comment
10 : 0	Table Size	RO	111b	MSI-X Table Size. This controller supports 8 entries.
13 : 11	Rsvd	-	-	Reserved.
14	Function Mask	RW	0b	If 1, all of the vectors associated with the function are masked, regardless of their per-vector Mask bit states. If 0, each vector's mask bit determines whether the vector is masked or not.
15	MSI-X Enable	RW	0b	If 1 and the MSI Enable bit in the MSI Message Control register is 0, the function is permitted to use MSI-X.

3.2.4.3 Table Offset / Table BIR for MSI-X

Table 3-36. Table Offset / Table BIR Register (Offset Address: 94h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Table Offset	RO	1000h	Indicates that MSI-X table is located at BaseAddress + 1000h.

3.2.4.4 PBA Offset for MSI-X

Table 3-37. Message Upper Address Register (Offset Address: 98h)

Bits	Field	Read/ Write	Value (Default)	Comment
31 : 0	PBA Offset	RO	1080h	Indicates that MSI-X table is located at BaseAddress + 1080h .

3.2.5 PCI Express Extended Capabilities

3.2.5.1 PCI Express Capabilities List Register

Table 3-38. PCI Express Capabilities List Register (Offset Address: A0h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Cap_ID	RO	10h	ID for PCI Express Capability reg.
15 : 8	Next_Ptr	RO	0h	Pointer to the next capabilities list.

3.2.5.2 PCI Express Capabilities Register

Table 3-39. PCI Express Capabilities Capability Register (Offset Address: A2h)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Capability Version	RO	10b	Indicates PCI-SIG defined PCI Express Capability structure version number.
7 : 4	Device / Port Type	RO	0b	Indicates PCI Express Endpoint.
8	Slot Implemented	RO	0b	This field is invalid for PCI Express Endpoint.
13 : 9	Interrupt Message Number	RO	0b	Indicates which MSI/MSI-X vector is used for the interrupt message generated in association with any of the status bits of this capability structure.
15 : 14	Rsvd	-	-	Reserved.

3.2.5.3 Device Capabilities Register

Table 3-40. Device Capabilities Register (Offset Address: A4h)

Bits	Field	Read/Write	Value (Default)	Comment
2 : 0	Max_Payload_Size Supported	RO	0b	Indicates the maximum payload size that the Function can support for TLPs. μPD720201/μPD720202 support 128bytes max payload size.
4 : 3	Phantom Functions Supported	RO	0b	Does not support Phantom Functions.
5	Extended Tag Field Supported	RO	0b	Indicates the maximum supported size of Tag field as a Requester. μPD720201/μPD720202 support 5-bit Tag field.

Bits	Field	Read/Write	Value (Default)	Comment
8 : 6	Endpoint L0s Acceptable Latency	RO	111b	Indicates the acceptable total latency that an Endpoint can withstand due to the transition from L0s state to the L0 state. 111b is no limit.
11 : 9	Endpoint L1 Acceptable Latency	RO	111b	Indicates the acceptable total latency that an Endpoint can withstand due to the transition from L1 state to the L0 state. 111b is no limit.
14 : 12	Rsvd	-	-	Reserved.
15	Role-Based Error Reporting	RO	1b	Supports Error Reporting functionality.
17 : 16	Rsvd	-	-	Reserved.
25 : 18	Captured Slot Power Limit Value	RO	0b	In combination with the Slot Power Limit Scale value, specifies the upper limit on power supplied by slot.
27 : 26	Captured Slot Power Limit Scale	RO	0b	Specifies the scale used for the Slot Power Limit Value.
28	Function Level Reset Capability	RO	0b	Optional Function Level Reset mechanism is not supported.
31 : 29	Rsvd	-	-	Reserved.

3.2.5.4 Device Control Register

Table 3-41. Device Control Register (Offset Address: A8h)

Bits	Field	Read/Write	Value (Default)	Comment
0	Correctable Error Reporting Enable	RW	0b	This bit, in conjunction with other bits, controls sending ERR_COR Message.
1	Non-Fatal Error Reporting Enable	RW	0b	This bit, in conjunction with other bits, controls sending ERR_NONFATAL Messages.
2	Fatal Error Reporting Enable	RW	0b	This bit, in conjunction with other bits, controls sending ERR_FATAL Messages.
3	Unsupported Request Reporting Enable	RW	0b	This bit, in conjunction with other bits, controls the signaling of Unsupported Requests by sending Error Messages.
4	Enable Relaxed Ordering	RW	1b	μPD720201/μPD720202 are permitted to set the Relaxed Ordering bit in the Attributes field of transactions it initiates that do not require strong write ordering.

Bits	Field	Read/Write	Value (Default)	Comment
7 : 5	Max_Payload_Size	RW	0b	This field sets maximum TLP payload seize for μPD720201/μPD720202.
8	Extended Tag Field Enable	RO	0b	Does not support this capability.
9	Phantom Function Enable	RO	0b	Does not support this capability.
10	Auxiliary (AUX) Power PM Enable	RWS	0b	When set this bit, enables a Function to draw AUX power independent of PME AUX power.
11	Enable No Snoop	RW	1b	If this bit is Set, μPD720201/μPD720202 are permitted to Set the No snoop bit in the Requester Attributes of transactions it initiates that do not require hardware enforced cache coherency.
14 : 12	Max_Read_Request_Size	RW	010b	This field sets the maximum Read Request size for the Function as a Requester.
15	Initiate Function Level Reset	RW	0b	A write of 1b initiates Function Level Reset to the Function. The value read by software from this bit is always 0b.

3.2.5.5 Device Status Register

Table 3-42. Device Status Register (Offset Address: AAh)

Bits	Field	Read/Write	Value (Default)	Comment
0	Correctable Error Detected	RW1C	0b	This bit indicates status of correctable errors detected.
1	Non-Fatal Error Detected	RW1C	0b	This bit indicates status of Non-Fatal errors detected.
2	Fatal Error Detected	RW1C	0b	This bit indicates status of Fatal errors detected.
3	Unsupported Request Detected	RW1C	0b	This bit indicates that μPD720201/μPD720202 received an Unsupported Request.
4	AUX Power Detected	RO	HwInit	If the AUXDET bit in HCConfiguration register is set to 1b, this bit is set to 1.
5	Transactions Pending	RO	0b	When set, this bit indicates that μPD720201/μPD720202 has issued Non-Posted Requests that have not been completed.
15 : 6	Rsvd	-	-	Reserved

3.2.5.6 Link Capabilities Register

Table 3-43. Link Capabilities Register (Offset Address: ACh)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Supported Link Speeds	RO	10b	This field indicates the supported Link speeds of the associated Port. μPD720201/μPD720202 supports 5.0GT/s and 2.5GT/s Link speeds.
9 : 4	Maximum Link Width	RO	1b	This field indicates the maximum Link width. μPD720201/μPD720201 supports 1Lane.
11 : 10	Active State Power Management(ASPM) Support	RO	11b	This field indicates the level of ASPM supported on the given PCI Express Link.
14 : 12	L0s Exit Latency	RO	110b	This field indicates the L0s exit latency for the given PCI Express Link. 110b indicates 2us-4us.
17 : 15	L1 Exit Latency	RO	111b	This field indicates the L1 exit latency for the given PCI Express Link. 111b indicates more than 64us.
18	Clock Power Management	RO	1b	1b indicates that the component tolerates the removal of any reference clock via the “ clock request”(CLKREQ#) mechanism when the Link is in the L1 states.
21 : 19	Rsvd	-	-	Reserved.
31 : 24	Port Number	RO	0b	This field indicates the PCI Express Port number for the given PCI Express Link.

3.2.5.7 Link Control Register

Table 3-44. Link Control Register (Offset Address: B0h)

Bits	Field	Read/Write	Value (Default)	Comment
1 : 0	Active State Power Management(ASPM) Control	RW	Hwlnit	This field controls the level of ASPM supported on the given PCI Express Link. If the PSEL bit in HCConfiguration register is set to 0b, default value is 11b. 00b : Disabled 01b : L0s Entry Enabled 10b : L1 Entry Enabled 11b : L0s and L1 Entry enabled
2	Rsvd	-	-	Reserved.

Bits	Field	Read/Write	Value (Default)	Comment
3	Read Completion Boundary (RCB)	RO	0b	Read Completion Boundary is 64byte.
4	Link Disable	RO	0b	This bit disables the Link by directing the LTSSM to the Disable state when Set. This bit is reserved on Endpoints, PCI Express to PCI/PCI-X bridges, and Upstream Ports of Switches.
5	Retrain Link	RO	0b	This bit is not applicable and is reserved for Endpoints, PCI Express to PCI/PCI-X bridges, and Upstream Ports of Switches. This bit always returns 0b when read.
6	Common Clock Configuration	RW	0b	When Set, this bit indicates that this component and the component at the opposite end of this Link are operating with a distributed common reference clock.
7	Extended Sync	RW	0b	When Set, this bit forces the transmission of additional Ordered Sets when exiting the L0s state and when in the Recovery state.
8	Enable Clock Power Management	RW	1b	0b: Clock power management is disabled and μPD720201/μPD720202 hold CLKREQ# signal low. 1b: When this bit is Set, μPD720201/μPD720202 are permitted to use CLKREQ# signal to power manage Link clock according to protocol defined in appropriate form factor specification. If the CLKREQFORCE bit in HCConfiguration register is '1', CLKREQ# signal always is held low although Enable Clock Power Management bit is '1'.
9	Hardware Autonomous Width Disable	RO	0b	Disables hardware from changing the Link width.
15 : 10	Rsvd	-	-	Reserved.

3.2.5.8 Link Status Register

Table 3-45. Link Status Register (Offset Address: B2h)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Current Link Speed	RO	1b	This field indicates the negotiated Link speed of the given PCI Express Link. 0001b : 2.5GT/s PCI Express Link 0010b : 5.0GT/s PCI Express Link
9 : 4	Negotiated Link Width	RO	1b	This field indicates the negotiated width of the given PCI Express Link.
11 : 10	Rsvd	-	-	Reserved.
12	Slot Clock Configuration	RO	1b	This bit indicates that the component uses the same physical reference clock that the platform provides on the connector.
13	Data Link Layer Link Active	RO	0b	This bit indicates the status of the Data Link Control and Management State Machine. It returns a '1'b to indicate the DL_Active state, '0'b otherwise.
15 : 14	Rsvd	-	-	Reserved.

3.2.5.9 Device Capabilities 2 Register

Table 3-46. Device Capabilities 2 Register (Offset Address: C4h)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Completion Timeout Ranges Supported	RO	0b	Completion Timeout programming not supported.
4	Completion Timeout Disable Supported	RO	1b	Indicates support for the Completion Timeout Disable mechanism.
10 : 5	Rsvd	-	-	Reserved.
11	LTR Mechanism Supported	RO	1b	Indicates support for the Latency Tolerance Reporting (LTR) mechanism capability.
31 : 12	Rsvd	-	-	Reserved.

3.2.5.10 Device Control 2 Register

Table 3-47. Device Control 2 Register (Offset Address: C8h)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Completion Timeout Value	RW	0b	Default range : 50us to 50ms.

Bits	Field	Read/Write	Value (Default)	Comment
4	Completion Timeout Disable	RW	0b	When Set, this bit disables the Completion Timeout mechanism.
9 : 5	Rsvd	-	-	Reserved.
10	LTR Mechanism Enable	RW	0b	When Set to 1b, this bit enables the Latency Tolerance Reporting (LTR) mechanism.
15 : 11	Rsvd	-	-	Reserved.

3.2.5.11 Device Status 2 Register

Table 3-48. Device Status 2 Register (Offset Address: CAh)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Rsvd	-	-	Reserved.

3.2.5.12 Link Capabilities 2 Register

Table 3-49. Link Capabilities 2 Register (Offset Address: CCh)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Rsvd	-	-	Reserved.

3.2.5.13 Link Control 2 Register

Table 3-50. Link Control 2 Register (Offset Address: D0h)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Target Link Speed	RWS	10b	This field is used to set the target compliance mode speed when software is using the Enter Compliance bit to force a Link into compliance mode. 0010b : 5.0GT/s Target Link Speed
4	Enter Compliance	RWS	0b	Software is permitted to force a Link to enter Compliance mode at the Target Link Speed by setting this bit to 1b in both components on a Link and then initiating a hot reset on the Link.

Bits	Field	Read/Write	Value (Default)	Comment
5	Hardware Autonomous Speed Disable	RWS	0b	When Set, this bit disables hardware from changing the Link speed for device-specific reasons other than attempting to correct unreliable Link operation by reducing Link speed.
6	Rsvd	-	-	Reserved.
9 : 7	Transmit Margin	RWS	0b	This field controls the value of the non-deemphasized voltage level at the Transmitter pins. This register is intended for debug, compliance testing purposes only.
10	Enter Modified Compliance	RWS	0b	When this bit is set to 1b, the device transmits Modified Compliance Pattern if the LTSSM enters Polling.Compliance substate.
11	Compliance SOS	RWS	0b	When set to 1b, the LTSSM is required to send SKP Ordered Sets periodically in between the (modified) compliance patterns,.
12	Compliance De-emphasis	RWS	0b	This bit sets the de-emphasis level in Polling.Compliance state if the entry occurred due to the Enter Compliance bit being 1b.

3.2.5.14 Link Status 2 Register

Table 3-51. Link Status 2 Register (Offset Address: D2h)

Bits	Field	Read/Write	Value (Default)	Comment
0	Current De-emphasis Level	RO	1b	When the Link is operating at 5GT/s speed, this bit reflects the level of de-emphasis. 1b : -3.5dB 0b : -6dB
15 : 1	Rsvd	-	-	Reserved.

3.2.6 RENESAS Specific Registers

3.2.6.1 FW Version Register

Table 3-52. FW Register (Offset Address: 6Ch)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Rsvd.	RO	HwInit	Reserved
15 : 8	FW Version Low	RO	HwInit	FW Version Low.
23 : 16	FW Version High	RO	HwInit	FW Version High.
31 : 24	Rsvd	RO	HwInit	Reserved

3.2.6.2 PHY Control 0 Register

Table 3-53. PHY Control 0 Register (Offset Address: DCh)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Rsvd.	RW	HwInit	Reserved

3.2.6.3 PHY Control 1 Register

Table 3-54. PHY Control 1 Register (Offset Address: E0h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Rsvd	RW (μPD720201) Rsvd (μPD720202)	HwInit	Reserved

3.2.6.4 PHY Control 2 Register

Table 3-55. PHY Control 2 Register (Offset Address: E4h)

Bits	Field	Read/Write	Value (Default)	Comment
μPD720201				
3 : 0	BC_MODE_P1	RW	0000b	Battery charging port type for PORT1. Can be set to one of the following: 0000b : SDP only 0001b : CDP only 0010b : SDP – DCP 0011b : CDP – DCP 0100b : SDP – FVO1 0101b : CDP – FVO1 0110b : SDP – FVO2 0111b : SDP – FVO2 1111b – 1000b : Reserved
7 : 4	BC_MODE_P2	RW	0000b	Battery charging port type for PORT2. Can be set to one of the values listed for bits 3:0 above.
11 : 8	BC_MODE_P3	RW	0000b	Battery charging port type for PORT3. Can be set to one of the values listed for bits 3:0 above.
15 : 12	BC_MODE_P4	RW	0000b	Battery charging port type for PORT4. Can be set to one of the values listed for bits 3:0 above.
17 : 16	TRTFCTL_P1	RW	01b	Hi-Speed Eye Tr/Tf fine control for PORT1. 00b : -1 (make low pitch) 01b : 0 (default) 10b : +1 11b : +2 (make steep pitch)
19 : 18	TRTFCTL_P2	RW	01b	Hi-Speed Eye Tr/Tf fine control for PORT2. 00b : -1 (make low pitch) 01b : 0 (default) 10b : +1 11b : +2 (make steep pitch)
21 : 20	TRTFCTL_P3	RW	01b	Hi-Speed Eye Tr/Tf fine control for PORT3. 00b : -1 (make low pitch) 01b : 0 (default) 10b : +1 11b : +2 (make steep pitch)

Bits	Field	Read/Write	Value (Default)	Comment
23 : 22	TRTFCTL_P4	RW	01b	Hi-Speed Eye Tr/Tf fine control for PORT4. 00b : -1 (make low pitch) 01b : 0 (default) 10b : +1 11b : +2 (make steep pitch)
31 : 24	Rsvd	Rsvd	Hwlnit	Reserved
μPD720202				
3 : 0	BC_MODE_P1	RW	0000b	Battery charging port type for PORT1. Can be set to one of the following: 0000b : SDP only 0001b : CDP only 0010b : SDP – DCP 0011b : CDP – DCP 0100b : SDP – FVO1 0101b : CDP – FVO1 0110b : SDP – FVO2 0111b : SDP – FVO2 1111b – 1000b : Reserved
7 : 4	BC_MODE_P2	RW	0000b	Battery charging port type for PORT2. Can be set to one of the values listed for bits 3:0 above.
15 : 8	Rsvd	Rsvd	0b	Reserved
19 : 16	TRTFCTL_P1P2	RW	0011b	Hi-Speed Eye Tr/Tf fine control for PORT1. X0X0b : -1 (make low pitch) X0X1b : 0 (default) X1X0b : +1 X1X1b : +2 (make steep pitch) Hi-Speed Eye Tr/Tf fine control for PORT2. 0X0Xb : -1 (make low pitch) 0X1Xb : 0 (default) 1X0Xb : +1 1X1Xb : +2 (make steep pitch) Note.“X” means “don’t care”
31 : 20	Rsvd	Rsvd	0b	Reserved

3.2.6.5 Host Controller Configuration (HCConfiguration) Register

Table 3-56. HCConfiguration Register (Offset Address: E8h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Rsvd	RW	0b	Reserved.
8	DeviceNonRemoval1 Enable	RW	0b	When set to '1b', the μPD720201 forces the Device Removal(DR) bit to '1b' in both the PORT1 PORTSC and PORT5 PORTSC. The μPD720202 forces the DR bit to '1b' in both the PORT1 PORTSC and PORT3 PORTSC.
9	DeviceNonRemoval2 Enable	RW	0b	When set to '1b', the μPD720201 forces the Device Removal(DR) bit to '1b' in both the PORT2 PORTSC and PORT6 PORTSC. The μPD720202 forces the DR bit to '1b' in both the PORT2 PORTSC and PORT4 PORTSC.
10	DeviceNonRemoval3 Enable	RW	0b	When set to '1b', the μPD720201 forces the Device Removal(DR) bit to '1b' in both the PORT3 PORTSC and PORT7 PORTSC.
11	DeviceNonRemoval4 Enable	RW	0b	When set to '1b', the μPD720201 forces the Device Removal(DR) bit to '1b' in both the PORT4 PORTSC and PORT8 PORTSC.
15 : 12	Reserved	RW	0000b	Reserved.
16	UsePPON	RW	1b	When set to '0b', the μPD720201 and μPD720202 force the Port Power Control (PPC) bit to '0b' in the HCCPARAMS register. When VBUS is not controlled by the PPON pin, this bit should be set to '0b'.
18 : 17	DisablePortCount	RW	00b	μPD720201 00b : All ports are enabled. 01b : Port 4 and Port 8 are disabled. 10b : Port 3,4,7 and 8 are disabled. 11b : Port 2,3,4,6,7 and 8 are disabled. μPD720202 00b : All ports are enabled. 01b : Port 2 and 4 are disabled.
23 : 19	Reserved	RW	00000b	Reserved.
24	PSEL	RW	1b	When set to '1b', the default value of the Active State Power Management Control fields in the PCI Express Link Control Register is 00b. When this bit is '0b', the default value is 11b.

Bits	Field	Read/Write	Value (Default)	Comment
25	Reserved	RW	0b	Reserved.
26	AUXDET	RW	1b	Auxiliary Power Detect. When the system supports remote wakeup from D3cold, this bit should be set to '1b'.
27	CLKREQ Force Disable	RW	0b	When set to '1b', μPD720201 and μPD720202 force the CLKREQ# disabled.
28	SerialNumber Capability Enable	RW	0b	When set to '1b', Serial Number Capability area is enabled.
31 : 29	Reserved	RW	0b	Reserved.

3.2.6.6 External ROM Information Register

Table 3-57. External ROM Information Register (Offset Address: ECh)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	ROM Information	RO	0000h	When system has mounted the External ROM, HW will set the External ROM ID.

3.2.6.7 External ROM Configuration Register

Table 3-58. External ROM Configuration Register (Offset Address: F0h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	ROM Parameter	RW	0000h	To access the External ROM, the software must set the ROM Parameter. Refer to section 6.2.

3.2.6.8 FW Download Control and Status Register

Table 3-59. FW Download Control and Status Register (Offset Address: F4h)

Bits	Field	Read/Write	Value (Default)	Comment
0	FW Download Enable	RW	0b	When set to '1b', DATA0 and DATA1 register are enabled for FW download by BIOS. When FW download is completed, this bit must be set to '0b'. After setting '0b', Result Code field is updated.
1	FW Download Lock	RW1S	0b	When set to '1b', FW Download process never operates even if FW Download Enable is '1b'. Once set, this bit remains '1b' until PONRSTB is asserted.
3 : 2	Reserved	RO	00b	Reserved
6 : 4	Result Code	RO	0b	This field shows the result of FW Download. 000b : Invalid (no result yet) 001b : Success 010b : Error 111b ~ 011b : Reserved.
7	Reserved	RO	0b	Reserved.

Bits	Field	Read/Write	Value (Default)	Comment
8	Set DATA0	RW1S	0b	When set to '1b', a download request is initiated to the μPD720201/μPD720202. Before set to '1b', FW data shall be written in the Data0 Register. When Data0 download is completed, this bit is automatically cleared to '0b'.
9	Set DATA1	RW1S	0b	When set to '1b', a download request is initiated to the μPD720201/μPD720202. Before set to '1b', FW data shall be written in the Data1 Register. When Data1 download is completed, this bit is automatically cleared to '0b'.
15 : 10	Reserved	RO	000000b	Reserved.

3.2.6.9 External ROM Access Control and Status Register

Table 3-60. FW Control and Status Register (Offset Address: F6h)

Bits	Field	Read/Write	Value (Default)	Comment
0	External ROM Access Enable	RW	0b	When set to '1b', accessing an external ROM is enabled. It is prohibited to set both this bit and FW Download Enable to '1b' at the same time. Before writing '1b' to this bit, the DATA0 register must be set to 53524F4Dh to enable FW writing.
1	External ROM Erase	RW	0b	When this bit is set to '1b', External ROM Data is erased. When this operation is complete, this bit is cleared to '0b' automatically. Before writing '1b' to this bit, the DATA0 register must be set to 5A65726Fh.
2	Reload	RW	0b	When this bit is set to '1b', External ROM Data is reloaded. This function is used when immediate reload is required after External ROM is updated. At the completion of reload process, this bit is cleared to '0b' automatically.
3	Reserved	RO	0b	Reserved
6 : 4	Result Code	RO	000b	This field shows the result of External ROM update process. 000b : Invalid (no result yet) 001b : Success 010b : Error 111b~011b : Reserved.
7	Reserved	RO	0b	Reserved.

Bits	Field	Read/Write	Value (Default)	Comment
8	Set DATA0	RW1S	0b	When set to '1b', External ROM Write Request is initiated. Before setting to '1b', FW data shall be written in the DATA0 register. When the data0 download is completed, this bit is automatically cleared to '0b'. Setting Get Data0 or Get DATA1 while Set DATA0 is '1b' results in undefined behavior.
9	Set DATA1	RW1S	0b	When set to '1b', External ROM Write Request is initiated. Before setting to '1b', FW data shall be written in the DATA1 register. When the data1 download is completed, this bit is automatically cleared to '0b'. Setting Get Data0 or Get DATA1 while Set DATA1 is '1b' results in undefined behavior.
10	Get DATA0	RW1S	0b	When set to '1b', External ROM Read Request is initiated. This bit is automatically cleared to '0b' when valid data is available in the Data0 register. Setting Set Data0 or Set DATA1 while Get DATA0 is '1b' results in undefined behavior.
11	Get DATA1	RW1S	0b	When set to '1b', External ROM Read Request is initiated. This bit is automatically cleared to '0b' when valid data is available in the Data1 register. Setting Set Data0 or Set DATA1 while Get DATA1 is '1b' results in undefined behavior.
14 : 12	Reserved	RO	000b	Reserved
15	External ROM Exists	RO	HwInit	Indicates that the External ROM is connected. Even if the external ROM exists, FW can be downloaded from External ROM . In this case, FW in the xHC is overwritten by FW download data. 1 : External ROM Exists 0 : No External ROM Exists

3.2.6.10 DATA0 Register

Table 3-61. DATA0 Register (Offset Address: F8h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	DATA0	RW	0000h	This register is a window to write and read FW data.

