USB Solutions Product Guide

RENESAS

Renesas' energy-efficient USB devices enable designers of today's Smart Society products to create power-efficient products that maximize battery life and help to preserve our world's valuable energy resources.

Excellent Design Solutions for USB 3.0 and Legacy 2.0 Applications

USB 3.0 (SuperSpeed™) achieves data transfer speeds that are up to 10 times faster than the previous version of the standard, enabling rapid and efficient transfers of data to and from external storage and multimedia devices.

USB is the most successful interface in the history of PCs with an installed base of 10+ billion units and growing at 3+ billion units per year. This success was brought about by the ease-of-use, interoperability and quality of USB-IF-certified devices. USB has always been an interface that makes adding peripherals to a PC as simple as hooking up a telephone to a wall-jack. Renesas played a key role in establishing the USB 3.0 ecosystem. For example, we have:

- > Contributed to the USB 3.0 first draft and final specification
- > Collaborated in developing and building the compliance test environment
- > Provided the PCB for the USB-IF's Peripheral Development Kit (PDK)
- > Enabled the building of the USB 3.0 ecosystem by providing the world's first IC implementation solutions!
- > Facilitated designs that achieve more of USB 3.0's SuperSpeed™ potential by offering USAP, hub and xHCI software

Offering a Complete Line of USB Hardware/Software Solutions for USB Applications

This Quick Guide provides an overview of the latest Renesas USB Host controllers, Hub controllers and USB-to-SATA bridge controllers, as well as associated software and support products such as USAP, hub and xHCI software. Although products for applying USB 3.0 technology are emphasized, devices for USB 2.0 implementations are also covered.

Leading the Way Forward

Renesas has led the industry by introducing the **world's first USB 3.0 host controller** in May 2009, and the company's lineup of USB 3.0 host controllers has been broadly adopted by customers worldwide, with total shipments already exceeding **60 million units.**

Many devices selling in the marketplace today have already been tested with our host controllers!

Jan. '96: USB 1.0
Renesas releases the world's 1st OHCI Host — 1st

Apr. '00: USB 2.0
Renesas releases world's 1st USB 2.0 Host — 1st

May '05: WUSB
Renesas releases world's 1st WHC/DWA — 1st

Jun. 2009: USB 3.0
Renesas releases the world's 1st USB 3.0 Host controller — 1st

Renesas played a key role in enabling the USB 3.0 ecosystem by introducing the world's first USB 3.0 host controller.

Overview: USB 2.0 vs. USB 3.0

Transferring Large Files quickly: USB 3.0 (SuperSpeed™) technology

Super Fast File Transfer Rate

> 10 x faster than USB 2.0 (480 Mbps vs. 5 Gbps)
> 25 Gbytes can transfer in 70 seconds versus 14 minutes with USB 2.0
> Faster Sync-and-Go

Typical File Sizes	1GB	6GB	16GB	25GB
USB 1.1	22 mins.	2.2 hours	5.9 hours	9.3 hours
USB 2.0	33 secs.	3.3 mins.	8.9 mins.	14 mins.
USB 3.0	3 secs.	20 secs.	53 secs.	70 secs.