3.2.6.11 DATA1 Register

Table 3-62. DATA1 Register (Offset Address: FCh)

Bits	Field	Read/ Write	Value (Default)	Comment
31 : 0	DATA1	RW	0000h	This register is a window to write and read FW data.

3.2.7 Advanced Error Reporting Capabilities

3.2.7.1 Advanced Error Reporting Enhanced Capability Header Register

Table 3-63. Advanced Error Reporting Enhanced Capability Header Register (Offset Address: 100h)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	PCI Express Extended Capability ID	RO	1h	ID for the Advanced Error Reporting Capability is 0001h.
19 : 16	Capability Version	RO	1h	Indicates the version of the Capability structure present.
31 : 20	Next Capability Offset	RO	Hwlnit	This field contains the offset to the next PCI Express Capability structure. When SerialNumber Capability Enable bit is set to '1b', this field is 140h. When SerialNumber Capability Enable bit is set to '0b', this field is 150h.

3.2.7.2 Uncorrectable Error Status Register

Table 3-64. Uncorrectable Error Status Register (Offset Address: 104h)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Rsvd	-	-	Reserved
4	Data Link Protocol Error Status	RW1CS	0b	Data Link Protocol Error Status.
5	Surprise Down Error Status	RO	0b	μPD720201/μPD720202 does not support this status.
11 : 6	Rsvd	-	-	Reserved.
12	Poisoned TLP Status	RW1CS	0b	Poisoned TLP Status.
13	Flow Control Protocol Error Status	RO	0b	μPD720201/μPD720202 does not support this status.
14	Completion Timeout Status	RW1CS	0b	Completion Timeout Status.
15	Completer Abort Status	RW1CS	0b	Completer Abort Status.
16	Unexpected Completion Status	RW1CS	0b	Unexpected Completion Status.
17	Receiver Overflow Status	RW1CS	0b	Receiver Overflow Status.
18	Malformed TLP Status	RW1CS	0b	Malformed TLP Status.
19	ECRC Error Status	RO	0b	μPD720201/μPD720202 does not support this status.
20	Unsupported Request Error Status	RW1CS	0b	Unsupported Request Error Status.

Bits	Field	Read/Write	Value (Default)	Comment
31 : 21	Rsvd	-	-	Reserved.

3.2.7.3 Uncorrectable Error Mask Register

Table 3-65. Uncorrectable Error Status Register (Offset Address: 108h)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Rsvd	-	-	Reserved.
4	Data Link Protocol Error Mask	RWS	0b	Data Link Protocol Error Mask.
5	Surprise Down Error Mask	RO	0b	μPD720201/μPD720202 does not support this status.
11 : 6	Rsvd	-	-	Reserved.
12	Poisoned TLP Mask	RWS	0b	Poisoned TLP Mask.
13	Flow Control Protocol Error Mask	RO	0b	μPD720201/μPD720202 does not support this status.
14	Completion Timeout Mask	RWS	0b	Completion Timeout Mask.
15	Completer Abort Mask	RWS	0b	Completer Abort Mask.
16	Unexpected Completion Mask	RWS	0b	Unexpected Completion Mask.
17	Receiver Overflow Mask	RWS	0b	Receiver Overflow Mask.
18	Malformed TLP Mask	RWS	0b	Malformed TLP Mask.
19	ECRC Error Mask	RO	0b	μPD720201/μPD720202 does not support this status.
20	Unsupported Request Error Mask	RWS	0b	Unsupported Request Error Mask.
31 : 21	Rsvd	-	-	Reserved.

3.2.7.4 Uncorrectable Error Severity Register

Table 3-66. Uncorrectable Error Severity Register (Offset Address: 10Ch)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Rsvd	-	-	Reserved.
4	Data Link Protocol Error Severity	RWS	1b	Data Link Protocol Error Severity.
5	Surprise Down Error Severity	RO	1b	μPD720201/μPD720202 does not support this status.
11 : 6	Rsvd	-	-	Reserved.
12	Poisoned TLP Severity	RWS	0b	Poisoned TLP Severity.

Bits	Field	Read/Write	Value (Default)	Comment
13	Flow Control Protocol Error Severity	RO	1b	μPD720201/μPD720202 does not support this status.
14	Completion Timeout Severity	RWS	0b	Completion Timeout Severity.
15	Completer Abort Severity	RWS	0b	Completer Abort Severity.
16	Unexpected Completion Severity	RWS	0b	Unexpected Completion Severity.
17	Receiver Overflow Severity	RWS	1b	Receiver Overflow Severity.
18	Malformed TLP Severity	RWS	1b	Malformed TLP Severity.
19	ECRC Error Severity	RO	0b	μPD720201/μPD720202 does not support this status.
20	Unsupported Request Error Severity	RWS	0b	Unsupported Request Error Severity.
31 : 21	Rsvd	-	-	Reserved.

3.2.7.5 Correctable Error Status Register

Table 3-67. Correctable Error Status Register (Offset Address: 110h)

Bits	Field	Read/Write	Value (Default)	Comment
0	Receiver Error Status	RO	0b	Receiver Error Status.
5 : 1	Rsvd	-	-	Reserved.
6	Bad TLP Status	RW1CS	0b	Bad TLP Status.
7	Bad DLLP Status	RW1CS	0b	Bad DLLP Status.
8	REPLAY_NUM Rollover Status	RW1CS	0b	REPLAY_NUM Rollover Status.
11 : 9	Rsvd	-	-	Reserved.
12	Replay Timer Timeout Status	RW1CS	0b	Replay Timer Timeout Status.
13	Advisory Non-Fatal Error Status	RW1CS	0b	Advisory Non-Fatal Error Status.
31 : 14	Rsvd	-	-	Reserved.

3.2.7.6 Correctable Error Mask Register

Table 3-68. Correctable Error Mask Register (Offset Address: 114h)

Bits	Field	Read/Write	Value (Default)	Comment
0	Receiver Error Mask	RO	0b	Receiver Error Mask.
5 : 1	Rsvd	-	-	Reserved.

Bits	Field	Read/Write	Value (Default)	Comment
6	Bad TLP Mask	RWS	0b	Bad TLP Mask.
7	Bad DLLP Mask	RWS	0b	Bad DLLP Mask.
8	REPLAY_NUM Rollover Mask	RWS	0b	REPLAY_NUM Rollover Mask.
11 : 9	Rsvd	-	-	Reserved.
12	Replay Timer Timeout Mask	RWS	0b	Replay Timer Timeout Mask.
13	Advisory Non-Fatal Error Mask	RWS	1b	Advisory Non-Fatal Error Mask.
15 : 14	Rsvd	-	-	Reserved.

3.2.7.7 Advanced Error Capabilities and Control Register

Table 3-69. Advanced Error Capabilities and Control Register (Offset Address: 118h)

Bits	Field	Read/Write	Value (Default)	Comment
4 : 0	First Error Pointer	RO	0b	The first Error Pointer is a field that identifies the bit position of the first error reported in the Uncorrectable Error Status register.
5	ECRC Generation Capable	RO	0b	No support.
6	ECRC Generation Enable	RO	0b	No support.
7	ECRC Check Capable	RO	0b	No support.
8	ECRC Check Enable	RO	0b	No support.
31 : 9	Rsvd	-	-	Reserved.

3.2.7.8 Header Log Register

Table 3-70. Header Log Register (Offset Address: 11Ch)

Bits	Field	Read/Write	Value (Default)	Comment
127 : 0	Header of TLP associated with error	RO	0h	The Header Log register captures the header for the TLP corresponding to a detected error.

3.2.8 Device Serial Number Enhanced Capability

3.2.8.1 Device Serial Number Enhanced Capability Header Register

Table 3-71. Device Serial Number Enhanced Capability Header Register (Offset Address: 140h)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	PCI Express Extended Capability ID	RO	3h	ID for the Device Serial Number Capability is 0003h.
19 : 16	Capability Version	RO	1h	Indicates the version of the Capability structure present.
31 : 20	Next Capability Offset	RO	150h	This field contains the offset to the next PCI Express Capability structure.

3.2.8.2 Serial Number Register

Table 3-72. Serial Number Register (Offset Address: 144h)

Bits	Field	Read/Write	Value (Default)	Comment
63 : 0	PCI Express Device Serial Number	RWO	Hwlnit	This field contains the IEEE defined 64-bit extended unique identifier (EUI-64 TM) loaded from External Serial ROM. This identifier includes a 24-bit company id value assigned by IEEE registration authority and a 40-bit extension identifier assigned by the manufacturer.

3.2.9 Latency Tolerance Reporting (LTR) Capability

3.2.9.1 LTR Extended Capability Header Register

Table 3-73. LTR Extended Capability Header Register (Offset Address: 150h)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	PCI Express Extended Capability ID	RO	18h	ID for the LTR Extended Capability is 0018h.
19 : 16	Capability Version	RO	1h	Indicates the version of the Capability structure present.
31 : 20	Next Capability Offset	RO	0h	This field contains the offset to the next PCI Express Capability structure.

3.2.9.2 Max Snoop Latency Register

Table 3-74. Max Snoop Latency Register (Offset Address: 154h)

Bits	Field	Read/Write	Value (Default)	Comment
9 : 0	Max Snoop LatencyValue	RW	0h	Along with the Max Snoop Latency Scale field, this register specifies the maximum no-snoop latency that a device is permitted to request. Software should set this to the platform's maximum supported latency or less.
12 : 10	Max Snoop latencyScale	RW	0h	This register provides a scale for the value contained within the Maximum Snoop Latency Value field.
15 : 13	Rsvd	-	-	Reserved.

3.2.9.3 Max No-Snoop Latency Register

Table 3-75. Max No-Snoop Latency Register (Offset Address: 156h)

Bits	Field	Read/Write	Value (Default)	Comment
9 : 0	Max No-Snoop LatencyValue	RW	0h	Along with the Max-No-Snoop Latency Scale field, this register specifies the maximum no-snoop latency that a device is permitted to request.
12 : 10	Max No-Snoop Latency Scale	RW	0h	This register provides a scale for the value contained within the max No-Snoop LatencyValue field.
15 : 13	Rsvd	-	-	Reserved.

3.3 Host Controller Capability Register

These registers specify the limits and capabilities of the host controller implementation.

All Capability Registers are Read-Only (RO) or hardware Initialized (HwInit attribute). The offsets for these registers are all relative to the beginning of the host controller’s MMIO address space. The beginning of the host controller’s MMIO address space is referred to as “Base” throughout this document.

Table 3-76. eXtensible Host Controller Capability

31 24	23 16	15 8	7 0	Offset
HCIVERSION (Interface Version Number)		Reserved		00h
HCSPARAMS1 (Structural Parameters 1)				
HCSPARAMS2 (Structural Parameters 2)				
HCSPARAMS3 (Structural Parameters 3)				
HCCPARAMS (Capability Parameters)				
DBOFF (Doorbell Offset)				
RTSOFF (Runtime Register Space Offset)				
Reserved				
				1Ch

3.3.1 Capability Registers Length (CAPLENGTH)

Table 3-77. CAPLENGTH (Offset Address: Base + 00h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	CAPLENGTH	RO	20h	This register is used as an offset to add to register base to find the beginning of the Operational Register Space. This value is referred to as “Operational Base” throughout this document.

3.3.2 Host Controller Interface Version Number (HCIVERSION)

Table 3-78. HCIVERSION (Offset Address: Base + 02h)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	HCIVERSION	RO	0100h	This is a two-byte register containing a BCD encoding of the xHCI specification revision number supported by this host controller. The most significant byte of this register represents a major revision and the least significant byte is the minor revision. e.g. 0100h corresponds to xHCI version 1.0

3.3.3 Structural Parameters 1 (HCSPARAMS1)

Table 3-79. HCSPARAMS1 (Offset Address: Base + 04h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Number of Device Slots (MaxSlots)	RO	20h	This field specifies the maximum number of Device Context Structures and Doorbell Array entries this host controller can support.
18 : 8	Number of Interrupters (MaxIntrs)	RO	008h	This field specifies the number of Interrupters implemented on this host controller. Each Interrupter is allocated to a vector of MSI-X and controls its generation and moderation. The value of this field determines how many Interrupter Register Sets are addressable in the Runtime Register Space.
23 : 19	Rsvd	-	-	Reserved.
31 : 24	Number of Ports (MaxPorts)	RO	08h (μPD720201) 04h (μPD720202)	This field specifies the number of physical downstream ports implemented on this host controller. The value of this field determines how many port registers are addressable in the Operational Register Space. Refer to section 3.4.8 and 5.2 for more information.

3.3.4 Structural Parameters 2 (HCSPARAMS2)

Table 3-80. HCSPARAMS2 (Offset Address: Base + 08h)

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Isochronous Scheduling Threshold	RO	1h	The value in this field indicates to system software the minimum distance (in time) that it is required to stay ahead of the host controller while adding TRBs, in order to have the host controller process them at the correct time. The value shall be specified in terms of number of microframes.
7 : 4	Event Ring Segment Table Max (ERST Max)	RO	1h	This field determines the maximum value supported the Event Ring Segment Table entries. The maximum number of Event Ring Segment Table entries = 2 ^{ERST Max}

Bits	Field	Read/Write	Value (Default)	Comment
25 : 8	Rsvd	-	-	Reserved.
26	Scratchpad Restore	RO	1b	A value of '0' indicates that the Scratchpad Buffer space may be freed and reallocated between power events.
31 : 27	Max Scratchpad Buffers	RO	00100b	This field indicates the number of Scratchpad Buffers system software shall reserve for the xHC.

3.3.5 Structural Parameters 3 (HCSPARAMS3)

Table 3-81. HCSPARAMS3 (Offset Address: Base + 0Ch)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	U1 Device Exit Latency	RO	0h	Worst case latency to transition a root hub Port Link State from U1 to U0. Applies to all root hub ports. A value of '0' indicates 0 us.
15 : 8	Rsvd	-	-	Reserved.
31 : 16	U2 Device Exit Latency	RO	0h	Worst case latency to transition a root hub Port Link State from U2 to U0. Applies to all root hub ports. A value of '0' indicates 0us.

3.3.6 Capability Parameters (HCCPARAMS)

Table 3-82. HCCPARAMS (Offset Address: Base + 10h)

Bits	Field	Read/Write	Value (Default)	Comment
0	64-bit Addressing Capability	RO	1b	This flag documents the addressing range capability of this implementation. The value of this flag determines whether the xHC has implemented the high order 32 bits of 64bits register and data structure pointer fields. A value of '1' indicates 64-bit address memory pointers implemented.
1	BW Negotiation Capability	RO	1b	This flag identifies whether the xHC has implemented the Bandwidth Negotiation. A value of '1' indicates BW Negotiation implemented.
2	Context Size	RO	1b	A value of '0' indicates the xHC uses 32-byte Context data structures, and '1' indicates 64-byte Context data structures.

Bits	Field	Read/Write	Value (Default)	Comment
3	Port Power Control	RO	Hwlnit	<p>This flag indicates whether the host controller implementation includes port power control. A '1' in this bit indicates the ports have port power switches. The value of this flag affects the functionality of the PP flag in each port status and control register.</p> <p>This bit is initialized by the UsePPON bit in the PCI Configuratin Space HConfiguratin Register. Refer to Section 3.2.6.5 for more information on the use of this flag.</p>
4	Port Indicators	RO	0b	<p>This bit indicates whether the xHC root hub ports support port indicator control. A value of '0' indicates that the port status and control registers does not include a read/writeable field for controlling the state of the port indicator.</p>
5	Light HC Reset Capability	RO	0b	<p>This flag indicates whether the host controller implementation supports a Light Host Controller Reset. A '0' in this bit indicates that Light Host Controller Reset is not supported.</p>
6	Latency Tolerance Messaging Capability	RO	1b	<p>This flag indicates whether the host controller implementation supports Latency Tolerance Messaging (LTM). A '1' in this bit indicates that LTM is supported.</p>
7	No Secondary SID Support	RO	1b	<p>This flag indicates whether the host controller implementation supports Secondary Stream IDs. A '1' in this bit indicates that Secondary Stream ID decoding is not supported.</p>
8	Parse All Event Data (PAE)	RO	1b	<p>This flag indicates whether the host controller implementation Parses all Event Data TRBs while advancing to the next TD after a short packet, or it skips all but the first Event Data TRB. A '0' in this bit indicates that only the first Event Data TRB is parsed.</p>
11 : 9	Rsvd	-	-	Reserved.
15 : 12	Maximum Primary Stream Array Size (MaxPSASize)	RO	5h	<p>This field identifies the maximum size Primary Stream Array that the xHC supports. The Primary Stream Array size = $2^{\text{MaxPSASize}+1}$</p>

Bits	Field	Read/Write	Value (Default)	Comment
31 : 16	xHCI Extended Capabilities Pointer	RO	140h	This field indicates the existence of a capabilities list. The value of this field indicates a relative offset , in 32-bit words, from Base to the beginning of the first extended capability. First extended capability : Base + (0140h << 2) = Base + 500h

3.3.7 Doorbell Offset (DBOFF)

Table 3-83. DBOFF (Offset Address: Base + 14h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Doorbell Array Offset	RO	800h	This field defines the DWORD offset of the Doorbell Array base address from the Base.

3.3.8 Runtime Register Space Offset (RTSOFF)

Table 3-84. RTSOFF Offset (Offset Address: Base + 18h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Runtime Register Space Offset	RO	600h	This field defines the 32-byte offset of the xHC Runtime Registers from Base.

3.4 Host Controller Operational Registers

This section defines the xHCI Operational Registers.

The base address of this register space is referred to as Operational Base (Refer to section 3.3.1). The Operational Base shall be DWORD aligned and is calculated by adding the value of the Capability Registers Length (CAPLENGTH) register to the Capability Base address. All registers are multiples of 32 bits in length.

Unless otherwise stated, all registers should be accessed as a 32-bit width on reads with an appropriate software mask, if needed. A software read/modify/write mechanism should be invoked for partial writes.

These registers are located at a positive offset from the Capabilities Registers.

Table 3-85. Host Controller Operational Registers

31 24	23 16	15 8	7 0	Offset
USBCMD (USB Command)				20h
USBSTS (USB Status)				24h
PAGESIZE (Page Size)				28h
Reserved				2C~33h
DNCTRL (Device Notification Control)				34h
CRCR (Command Ring Control)				38h
Reserved				40~4Fh
DCBAAP (Device Context Base Address Array Pointer)				50h
CONFIG (Configure)				58h
Reserved				5C~3FFh
Host Controller Port Register Set 1 – 4				420~49Fh

3.4.1 USB Command Register (USBCMD)

The Command Register indicates the command to be executed by the serial bus host controller. Writing to the register causes a command to be executed.

Table 3-86. USBCMD Register (Offset Address: Operational Base (20h) + 00h)

Bits	Field	Read/Write	Value (Default)	Comment
0	Run/Stop	RW	0b	'1' = Run, '0' = Stop. When set to '1', the xHC proceeds with execution of the schedule. The xHC continues execution as long as this bit is set to a '1'. When this bit is cleared to '0', the xHC completes the current and any actively pipelined transactions on the USB and then halts.
1	Host Controller Reset (HCRST)	RW	0b	This control bit is used by software to reset the host controller. The effects of this bit on the xHC and the Root Hub registers are similar to a Chip Hardware Reset. When software writes a '1' to this bit, Any transaction currently in progress on USB is immediately terminated. A USB reset is not driven on downstream ports. PCI Configuration registers are not affected by this reset. This bit is cleared to '0' by the Host Controller when the reset process is complete. Software cannot terminate the reset process early by writing a '0' to this bit and shall not write any xHC Operational or Runtime registers until while HCRST is '1'. Software shall not set this bit to '1' when the HCHalted bit in the USBSTS register is a '0'.
2	Interrupter Enable	RW	0b	This bit provides system software with a means of enabling or disabling the host system interrupts generated by Interrupters. When this bit is a '1', then Interrupter host system interrupt generation is allowed.
3	Host System Error Enable	RW	0b	When this bit is a '1', and the HSE bit in the USBSTS register is a '1', the xHC shall assert out-of-band error signaling to the host. The signaling is acknowledged by software clearing the HSE bit.
6 : 4	Rsvd	-	-	Reserved.

Bits	Field	Read/Write	Value (Default)	Comment
7	Light Host Controller Reset	RO	0b	Not implemented.
8	Controller Save State	RW	0b	When written by software with '1' and HCHalted = '1', then the xHC shall save any internal state that will be restored by a subsequent Restore State operation. When written by software with '1' and HCHalted = '0', or written with '0', no Save State operation shall be performed. This flag always returns '0' when read. Note that undefined behavior may occur if a Save State operation is initiated while Restore State Status (RSS) = '1'
9	Controller Restore State	RW	0b	When set to '1', and HCHalted = '1', then the xHC shall perform a Restore State operation and restore its internal state. When set to '1' and Run/Stop = '1' or HCHalted(HCH) = '0', or when cleared to '0', no Restore State operation shall be performed. This flag always returns '0' when read. Note that undefined behavior may occur if a Restore State operation is initiated while Save State Status (SSS) = '1'
10	Enable Wrap Event	RW	0b	When set to '1', the xHC shall generate a MFINDEX Wrap Event every time the MFINDEX register transitions from 03FFFh to 0. When cleared to '0' no MFINDEX Wrap Events are generated.
11	Enable U3 MFINDEX Stop	RW	0b	When set to '1', the xHC may stop the MFINDEX counting action if all Root Hub ports are in the U3, Disconnected, Disabled, or Powered-off state. When cleared to '0', the xHC may stop the MFINDEX counting action if all Root Hub ports are in the Disconnected, Disabled, or Powered-off state.
31 : 12	Rsvd	-	-	Reserved.

3.4.2 USB Status Register (USBSTS)

This register indicates pending interrupts and various states of the Host Controller. The status resulting from a transaction on the serial bus is not indicated in this register. Software sets a bit to '0' in this register by writing a '1' to it (RW1C).

Table 3-87. USBSTS Register (Offset Address: Operational Base (20h) + 04h)

Bits	Field	Read/Write	Value (Default)	Comment
0	HCHalted	RO	1b	This bit is a '0' whenever the Run/Stop bit is a '1'. The xHC sets this bit to '1' after it has stopped executing as a result of the Run/Stop bit being cleared to '0', either by software or by the xHC hardware(e.g. internal error). If this bit is '1', then SOFs, microSOFs, or Isochronous Timestamp Packets (ITP) shall not be generated by the xHC.
1	Rsvd	-	-	Reserved.
2	Host System Error (HSE)	RW1C	0b	The xHC sets this bit to '1' when a serious error is detected, either internal to the xHC or during a host system access involving the xHC module. When this error occurs, the xHC clears the Run/Stop bit in the USBCMD register. If the HSEE bit in the USBCMD register is a '1', the xHC shall also assert out-of-band error signaling to the host.
3	Event Interrupt (EINT)	RW1C	0b	The xHC sets this bit to '1' when the Interrupt Pending (IP) bit of any Interrupter transitions from '0' to '1'. The EINT flag does not generate an interrupt, it is simply a logical OR of the IMAN register IP flag '0' to '1' transitions. As such, it does not need to be cleared to clear an xHC interrupt.
4	Port Change Detect	RW1C	0b	The xHC sets this bit to a '1' when any port has a change bit transition from a '0' to a '1'. This bit is loaded with the OR of all PORTSC change bits.
7 : 5	Rsvd	-	-	Reserved.
8	Save State Status	RO	0b	When the Controller Save State flag in the USBCMD register is written with '1', this bit shall be set to '1' and remain '1' while the xHC saves its internal state. When the Save State operation is complete, this bit shall be cleared to '0'.

Bits	Field	Read/Write	Value (Default)	Comment
9	Restore State Status	RO	0b	When the Controller Restore State flag in the USBCMD register is written with '1', this bit shall be set to '1' and remain '1' while the xHC restores its internal state. When the Restore State operation is complete, this bit shall be cleared to '0'.
10	Save/Restore Error	RW1C	0b	If an error occurs during a Save or Restore operation, this bit shall be set to '1'. This bit shall be cleared to '0' when a Save or Restore operation is initiated or when written with '1'.
11	Controller Not Ready (CNR)	RO	1b	'0' = Ready and '1' = Not Ready. Software shall not write any Doorbell or Operational register of the xHC, other than the USBSTS register, until CNR = '0'. This flag is set by the xHC after a Chip hardware Reset and cleared when the xHC is ready to begin accepting register writes.
12	Host Controller Error	RO	0b	'0' = No internal xHC error conditions exist and '1' = Internal xHC error condition. If both μPD720201 and μPD720202 detect no correct firmware in Serial ROM, this flag is set.
31 : 13	Rsvd	-	-	Reserved.

3.4.3 Page Size Register (PAGESIZE)

Table 3-88. PAGESIZE Register (Offset Address: Operational Base (20h) + 08h)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Page Size	RO	0001h	This field defines the page size supported by the xHC. This xHC supports 4k byte page size . Page size = 2 ^(Page Size +12)
31 : 16	Rsvd	-	-	Reserved.

3.4.4 Device Notification Control Register (DNCTRL)

This register is used by software to enable or disable the reporting of the reception of specific USB Device Notification Transaction Packets. A Notification Enable (Nx, where x = 0 to 15) flag is defined for each of the 16 possible device notification types. If a flag is set for a specific notification type, a Device Notification Event will be generated when the respective notification packet is received. After reset all notifications are disabled.

Table 3-89. DNCTRL Register (Offset Address: Operational Base (20h) + 14h)

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Notification Enable (N0 –N15)	RW	0h	When a Notification Enable bit is set, a Device Notification Event will be generated when a Device Notification Transaction Packet is received with the matching value in the Notification Type field. For example, setting N1(bit1) to '1' enables Device Notification Event generation if a Device Notification Transaction Packet is received with its Notification Type field set to '1' (FUNCTION_WAKE).
31 : 16	Rsvd	-	-	Reserved.

3.4.5 Command Ring Control Register (CRCR)

The Command Ring Control Register provides Command Ring control and status capabilities, and identifies the address and Cycle bit state of the Command Ring Dequeue Pointer. The Command Ring is 64 byte aligned, so the low order 6bits of the Command Ring Pointer shall always be '0'.

Table 3-90. CRCR Register (Offset Address: Operational Base (20h) + 18h)

Bits	Field	Read/Write	Value (Default)	Comment
0	Ring Cycle State (RCS)	RW	0b	<p>This bit identifies the value of the xHC Consumer Cycle State flag for the TRB referenced by the Command Ring Pointer.</p> <p>Writes to this flag are ignored if Command Ring Running is '1'.</p> <p>If the CRCR is written while the Command Ring is stopped (CRR = '0'), then the value of this flag shall be used to fetch the first Command TRB the next time the Host Controller Doorbell register is written with the DB Reason field set to Host Controller Command.</p> <p>If the CRCR is not written while the Command Ring is stopped (CRR = '0'), then the Command Ring will begin fetching Command TRBs using the current value of the internal Command Ring CCS flag.</p> <p>Reading this flag always returns '0'.</p>
1	Command Stop	RW	0b	<p>Writing a '1' to this bit shall stop the operation of the Command Ring after the completion of the currently executing command, and generate a Command Completion Event with the Completion Code set to Command Ring Stopped and the Command TRB Pointer set to the current value of the Command Ring Dequeue Pointer.</p> <p>Next write to the Host Controller Doorbell with DB Reason field set to Host Controller Command shall restart the Command Ring operation.</p> <p>Writes to this flag are ignored by the xHC if Command Ring Running (CRR) = '0'. Reading this bit shall always return '0'.</p>

Bits	Field	Read/Write	Value (Default)	Comment
2	Command Abort	RW	0b	<p>Writing a '1' to this bit shall immediately terminate the currently executing command, stop the Command Ring, and generate a Command Completion Event with the Completion Code set to Command Ring Stopped.</p> <p>The next write to the Host Controller Doorbell with DB Reason field set to Host Controller Command shall restart the Command Ring operation.</p> <p>Writes to this flag are ignored by the xHC if Command Ring Running (CRR) = '0'. Reading this bit always returns '0'.</p>
3	Command Ring Running (CRR)	RO	0b	<p>This flag is set to '1' if the Run/Stop bit is '1' and the Host Controller Doorbell register is written with the DB Reason field set to Host Controller Command. It is cleared to '0' when the Command Ring is "stopped" after writing a '1' to the Command Stop (CS) or Command Abort(CA) flags, or if the Run/Stop bit is cleared to '0'.</p>
5 : 4	Rsvd	-	-	Reserved.
64 : 6	Command Ring Pointer	RW	0h	<p>This field defined high order bits of the initial value of the 64-bit Command Ring Dequeue Pointer.</p> <p>Writes to this field are ignored when Command Ring Running (CRR) = '1'.</p> <p>If the CRCR is written while the Command Ring is stopped (CRR = '0'), the value of this field shall be used to fetch the first Command TRB the next time the Host Controller Doorbell register is written with the DB Reason field set to Host Controller Command.</p> <p>If the CRCR is not written while the Command Ring is stopped (CRR = '0') then the Command Ring shall begin fetching Command TRBs at the current value of the internal xHC Command Ring Dequeue Pointer. Reading this field always returns '0'.</p>

3.4.6 Device Context Base Address Array Pointer Register (DCBAAP)

The Device Context Base Address Array Pointer Register identifies the base address of the Device Context Base Address Array. The memory structure referenced by this physical memory pointer is assumed to be physically contiguous and 64-byte aligned.

Table 3-91. DCBAAP Register (Offset Address: Operational Base (20h) + 30h)

Bits	Field	Read/Write	Value (Default)	Comment
5 : 0	Rsvd	-	-	Reserved.
63 : 6	Device Context Base Address Array Pointer	RW	0h	This field defines high order bits of the 64-bit base address of the Device Context Pointer Array table. A table of address pointers that reference Device Context structures for the devices attached to the host.

3.4.7 Configure Register (CONFIG)

This register defines runtime xHC configuration parameters.

Table 3-92. CONFIG Register (Offset Address: Operational Base (20h) + 38h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Max Device Slots Enabled (MaxSlotsEn)	RW	0h	This field specifies the maximum number of enabled Device Slots. Valid values are in the range of 0 to MaxSlots. Enabled Devices Slots are allocated contiguously. e.g. A value of 16 specifies that Device Slots 1 to 16 are active. A value of '0' disables all Device Slots. A disabled Device Slot shall not respond to Doorbell Register references. This field shall not be modified if the xHC is running.
31 : 8	Rsvd	-	-	Reserved.

3.4.8 Host Controller Port Register Set

μPD720201 implements 8 root hub ports: 4 SuperSpeed ports and 4 Hi-Speed ports. A root Hub port that supports the USB3 protocol is comprised of a PORTSC, a USB3 PORTPMSC and PORTLI register. A root Hub port that supports the USB2 protocol is comprised of a PORTSC and PORTPMSC register. Ports are numbered from 1 to MaxPorts. MaxPorts is defined in the HCSPARAMS1 register. On the μPD720201, Port1 (P1), Port2 (P2), Port3 (P3) and Port4 (P4) are SuperSpeed ports, while Port5 (P5), Port6 (P6), Port7 (P7) and Port8 (P8) are Hi-Speed ports. These assignments are defined in the xHCI Supported Protocol Extended Capability (defined in section 3.7.2). The mapping of Root Hub Ports to the physical USB3 compatible connectors (C1, C2, C3 and C4) of a system are shown below. Refer to section 5.2 for more information. Note that the Port Power Pin, PPONx(x:1 to 4) of μPD720201, is ORed with both Port Power flag of the PORTSC of Porty(y:1 to 4) and that of Portz(z:5 to 8).

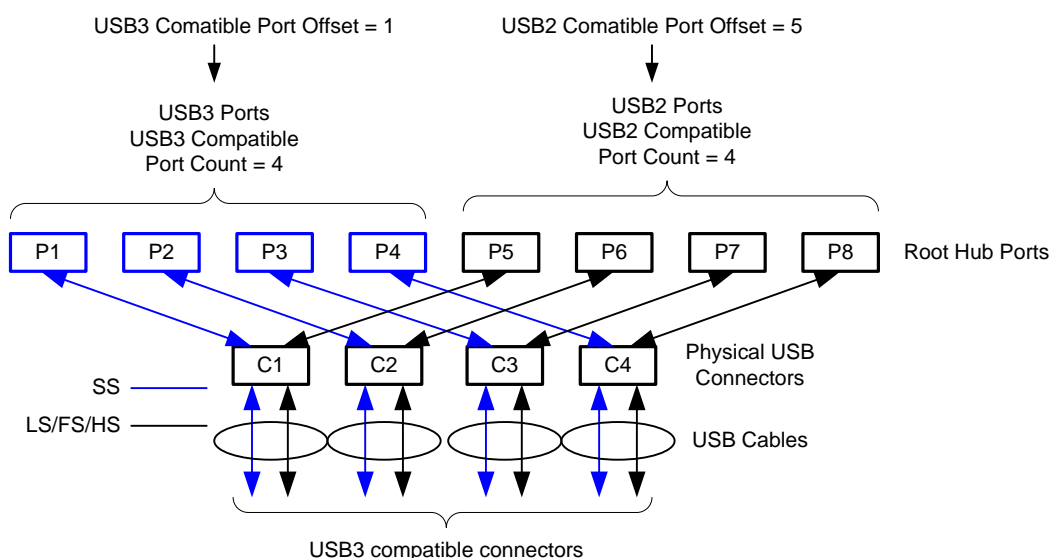


Table 3-93. Host Controller Port Register Set (Offset shows from Base)

31	23	15	7	720201	720202
24	16	8	0	Offset	Offset
Port1(SS) PORTSC (Port Status and Control)				420h	420h
Port1(SS) PORTPMSC (Port Power Management Status and Control)				424h	424h
Port1 PORTLI (Port Link Info)				428h	428h
Reserved				42Ch	42Ch
Port2(SS) PORTSC (Port Status and Control)				430h	430h
Port2(SS) PORTPMSC (Port Power Management Status and Control)				434h	434h
Port2 PORTLI (Port Link Info)				438h	438h
Reserved				43Ch	43Ch
Port3(SS) PORTSC (Port Status and Control)				440h	-
Port3(SS) PORTPMSC (Port Power Management Status and Control)				444h	-
Port3 PORTLI (Port Link Info)				448h	-
Reserved				44Ch	-
Port4(SS) PORTSC (Port Status and Control)				450h	-
Port4(SS) PORTPMSC (Port Power Management Status and Control)				454h	-
Port3 PORTLI (Port Link Info)				458h	-

Reserved	45Ch	-
Port5(LS/FS/HS) PORTSC (Port Status and Control)	460h	440h
Port5(LS/FS/HS) PORTPMSC (Port Power Management Status and Control)	464h	444h
Reserved	468h	448h
Reserved	46Ch	44Ch
Port6(LS/FS/HS) PORTSC (Port Status and Control)	470h	450h
Port6(LS/FS/HS) PORTPMSC (Port Power Management Status and Control)	474h	454h
Reserved	478h	458h
Reserved	47Ch	45Ch
Port7(LS/FS/HS) PORTSC (Port Status and Control)	480h	-
Port7(LS/FS/HS) PORTPMSC (Port Power Management Status and Control)	484h	-
Reserved	488h	-
Reserved	48Ch	-
Port8(LS/FS/HS) PORTSC (Port Status and Control)	490h	-
Port8(LS/FS/HS) PORTPMSC (Port Power Management Status and Control)	494h	-
Reserved	498h	-
Reserved	49Ch	-

3.4.8.1 Port Status and Control Register (PORTSC)

This register is only reset by platform hardware during a cold reset or in response to a Host Controller Reset (HCRST).

Software cannot change the state of the port unless Port Power (PP) is asserted ('1'), regardless of the Port Power Control (PPC) capability. The host is required to have power stable to the port within 20 milliseconds of the '0' to '1' transition of PP. If PPC = '1' software is responsible for waiting 20ms after asserting PP, before attempting to change the state of the port.

Table 3-94. PORTSC Register (Offset Address: Operational Base (20h) + (400h + (10h *(n-1)))

Bits	Field	Read/Write	Value (Default)	Comment
0	Current Connect Status (CCS)	RO	0b	'1' = Device is present on port. '0' = No device is present. This value reflects the current state of the port, and may not correspond directly to the event that caused the Connect Status Change (CSC) bit to be set to '1'. This flag is '0' if PP is '0'.

Bits	Field	Read/Write	Value (Default)	Comment
1	Port Enable/Disable (PED)	RW1CS	0b	Ports may only be enabled by the xHC. Software cannot enable a port by writing a '1' to this flag. A port may be disabled by software writing a '1' to this flag. This flag shall automatically be cleared to '0' by a disconnect event or other fault condition. PED shall automatically be cleared to '0' when PR is set to '1', and set to '1' when PR transitions from '1' to '0' after a successful reset.
2	Rsvd.	-	-	Reserved.
3	Over-current Active (OCA)	RO	0b	This port currently has an over-current condition. '0' = This port does not have an over-current condition. This bit shall automatically transition from a '1' to a '0' when the over-current condition is removed.
4	Port Reset (PR)	RW1S	0b	'1' = Port Reset signaling is asserted. '0' = Port is not in Reset. When software writes a '1' to this bit (from a '0') the bus reset sequence is initiated; USB2 protocol ports shall execute the bus reset sequence as defined in the USB2 Spec. USB3 protocol ports shall execute the Hot Reset sequence as defined in the USB3 Spec. PR remains set until reset signaling is completed by the root hub. This flag is '0' if PP is '0'.
8 : 5	Port Link State (PLS)	RWS	100b	This field is used to power manage the port and reflects its current link state. When the port is in the Enable state, system software may set the link U state by writing this field. System software may also write this field to force a Disabled to Disconnected state transition o the port. This field is undefined if PP= '0'. Write and Read value is shown in table3-91 and table 3-92. Note: The Port Link State Write Strobe (LWS) shall be set tot '1' to write this field.

Bits	Field	Read/Write	Value (Default)	Comment														
9	Port Power (PP)	RWS	0b	<p>This flag reflects a port's logical, power control state. When PP equals a '0', the port is nonfunctional and shall not report attaches, detaches, or Port Link State (PLS) changes. However, the port shall report over-current conditions when PP = '0' if PPC = '0'.</p> <p>0 = This port is in the Powered-off state.</p> <p>1 = This port is not in the Powered-off state.</p> <p>When an over-current condition is detected on a powered port, the xHC shall transition the PP bit in each affected port from a '1' to '0'.</p> <p>This bit is set after the software sets Max Device Slots Enable (MaxSlotsEn) field in Configure (CONFIG) register or Host Controller Reset (HCRST) flag in USBCMD register.</p>														
13 : 10	Port Speed	RO	0b	<p>This field identifies the speed of the attached USB Device. This field is only relevant if a device is attached (CCS = '1'). In all other cases this field shall indicate Undefined Speed.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Undefined Speed</td> </tr> <tr> <td>1</td> <td>Full-Speed</td> </tr> <tr> <td>2</td> <td>Low-Speed</td> </tr> <tr> <td>3</td> <td>Hi-Speed</td> </tr> <tr> <td>4</td> <td>SuperSpeed</td> </tr> <tr> <td>5-15</td> <td>Reserved.</td> </tr> </tbody> </table>	Value	Meaning	0	Undefined Speed	1	Full-Speed	2	Low-Speed	3	Hi-Speed	4	SuperSpeed	5-15	Reserved.
Value	Meaning																	
0	Undefined Speed																	
1	Full-Speed																	
2	Low-Speed																	
3	Hi-Speed																	
4	SuperSpeed																	
5-15	Reserved.																	
15 : 14	Port Indicator Control	RWS	0b	Writing to these bits has no effect .														
16	Port Link State Write Strobe (LWS)	RW	0b	<p>When this bit is set to '1' on a write reference to this register, this flag enables writes to the PLS field. When '0', write data in PLS field is ignored. Reads to this bit return '0'.</p>														

Bits	Field	Read/Write	Value (Default)	Comment
17	Connect Status Change (CSC)	RW1CS	0b	'1' = Change in CCS. '0' = No change. This flag indicates a change has occurred in the port's Current Connect Status (CCS) or Cold Attach Status (CAS) bits. Note that this flag shall not be set if the CCS transition was due to software setting PP to '0', or the CAS transition was due to software setting WPR to '1'. The xHC sets this bit to '1' for all changes to the port device connect status, even if system software has not cleared an existing Connect Status Change.
18	Port Enabled/Disabled Change (PEC)	RW1CS	0b	'1' = change in PED. '0' = No change. Note that this flag shall not be set if the PED transition was due to software setting PP to '0'. Software shall clear this bit by writing a '1' to it.
19	Warm Port Reset Change (WRC)	RW1CS	0b	Writing to this bit has no effect.
20	Over-current Change (OCC)	RW1CS	0b	This bit shall be set to a '1' when there is a '0' to '1' or '1' to '0' transition of Over-current Active (OCA). Software shall clear this bit by writing a '1' to it.
21	Port Reset Change (PRC)	RW1CS	0b	'0' = No change. '1' = Reset complete. This flag is set to '1' due a '1' to '0' transition of Port Reset (PR). Software shall clear this bit by writing a '1' to it.
22	Port Link State Change (PLC)	RW1CS	0b	'0' = No change. '1' = Link Status Changed. This flag is set to '1' due to table 3-93. Note that this flag shall not be set if the PLS transition was due to software setting PP to '0'. Software shall clear this bit by writing a '1' to it.
23	Port Config Error Change (CES)	RW1CS/ Rsvd	0b	'0' = No change. '1' = Port Config Error detected. This flag indicates that the port failed to configure its link partner. Software shall clear this bit by writing a '1' to it. Note: This flag is valid only for USB3 protocol ports. For USB2 protocol ports this bit shall be Reserved.

Bits	Field	Read/Write	Value (Default)	Comment
24	Cold Attach Status (CAS)	RO	0b	'1' = Far-end Receiver Terminations were detected in the Disconnected state and the Root Hub Port State Machine was unable to advance to the Enable state. Software shall clear this bit by writing a '1' to WPR or the xHC shall clear this bit if CCS transitions to '1'. This flag is '0' if PP is '0' or for USB2 protocol ports.
25	Wake on Connect Enable (WCE)	RWS	0b	Writing this bit to a '1' enables the port to be sensitive to device connects as system wake-up events.
26	Wake on Disconnect Enable (WDE)	RWS	0b	Writing this bit to a '1' enables the port to be sensitive to device disconnects as system wake-up events
27	Wake on Over-current Enable (WOE)	RWS	0b	Writing this bit to a '1' enables the port to be sensitive to over-current conditions as system wake-up events.
29 : 28	Rsvd	-	-	Reserved.
30	Device Removable (DR)	RO	0b	This flag indicates if this port has a removable device attached. '1' = Device is non-removable. '0' = Device is removable.
31	Warm Port Reset (WPR)	RW1S /Rsvd	0b	When software writes a '1' to this bit, the Warm Reset sequence as defined in the USB3 Specification is initiated and the PR flag is set to '1'. Once initiated, the PR,PRC, and WRC flags shall reflect the progress of the Warm Reset sequence. This flag shall always return '0' when read. This flag only applies to USB3 protocol ports. For USB2 protocol ports it shall be Reserved.

Note : n = Port Number 1, 2, 3, 4, 5, 6, 7 and 8 for μPD720201, n = Port Number 1,2,3 and 4 for μPD720202.

Table 3-95. PLS Write Value

Write Value	Description
0	The link shall transition to a U0 state from any of the U states.
2	USB2 protocol ports only. The link should transition to the U2 state.
3	The link shall transition to a U3 state from the U0 state. This action selectively suspends the device connected to this port.
5	USB3 protocol ports only. If the port is in the Disabled state (PLS = Disabled, PP=1), then the link shall transition to a RxDetect state and the port shall transition to the Disconnected state, else ignored.
1,4,6-14	Ignored

15	USB2 protocol ports only. If the port is in the U3 state (PLS = U3), then the link shall remain in the U3 state and the port shall transition to the U3Exit substate, else ignored.
----	---

Table 3-96. PLS Read Value

Read Value	Description
0	Link is in the U0 State
1	Link is in the U1 State
2	Link is in the U2 State
3	Link is in the U3 State (Device Suspended)
4	Link is in the Disable State
5	Link is in the RxDetect State
6	Link is in the Inactive State
7	Link is in the Polling State
8	Link is in the Recovery State
9	Link is in the Hot Reset State
10	Link is in the Compliance Mode State
11	Link is in the Test Mode State
14 : 12	Reserved
15	Link is in the Resume State

Table 3-97. PLS transitions

Transition	Condition
U3 -> Resume	Wakeup signaling from a device
Resume -> Recovery -> U0	Device Resume complete (USB3 protocol ports only)
Resume -> U0	Device Resume complete (USB2 protocol ports only)
U3 -> Recovery -> U0	Software Resume complete (USB3 protocol ports only)
U3 -> U0	Software Resume complete (USB2 protocol ports only)
U2 -> U0	L1 Resume complete (USB2 protocol ports only)
U0 -> U0	L1 Entry Reject (USB2 protocol ports only)
Any state -> Inactive	Error (USB3 protocol ports only)

3.4.8.2 Port PM Status and Control Register (PORTPMSC)

The definitions of the fields in the PORTPMSC register depend on the USB protocol supported by the port. This register is only reset by platform hardware during a cold reset or in response to a Host Controller Reset (HCRST).

3.4.8.3 USB3 Protocol PORTPMSC definition

Table 3-98. USB3 PORTPMSC Register (Offset Address: Operational Base (20h) + (404h + (10h*(n-1)))

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	U1 Timeout	RWS	0h	Timeout value for U1 inactivity timer. If equal to FFh, the port is disabled from initiating U1 entry. This field shall be set to '0' by the assertion of PR to '1'.
15 : 8	U2 Timeout	RWS	0h	Timeout value for U2 inactivity timer. If equal to FFh, the port is disabled from initiating U2 entry. This field shall be set to '0' by the assertion of PR to '1'.
16	Force Link PM Accept (FLA)	RW	0b	When this bit is set to '1', the port shall generate a Set Link Function LMP with the Force_LinkPM_Accept bit asserted. This flag shall be set to '0' by the assertion of PR to '1' or when CCS = transitions from '0' to '1'. Writes to this flag have no affect if PP = '0'. This flag is '0' if PP is '0'.
31 : 17	Rsvd	-	-	Reserved.

Note: In the equation for Offset Address, n = Port Number 1,2,3 or 4 for μPD720201. n = 1,2 for μPD720202.