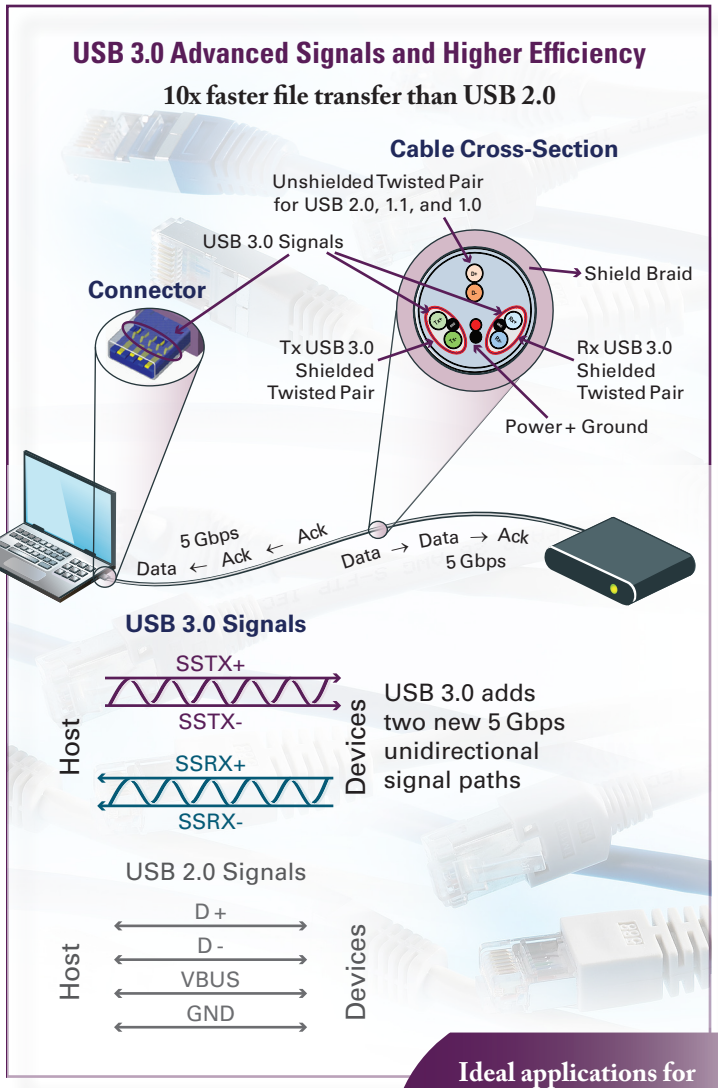
Enables uncompressed 1080p video over USB

> Enhanced power management for maximum power savings
> 1/3 the power consumption of USB 2.0 for moving a given amount of data!
> Interrupt driven, non-polling architecture

Quick Charging for Mobile Platforms

> More power at the connector (4.5 W vs. 2.5 W)
> USB 3.0 : 4.5 watts (900 mA)
> USB 2.0 : 2.5 watts (500 mA)

Backwards Compatible with USB 2.0



Ideal applications for USB 3.0 are where large files need to be moved quickly such as HD video, multi-media and data back-up

USB 3.0 power management

USB 3.0 supports a new power management architecture and detailed management of the PHY and clock system. In USB 2.0, there are two states: ACTIVE and SUSPEND. By contrast, USB 3.0 has two additional low-power states, called U1 and U2, which differ in the amount of power saved and the time each takes to return to the ACTIVE state.

USB 2.0 power management

PC State	Operational	Standby	Operational
USB 2.0 Host	Operational	Suspend	Operational
USB 2.0 Device	Operational	Suspend	Operational

USB 3.0 power management

PC State	Operational	Standby	Operational
USB 3.0 Host		U3	
USB 3.0 Device		U3	

U0:Normal, U1/U2: Low power mode, U3:Suspend

USB 3.0 Host Controllers

Renesas μPD720201 and μPD720202 third-generation Universal Serial Bus 3.0 host controllers comply with the Universal Serial Bus 3.0 Specification (USB 3.0) and Intel's eXtensible Host Controller Interface (xHCI). The μPD720201 supports up to four SuperSpeed™ USB 3.0 ports, and μPD720202 supports up to two SuperSpeed USB 3.0 ports.

These devices use a PCI Express® Gen 2 system interface bus, which makes it easy to add multiple SuperSpeed ports to systems containing the PCI Express bus interface. When connected to USB 3.0-compliant peripherals, the μPD720201 and μPD720202 can transfer information at clock speeds of up to 5 Gbps. While these host controllers are fully compliant and backward-compatible with the previous-generation USB 2.0 standard, they support data transfer speeds up to ten times faster so transfers of large amounts of information are performed much faster and more efficiently.

Target Systems

- Desktop and laptop computers
- PCI Express card/Express card
- Digital TV, HDD recorder, STB

Support Materials:

Product Brief
Data Sheet
User's Manual

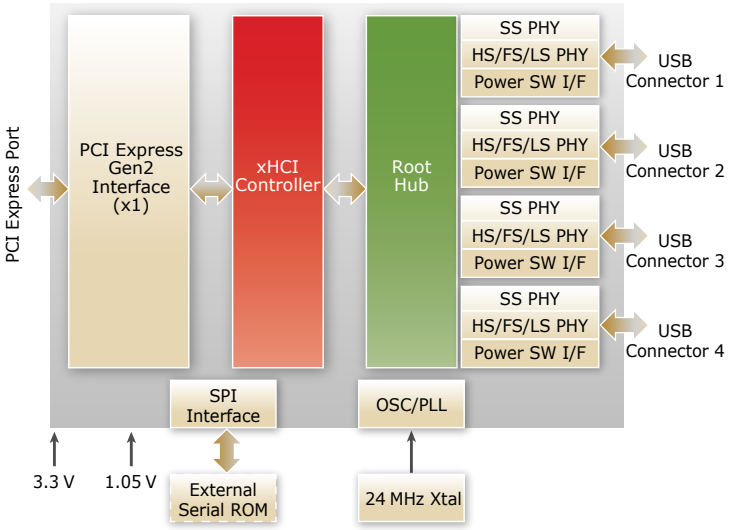
Evaluation Boards:
ET-D720201-014 (4-port)
ET-D720202-014 (2-port)