3.4.8.4 USB2 Protocol PORTPMSC definition

Table 3-99. USB2 PORTPMSC Register (Offset Address: Operational Base (20h) +(404h + (10h*(n-1)))

Bits	Field	Read/Write	Value (Default)	Comment														
2 : 0	L1 Status (L1S)	RO	000b	<p>This field is used by software to determine whether an L1-based suspend request (LMP transaction) was successful, specifically:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Invalid – This field shall be ignored by software.</td> </tr> <tr> <td>1</td> <td>Success – Port successfully transitioned to L1 (ACK)</td> </tr> <tr> <td>2</td> <td>Not Yet – Device is unable to enter L1 at this time (NYET)</td> </tr> <tr> <td>3</td> <td>Not Supported – Device does not support L1 transitions (STALL)</td> </tr> <tr> <td>4</td> <td>Timeout/Error – Device failed to respond to the LPM Transaction or an error occurred.</td> </tr> <tr> <td>5-7</td> <td>Reserved</td> </tr> </tbody> </table>	Value	Meaning	0	Invalid – This field shall be ignored by software.	1	Success – Port successfully transitioned to L1 (ACK)	2	Not Yet – Device is unable to enter L1 at this time (NYET)	3	Not Supported – Device does not support L1 transitions (STALL)	4	Timeout/Error – Device failed to respond to the LPM Transaction or an error occurred.	5-7	Reserved
Value	Meaning																	
0	Invalid – This field shall be ignored by software.																	
1	Success – Port successfully transitioned to L1 (ACK)																	
2	Not Yet – Device is unable to enter L1 at this time (NYET)																	
3	Not Supported – Device does not support L1 transitions (STALL)																	
4	Timeout/Error – Device failed to respond to the LPM Transaction or an error occurred.																	
5-7	Reserved																	
3	Remote Wake Enable (RWE)	RW	0b	The host system sets this flag to enable or disable the device for remote wake from L1.														
7 : 4	Host Initiated Resume Duration (HIRD)	RW	0h	System software sets this field to indicate to the recipient device how long the xHC will drive resume if it initiates an exit from L1. The value of 0000b is interpreted as 50us. Each incrementing value up adds 75us to the previous value.														
15 : 8	L1 Device Slot	RW	0h	System software sets this field to indicate the ID of the Device Slot associated with the device directly attached to the Root Hub port. A value of '0' indicates no device is present. The xHC uses this field to lookup information necessary to generate the LMP Token packet.														
16	Hardware LPM Enable (HLE)	RW	0b	If this bit is set to '1', then hardware controlled LPM shall be enabled for this port..														

Bits	Field	Read/Write	Value (Default)	Comment																		
27 : 15	Rsvd	-	-	Reserved																		
31 : 28	Port Test Control	RW	0h	<p>When this field is '0', the port is NOT operating in a test mode. A non-zero value indicates that it is operating in test mode and the specific test mode is indicated by the specific value.</p> <p>A non-zero Port Test Control value is only valid to a port that is in the Powered-off state (PLS = Disable). If the port is not in this state, the xHC shall respond with the Port Test Control field set to Port Test Control Error.</p> <p>The encoding of the Test Mode bits for a USB2 protocol port are:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Test Mode</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Test mode not enabled</td> </tr> <tr> <td>1</td> <td>Test J_STATE</td> </tr> <tr> <td>2</td> <td>Test K_STATE</td> </tr> <tr> <td>3</td> <td>Test SE0_NAK</td> </tr> <tr> <td>4</td> <td>Test Packet</td> </tr> <tr> <td>5</td> <td>Test FORCE_ENABLE</td> </tr> <tr> <td>6-14</td> <td>Reserved</td> </tr> <tr> <td>15</td> <td>Port Test Control Error</td> </tr> </tbody> </table>	Value	Test Mode	0	Test mode not enabled	1	Test J_STATE	2	Test K_STATE	3	Test SE0_NAK	4	Test Packet	5	Test FORCE_ENABLE	6-14	Reserved	15	Port Test Control Error
Value	Test Mode																					
0	Test mode not enabled																					
1	Test J_STATE																					
2	Test K_STATE																					
3	Test SE0_NAK																					
4	Test Packet																					
5	Test FORCE_ENABLE																					
6-14	Reserved																					
15	Port Test Control Error																					

Note: In the equation for Offset Address, n = Port Number 5,6,7 or 8 for μPD720201. n = 3 or 4 for μPD720202.

3.4.8.5 Port Link Info Register (PORTLI)

The definitions of the fields in the PORTLI register depend on the USB protocol supported by the port. The USB3 Port Link Info register reports the Link Error Count, while the USB2 Port Link Info register is reserved and shall be treated as Reserved by software.

Table 3-100. USB3 PORTLI Register (Offset Address: Operational Base (20h) + (408h + (10h * (n-1)))

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Link Error Count	RO	0h	This field returns the number of link errors detected by the port. This value shall be reset to '0' by the assertion of a Chip hardware Reset, HCRST, when PR transitions from '1' to '0', or when CCS = transitions from '0' to '1'.
31 : 16	Rsvd	-	-	Reserved.

Note: n = Port Number 1,2,3 or 4 for μPD720201. n = 1 or 2 for μPD720202.

3.5 Host Controller Runtime Registers

This section defines the xHCI Runtime Register space. The base address of this register space is referred to as Runtime Base (Refer to section 3.3.8). The Runtime Base shall be 32-byte aligned and is calculated by adding the value Runtime Register Space Offset register to the Capability Base address. All Runtime registers are multiples of 32 bits in length.

Unless otherwise stated, all registers should be accessed with Dword references on reads, with an appropriate software mask if needed. A software read/modify/write mechanism should be invoked for partial writes.

Software should write registers containing a Qword address field using only Qword references. If a system is incapable of issuing Qword references, then writes to the Qword address fields shall be performed using 2 Dword references; low Dword-first, high-Dword second.

Table 3-101. Host Controller Runtime Registers

31 24	23 16	15 8	7 0	Offset
MFINDEX (Microframe Index)				600h
Reserved				604~61Fh
IR0 (Interrupter Register Set 0)				620~63Fh
IR1 (Interrupter Register Set 1)				640~65Fh
IR2 (Interrupter Register Set 2)				660~67Fh
IR3 (Interrupter Register Set 3)				680~69Fh
IR4 (Interrupter Register Set 4)				6A0~6BFh
IR5 (Interrupter Register Set 5)				6C0~6DFh
IR6 (Interrupter Register Set 6)				6E0~6FFh
IR7 (Interrupter Register Set 7)				700~71Fh

3.5.1 Microframe Index Register (MFINDEX)

This register is used by the system software to determine the current periodic frame. The register value is incremented every 125 microseconds (once each microframe).

This register is only incremented while Run/Stop (R/S) = '1'.

The value of this register affects the SOF value generated by USB2 Bus Instances.

Table 3-102. MFINDEX Register (Offset Address: Runtime Base (600h) + 00h)

Bits	Field	Read/ Write	Value (Default)	Comment
13 : 0	Microframe Index	RO	0h	The value in this register increment at the end of each microframe. Bit [13:3] may be used to determine the current 1ms Frame Index.
31 14	Rsvd	-	-	Reserved.

3.5.2 Interrupter Register Set

The Interrupter logic consists of an Interrupter Management Register, an Interrupter Moderation Register, and the Event Ring Registers. A one to one mapping is defined for Interrupter to MSI-X vector.

Table 3-103. Interrupter Register Set

31 24	23 16	15 8	7 0	Offset
Interrupter Management				00h
Interrupter Moderation Counter		Interrupter Moderation Interval		04h
Reserved		Event Ring Segment Table Size		08h
Reserved				0Ch
Event Ring Segment Table Base Address Lo			Reserved	10h
Event Ring Segment Table Base Address Hi				14h
Event Ring Dequeue Pointer Lo			Reserved	18h
Event Ring Dequeue Pointer Hi				1Ch

3.5.2.1 Interrupter Management Register (IMAN)

The Interrupter Management register allows system software to enable, disable, detect, and force xHC interrupts.

Table 3-104. IMAN Register (Offset Address: Runtime Base (600h) + 020h + (20h*Interrupter))

Bits	Field	Read/ Write	Value (Default)	Comment
0	Interrupter Pending (IP)	RW1C	0b	This flag represents the current state of the Interrupter. If IP='1', an interrupt is pending for this Interrupter. This flag is set to '1' when IE = '1', the IMODC Interrupt Moderation Counter field = '0' the Event Ring associated with the Interrupter I not empty, and EHB = '0'. A '0' value indicates that no interrupt is pending for the Interrupter. If MSI interrupts are enabled, this flag shall be cleared automatically when the PCI Dword write generated by the Interrupt assertion is complete. If PCI Pin Interrupts are enabled, this flag shall be cleared by software.
1	Interrupt Enable (IE)	RW	0b	This flag specifies whether the Interrupter is capable of generating an interrupt. When this bit and the IP bit are set '1', the Interrupter shall generate an interrupt when the Interrupter Moderation Counter reaches '0'. If this bit is '0', then the Interrupter is prohibited from generating interrupts.
31 : 2	Rsvd	-	-	Reserved.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

3.5.2.2 Interrupter Moderation Register (IMOD)

The Interrupter Moderation Register controls the “interrupt moderation” feature of an interrupter, allowing system software to throttle the interrupt rate generated by the xHC.

Table 3-105. IMOD Register (Offset Address: Runtime Base (600h) + 024h + (20h*Interrupter))

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Interrupt Moderation Interval (IMODI)	RW	FA0h (~1ms)	Minimum inter-interrupt interval. The interval is specified in 250ns increments. A value of '0' disables interrupt throttling logic and interrupts shall be generated immediately if IP = '0', EHB = '0', and the Event Ring is not empty.
31 : 16	Interrupt Moderation Counter (IMODC)	RW	0h	Down counter. Loaded with Interval value whenever IP is cleared to '0', counts down to '0', and stops. The associated interrupt shall be signaled whenever this counter is '0', the Event Ring is not empty, the IE and IP flags = '1', and EHB = '0'. This counter may be directly written by software at any time to alter the interrupt rate.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

3.5.2.3 Event Ring Segment Table Size Register (ERSTSZ)

The Event Ring Segment Table Size Register defines the number of segments supported by the Event Ring Segment table.

Table 3-106. ERSTSZ Register (Offset Address: Runtime Base (600h) + 028h + (20h*Interrupter))

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Event Ring Segment Table Size	RW	0h	This field identifies the number of valid Event Ring Segment Table entries in the Event Ring Segment Table pointed to by the Event Ring Segment Table Base Address register. The maximum value supported by an xHC implementation for this register is defined by the ERST Max field in the HSCPARAMS2 register. For Secondary Interrupters: Writing a value of '0' to this field disables the Event Ring. Any events targeted at this Event Ring when it is disabled shall result in undefined behavior of the Event Ring. For the Primary Interrupter: Writing a value of '0' to this field shall result in undefined behavior of the Event Ring. The Primary Event Ring cannot be disabled.
31 : 16	Rsvd	-	-	Reserved.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

3.5.2.4 Event Ring Segment Table Base Address Register (ERSTBA)

The Event Ring Segment Table Base Address Register identifies the start address of the Event Ring Segment Table.

Table 3-107. ERSTBA Register (Offset Address: Runtime Base (600h) + 30h + (20h*Interrupter))

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Rsvd	-	-	Reserved.
63 : 4	Event Ring Segment Table Base Address Register	RW	0h	This field defines the high order bits of the start address of the Event Ring Segment Table. Writing this register sets the Event Ring State Machine : EREP advancement to the Start state. This field shall not be modified if HCHalted (HCH) = '0'.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

3.5.2.5 Event Ring Dequeue Pointer Register (ERDP)

The Event Ring Dequeue Pointer Register is written by software to define the Event Ring Dequeue Pointer location to the xHC. Software updates this pointer when it is finished the evaluation of an Event(s) on the Event Ring.

Table 3-108. ERDP Register (Offset Address: Runtime Base (600h) + 038h + (20h*Interrupter))

Bits	Field	Read/Write	Value (Default)	Comment
2 : 0	Dequeue ERST Segment Index (DESI)	RW	000b	This field may be used by the xHC to accelerate checking the Event Ring full condition. This field is written with the low order 3 bits of the offset of the ERST entry which defines the Event Ring segment that Event Ring Dequeue Pointer resides in.
3	Event Hander Busy (EHB)	RW1C	0b	This flag shall be set to '1' when the IP bit is set to '1' and cleared to '0' by software when the Dequeue Pointer register is written.
63 : 4	Event Ring Dequeue Pointer	RW	0h	This field defines the high order bits of the 64-bit address of the current Event Ring Dequeue Pointer.

3.6 Doorbell Registers

The Doorbell Array is organized as an array of up to 32 Doorbell Registers. One 32-bit Doorbell Register is defined in the array for each Device Slot. System software utilizes the Doorbell Register to notify the xHC that it has Device Slot related work for the xHC to perform.

These registers are pointed to by the Doorbell Offset Register (DBOFF) in the xHC Capability register space. The Doorbell Array base address shall be Dword aligned and is calculated by adding the value in the DBOFF register (section 0) to “Base”. All registers are 32 bits in length. Software should read and write these registers using only Dword accesses.

Table 3-109. Doorbell Registers

31 24	23 16	15 8	7 0	Offset
DB Stream ID		Reserved	DB Target	800h ~ 88Fh

Table 3-110. Doorbell Register

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	DB Target	RW	0h	This field defines the target of the doorbell reference. The table below defines the xHC notification that is generated by ringing the doorbell. Note that Doorbell Register 0 is dedicated to Command Ring and decodes this field differently than the other Doorbell Registers. Device Context Doorbells (1 – 255)
15 : 8	Rsvd	-	-	Reserved
31 : 16	DB Stream ID	RW	0h	Doorbell Stream ID. If the endpoint of a Device Context Doorbell defines Streams, then this field shall be used to identify which Stream of the endpoint the doorbell reference is targeting. System software is responsible for ensuring that the value written to this field is valid. If the endpoint does not define Streams (MaxPStreams = 0) and a non-'0' value is written to this field, the doorbell reference shall be ignored. This field only applies to Device Context Doorbells and shall be cleared to '0' for Host Controller Commands. This field returns '0' when read.

3.7 xHCI Extended Capabilities

The μPD720201 and μPD720202 exports xHCI-specific extended capabilities utilizing a method similar to the PCI extended capabilities. It specifies a non-zero value in xHCI Extended Capabilities Pointer field of the HCPARAMS register. This value is an offset into xHC MMIO space from the Base, where the Base is beginning of the host controller’s MMIO address space.

3.7.1 USB Legacy Support Capability

The USB Legacy Support provided by the xHC is optional normative functionality that is applicable to pre-OS software (BIOS) and the operating system for the coordination of ownership of the xHC. This capability is chained through the xHCI Extended Capabilities Pointer (xECP) field and resides in MMIO space.

Table 3-111. HC Extended Capability Registers

31 24	23 16	15 8	7 0	Offset
USB Legacy Support Capability Register (USBLEGSUP)				500h
USB Legacy Support Control and Status Register (USBLEGCTLSTS)				504h

3.7.1.1 USB Legacy Support Capability (USBLEGSUP)

This register is an xHC extended capability register. It includes a specific function section and a pointer to the next xHCI Extended Capability. This register is used by pre-OS software (BIOS) and the operating system to coordinate ownership of the xHC. This register is in the Auxiliary Power well.

Table 3-112. USBLEGSUP (Offset Address: xECP (500h) + 00h)

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Capability ID	RO	1h	This field identifies the xHCI Extended capability. The xHCI Extended capability ID for the USB Legacy Support is 01h.
15 : 8	Next Capability Pointer	RO	4h	This field points to the xHC MMIO space offset of the next xHCI extended capability pointer.
16	HC BIOS Owned Semaphore	RW	0h	The BIOS sets this bit to establish ownership of the xHC. System BIOS will set this bit to a '0' in response to a request for ownership of the xHC by system software.
23 : 17	Rsvd	-	-	Reserved.
24	HC OS Owned Semaphore	RW	0h	System software sets this bit to request ownership of the xHC. Ownership is obtained when this bit reads as '1' and the HC BIOS Owned Semaphore bit reads as '0'.
31 : 25	Rsvd	-	-	Reserved.

3.7.1.2 USB Legacy Support Control / Status (USBLEGCTLSTS)

Pre-OS (BIOS) software uses this register to enable System Management Interrupts (SMIs) for every xHCI/USB event it needs to track. Bits [21:16] of this register are simply shadow bit of USBSTS register [5:0]. This register is in the Auxiliary Power well.

Table 3-113. USBLEGCTLSTS (Offset Address: xECP (500h) + 04h)

Bits	Field	Read/Write	Value (Default)	Comment
0	USB SMI Enable	RW	0b	When this bit is a '1', and the SMI on SMI on Event Interrupt bit in this register is a '1', the host controller will issue an SMI immediately.
3 : 1	Rsvd	-	-	Reserved.
4	SMI on Host System Error Enable	RW	0b	When this bit is a '1', and the SMI on Host System Error bit in this register is a '1', the host controller will issue an SMI immediately.
12 : 5	Rsvd	-	-	Reserved.
13	SMI on OS Ownership Enable	RW	0b	When this bit is a '1' and the OS Ownership Change bit is '1', then the host controller will issue an SMI.
14	SMI on PCI Command Enable	RW	0b	When this bit is '1' and SMI on PCI Command is '1', then the host controller will issue an SMI.
15	SMI on BAR Enable	RW	0b	When this bit is '1' and SMI on BAR is '1', then the host controller will issue an SMI.
16	SMI on Event Interrupt	RO	0b	Shadow bit of Event Interrupt (EINT) bit in the USBSTS register. This bit follows the state the Event Interrupt (EINT) bit in the USBSTS register, e.g. it automatically clears when EINT clears or set when EINT is set.
19 : 17	Rsvd	-	-	Reserved.
20	SMI on Host System Error	RO	0b	Shadow bit of Host System Error (HSE) bit in the USBSTS register. To clear this bit to '0', system software shall write a '1' to the Host System Error (HSE) bit in the USBSTS register.
28 : 21	Rsvd	-	-	Reserved.
29	SMI on OS Ownership Change	RW1C	0b	This bit is set to '1' whenever the HC OS Owned Semaphore bit in the USBLEGSUP register transitions from '1' to a '0' or '0' to a '1'.
30	SMI on PCI Command	RW1C	0b	This bit is set to '1' whenever the PCI Command Register is written.

Bits	Field	Read/Write	Value (Default)	Comment
31	SMI on BAR	RW1C	0b	This bit is set to '1' whenever the Base Address Register (BAR) is written.

Note: SMI – System Management Interrupt.
BAR – Base Address Register.

3.7.2 xHCI Supported Protocol Capability

Table 3-114. xHCI Supported Protocol Capability Register

31	2423	16 15	87	0	Offset	
Revision Major		Revision Minor		Next Capability Pointer	Capability ID	00h
Name String						04h
PSIC	Protocol Defined		Compatible Port Count	Compatible Port Offset		08h
Reserved					Protocol Slot Type	0Ch

3.7.2.1 USB 3.0 Supported Protocol Capability

Table 3-115. Offset 00h - xHCI Supported Protocol Capability Field (Offset Address: xECP + 10h (510h))

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Capability ID	RO	02h	This field identifies the xHCI Extended capability. The xHCI Extended capability ID for the USB Supported Protocol is 02h.
15 : 8	Next Capability Pointer	RO	05h	This field points to the xHC MMIO space offset of the next xHCI extended capability pointer.
23 : 16	Minor Revision	RO	00h	Minor Specification Release Number in Binary –Coded Decimal.
31 : 24	Major Revision	RO	03h	Major Specification Release Number in Binary –Coded Decimal.

Table 3-116. Offset 04h - xHCI Supported Protocol Capability Field (Offset Address: xECP + 14h (514h))

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Name String	RO	20425355h	This field is a mnemonic name string that references the specification with which the xHC is compliant.

Table 3-117. Offset 08h - xHCI Supported Protocol Capability Field (Offset Address: xECP + 18h (518h))

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	USB3 Compatible Port Offset	RO	01h	This field specifies the starting Port Number of Root Hub Port that supports this protocol.
15 : 8	USB3 Compatible Port Count	RO	04h (μPD720201) 02h (μPD720202)	This field identifies the number of consecutive Root Hub Ports that support this protocol.

Bits	Field	Read/Write	Value (Default)	Comment
27 : 16	Protocol Defined	RO	0h	This field is reserved.
31 : 28	PSIC	RO	0h	Protocol Speed ID Count. This field indicates the number of Protocol Speed ID Dwords that the xHCI Supported Protocol Capability data structure contains.

Table 3-118. Offset 0Ch - xHCI Supported Protocol Capability Field (Offset Address: xECP + 1Ch (51Ch))

Bits	Field	Read/Write	Value (Default)	Comment
4 : 0	Protocol Slot Type	RO	0h	This field is reserved.
31 : 5	Rsvd	-	-	Reserved.

3.7.2.2 USB 2.0 Supported Protocol Capability

Table 3-119. Offset 00h - xHCI Supported Protocol Capability Field (Offset Address: xECP + 24h (524h))

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Capability ID	RO	02h	This field identifies the xHCI Extended capability. The xHCI Extended capability ID for the USB Supported Protocol is 02h.
15 : 8	Next Capability Pointer	RO	07h	This field points to the xHC MMIO space offset of the next xHCI extended capability pointer.
23 : 16	Minor Revision	RO	00h	Minor Specification Release Number in Binary –Coded Decimal.
31 : 24	Major Revision	RO	02h	Major Specification Release Number in Binary –Coded Decimal.

Table 3-120. Offset 04h - xHCI Supported Protocol Capability Field (Offset Address: xECP + 28h (528h))

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Name String	RO	20425355h	This field is a mnemonic name string that references the specification with which the xHC is compliant.

Table 3-121. Offset 08h - xHCI Supported Protocol Capability Field (Offset Address: xECP + 2Ch (52Ch))

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	USB2 Compatible Port Offset	RO	05h (μPD720201) 03h (μPD720202)	This field specifies the starting Port Number of Root Hub Port that supports this protocol.
15 : 8	USB2 Compatible Port Count	RO	04h (μPD720201) 02h (μPD720202)	This field identifies the number of consecutive Root Hub Ports that support this protocol.
16	Rsvd	-	-	Reserved
17	HSD	RO	0b	Hi-Speed Only. 0b indicates this USB2 ports are Low, Full, and Hi-Speed capable.
18	IHI	RO	0b	Integrated Hub Implemented. 0b indicates this host does not implement integrated hub.
19	HLC	RO	0b	Hardware LMP Capability. If this bit is set to '1', the ports described by this capability support hardware controlled USB2 Link Power Management.
27 : 20	Rsvd	-	-	Reserved
31 : 28	PSIC	RO	0h	Protocol Speed ID Count. This field indicates the number of Protocol Speed ID Dwords that the xHCI Supported Protocol Capability data structure contains.

Table 3-122. Offset 0Ch - xHCI Supported Protocol Capability Field (Offset Address: xECP + 30h (530h))

Bits	Field	Read/Write	Value (Default)	Comment
4 : 0	Protocol Slot Type	RO	0h	This field is reserved.
31 : 5	Rsvd	-	-	Reserved.

3.7.3 Debug Capability

Table 3-123. Debug Capability Register Layout

31 24	23 16	15 8	7 0	Offset	
Reserved		DCERST Max	Next Capability Pointer	Capability ID	00h
Reserved		DB Target		Reserved	04h
Reserved		Event Ring Segment Table Size			08h
Reserved					0Ch
Event Ring Segment Table Base Address Lo				Reserved	10h
Event Ring Segment Table Base Address Hi					14h
Event Ring Dequeue Pointer Lo				Reserved	18h
Event Ring Dequeue Pointer Hi					1Ch
Debug Capability Control Register					20h
Debug Capability Status Register					24h
Debug Capability Port Status and Control Register					28h
Reserved					2Ch
Debug Capability Context Pointer Lo				Reserved	30h
Debug Capability Context Pointer Hi					34h
Vendor ID		Reserved	DbC Protocol		38h
Device Revision		Product ID			3Ch

3.7.3.1 Debug Capability ID Register

Table 3-124. Offset 00h – Debug Capability Field (Offset Address: xECP + 50h (550h))

Bits	Field	Read/Write	Value (Default)	Comment
7 : 0	Capability ID	RO	02h	This field identifies the xHCI Extended capability. The xHCI Extended capability ID for the USB Supported Protocol is 02h.
15 : 8	Next Capability Pointer	RO	00h	This field points to the xHC MMIO space offset of the next xHCI extended capability pointer.
20 : 16	DCERST Max	RO	00h	This field determines the maximum value supported the Debug Capability Event Ring Segment Table Base Size registers. 0h indicates that the maximum number of Event Ring Segment Table entries is 1.
31 : 21	Rsvd.	-	-	Reserved.

3.7.3.2 Debug Capability Doorbell Register

Table 3-125. Offset 04h – Debug Capability Field (Offset Address: xECP + 54h (554h))

Bits	Field	Read/Write	Value (Default)	Comment								
7 : 0	Rsvd	-	-	Reserved.								
15 : 8	DB Target	WO	00h	Doorbell Target. This field defines the target of the doorbell reference. The table below defines the Debug Capability notification that is generated by ringing the doorbell. <table border="1"> <thead> <tr> <th>Value</th> <th>Definition</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Data EP 1 OUT Enqueue Pointer Update</td> </tr> <tr> <td>1</td> <td>Data EP 1 IN Enqueue Pointer Update</td> </tr> <tr> <td>2 : 255</td> <td>Reserved.</td> </tr> </tbody> </table>	Value	Definition	0	Data EP 1 OUT Enqueue Pointer Update	1	Data EP 1 IN Enqueue Pointer Update	2 : 255	Reserved.
Value	Definition											
0	Data EP 1 OUT Enqueue Pointer Update											
1	Data EP 1 IN Enqueue Pointer Update											
2 : 255	Reserved.											
31 : 16	Rsvd	-	-	Reserved.								

3.7.3.3 Debug Capability Event Ring Segment Table Size Register

Table 3-126. Offset 08h – Debug Capability Field (Offset Address: xECP + 58h (558h))

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Event Ring Segment Table Size	RW	0000h	This field identifies the number of valid Event Ring Segment Table entries in the Event Ring Segment Table pointed to by the Debug Capability Event Ring Segment Table Base Address Register. Software shall initialize this register before setting the Debug Capability Enable field in the Debug Capability Control Register.
31 : 16	Rsvd.	-	-	Reserved.

3.7.3.4 Debug Capability Event Ring Segment Table Base Address Register

Table 3-127. Offset 0Ch – Debug Capability Field (Offset Address: xECP + 60h (560h))

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Rsvd.	-	-	Reserved.

Bits	Field	Read/Write	Value (Default)	Comment
63 : 4	Event Ring Segment Table Base Address Register	RW	0h	This field defines the high order bits of the start address of the Debug Capability Event Ring Segment Table. Software shall initialize this register before setting the Debug Capability Enable field.

3.7.3.5 Debug Capability Event Ring Dequeue Pointer Register

Table 3-128. Offset 18h – Debug Capability Field (Offset Address: xECP + 68h (568h))

Bits	Field	Read/Write	Value (Default)	Comment
2 : 0	DESI	RW	000b	This field may be used by the xHC to accelerate checking the Event Ring full condition. This field is written with the low order 3bits of the offset of the ERST entry which defines the Event Ring segment that the Event Ring Dequeue Pointer resides in.
3	Rsvd	-	-	Reserved.
63 : 4	Dequeue Pointer	RW	0h	This field defines the high order bits of the 64-bit address of the current Debug Capability Event Ring Dequeue Pointer. Software shall initialize this register before setting the Debug Capability Enable field.

3.7.3.6 Debug Capability Event Ring Dequeue Pointer Register

Table 3-129. Offset 20h – Debug Capability Field (Offset Address: xECP + 70h (570h))

Bits	Field	Read/Write	Value (Default)	Comment
0	DCR	RO	0b	DbC Run. When '0', Debug Device is not in the Configured state. When '1', Debug Device is in the Configured state and bulk Data pipe transactions are accepted by Debug Capability and routed to the IN and OUT Transfer Rings. A '0' to '1' transition of the Port Reset bit will clear this bit to '0'.

Bits	Field	Read/Write	Value (Default)	Comment
1	LSE	RW	0b	Link Status Event Enable. Setting this bit to a '1' enables the Debug Capability to generate Port Status Change Events due the Port Link Status Change bit transitioning from a '0' to a '1'.
2	HOT	RW1S	0b	Halt OUT TR. While this bit is '1', the Debug Capability shall generate STALL TPs for all IN TPs received for the OUT TR. The Debug Capability shall clear this bit when a ClearFeature(ENDPOINT_HALT) request is received for the endpoint. This field is valid only when the Debug Capability is in Run Mode (DCR = '1'). When not in Run Mode, this field shall return '0' when read, and writes will have no effect.
3	HIT	RW1S	0b	Halt IN TR. While this bit is '1', the Debug Capability shall generate STALL TPs for all OUT DPs received for the IN TR. The Debug Capability shall clear this bit when a ClearFeature(ENDPOINT_HALT) request is received for the endpoint. This field is valid only when the Debug Capability is in Run Mode
4	DRC	RW1C	0b	This bit shall be set to '1' when DCR bit is cleared to '0', i.e. by any DbC Port State transition that exits the DbC-Configured state. While this bit is '1' the Debug Capability Doorbell Register (DCDB) is disabled. Software shall clear this bit to re-enable the DCDB.
15 : 5	Rsvd.	-	-	Reserved.
23 : 16	Debug Max Burst Size	RO	0h	This field identifies the maximum burst size supported by the bulk endpoints of this DbC implementation.
30 : 24	Device Address	RO	0h	This field reports the USB device address assigned to the Debug Device during the enumeration process. This field is valid when the DbC Run bit is '1'.

Bits	Field	Read/Write	Value (Default)	Comment
31	DCE	RW	0h	Debug Capability Enable. Setting this bit to a '1' enables xHC USB Debug Capability operation. This bit is a '0' if the USB Debug Capability is disabled. Clearing this bit releases the Root Hub port assigned to the Debug Capability, and terminates any Debug Capability Transfer or Event Ring activity.,

3.7.3.7 Debug Capability Status Register

Table 3-130. Offset 24h – Debug Capability Field (Offset Address: xECP + 74h (574h))

Bits	Field	Read/Write	Value (Default)	Comment
0	Event Ring Not Empty	RO	0b	When '1', this field indicates that the Debug Capability Event Ring has a Transfer Event on it. It is automatically cleared to '0' by the xHC when the Debug Capability Event Ring is empty, i.e. the Debug Capability Enqueue Pointer is equal to the Debug Capability Event Ring Dequeue Pointer register.
23 : 1	Rsvd	-	-	Reserved.
31 : 24	Debug Port Number	RO	0h	This field provides the ID of the Root Hub port that the Debug Capability has been automatically attached to. The value is '0' when the Debug Capability is not attached to a Root Hub port.

3.7.3.8 Debug Capability Port Status and Control Register

Table 3-131. Offset 28h – Debug Capability Field (Offset Address: xECP + 78h (578h))

Bits	Field	Read/Write	Value (Default)	Comment																								
0	CCS	RO	0b	Current Connect Status. '1' = A Root Hub port is connected to a Debug Host and assigned to the Debug Capability. '0' = No Debug Host is present. This value reflects the current state of the port, and may not correspond to the value reported by the Connect Status Change (CSC) field in the Port Status Change Event that was generated by a '0' to '1' transition of this bit. This flag is '0' if DCE is '0'.																								
1	PED	RW	0b	Port Enabled/Disabled. This flag shall be set to '1' by a '0' to '1' transition of CCS or a '1' to '0' transition of the PR. This field is '0' if DCE or CCS are '0'.																								
3 : 2	Rsvd	-	-	Reserved.																								
4	PR	RO	0b	'1' = Port is in Reset. '0' = Port is not in Reset. This bit is set to '1' when the bus reset sequence as defined in the USB Specification is detected on the Root Hub port assigned to the Debug Capability. This field is '0' if DCE or CCS are '0'.																								
8 : 5	PLS	RO	000b	This field reflects its current link state. This field is only relevant when a Debug Host is attached. <table border="0"> <tr> <td>Value</td> <td>Meaning</td> </tr> <tr> <td>0</td> <td>U0 State</td> </tr> <tr> <td>1</td> <td>U1 State</td> </tr> <tr> <td>2</td> <td>U2 State</td> </tr> <tr> <td>3</td> <td>U3 State</td> </tr> <tr> <td>4</td> <td>Disabled State</td> </tr> <tr> <td>5</td> <td>RxDetect State</td> </tr> <tr> <td>6</td> <td>Inactive State</td> </tr> <tr> <td>7</td> <td>Polling State</td> </tr> <tr> <td>8</td> <td>Recovery State</td> </tr> <tr> <td>9</td> <td>Hot Reset State</td> </tr> <tr> <td>15: 10</td> <td>Reserved</td> </tr> </table>	Value	Meaning	0	U0 State	1	U1 State	2	U2 State	3	U3 State	4	Disabled State	5	RxDetect State	6	Inactive State	7	Polling State	8	Recovery State	9	Hot Reset State	15: 10	Reserved
Value	Meaning																											
0	U0 State																											
1	U1 State																											
2	U2 State																											
3	U3 State																											
4	Disabled State																											
5	RxDetect State																											
6	Inactive State																											
7	Polling State																											
8	Recovery State																											
9	Hot Reset State																											
15: 10	Reserved																											
9	Rsvd	-	-	Reserved.																								

Bits	Field	Read/Write	Value (Default)	Comment										
13 : 10	Port Speed	RO	0h	<p>This field identifies the speed of the port. This field is only relevant when a Debug Host is attached (CCS = '1') in all other cases this field shall indicate Undefined Speed.</p> <table border="0"> <tr> <td>Value</td> <td>Meaning</td> </tr> <tr> <td>0</td> <td>Undefined Speed</td> </tr> <tr> <td>1 – 15</td> <td>Protocol Speed ID</td> </tr> </table>	Value	Meaning	0	Undefined Speed	1 – 15	Protocol Speed ID				
Value	Meaning													
0	Undefined Speed													
1 – 15	Protocol Speed ID													
16 : 14	Rsvd	-	-	Reserved.										
17	CSC	RW1S	0b	<p>Connect Status Change. '1' = Change in Current Connect Status. '0' = No change. Indicates a change has occurred in the port's Current Connect Status. The xHC sets this bit to '1' for all changes to the Debug Device connect status, even if system software has not cleared an existing DbC Connect Status Change. This field is '0' if DCE is '0'.</p>										
20 : 18	Rsvd	-	-	Reserved.										
21	PRC	RW1C	0b	<p>Port Reset Change. This bit is set when reset processing on this port is complete. '0' = No change. '1' = Reset complete. Software shall clear this bit by writing a '1' to it. This field is '0' if DCE is '0'.</p>										
22	PLC	RW1C	0b	<p>Port Link Status Change. This flag is set to '1' due to the following PLS transitions:</p> <table border="0"> <tr> <td>Transition</td> <td>Condition</td> </tr> <tr> <td>U0 -> U3</td> <td>Suspend signaling detected from Debug Host.</td> </tr> <tr> <td>U3 -> U0</td> <td>Resume complete</td> </tr> <tr> <td>Polling -> Disabled</td> <td>Training Error</td> </tr> <tr> <td>Ux or Recovery -> Inactive</td> <td>Error</td> </tr> </table>	Transition	Condition	U0 -> U3	Suspend signaling detected from Debug Host.	U3 -> U0	Resume complete	Polling -> Disabled	Training Error	Ux or Recovery -> Inactive	Error
Transition	Condition													
U0 -> U3	Suspend signaling detected from Debug Host.													
U3 -> U0	Resume complete													
Polling -> Disabled	Training Error													
Ux or Recovery -> Inactive	Error													
23	CEC	RW1C	0b	<p>Port Config Error Change. This flag indicates that the port failed to configure its link partner. '0' = Nochange. '1' = Port Config Error detected. Software shall clear this bit by writing a '1' to it.</p>										
31 : 24	Rsvd	-	-	Reserved.										

3.7.3.9 Debug Capability Context Pointer Register

Table 3-132. Offset 30h – Debug Capability Field (Offset Address: xECP + 80h (580h))

Bits	Field	Read/Write	Value (Default)	Comment
3 : 0	Rsvd	-	-	Reserved.
63 : 4	Debug Capability Context Pointer Register	RW	0h	This field defines the high order bits of the start address of the Debug Capability Context data structure associated with the Debug Capability. Software shall initialize this register before setting the Debug Capability Enable bit in the Debug Capability Control Register to '1'.

3.7.3.10 Debug Capability Device Descriptor Info Register 1

Table 3-133. Offset 38h – Debug Capability Field (Offset Address: xECP + 88h (588h))

Bits	Field	Read/Write	Value (Default)	Comment								
7 : 0	DbC Protocol	RW	00h	This field presented by the Debug Device in the USB Interface Descriptor bInterfaceProtocol field. <table border="0" style="margin-left: 20px;"> <tr> <td>Value</td> <td>Function</td> </tr> <tr> <td>0</td> <td>Debug Target vendor defined.</td> </tr> <tr> <td>1</td> <td>GNU Remote Debug Command Set supported.</td> </tr> <tr> <td>2 - 255</td> <td>Reserved.</td> </tr> </table>	Value	Function	0	Debug Target vendor defined.	1	GNU Remote Debug Command Set supported.	2 - 255	Reserved.
Value	Function											
0	Debug Target vendor defined.											
1	GNU Remote Debug Command Set supported.											
2 - 255	Reserved.											
15 : 8	Rsvd	-	-	Reserved.								
31 : 16	Vendor ID	RW	00h	This field is presented by the Debug Device in the USB Device Descriptor idVendor field.								

3.7.3.11 Debug Capability Device Descriptor Info Register 2

Table 3-134. Offset 3Ch – Debug Capability Field (Offset Address: xECP + 8Ch (58Ch))

Bits	Field	Read/Write	Value (Default)	Comment
15 : 0	Product ID	RW	0000h	This field is presented by the Debug Device in the USB Device Descriptor idProduct field.

Bits	Field	Read/Write	Value (Default)	Comment
31 : 16	Device Revision	RW	0000h	This field is presented by the Debug Device in the USB Device Descriptor bcdDevised field.

3.8 MSI-X / PBA Table

Table 3-135. MSI-X Table Registers

31	23	15	7	Offset
24	16	8	0	
Message Address				00h
Message Upper Address				04h
Message Data				08h
Reserved			MB	0Ch

Table 3-136. PBA Table Registers

31	23	15	7	Offset
24	16	8	0	
PBA Table				00h

3.8.1 Message Address for MSI-X Table

Table 3-137. Message Address (Offset Address: Base + 1000h + (10h*Interrupter))

Bits	Field	Read/ Write	Value (Default)	Comment
31 : 0	Message Address	RW	0h	System-specified message lower address. For MSI-X messages, the contents of this field from an MSI-X Table entry specify the lower portion of the DWORD-aligned address.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

3.8.2 Message Upper Address for MSI-X Table

Table 3-138. Message Upper Address (Offset Address: Base + 1004h + (10h*Interrupter))

Bits	Field	Read/ Write	Value (Default)	Comment
31 : 0	Message Upper Address	RW	0h	System-specified message Upper address.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

3.8.3 Message Data for MSI-X

Table 3-139. Message Data (Offset Address: Base + 1008h + (10h*Interrupter))

Bits	Field	Read/ Write	Value (Default)	Comment
31 : 0	Message Data	RW	0h	System-specified message Data.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

3.8.4 Vector Control for MSI-X

Table 3-140. Message Data (Offset Address: Base + 100Ch + (10h*Interrupter))

Bits	Field	Read/Write	Value (Default)	Comment
0	Mask Bit	RW	0b	When this bit is set, the function is prohibited from sending a message using this MSI-X Table.
31 : 1	Rsvd	-	-	Reserved.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

3.8.5 Pending Bits for MSI-X PBA Entries

Table 3-141. Message Data (Offset Address: Base + 1080h)

Bits	Field	Read/Write	Value (Default)	Comment
31 : 0	Pending Bits	RO	0h	For each Pending Bit that is set, the function has a pending message for the associated MSI-X Table entry.

Note: Interrupter is 0, 1, 2, 3, 4, 5, 6 or 7.

4. Power Management

4.1 Power Management States

This section defines the PCI Express Power Management states.

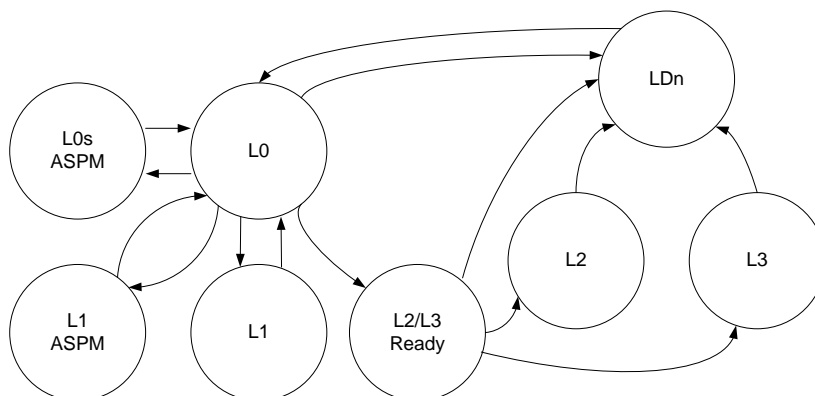
4.1.1 PCI Express Link State Power Management (L-States)

PCI Express defines Link power management states, replacing the bus power management states that were defined by the PCI Bus Power Management Interface Specification. Link states are not visible to PCI Power Management legacy compatible software, and are either derived from the power management D-states of the corresponding components connected to that Link or by Active State Power Management (ASPM) protocols. PCI Express Power Management defines L0, L0s, L1, L2/L3 Ready, L2, L3 and LDn. Refer to PCI Express Base Specification Rev.2.0 for more detail on PCI Express Link State Power Management.

Table 4-1. PCI Express Link States

L-States	Description
L0	Active state. All PCI Express transactions and other operations are enabled.
L0s	A low resume latency, energy saving “standby” ASPM state. Entry into the L0s state is managed separately for each direction of the Link. It is the responsibility of each device at either end of the Link to initiate an entry into the L0s state on its transmitting Lanes. Power management software (BIOS or OS) enables or disables this function by programming the ASPM control field in the Link Control Register. Renesas Electronics does not recommend using L0s function because transfer throughput decreases.
L1 (ASPM)	Higher latency, lower power “standby” ASPM state. The μPD720201 and μPD720202 can initiate entry into the L1 ASPM state in the D0 state when they detect idle time on the PCIe bus and both components on a Link enable the L1 Entry enable bit of ASPM control field in the Link Control Register. Power management software (BIOS or OS) enables or disables this function by programming the ASPM control field in the Link Control Register (3.2.5.7).
L1	Higher latency, lower power “standby” state. The μPD720201 and μPD720202 initiates entry into the L1 state in the D3hot state.
L2/L3 Ready	Staging point for L2 or L3. The μPD720201 and μPD720202 enters the L2/L3 Ready state after receiving the PME_Turn_Off Message from the Root Complex and responding with the PME_TO_Ack.
L2	Auxiliary –powered Link, deep-energy-saving state.
L3	Link Off state. When no power is present, the component is in the L3 state.
LDn	A transitional Link Down pseudo-state prior to L0.

Figure 4-1. Link Power Management State Flow Diagram



4.1.2 PCI Express Device Power Management States (D-States)

PCI Express supports all PCI Device power management states. The μPD720201 and μPD720202 supports D0 and D3 (D3hot and D3cold) states.

Table 4-2. PCI Express Device Power Management States

D-States	Description
D0	Normal operation state.
D3hot	When the Power State field in the Power Management Status / Control Register (Refer to 3.2.2.3) is set to 11b and PERST# is high, μPD720201 and μPD720202 is D3hot state. In this state, configuration and message requests are accepted.
D3cold	When the Power State field in the Power Management Status / Control Register (Refer to 3.2.2.3) is set to 11b and PERST# is low, μPD720201 and μPD720202 is D3cold state.

4.1.3 CLKREQ# Signal

The μPD720201 and μPD720202 supports the CLKREQ# signal and assigns it to the PECREQB pin. Since the CLKREQ# signal is an open drain and active low signal an external pull-up resistor is required. Operation of the CLKREQ# signal is determined by the state of the enable clock management bit in the Link Control Register (Refer to 3.2.5.7). When the enable clock management bit is disabled, the CLKREQ# signal is asserted at all times. When the enable clock management bit is enabled, the CLKREQ# signal may be de-asserted during an L1 Link state.

Table 4-3. Operation of CLKREQ# Signal

D-States	Description
D0, D3hot	The conditions that CLKREQ# is de-asserted are: Enable clock management bit in the Link Control Register is 1b and Link state is L1.

4.1.4 Summary of PCI Express Power Management States

Table summarizes the relationship between D-state and L-State.

Table 4-4. Summary of PCI Express Power Management States

D-States	L-States	Reference Clock	Conditions
D0	L0	ON	Active state.
	L0s	ON	- The L0s Entry Enable bit (3.2.5.7) in the ASPM Control field of the μPD720201 and μPD720202 is enabled.
	L1 ASPM	ON	- The L1 Entry Enable bit in the ASPM Control field of both the μPD720201/202 and the Root Complex are enabled. - μPD720201/202 detects idle time on the PCIe bus.
		OFF	- L1 Entry Enable bit of both the μPD720201/μPD720202 and the Root Complex are enabled. - μPD720201/202 detects idle time on the PCIe bus. - The PECREQB pin is connected to the CLKREQ# of the system. - The Enable clock management bit (3.2.5.7) is set to 1b.
D3hot	L1	ON	- The Power State field is set to 11b and PERST# is high. Main power sources remains during this state.
		OFF	- The Power State field is set to 11b and PERST# is high. Main power sources remains during this state. - The PECREQB pin is connected to the CLKREQ# of the system. - The Enable clock management bit (3.2.5.7) is set to 1b.
D3cold	L2	OFF	- Power State field set to 11b. - Execution of the PME_Turn_Off/PME_TO_Ack handshake sequences. - PERST# is low. Main power remains during this state.

4.2 Power Management Event (PME) Mechanism

Power Management Event (PME) is typically utilized to revive the system. The PME mechanism is software compatible with the PME mechanism defined by the PCI Bus Power Management Interface Specification. Power Management Events are generated by the μPD720201 and μPD720202 as a means of requesting a Power Management state change. When the Link state is L1 and D-state is D3hot, the μPD720201 and μPD720202 asserts the WAKEB signal and sends PME Message to the root complex to wake up the system. On the other hand, when the Link state is L2 (D-state is D3cold), μPD720201 and μPD720202 assert the WAKEB signal to re-establish reference clock before sending PME Message to the root complex.

4.2.1 PME support

If the power state of host controller should be changed from D0 or D3 to the other, PME event will occur as shown in the PME_support bits in PMC (Power Management Capabilities) register. The 5-bit field in the PME_support indicates the power states in which μPD720201 and μPD720202 may send PME Message. A value of 0b for any bit indicates that it is not capable of sending PME Message while in that power state. Note that the default value of the Bit15 of the PME_support for D3cold is “Hwlnit” and depends on the AUXDET bit in the Host Controller Configuration Register.

4.2.2 Pin configuration for supporting PME generation from D3cold

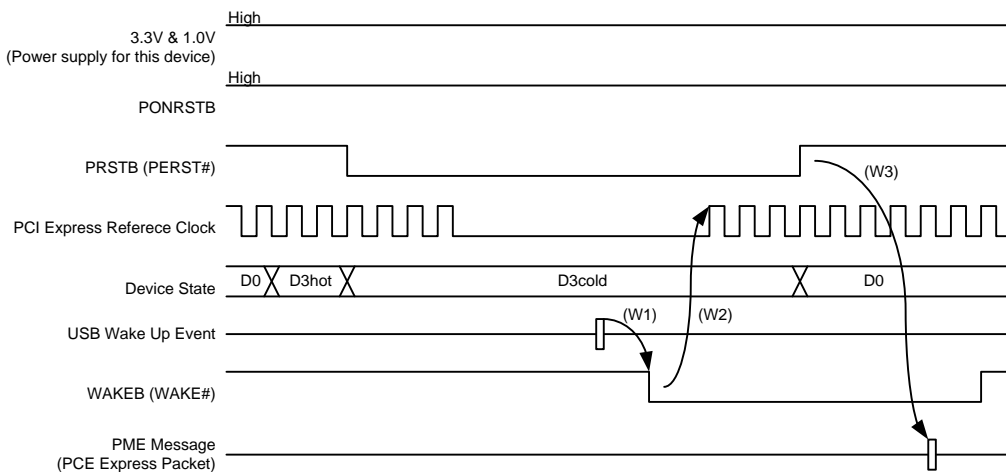
In case where the PME generation from D3cold is required, system board implementation shall be taken into consideration.