USB 3.0 PCB Design Guide

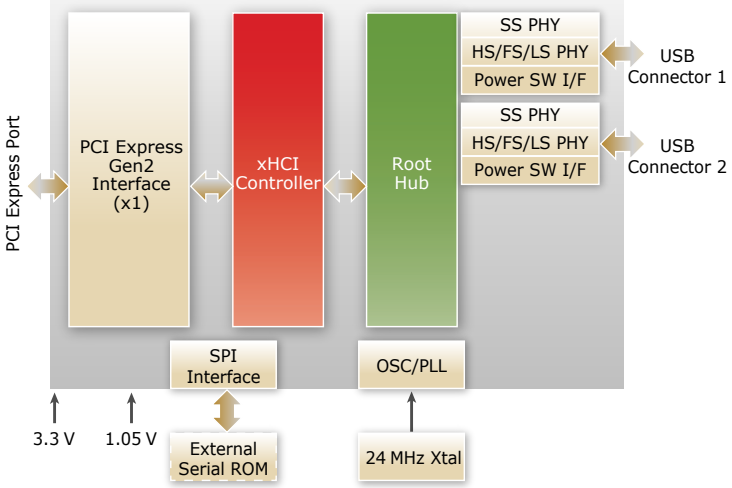
Software Drivers for Windows®:
XP, Vista, and 7.

Linux Application Note

μPD720201K8-BAC-A

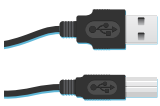


μPD720202K8-BAA-A



Features of μPD720201/2 (3rd. Gen. USB 3.0 Host Controller)

We are now on our third generation host controller and it's the best in the industry.



xHCI 1.0 Compliant

Supports SuperSpeed™ Debug Port (Microsoft requirement by June, 2012)

Supports USB-IF Battery Charging Specification

Industry-leading level of performance & ultra low power consumption

Optimizes operation of PCIe/USB for the best performance (380 MB/s Read, 350 MB/s Write)

Eliminates supply current during S3 (less than 10 mW).

Small footprint

4 port: 68-pin QFN (8 mm x 8 mm)

2 port: 48-pin QFN (7 mm x 7 mm)

Firmware is downloadable from BIOS, eliminating requirement for an external ROM (BOM cost savings!) when the μPD720201 or μPD720202 is mounted on the motherboard.

Key Features

Differences from second-generation μPD720200A

> Improved effective throughput
> Decreased power consumption
> Small package size

μPD720201K8-BAC-A features

> 4 USB downstream ports
> 68-pin QFN, 8 mm x 8 mm

μPD720202K8-BAA-A features

> 2 USB downstream ports
> 48-pin QFN, 7 mm x 7 mm

Common Features

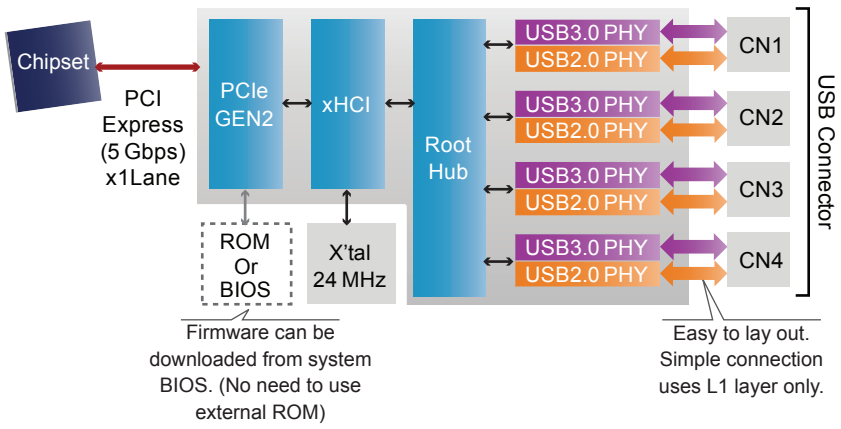
> Universal Serial Bus 3.0 Specification Revision 1.0
> PCI Express Base Specification Revision 2.0
> Intel's eXtensible Host Controller Interface (xHCI) Specification Revision 1.0
> PCI Express Card Electromechanical Specification Revision 2.0
> PCI Bus Power Management Interface Specification Revision 1.2
> USB Battery Charging Specification Revision 1.1
> USB legacy function
> Supports serial peripheral interface (SPI) type ROM for firmware
> Supports firmware download interface from system BIOS
> System clock: 24 MHz crystal
> 3.3 V and 1.05 V power supply