Pin name	Wake Up support from D3cold and D3hot	Wake Up support only from D3hot
3.3 V and 1.05 V	Both 3.3 V and 1.05 V power must be maintained to the μPD720201/202 during D3cold and D3hot states	Both 3.3 V and 1.05 V power must be maintained to the μPD720201/202 during D3hot states.
PONRSTB	“High” during D3cold and D3hot states.	“High” during D3hot states.
PEWAKEB	Connect to WAKE# of the system chipset and is pulled “high” with 3.3 V maintained during D3cold and D3hot states.	Connect to WAKE# of the system chipset and is pulled “high” with 3.3 V maintained during D3hot state.
PECREQB	Connect to CLKREQ# of the system chipset and is pulled “high” with 3.3 V maintained during D3hot states. (PECREQB is not used during D3cold.)	Connect to CLKREQ# of the system chipset and is pulled “high” with 3.3 V maintained during D3hot states. (PECREQB is not used during D3cold.)
OCI (2:1)B	Pulled “high” with 3.3 V maintained during D3cold and D3hot.	Pulled “high” with 3.3 V maintained during D3hot.
SPISO	Pulled “high” with 3.3 V maintained during D3cold and D3hot. Note that the power of the Serial ROM must be maintained during D3cold and D3hot states.	Pulled “high” with 3.3 V maintained during D3hot. Note that the power of the Serial ROM must be maintained during D3hot states.

4.2.3 Timing Diagram for PME

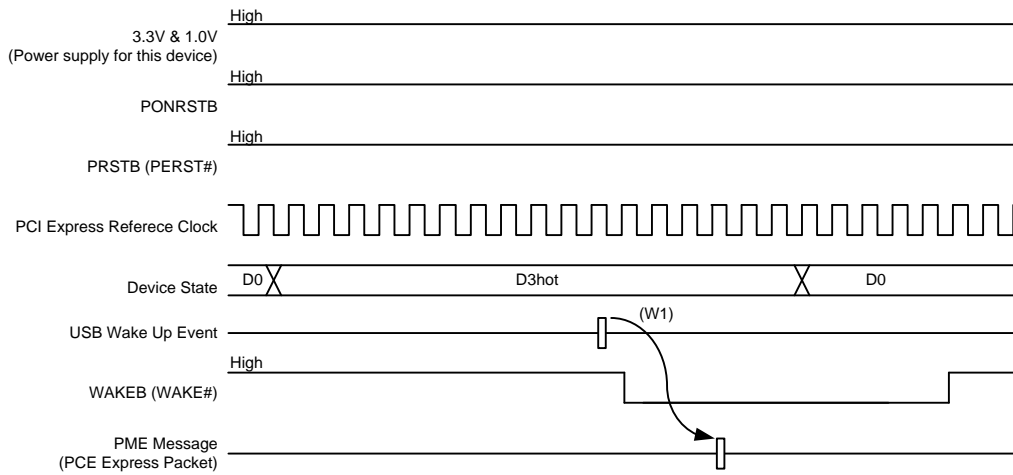
When Power State bits in PMCSR register indicate D3 and PONRST# is clamped high, the μPD720201 and μPD720202 maintain Power Management Context (PMCSR register and PORTSC register), even if the PERST# goes low and reference clock is removed. Note that the voltage level of the PERST# depends on the system during a sleeping state.

Figure 4-2. Wake Up State Transition from D3cold (AUXDET bit = '1')



- 1) PERSTB should be “high” during normal PCI operation.
- 2) System SW sets PME_En bit in the PMCSR register.
- 3) System SW sets D3 in Power State bits in the PMCSR register.
- 4) System goes into sleeping states and PERSTB goes low. μPD720201/202 is D3cold state.
- 5) When USB wake-up event occurs, WAKEB is asserted (W1).
- 6) Reference clock is re-established and PERSTB goes high (W2)
- 7) μPD720201/202 sends PME Message to the root complex (W3).

Figure 4-3. Wake Up State Transition only from D3hot



- 1) PERSTB should be “high” during normal PCI operation.
- 2) System SW sets PME_En bit in the PMCSR register.
- 3) System SW sets D3 in Power State bits in the PMCSR register.
- 4) System goes into sleeping states and PERSTB maintain “high”. μPD720201/202 is D3hot state.
- 5) When USB wake-up event occurs, μPD720201/202 sends PME Message to the root complex (W1) and asserts the WAKEB.

4.2.4 Wakeup Events

An external USB event may initiate a system level resume. When resume signaling is detected by a suspend USB port, the PME Event occurs if enabled (i.e. PMCSR PME_En bit = '1').

The following table summarizes the system wake-up events, defining the state of the Port Link State (PLS), Current Connect Status (CCS), Port Enabled/Disabled (PED), Over-Current Active (OCA) fields in the PORTSC register and the Port Change Detect (PCD) bit in the USBSTS register as function of the respective Wake Enable flag (WDE, WCE, WOE). The table values indicate the state of the fields after the respective event.

Table 4-5. Wakeup Events

Port Status and Signaling Device State Type	Port State After Event				
	PLS	CCS	PED	OCA	PCD
Port is in the U3. Resume signaling received.	Resume	1	1	0	1
A port is in a state that may detect a disconnect, and the port's WDE bit is '1'. A disconnect is detected.	RxDetect	0	0	0	1
Port is in the Disconnected state and the port's WCE bit is '1'. A connect is detected.	U0 (SS) Polling (USB2)	1	1 (SS) 0 (USB2)	0	1
If a port is in a state that may detect an over-current condition and the port's WOE bit is '1'. An over-current condition occurs.	Disabled	0	0	1	1

Note: A USB2 port may detect a disconnect when the port is in the Disabled, Enabled, or Reset state. A USB3 Port may detect a disconnect when the port is in the Loopback, Compliance, Error, Polling, Enabled, or Reset States.

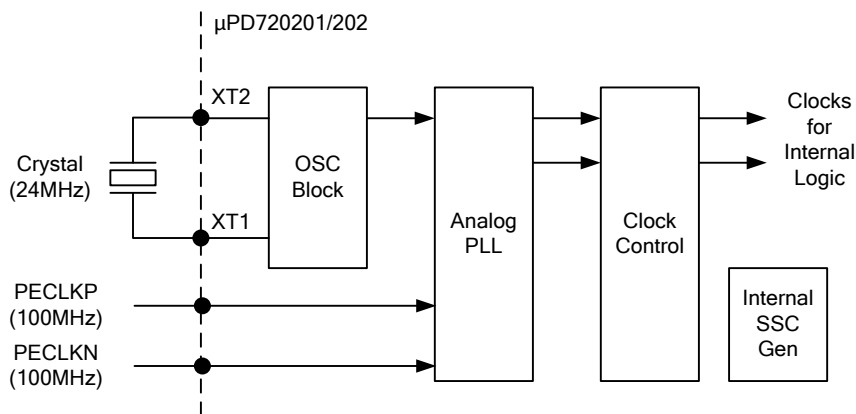
4.3 Control for System Clock Operation

When μPD720201 and μPD720202 are put into power down state as D3hot and D3cold, its internal clock system is controlled to reduce power consumption. This section describes the clock system and power management for the clock path.

4.3.1 Clock system

The μPD720201 and μPD720202 use 24 MHz crystal for system clock signal. The μPD720201 and μPD720202 also use 100MHz PCI Express reference clock for system clock. Internal analog PLL generates the system clock signals for internal logic circuit. Internal system clock signals can be controlled to stop and run by the μPD720201/202 itself. Spread Spectrum Clock (SSC) for the SuperSpeed signal is generated internally.

Figure 4-4. μPD720201/202's Clock System



4.4 Latency Tolerance Reporting (LTR) mechanism

μPD720201 and μPD720202 supports Latency Tolerance Reporting (LTR). Regarding LTR mechanism, refer to Latency Tolerance Reporting ECN of PCI Express Specification.

When the LTR Mechanism Enable bit of Device Control Register is set to 1b, μPD720201 and μPD720202 enable the Latency Tolerance Reporting (LTR) mechanism.

4.4.1 Timing of sending LTR message

μPD720201 and μPD720202 send the LTR Message on PCI Express bus after the following events.

- a) When μPD720201 and μPD720202 receive the LTM Device Notification from USB 3.0 devices
- b) When μPD720201 and μPD720202 receive the SET_LTV Command from the xHCI driver (Refer to 4.16.14 in eXtensible Host Controller Interface (xHCI) Specification Revision 1.0)
- c) When the LTR Mechanism Enable in Device Control 2 Register is cleared from 1b to 0b.
- d) When the HCHalted bit in USBSTS register is set to 1b
- e) When the internal BELT value is updated. (For example, when the device is disconnected and current BELT value is for the disconnected device)

5. How to Connect to External Elements

5.1 Handling Unused Pins

Table 5-1. Unused Pin Connection

Pin	Direction	Connection Method
U2DPx	I/O	Connect to GND, directly or through a resistor
U2DMx	I/O	Connect to GND, directly or through a resistor
U3TXDPx	O	Open
U3TXDNx	O	Open
U3RXDPx	I	Connect to GND, directly or through a resistor
U3RXDNx	I	Connect to GND, directly or through a resistor
OCix	I	Pull-up by 3.3V (VDD33)
PPONx	O	Open
SMIB	O	Open
SPISCK	O	Pull-down with 10k ohm resistor
SPICSB	O	Pull-down with 10k ohm resistor
SPISI	O	Pull-down with 10k ohm resistor
SPISO	I	Pull-up with 10k ohm resistor

Note: When a system has fewer than 4 downstream ports (μPD720201) or fewer than 2 downstream ports (μPD720202), the implemented ports must be assigned as shown in Tables 5-2 and 5-3 below. In addition, the DisablePortCount field in the HCConfiguration register must be set accordingly.

Table 5-2. Port configuration for μPD720201

DisablePortCount register	Port1	Port2	Port3	Port4
00b				
01b				X
10b			X	X
11b		X	X	X

X : Unused port.

Table 5-3. Port configuration for μPD720202

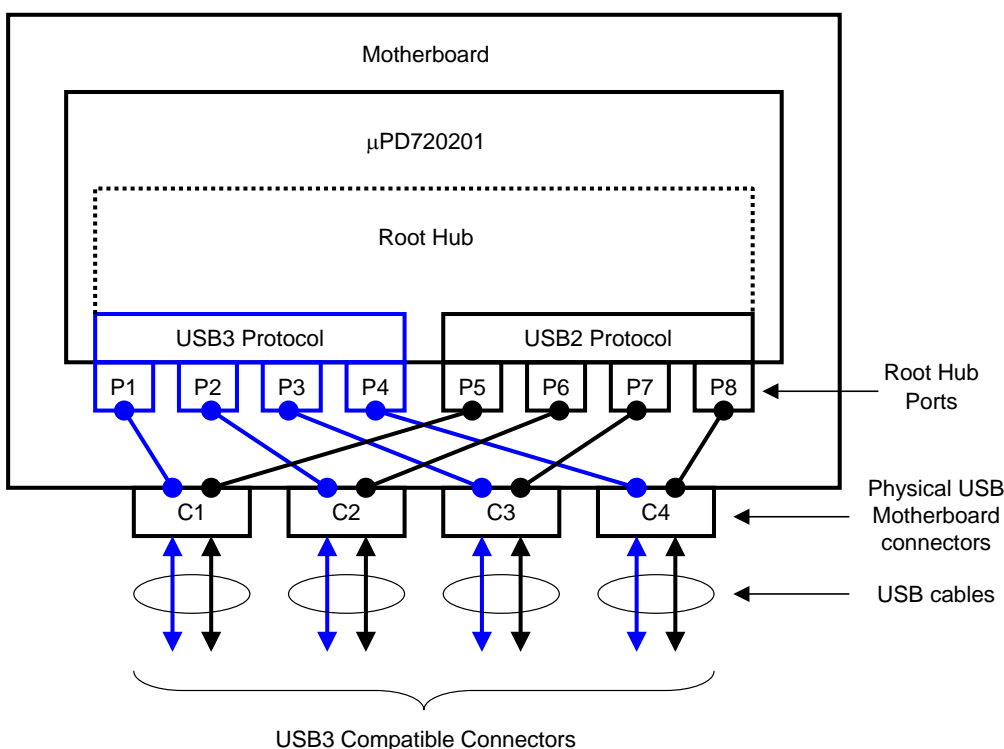
DisablePortCount register	Port1	Port2
00b		
01b		X

X : Unused port.

5.2 USB Port Connection

The μPD720201 implements 8 Root Hub ports (P1 – P8): 4 SuperSpeed and 4 Hi-Speed. The ports P1 to P4 provide a SuperSpeed data bus (i.e. U3RXDPx/U3RXDNx and U3TXDPx/U3TXDNx signal pairs), while P5 to P8 provide a USB2 data bus (i.e. U2DPx/U2DMx signal pair). The USB3 protocol P1 to P4 attach to the Physical USB3 compatible connector C1 to C4 respectively, while the USB2 protocol P5 and P8 attach to the Physical USB3 compatible connector C1 to C4 respectively.

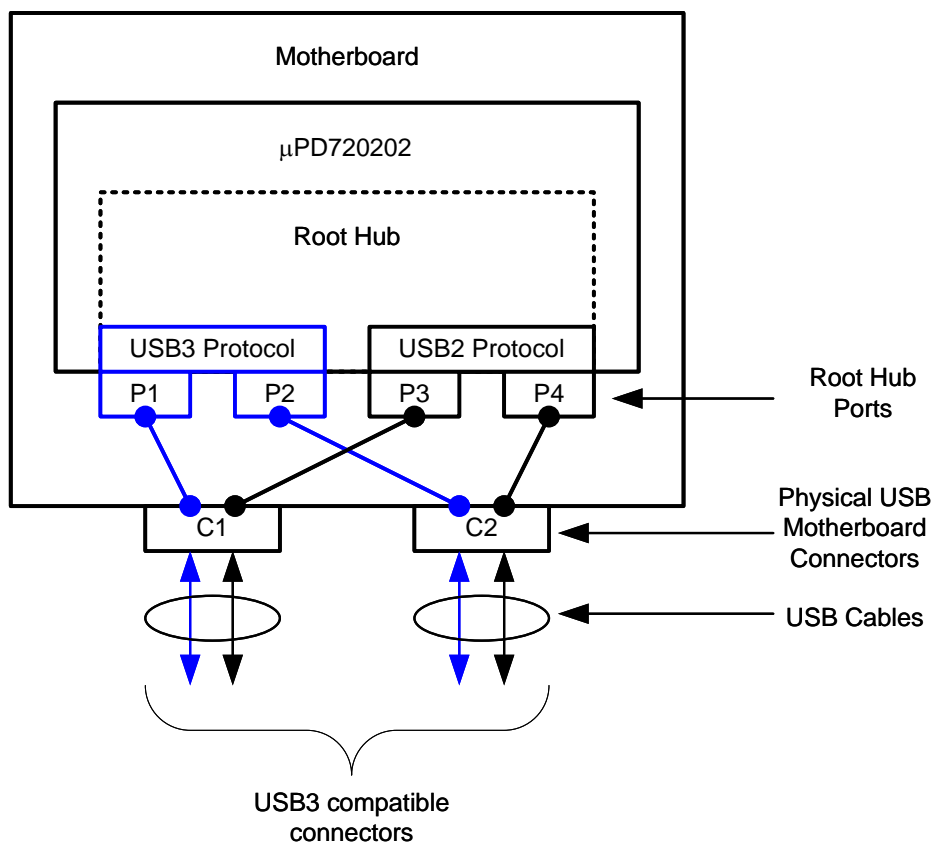
Figure 5-1. Root Hub Port to USB Connector Mapping of μPD720201



USB3 Compatible Connectors	Root Hub Ports	Associated with USB Interface of μPD720201	
C1	P1	U3TXDP1, U3TXDN1, U3RXDP1, U3RXDN1	OC11B, PPON1
	P5	U2DP1, U2DM1	
C2	P2	U3TXDP2, U3TXDN2, U3RXDP2, U3RXDN2	OC12B, PPON2
	P6	U2DP2, U2DM2	
C3	P3	U3TXDP3, U3TXDN3, U3RXDP3, U3RXDN3	OC13B, PPON3
	P7	U2DP3, U2DM3	
C4	P4	U3TXDP4, U3TXDN4, U3RXDP4, U3RXDN4	OC14B, PPON4
	P8	U2DP4, U2DM4	

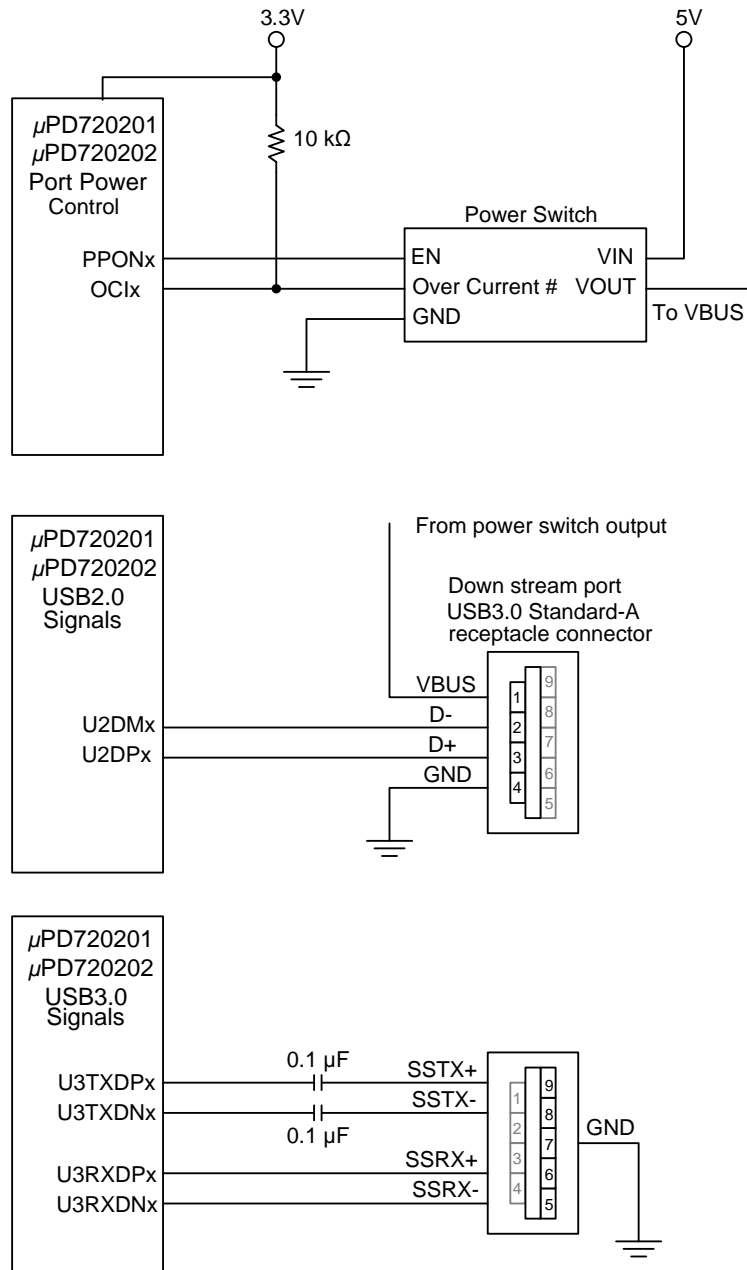
The μPD720202 implements 4 Root Hub ports (P1 – P4): 2 SuperSpeed and 2 Hi-Speed. The ports P1 and P2 provide a SuperSpeed data bus (i.e. U3RXDPx/U3RXDNx and U3TXDPx/U3TXDNx signal pairs), while P3 and P4 provide a USB2 data bus (i.e. U2DPx/U2DMx signal pair). The USB3 protocol P1 and P2 attach to Physical USB3 compatible connectors C1 and C2 respectively, while the USB2 protocol P3 and P4 attach to the Physical USB3 compatible connectors C1 and C2 respectively.

Figure 5-2. Root Hub Port to USB Connector Mapping of μPD720202



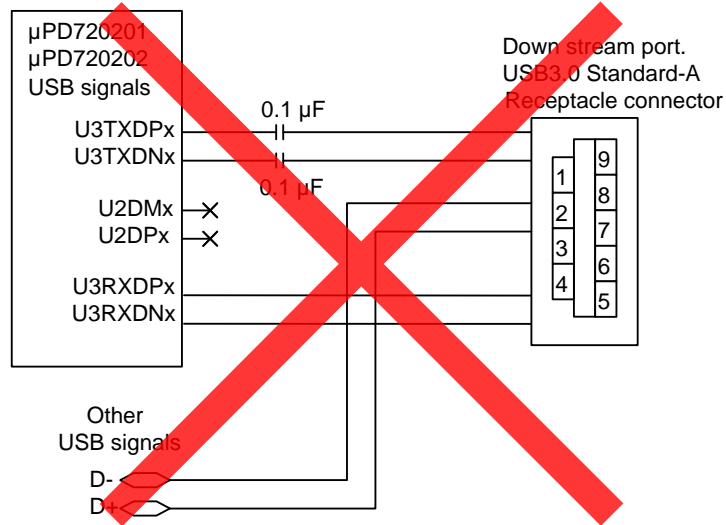
USB3 Compatible Connectors	Root Hub Ports	Associated with USB Interface of μPD720202	
		C1	P1
	P3	U2DP1, U2DM1	
C2	P2	U3TXDP2, U3TXDN2, U3RXDP2, U3RXDN2	OC12B, PPON2
	P4	U2DP2, U2DM2	

Figure 5-3. USB Downstream Port Connection



Note: The 3.3 V that pulls up OC1x must be the same 3.3 V supplied to the μPD720201 and μPD720202.

Figure 5-4. Prohibited USB Downstream Port Connection

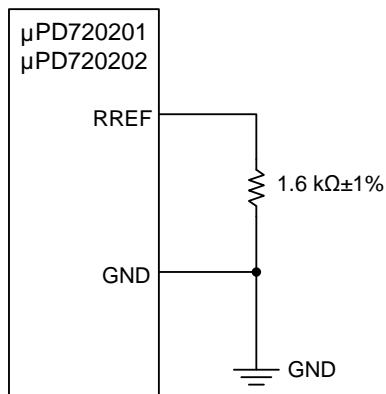


Important:

For USB 3.0 Specification compliance, the composition that only SuperSpeed signals are connected is strictly prohibited. Also, to avoid potentially severe conflicts between USB drivers, it is essential for the USB 3.0 driver to control the USB 2.0 signals as well as the USB 3.0 signals. This means the USB 2.0 signals in the USB 3.0 connector must come from the same controller (μPD720201/μPD720202) as the USB 3.0 signals.

5.3 Analog Circuit Connection

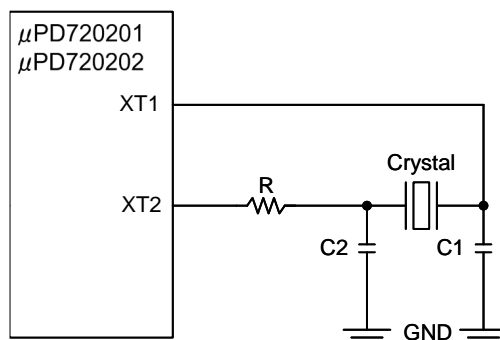
Figure 5-5. RREF Connection



Note: The board layout should minimize the total path length from RREF through the resistor to GND and path length to GND. GND must be stable.
Due to analog sensitivity, 1.62K should not be used instead of 1.60K, and two or more resistors in series or parallel should not be used in place of a single 1.60K resistor.
Although 1.6K is usually a standard 5% value, 1.60K is also commonly available in 1% tolerance.

5.4 Crystal Connection

Figure 5-6. Crystal Connection



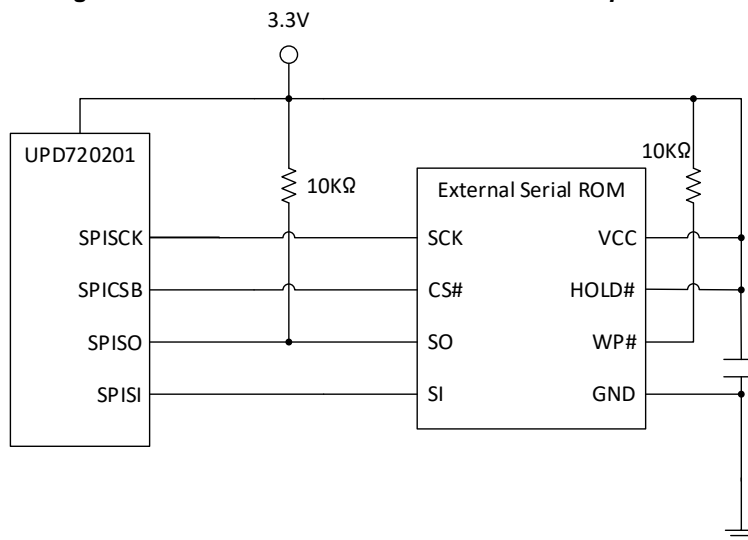
Note: Clock shall be 24 MHz within 100ppm. Moreover optimal crystal parameters and RC component values may be affected by the PCB layout..

5.5 External Serial ROM Connection

Figure 5-7 and Figure 5-8 shows the HW configuration for an external serial ROM. Refer to TN-USB-A0004A/E (μPD720202K8-701-BAA-A External Serial ROM Connection circuit update) for more detail.

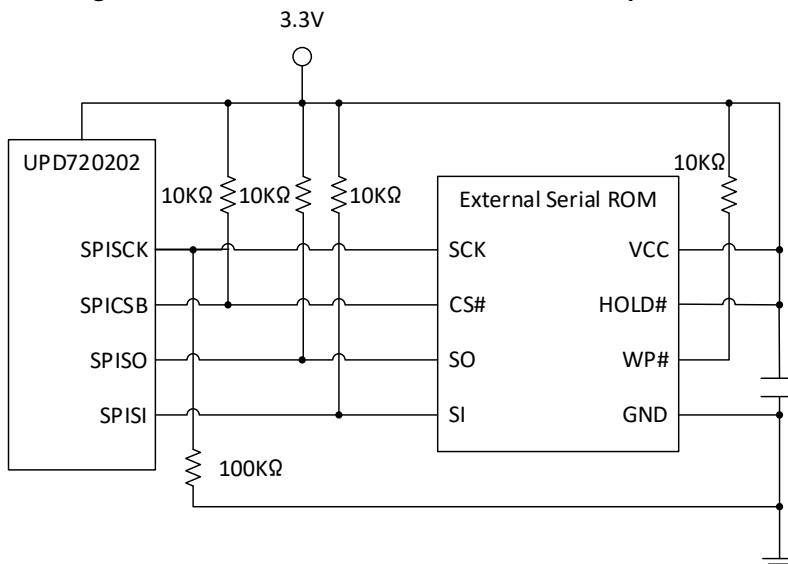
When the external serial ROM is not installed, Refer to Figure 5-9.

Figure 5-7. External Serial ROM Connection for μPD720201



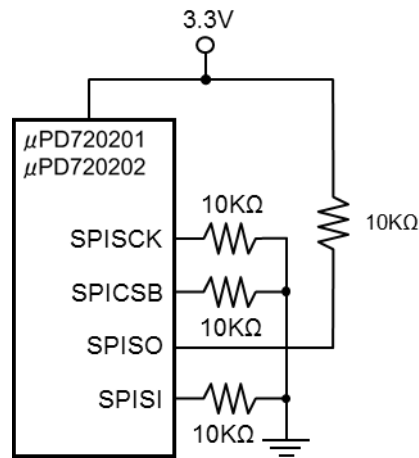
Note: The 3.3 V that pulls SO must be the same as the 3.3 V supplied to the μPD720201

Figure 5-8. External Serial ROM Connection for μPD720202



Note: The 3.3 V that pulls SO must be the same as the 3.3 V supplied to the μPD720202

Figure 5-9. Unused Pins Connection When the External Serial ROM Is Not Mounted



Note: SPISO pin must be pulled up by VDD33 (3.3V) through a pull-up resistor in all cases.

Table 5-4 and Table 5-5 show the supported External Serial ROM types.

Table 5-4. Supported External Serial ROM List (A)

Vendor	Product Name
Macronix	MX25L512E/MX25L1006E/MX25L2006E/MX25L4006E
Winbond	W25X10BV/W25X20BV/W25X40BV
Atmel	AT25F512B
AMIC	A25L512/A25L010/A25L020/A25L040

Table 5-5. Supported External Serial ROM List (B)

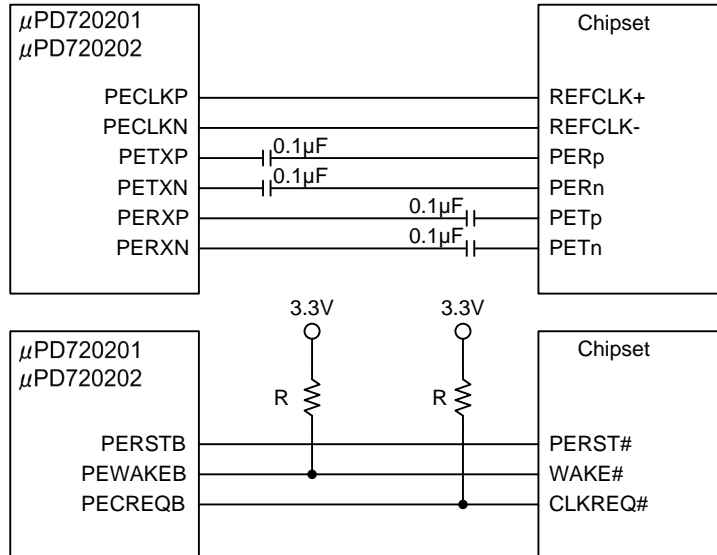
Vendor	Product Name
Macronix	MX25L5121E/MX25L1021E
Micron (Numonyx)	M25P05-A/M25P10-A/M25P20/M25P40
Chingis	Pm25LD512C/ Pm25LD512C2
SST	SST25VF512A/SST25VF010A

For the External Serial ROMs shown in Table 5-5, it is necessary to adjust the pull-up resistor value from 10k ohm so as to comply with Table 3-25 of μPD720201 & μPD720202 Data Sheet : R19DS0047E.

Even if the pull-up resistor is not changed, ROM will work normally if PCIe reset is not asserted while μPD720201 and μPD720202 is loading the firmware from ROM.

5.6 PCI Express Interface Connection

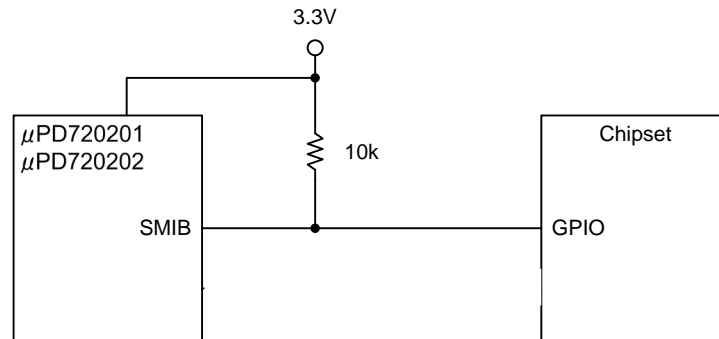
Figure 5-10. PCI Express Interface Connection



Note: PEWAKEB and PECREQB pin use an open drain buffer and should be pulled high.

5.7 SMIB/SMI Interface Connection

Figure 5-11. SMIB Interface Connection



Note: The 3.3 V that pulls up SMIB must be the same as the 3.3 V supplied to the μPD720201 and μPD720202.

6. How to Access External ROM

μPD720201 and μPD720202 (-701 versions) support the External ROM (Serial Peripheral Interface (SPI) type ROM) for firmware (FW). To access the External ROM, μPD720201 and μPD720202 support the External ROM Access Control and Status Register (ERACSR) in PCI Configuration registers. This section describes how to access the External ROM. μPD720201K8-711-BAC-A & μPD720201K8-711-BAC-M1-A & μPD720202K8-711-BAA-A & μPD720202K8-711-BAA-M1-A do not support the External ROM (Serial Peripheral Interface (SPI) type ROM). μPD720201K8-711-BAC-A & μPD720201K8-711-BAC-M1-A & μPD720202K8-711-BAA-A & μPD720202K8-711-BAA-M1-A should use the FW Download function.

6.1 Access External ROM Registers

Accessing the External ROM related registers uses a total of five registers in the PCI Configuration registers of μPD720201 and μPD720202.

1. External ROM Information Register (Refer to Table 3-57)
 - When the External ROM is mounted for μPD720201 or μPD720202, μPD720201 or μPD720202 sets the ROM Information.
2. External ROM Configuration Register (Refer to Table 3-58)
 - To access the External ROM, the software shall set the ROM Parameter.
3. External ROM Access Control and Status Register (ERACSR)(Refer to Table 3-60)
 - This register contains bits to access the External ROM and to check the status for the result.
4. Data0 Register (Refer to Table 3-61)
5. Data1 Register (Refer to Table 3-62)
 - Data0/1 registers are window registers for reading the External ROM data & writing FW.

Table 6-1 below shows the External ROM Information & Parameter which μPD720201/720202 supports. To access the External ROM, the software must set the ROM parameter before accessing the External ROM.

Table 6-1. External ROM Information & Parameter

Vendor	Product Name	ROM Information (PCI Configuration register offset 0xEC)	ROM Parameter (PCI Configuration register offset 0xF0)	Block Erase Size (Byte)
Macronix	MX25L512E	00C2_2010h	0000_0700h	16K
	MX25L1006E	00C2_2011h		
	MX25L2006E	00C2_2012h		
	MX25L4006E	00C2_2013h		
	MX25L5121E	00C2_2210h	0000_0500h	
	MX25L1021E	00C2_2211h		
Winbond	W25X10BV	00EF_3011h	0000_0700h	16K
	W25X20BV	00EF_3012h		
	W25X40BV	00EF_3013h		
Numonyx	M25P05-A	0020_2010h	0000_0750h	32K
	M25P10-A	0020_2011h		
	M25P20	0020_2012h	0000_0760h	64K
	M25P40	0020_2013h		
Chingis	Pm25LD512C	019D_20FFh	0000_0700h	16K
	Pm25LD512C2	019D_207Fh		
ATMEL	AT25F512B	001F_6500h	0000_0700h	16K
EON	EN25F05	001C_3110h	0000_0700h	16K
	EN25F10	001C_3111h		
	EN25F20	001C_3112h		
	EN25F40	001C_3113h		
AMIC	A25L512	0037_3010h	0000_0700h	16K
	A25L010	0037_3011h		
	A25L020	0037_3012h		
	A25L040	0037_3013h		
SST	SST25VF512A	00BF_0048h	0001_0791h	16K
	SST25VF010A	00BF_0049h		

6.2 Access External ROM

This section describes the outline of accessing the External ROM sequence. μPD720201 and μPD720202 support the following functions.

1. Writing FW to the External ROM.
2. Reading ROM Data from the External ROM
3. Erasing the External ROM data of the whole chip to be “1b”. (Refer to section6.3.2.3 about the External ROM data)

6.2.1 How to write FW to External ROM

6.2.1.1 Outline

When the System Software starts to write the FW to the External ROM, at first the System Software needs to check “External ROM Exists”. If “External ROM Exists” is ‘1b’, it indicates the External ROM is connected. After that, the System Software needs to write “53524F4Dh” to “DATA0” and set “External ROM Access Enable” to ‘1b’. The System Software writes the first External ROM data to “DATA0”, and writes the second External ROM data to “DATA1”, then sets “Set DATA0” and “Set DATA1” to ‘1b’. After that, the System Software confirms whether “Set DATA0” is ‘0b’. If it is ‘0b’, the System Software writes the third data to “DATA0” and sets “Set DATA0”. Then the System Software confirms “Set DATA1” is ‘0b’ to write next data to “DATA1”. The System Software continues this sequence until the last data is written to “DATA0” or “DATA1”. After all data is written, the System Software must set “External ROM Access Enable” to ‘0b’.

When “External ROM Access Enable” is ‘0b’, the System Software needs to verify that “Result Code” is changed to a value other than ‘000b’. If “Result Code” is ‘001b’, FW writing is successful. If “Result Code” is ‘010b’, FW writing failed.

6.2.1.2 Sequence to write the FW (External ROM data) of μPD720201 and μPD720202

1. Read “External ROM Exists” and confirm it is ‘1b’.
2. Write ‘53524F4Dh’ to “DATA0”.
3. Set “External ROM Access Enable” to ‘1b’
4. Read “Result Code” and confirm it is ‘000b’.
5. Read “Set DATA0” and confirm it is ‘0b’.
6. Write FW data to “DATA0”.
7. Read “Set DATA1” and confirm it is ‘0b’.
8. Write FW data to “DATA1”.
9. Set “Set DATA0” and “Set DATA1” to ‘1b’.
10. Read “Set DATA0” and confirm it is ‘0b’.
11. Write FW data to “DATA0”.
12. Set “Set DATA0” to ‘1b’.
13. Read “Set DATA1” and confirm it is ‘0b’.
14. Write FW data to “DATA1”.
15. Set “Set DATA1” to ‘1b’.
16. Return to step 10 and repeat steps 10 to 15.
17. After writing the last data of FW, the System Software must set “External ROM Access Enable” to ‘0b’.
18. Read “Result Code” and confirm it is ‘001b’.

Note1: The FW of μPD720201 and μPD720202 includes the CRC16 code. The μPD720201 and μPD720202 return “Result Code” after finishing the CRC check.

Note2: If an immediate reload is required after the updating External ROM (sequence 18), the System Software sets “Reload” to ‘1b’. **The System Software must not set “Reload” to ‘1b’ when “Run/Stop” of USBCMD Register is ‘1b’.** At the completion of reload process, that bit cleared to ‘0b’ automatically.

6.2.2 How to read ROM Data from External ROM

6.2.2.1 Outline

When the System Software starts to read the External ROM data from the External ROM, first the System Software needs to check “External ROM Exists”. If “External ROM Exists” is ‘1b’, it indicates the External ROM is connected. After that, the System Software needs to write “53524F4Dh” to “DATA0” and set “External ROM Access Enable” to ‘1b’. The System Software sets “Get DATA0” and “Get DATA1” to ‘1b’ to read the External ROM data from the External ROM. After that, the System Software confirms whether “Get DATA0” is ‘0b’. If it is ‘0b’, the System Software gets the first External ROM data from “DATA0”. Then the System Software sets “Get DATA0” to ‘1b’ and confirms whether “Get DATA1” is ‘0b’. If “Get DATA1” is ‘0b’, the System Software gets the second External ROM data from “DATA1”. After that, the System Software sets “Get DATA1” to ‘1b’ and confirms whether “Get DATA0” is ‘0b’ for the getting next External ROM data.

The System Software continues this sequence until the last data is read from “DATA0” or “DATA1”. After all data is read, the System Software must set “External ROM Access Enable” to ‘0b’.

6.2.2.2 Sequence to read External ROM data from External ROM

1. Read “External ROM Exists” and confirm it is ‘1b’.
2. Write ‘53524F4Dh’ to “DATA0”.
3. Set “1b” to “External ROM Access Enable”
4. Read “Result Code” and confirm it is ‘000b’.
5. Set “Get DATA0” and “Get DATA1” to ‘1b’.
6. Read “Get DATA0” and confirm it is ‘0b’.
7. Get External ROM data from “DATA0”.
8. Set “Get DATA0” to ‘1b’.
9. Read “Get DATA1” and confirm it is ‘0b’.
10. Get External ROM data from “DATA1”.
11. Set “Get DATA1” to ‘1b’.
12. Return to sequence 6 and repeat sequence 6 to sequence 11.
13. After reading the last data of External ROM data, the System Software must set “External ROM Access Enable” to ‘0b’.

6.2.3 How to erase the data of the whole chip to be “1b” (Chip Erase)

6.2.3.1 Outline

When Chip Erase is required, first the System Software needs to check “External ROM Exists”. If “External ROM Exists” is ‘1b’, it indicates External ROM is connected. After that, the System Software needs to write “5A65726Fh” to “DATA0” and set “External ROM Erase” to ‘1b’. When this operation is complete, the “External ROM Erase” is cleared to ‘0b’ automatically.

When the System Software updates the FW in the field, the System Software shall not do Chip Erase. (Refer to section 6.3.4)

6.2.3.2 Sequence for Chip Erase

1. Read “External ROM Exists” and confirm it is ‘1b’.
2. Write ‘5A65726Fh’ to “DATA0”.
3. Set “1b” to “External ROM Erase”
4. Read “External ROM Erase” and confirm it is ‘000b’.

6.3 Data Format

This section describes the data formats for μPD720201/ μPD720202.

6.3.1 Firmware

The format of FW released by Renesas Electronics is shown in Figure 6-1. Each row is 8 bytes, LSB on the left. The First 2 Bytes are the header code. This value is a fixed value (55AAh). The value at offset 0004h is the FW Ver Pointer. The FW Ver Pointer indicates the address of the FW version. The other parts are undisclosed.

Figure 6-1. Firmware

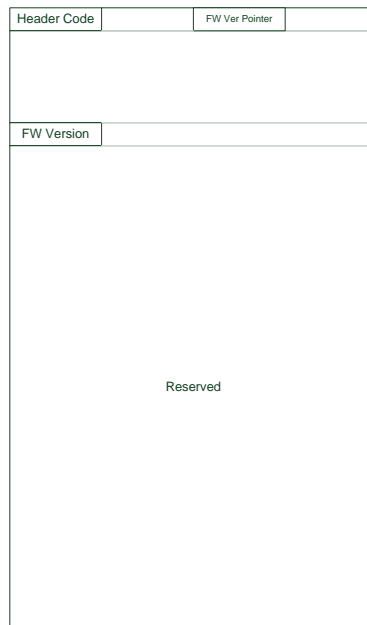


Table 6-2. Firmware Block Description

Offset(Byte)	Size (Byte)	Field Name	Description
0000h	2	Header Code	Header Code is 55AAh.
0002h	2	Reserved	Reserved
0004h	2	FW Ver Pointer	FW Version Address
(FW Ver Pointer)h	2	FW Version	FW Version.

6.3.2 Vendor Specific Configuration Data Block

The System Software can write the Vendor Specific Configuration Data Block to the External ROM. The Vendor Specific Configuration Data Block configures the RENESAS Specific register when μPD720201/ μPD720202 downloads the FW from External ROM.

6.3.2.1 Data Format

Figure 6-2. Vendor Specific Configuration Data Block

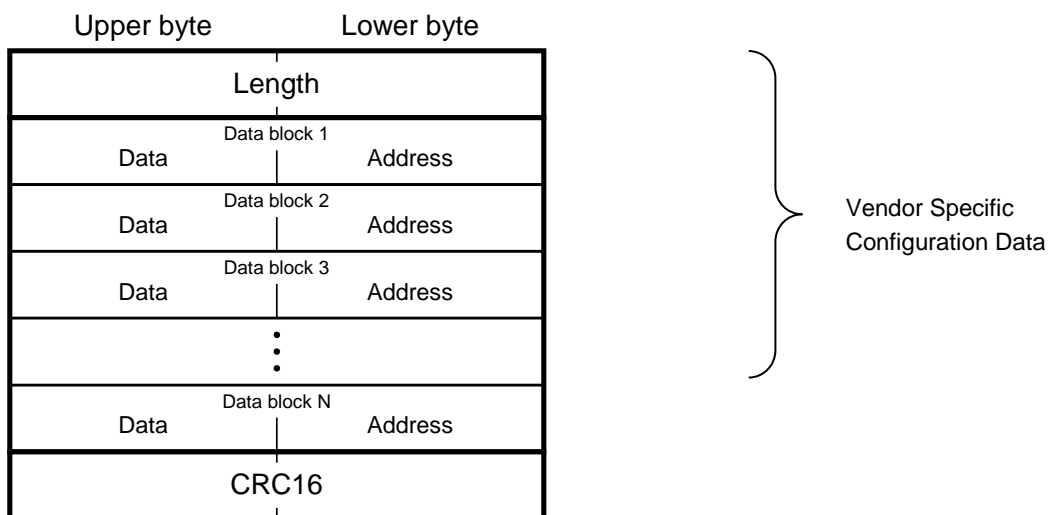


Table 6-3. Vendor Specific Configuration Data Block Description

Offset(Byte)	Size (Byte)	Field Name	Description
0000h	2	Length	Indicate the length of Vendor Specific Configuration Block.
0002h	2*N	Vendor Specific Configuration Data N	Indicate the Vendor Specific Configuration Data (N > 0).
(0002+2*N)h	2	CRC16	CRC16 of Length field and Vendor Specific Configuration Data N field

The Vendor Specific Configuration field consists of one Data block or more. Data block N consists of 2 Byte, and the first 1 Byte is Address of section 6.3.2.2, Second Byte is the value to write to the Address.

6.3.2.2 Address map for Vendor Specific Configuration Block

The Vendor Specific Configuration Block has an individual address map. When μPD720201/ μPD720202 downloads the ROM data from the External ROM, μPD720201/ μPD720202 configures the RENESAS Specific register by the Vendor Specific Configuration Data Block. The address map is below.

Table 6-4. Address Map for Vendor Specific Configuration Block

Address (Byte)	Register	PCI Configuration register Offset Address (Byte)
03h - 00h	Subsystem Vendor ID, Subsystem ID (Refer to section 3.2.1.13 & section 3.2.1.14)	02Fh - 02Ch
0Bh - 04h	Serial Number (Refer to section 3.2.8.2)	14Bh - 144h

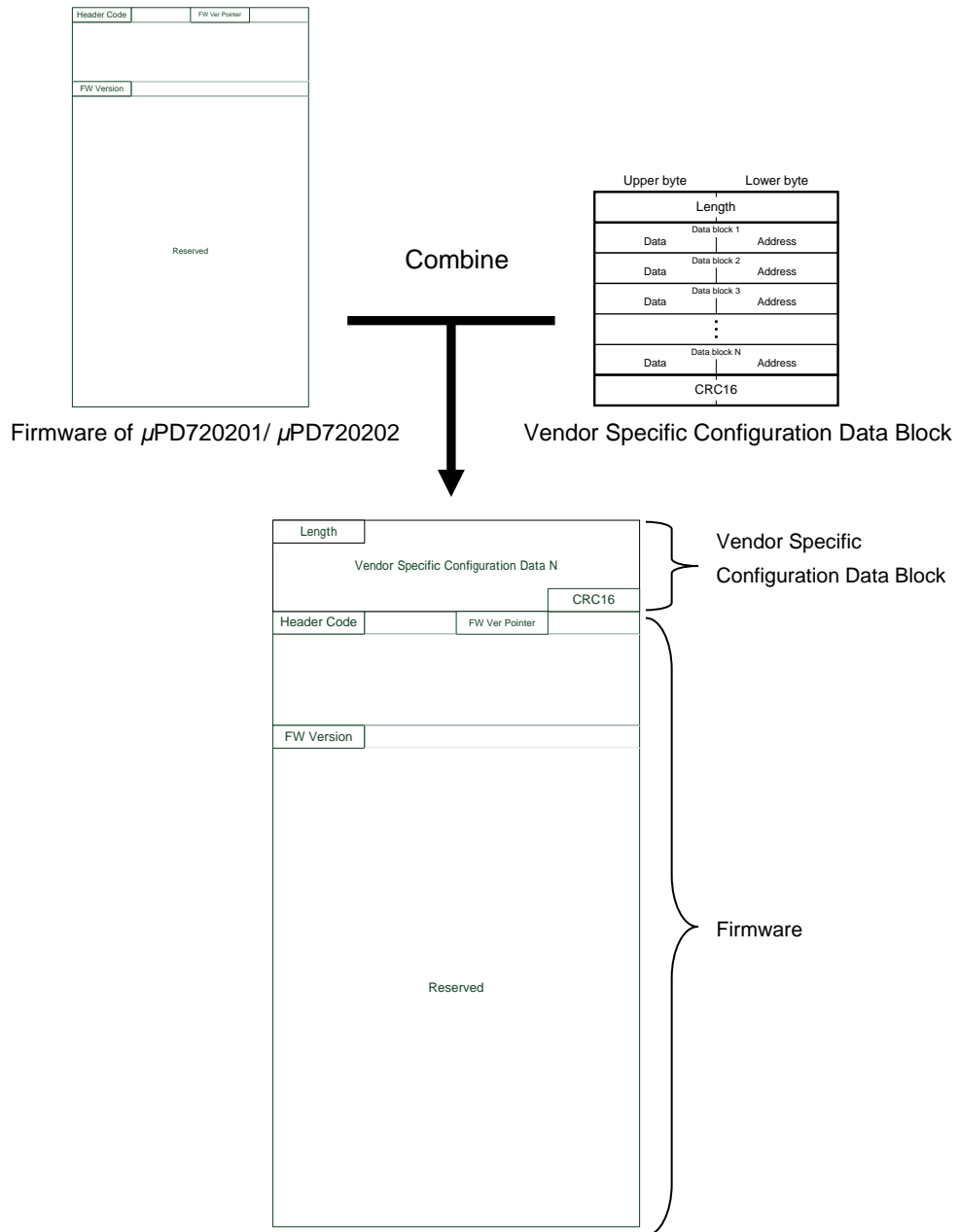
Address (Byte)	Register	PCI Configuration register Offset Address (Byte)
0Fh – 0Ch	PHY Control 0 (Refer to section 3.2.6.2)	0DFh – 0DCh
13h – 10h	PHY Control 1 (Refer to section 3.2.6.3)	0E3h – 0E0h
17h – 14h	PHY Control 2 (Refer to section 3.2.6.4) (Note)	0E7h – 0E4h
1Bh - 18h	Host Controller Configuration (Refer to section 3.2.6.5)	0EBh – 0E8h

Note: Even if BC_MODE_Px is set to a user defined value by the external ROM configuration, the System Software like BIOS can change the BC_MODE_Px to a user defined value. Please see the section 8.3 for the reflecting timing.