Firmware download from system BIOS

Simplified layout cuts BOM cost!!

Microcontroller implementation allows Renesas to readily respond if implementation issues arise.

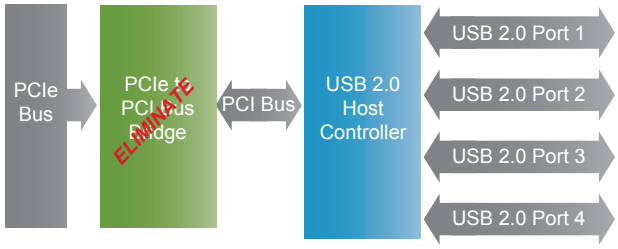
μPD720201 Host Controller



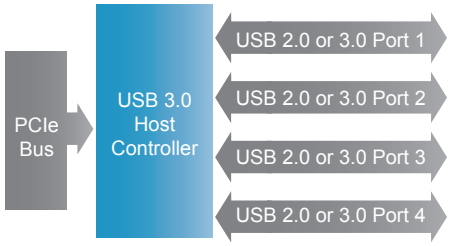
Design Idea

Eliminate PCIe-to-PCI Bridge Chips in Older Designs!

Old Design



Simplified Design



Renesas USB 3.0 Host Controller Comparison

Third Generation Solutions

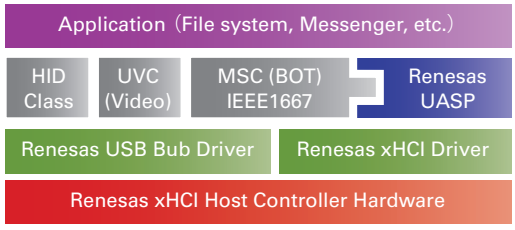
Product Name	μPD720200	μPD720200A	μPD720201	μPD720202
Generation	1st	2nd	3rd	3rd
USB Ports	2 Ports (SS/HS/FS/LS)		**4 Ports** (SS/HS/FS/LS)	2 Ports (SS/HS/FS/LS)
System I/F	PCI Express Gen2 x 1 Lane (5Gbps)			
Compliant Specs	USB 3.0 Rev. 1.0, PCI Express Rev. 2.0, and Intel xHCI Rev. 0.96		USB 3.0 Rev. 1.0, PCI Express Rev. 2.0, and Intel **xHCI Rev. 1.00**	
SSCG	No		On chip	
Debug Port	No		**Supports in all ports**	
Battery charge	No		**Yes**	
Performance (on Gen2)	Read: 300 MB/s Write: 200 MB/s		**Read: 380 MB/s** **Write: 350 MB/s**	
Power Consumption	Sleep: 62 mW No dev.: 405 mW Normal: 688 mW	Sleep: 46 mW No dev.: 50 mW Normal: 567 mW	**Sleep: 1.2 mW** **No device attached: 12 mW** **Normal: 490 mW**	
VDD	3.3 V +/-0.3 V, 1.05vV +/-5%		3.3 V +/-0.3 V, 1.05 V +/-5%	
Package	176-pin FPBGA (10 mm x 10 mm) 0.65 pitch		68-pin QFN (8 mm x 8 mm)	48-pin QFN (7 mm x 7 mm)
Certification	380000000, 380000013		380000036, 380000037	
Schedule	MP = Now		MP = Now	

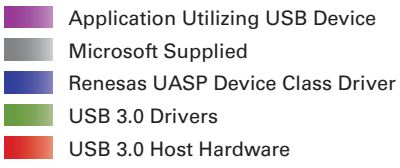
USB Software Products

Renesas' UASP, hub and xHCI software for Windows®XP, Windows®Vista and Windows®7

Note: Renesas UASP software is not downloadable from the Internet. It is available for license by Renesas to manufacturers of USB 3.0-to-SATA bridge device IC.

Iteration of Software and Hardware





What is UASP?

UASP (USB Attached SCSI Protocol) is the newly defined USB mass storage class protocol that takes full advantage of USB 3.0's new dual-simplex and stream-transfer features.

> Enables storage products to operate much faster by utilizing new, faster bandwidth
> Reduces the protocol overhead of BOT
> Supports SATA Native Command Queuing
> Processes multiple commands in parallel

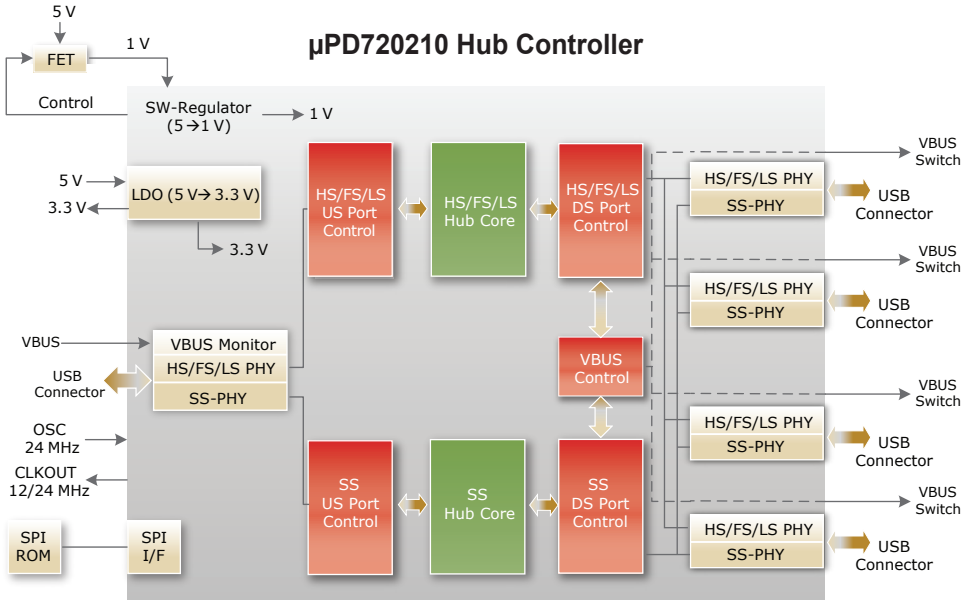
The newly defined UASP standard improves the performance of SuperSpeed (USB3.0) storage devices!

USB 3.0 Hub Controller

The µPD720210 is a 4-Port Universal Serial Bus 3.0 hub controller that complies with the Universal Serial Bus 3.0 Specification and is 100% compatible with Renesas' industry-standard host controllers.

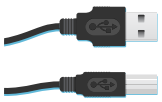
This device with the Universal Serial Bus (USB) Specification Revision 3.0 operates at up to 5 Gbps. It incorporates Renesas' market-proven design expertise in USB 3.0 interface technologies and our market-proven USB 2.0 hub core. The chip is fully compatible with all prior versions of USB and 100% compatible with Renesas' industry-standard USB 3.0 host controller. It comes in a small 76-pin QFN package and integrates several commonly required external components, making it ideally suited for applications with limited PCB space. In addition, the µPD720210 incorporates Renesas' low-power technologies.

Support Materials:
Product Brief
Data Sheet
User's Manual
Reference Design



Note: US = Upstream and DS = Downstream

Features of the µPD720210 Hub Controller



Best compatibility

Offers maximum compatibility with Renesas' host, which is the de facto standard USB3.0 host controller (more than 95% share)

Integrates our very mature USB 2.0 hub product

Supports USB-IF and other mainstream battery-charging specifications

Low power consumption for ecosystem

Reduces power consumption for energy Star® applications

Supports USB 2.0/USB 3.0 low-power management

Operating Condition		Power Consumption
Headless		30 mW
No USB Connections on Downstream Ports		50 mW
SuperSpeed Devices Attached U3 Power State	x 4	86 mW
Device Attached	x 1	222 mW
Operating	x 1	419 mW

Small footprint & low BOM cost

76-pin QFN (9 mm x 9 mm)

Clock signal out, eliminates need for additional Xtals in non-removable device applications