6.3.2.3 External ROM Data

The External ROM Data is a data for writing Firmware with Vendor Specific Configuration Data to the External ROM. This data image is the following.

Figure 6-3. External ROM Data



6.3.3 CRC16 calculation

CRC16 is generated by the following polynomial which is defined by ITU-T V.41.

$$x^{16} + x^{12} + x^5 + 1$$

The following function is an example of CRC16 calculation.

```
const UWORD16 crc_table[16] = {
    0x0000, 0x1081, 0x2102, 0x3183, 0x4204, 0x5285, 0x6306, 0x7387, // 0 - 7
    0x8408, 0x9489, 0xA50A, 0xB58B, 0xC60C, 0xD68D, 0xE70E, 0xF78F, // 8 - 15
};
```

```
UWORD16 update_crc16(UWORD16 crc, const BYTE *t, int len){
    int n;
    UWORD16 c = crc ^ 0xffffU;
    BYTE m;

    for(n = 0; n < len; n++) {
        m = t[n];
        c = crc_table[(c ^ m) & 0xf] ^ (c >> 4);
        c = crc_table[(c ^ (m >> 4)) & 0xf] ^ (c >> 4);
    }

    return c ^ 0xffffU;
}
```

Note: const UWORD16 crc_table[16] calculates the following routine.

```
void make_crc_table(UWORD16 crc_table[]){
    int n,k;

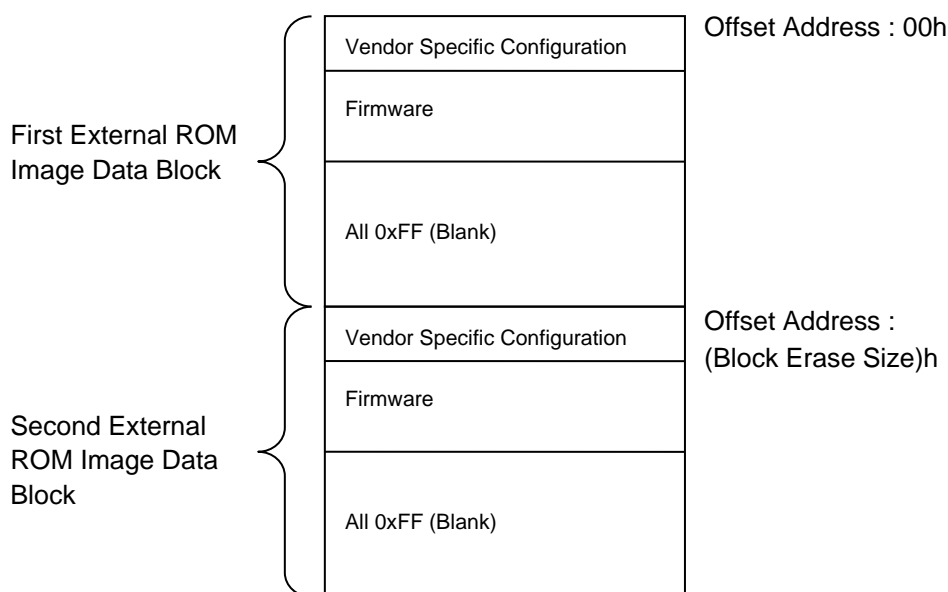
    for(n = 0; n < 16; n++) {
        UWORD16 c = (UWORD16)n;
        for(k = 0; k < 4; k++) {
            if(c & 1) c = 0x8408U ^ (c >> 1);
            else    c >>= 1;
        }
        crc_table[n] = c;
    }
}
```


6.3.4 External ROM Data format

This section describes the External ROM data format of the External ROM. The External ROM Data consists of two blocks as Figure 6-4. This means that μPD720201 and μPD720202 can have two kinds of a different FW. The first is located at offset address 00h. The second is located at the offset address equal to the Block Erase Size (Refer to Table 6-1).

This purpose is to prevent the ROM from being in blank status in the field. When the System Software updates the FW in the field, the System Software shall not do Chip Erase.

Figure 6-4. External ROM Data Format



6.3.4.1 First External ROM Image Data Block of Figure 6-4

The System Software can write the External ROM Data Image to the First External ROM Image Data Block when the External ROM is in blank status. After Chip Erase, the System Software can also write the External ROM Data Image to the First External ROM Image Data Block.

This External ROM Data Block can only be erased by using Chip Erase.

6.3.4.2 Second External ROM Image Data Block of Figure 6-4

The System Software can write the External ROM Data Image to the Second External ROM Image Data Block when the System Software has already written the External ROM Data Image to the First External ROM Image Data Block.

This External ROM Data Block always is erased when the System Software first sets “Set DATA0” to ‘1b’ for writing the FW.

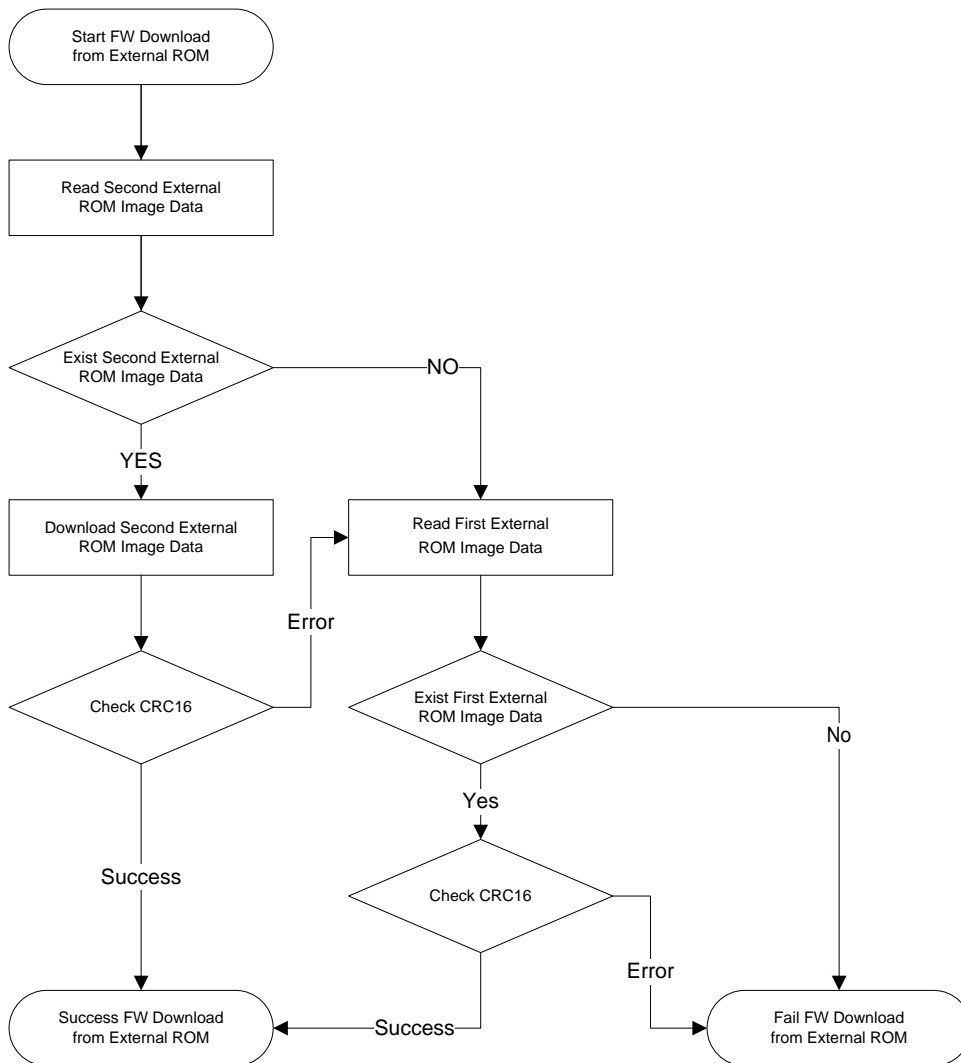
6.3.4.3 Loading the FW from the External ROM

At first, when μPD720201/μPD720202 downloads the External ROM data from the External ROM, μPD720201 / μPD720202 reads data from the Second External ROM Image Data Block. If the Second External ROM Image Data is in blank status or is broken (an illegal data), μPD720201/μPD720202 reads data from the First External ROM Image Data Block and downloads the First External ROM Image Data.

If the Second External ROM Image Data Block has valid FW (External ROM data), μPD720201/μPD720202 downloads this data from the External ROM data.

Note: μPD720201/μPD720202 starts to download firmware from the External ROM after de-asserting PONRSTB and PERSTB.

Figure 6-5. Loading FW from External ROM



7. FW Download Interface

μPD720201 and μPD720202 supports Firmware Download Interface from the System Software (BIOS or Device Driver) for firmware. This section describes these functions.

μPD720201K8-711-BAC-A & μPD720201K8-711-BAC-M1-A & μPD720202K8-711-BAA-A & μPD720202K8-711-BAA-M1-A should use the FW Download function.

μPD720201K8-711-BAC-A & μPD720201K8-711-BAC-M1-A & μPD720202K8-711-BAA-A & μPD720202K8-711-BAA-M1-A do not support the External ROM (Serial Peripheral Interface (SPI) type ROM).

7.1 How to Download a Firmware into μPD720201/μPD720202

The FW Download mechanism assumes that the FW released by Renesas Electronics is located in the BIOS or other storage in advance. And BIOS or Driver reads it by DWORDS and writes it into μPD720201 and μPD720202 with the FW Download related registers (DWORD size) in the PCI Configuration Registers.

7.1.1 FW download registers

FW Download related registers consist of a total of three registers in PCI Configuration registers.

1. FW Download Control & Status Register (refer to Table 3-59)
This register contains bits which control FW Download function, and status for the result.
2. DATA0 Register (refer to Table 3-61)
3. DATA1 Register (refer to Table 3-62)
DATA0 and DATA1 are window registers for loading FW.

7.1.2 Outline of FW download sequences

When the System Software starts FW Download, the System Software sets "FW Download Enable" to '1b'. Then the System Software writes the first data to "DATA0", and writes the second data to "DATA1", then sets "Set DATA0" and "Set DATA1" to '1b'. After that, the System Software confirms whether "Set DATA0" is '0b'. If it is '0b', the System Software writes the third data to "DATA0" and sets "Set DATA0". Then the System Software confirms "Set DATA1" is '0b' before writing the next data to "DATA1". The System Software continues this sequence until the last data is written to "DATA0" or "DATA1". After all data is written, the System Software must set "FW Download Enable" to '0b'.

When "FW Download Enable" is '0b', the System Software needs to poll "Result Code" for change (other than '000b'). If "Result Code" is '001b', FW download is a success.

7.1.3 FW download sequences

1. Set "FW Download Enable" to '1b'.
2. Read "Set DATA0" and confirm it is '0b'.
3. Write FW data to "DATA0".
4. Read "Set DATA1" and confirm it is '0b'.
5. Write FW data to "DATA1".
6. Set "Set DATA0" & "Set DATA1" to '1b'.
7. Read "Set DATA0" and confirm it is '0b'.
8. Write FW data to "DATA0". Set "Set DATA0" to '1b'.
9. Read "Set DATA1" and confirm it is '0b'.
10. Write FW data to "DATA1". Set "Set DATA1" to '1b'.
11. Return to step 7 and repeat the sequence from step 7 to step 10.
12. After writing the last data of FW, the System Software must set "FW Download Enable" to '0b'.
13. Read "Result Code" and confirm it is '001b'.

- Note 1:** If the Lock FW download function is needed, the System Software can lock FW download by setting “FW Download Lock” after the step 13 in the above sequence. (Refer to Table 3-59)
- Note 2:** System Software must configure RENESAS Specific registers if the Vendor specific configuration is needed. (Refer to section 3.2.6)
- Note 3:** The System Software must not set “FW Download Enable” to ‘1b’ when “Run/Stop” of USBCMD Register is ‘1b’.
- Note 4:** The “Result Code” for the External ROM Access Control and Status Register is “don’t care” during FW Download.
- Note 5:** If the External ROM is installed and the FW Download function is used, μPD720201 and μPD720202 behaves according to the FW from the FW Download function.
- Note 6:** μPD720201/μPD720202 starts to download firmware after de-asserting PONRSTB and PERSTB.

8. Battery Charging Function

μPD720201 and μPD720202 support the USB Battery Charging Function. It is possible to permit devices to draw VBUS current in excess of the USB2.0 specification for charging on the downstream port of μPD720201 and μPD720202. This function complies with Battery Charging Specification Rev1.2.

8.1 Features

- All of μPD720201 and μPD720202 downstream ports support SDP, CDP, DCP, FVO.
- It is possible to select one Battery charging mode from 8 types.
- It is possible to set the Battery charging mode on each port individually.
- VBUS shall be controlled by PPONx in each port respectively.

SDP: Standard Downstream Port (no Battery Charging support)
 CDP: Charging Downstream Port (as defined in BC1.2)
 DCP: Dedicated Charging Port (as defined in BC1.2)
 FVO: Fixed Voltage Output (D+ and D- are pulled up at the pre-defined voltage)

8.2 Battery Charging Mode

μPD720201 and μPD720202 support the Battery charging modes shown in Table 8-1.

Table 8-1. Battery Charging Mode

Battery charging mode number	Battery charging port type	
	Under D0/D3-hot state	Under D3-cold state
0	SDP	
1	CDP	
2	SDP	DCP
3	CDP	DCP
4	SDP	FVO1
5	CDP	FVO1
6	SDP	FVO2
7	CDP	FVO2

Note 1: To enable Battery charging function under S3/S4/S5, μPD720201 and μPD720202 must remain powered under S3/S4/S5. When the power is supplied only in S0 and S3, the charging function is only available in those power states.

Note 2: When “wake on connect function” and “wake on disconnect function” are enabled, modes 2 to 7 are not available, because these functions need to detect device attach or detach.

Note 3: The pre-defined voltage for D+ and D- differs between FVO1 and FVO2 to support the difference devices .

8.3 How to Set Up

The battery charging mode of μPD720201 or μPD720202 is set by PHY control 2 register in PCI configuration space. (Refer to section 3.2.6.4.) The PHY Control 2 register can be accessed simply and directly like any other PCI configuration register.

Setting a value in this register reflects to the downstream port after any of the following events:

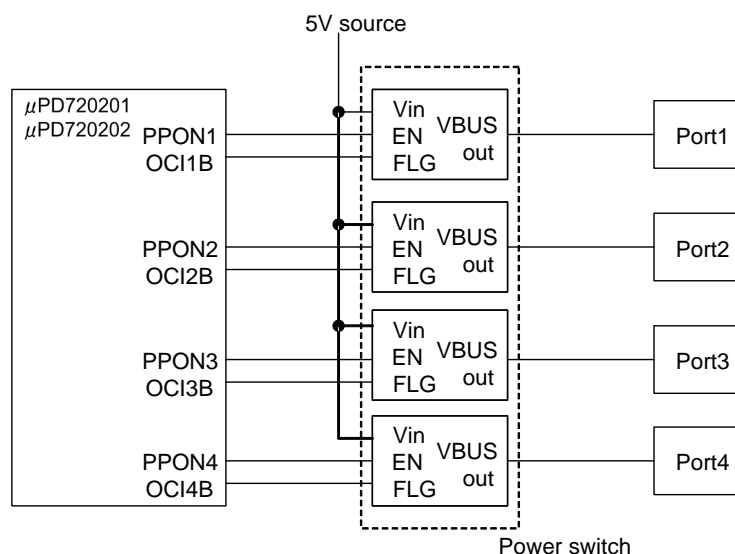
1. Resetting the host controller by using HCRST.
2. Device state transits to D3-cold.
3. Device state changes from D3-cold to D0.
4. Overcurrent is detected.

Furthermore, when External ROM for the firmware is selected in the HW configuration, it is possible to set the battery charging function by using the Vendor Specific Configuration Data Block of External ROM. Refer to chapter 6.

8.3.1 HW configuration requirement

Some Battery charging functions change the port type in each device state. VBUS shall be cut off temporarily when the charging port is changed, as required by the Battery Charging Specification. Thus, VBUS shall be controlled by a power switch controlled by PPONx for each port. And it is recommended to use power switches having the VBUS discharge function.

Figure 8-1. VBUS Control Configuration with Battery Charging Function



REVISION HISTORY

μPD720201/μPD720202 User's Manual: Hardware

Rev.	Date	Description	
		Page	Summary
0.01	March.31, 2011	-	First Edition issued
0.02	May 17, 2011	-	<ul style="list-style-type: none"> ● 1.3 Ordering Information <ul style="list-style-type: none"> ➢ Updated ordering information.
0.03	June 29, 2011	-	<ul style="list-style-type: none"> ● Chapter1 <ul style="list-style-type: none"> ➢ Changed the revision of USB Battery Charging Specification ● Chapter2 <ul style="list-style-type: none"> ➢ Added the note to 2.3 system clock ● Chapter3 <ul style="list-style-type: none"> ➢ Modified the description Table 5-2. ● Chapter5 <ul style="list-style-type: none"> ➢ Added the Chapter 5
0.04	Sep. 15, 2011	-	<ul style="list-style-type: none"> ● Chapter3 <ul style="list-style-type: none"> ➢ Updated Table 5-3. PCI Type 0 Configuration Space Header ➢ Changed the value (Default) of Max_Read_Request_Size of Table 3-41. Device Control Register (Offset Address: A8h) ➢ Changed the section 3.2.6.8 FW Download Control and Status Register ➢ Updated the section 3.3 Host Controller Capability Register ➢ Updated the section 3.4 Host Controller Operational Registers ➢ Updated the section 3.5 Host Controller Runtime Registers ➢ Updated the section 3.6 Doorbell Registers ➢ Updated the section 3.7 xHCI Extended Capabilities ➢ Updated the section 3.8 MSI-X / PBA Table ● Chapter4 <ul style="list-style-type: none"> ➢ Updated Chapter 4 Power Management ● Chapter5 <ul style="list-style-type: none"> ➢ Updated Table 5-4. Supported External Serial ROM List.
1.00	Sep. 26, 2011	-	<ul style="list-style-type: none"> ● Document promoted from Preliminary to v1.00. (Document No. R19UH0078E) ● Chapter 1 <ul style="list-style-type: none"> ➢ Updated the section 1.2 Applications

Rev.	Date	Description	
		Page	Summary
2.00	Feb. 22, 2012	-	<ul style="list-style-type: none"> ● Chapter2 <ul style="list-style-type: none"> ➤ Changed Table 2-7.SPI Interface (SPISO). ● Chapter3 <ul style="list-style-type: none"> ➤ Modified the typo of Table 3-2 PCI Type 0 Configuration Space Header (Offset E4h – DCh). ➤ Updated Table 3-7 Revision ID Register (μPD720201). ➤ Updated Table 3 25 PMC Register (Offset Address: 52h) ➤ Updated Table 3-53 PHY Control 0 register. ➤ Updated Table 3-54 PHY Control 1 register. ➤ Updated Table 3-55 PHY Control 2 register. ➤ Updated Table 3-56 HCConfiguration Register.(Bit 7:0) ➤ Updated Table 3-57 External ROM Information Register ➤ Updated Table 3-58 External ROM Configuration Register. ➤ Changed Comment of Table 3-59 FW Download Control and Register(Bit 1, Bit 6:4). ➤ Modified Table 3-72 Serial Number Register (Read/Write) ➤ Updated Comment of Table 3-82 HCCPARAMS (Bit 3). ● Chapter4 <ul style="list-style-type: none"> ➤ Modified 4.2 Power Management Event (PME) Mechanism ● Chapter5 <ul style="list-style-type: none"> ➤ Changed Table 5-1 Unused Pin connection. ➤ Modified Figure 5-1 Root Hub Port to USB Connector Mapping of μPD720201 ➤ Modified Figure 5-2 Root Hub Port to USB Connector Mapping of μPD720202 ➤ Changed 5.5 External Serial ROM Connection ● Added Chapter 6 How to Access External ROM ● Added Chapter 7 Firmware Download Function ● Added Chapter 8 Battery Charging Function
3.00	May 25, 2012	-	<ul style="list-style-type: none"> ● Chapter1 <ul style="list-style-type: none"> ➤ Updated 1.3 Ordering Information ● Chapter3 <ul style="list-style-type: none"> ➤ Modified the typo of value (Bit8:6) of Table 3-25 PMC Register.
4.00	Sep. 20, 2012	-	<ul style="list-style-type: none"> ● Chapter 6 <ul style="list-style-type: none"> ➤ Modified the Section 6.1 Access External ROM Registers ➤ Modified the Section 6.2.1.2 Sequence to write the FW (External ROM data) of μPD720201 and μPD720202 ● Chapter 7 <ul style="list-style-type: none"> ➤ Modified the Section 7.1.1 FW download registers

Rev.	Date	Description	
		Page	Summary
5.00	Jan. 18, 2013	-	<ul style="list-style-type: none"> ● Chapter 1 <ul style="list-style-type: none"> ➤ Updated 1.1 Features ➤ Added "Note" to 1.3 Ordering Information ● Chapter 3 <ul style="list-style-type: none"> ➤ Updated Table 3-55. (PHY Control 2 Register [3:0]) ● Chapter 4 <ul style="list-style-type: none"> ➤ Added the 4.4 Latency Tolerance Reporting (LTR) Mechanism ● Chapter 5 <ul style="list-style-type: none"> ➤ Updated Figure 5-7. External Serial ROM Connection. Changed the pull-up resistor value for SPISO from 47k ohm to 10k ohm. ➤ Divided the supported External serial ROM list into 2 groups (Table 5-4 Supported External Serial ROM List (A) and Table 5-5 Supported External Serial ROM List (B)) and added the comments for them. ● Chapter 6 <ul style="list-style-type: none"> ➤ Added the description about μPD720201K8-711-BAC-A & μPD720202K8-711-BAA-A ● Chapter 7 <ul style="list-style-type: none"> ➤ Added the description about μPD720201K8-711-BAC-A & μPD720202K8-711-BAA-A ● Chapter 8 <ul style="list-style-type: none"> ➤ Updated section 8.1 and 8.2. ● All Chapters <ul style="list-style-type: none"> ➤ Modified the typo
6.00	Jan. 29, 2014	-	<ul style="list-style-type: none"> ● Chapter 5 <ul style="list-style-type: none"> ➤ Modified the connection method (SPISO) in Table 5-1. Changed the pull-up resistor value for SPISO from 47k ohm to 10k ohm. ● Chapter 6 <ul style="list-style-type: none"> ➤ Added "Note" to Table 6-4
7.00	Jun 30, 2023	-	<ul style="list-style-type: none"> ● Added the new part numbers ● Added the figure based on TN-USB-A0004A/E (μPD720202K8-701-BAA-A External Serial ROM Connection circuit update)
7.10	Sep 25, 2023	2	<ul style="list-style-type: none"> ● Chapter 1 <ul style="list-style-type: none"> ➤ Updated 1.3 Ordering Information

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