External ROM is optional for VID/PID and UUID (plan)

Internal voltage regulator (planned upgrade)

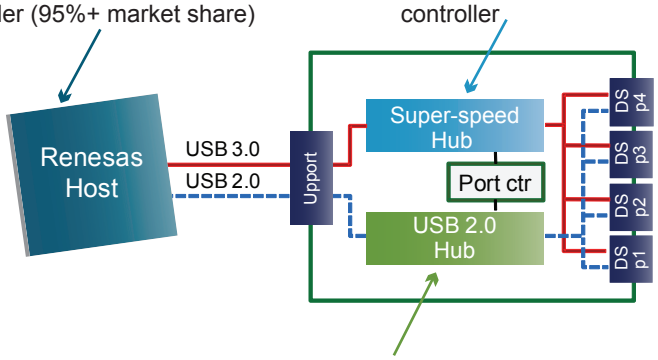
Unmatched compatibility/interoperability performance

Minimizing implementation and application issues

µPD720210 Hub Controller

Renesas' USB 3.0 host achievement: World's first certified USB 3.0 host controller (95%+ market share)

Guaranteed compatibility with our USB 3.0 host controller



Perfect compatibility with our industry-standard host

Renesas' USB 2.0 hub achievements:

> World's first certified USB 2.0 hub device

> Renesas has shipped over 70 M pcs. and is still shipping over 1 M devices per month

We can ensure compatibility with existing USB 2.0 host and hub devices.

Key Features of µPD720210 3rd Generation USB Hub Controller

> Compliant with Universal Serial Bus 3.0 Specification Revision 1.0, which was released by USB Implementers Forum, Inc.

> Supports the following speed data rates: Low-speed (1.5 Mbps) / Full-speed (12 Mbps) / High-speed (480 Mbps) / Super-speed (5 Gbps)

> µPD720210 supports up to 4 downstream ports for all speeds

> Supports all USB compliant data transfer types:
Control / Bulk / Interrupt / Isochronous transfer

> Supports USB3.0/2.0 power management

> Up to 4 configurable ports

> Supports individual or global over-current detection and individual or ganged power control

> Supports downstream port status with LED

> Supports non-removable devices by I/O pin configuration

> Supports clock output (24/12 MHz) for non-removal device

> Low power consumption, suitable for Energy Start programs

> System clock: 24 MHz crystal

> Supports USB Battery Charging Specification Revision 1.2 and other portable devices

> Small and low-pin-count package with simple pin assignment for PCB layout

> Integrated voltage regulator and CLK-OUT to reduce total BOM cost

Part Number

µPD720210K8-BAF-A

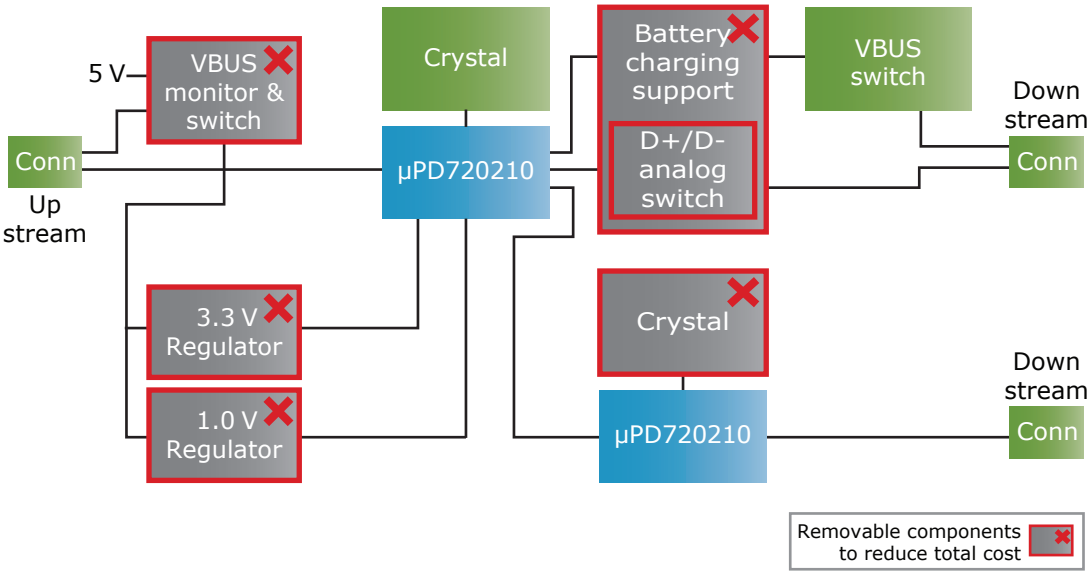
Package

76-pin QFN (9 x 9 mm)

Target Systems

PCs, servers, docking stations, monitors, external hub boxes, keyboards, etc.

BOM Cost Reduction



Take-away point:
Renesas' silicon has the lowest total BOM cost

Summary of Renesas Bill of Materials Cost Reductions

	Competition	Renesas	Savings
5.0V to 3.3V Regulator	$0.08	$-	$0.08
1.0V SW Regulator	$0.15	$0.05	$0.10
Downstream External Crystal	$0.10	$-	$0.10
Battery Charging Communication IC	$1.40	$0.40	$1.00
Total	$1.73	$0.45	**$1.28**

Up to $1.28 BOM savings (4 charging ports)

Renesas' Hub enables faster charging by supporting all mainstream charging modes!

Integrating these charging standards saves $0.35/port compared to ext. IC:

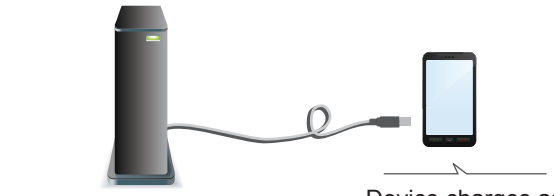
Port Type

> Standard Downstream Port (SDP)

> Charging Downstream Port (CDP)

> Dedicated Charging Port (DCP)

> Apple



Renesas Hub (within docking station) informs the device of how much power is available for charging.

Device charges as quickly as possible!

Device is recognized by the PC (laptop)

Renesas' Hub (within docking station) informs laptop that a device is already connected to the docking station.

Internal timing signal generation eliminates the need for external clock crystal.

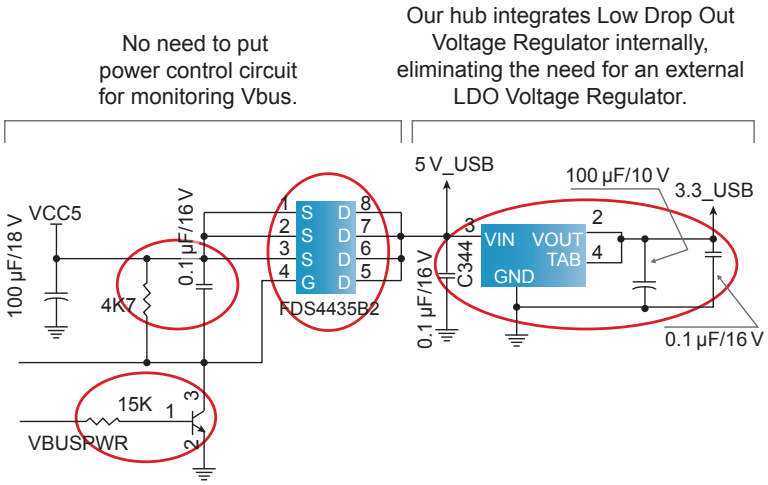
Example of monitor application

Energy Star® power program requirements for PC monitors:

> Less than 1W (Tier-2) during sleep mode
(In future, requirement will drop to less than 0.5 W)

> Renesas hub controller cuts off power consumption when Vbus is off

Typical circuit



USB 3.0-to-SATA Bridge Controller

The Renesas µPD720230 is a single-chip, USB 3.0-to-SATA3 bridge controller that complies with the Universal Serial Bus 3.0 (USB 3.0) Specification Revision 1.0 and the Serial ATA (SATA) Specification Revision 3.0.

The µPD720230 has a USB 3.0 physical layer (PHY) that supports the SuperSpeed (5 Gbps) data transfer mode and a USB 2.0 PHY that supports HighSpeed (480 Mbps) and FullSpeed (12 Mbps) data transfer modes. Additionally, the device supports the USB Attached SCSI Protocol (UASP), which significantly speeds up the transfer of large volumes of data to and from USB storage devices.

The SATA Gen3 PHY supports SATA Gen3 (6 Gbps), Gen2 (3 Gbps), and Gen1 (1.5 Gbps) interfaces.

UASP Driver

Renesas' UASP driver is available for Windows XP, Vista and 7 (32-bit and 64-bit) operating systems. Compatible with the following USB 3.0 host:

> Renesas µPD720200/200A/201/202 USB3.0 host controllers
> AMD A70M, A75, and future chipsets
> Other mainstream chipsets (in planning)

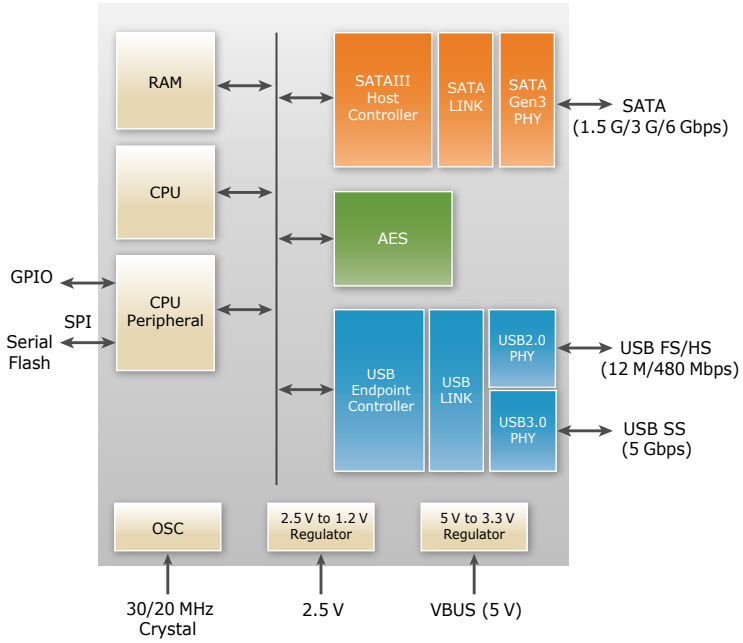
Target Applications

External HDD/SDD

Enclosure case

Support Materials:

Product Brief
Data Sheet
User's Manual
Evaluation Board



Key Features

USB Interface

> SuperSpeed (5 Gbps), HighSpeed (480 Mbps), FullSpeed (12 Mbps) transport modes
> Mass-Storage Class, USB Attached SCSI Protocol (UASP) compliance
> Mass Storage Class, Bulk-Only Transport (BOT) compliance

Sata Interface

> SATA Gen3 (6 Gbps), Gen2 (3 Gbps), and Gen1 (1.5 Gbps) support
> Host interface power management
> Multiple LUN support
> Backend RAID and port multiplier chip support
> Hot plug support
> Full ATA-8, 48-bit logical block address support for drives larger than 2 TB

Features

> Power management
  – USB 3.0 U1/U2/U3 state
  – USB 2.0 Suspend/LPM
> Security
  – IEEE1619 standard XTS- AES 128bit/256bit encryption
  – IEEE1667TM authentication mechanism
> Integrated 32bit RISC CPU
> 10 configurable GPIOs
> Clock input: 30 MHz or 20 MHz crystal
> Power supply: 2.5 V and 5 V from VBUS
> On-chip 1.2 V and 3.3 V regulator
> 48-pin QFN (6 x 6 mm)

Ordering Information

Part Number

> µPD720230K8-622-BAE-A

Package

> 48-pin QFN (6 x 6 mm)

Part Number Guide to All Renesas USB Products

USB 3.0

USB 2.0

Part Number	USB Version	Type	Ports	Temp.	Package
µPD720200AF1-DAP-A	USB 3.0	Host Controller	2-port	0 to +85°C	176-pin FPBGA (10 mm x 10 mm, 0.65 mm pitch)
µPD720201K8-701-BAC-A	USB 3.0	Host Controller	4-port	0 to +85°C	68-pin QFN (8 mm x 8 mm, 0.4 mm pitch)
µPD720201K8-711-BAC-A	USB 3.0	Host Controller	4-port	-40 to +85°C	68-pin QFN (8 mm x 8 mm, 0.4 mm pitch)
µPD720202K8-701-BAA-A	USB 3.0	Host Controller	2-port	0 to +85°C	48-pin QFN (7 mm x 7 mm, 0.5 mm pitch)
µPD720202K8-711-BAA-A	USB 3.0	Host Controller	2-port	-40 to +85°C	48-pin QFN (7 mm x 7 mm, 0.5 mm pitch)
uPD720210K8-BAF-A	USB 3.0	Hub	4-port	0 to +70°C	76-pin QFN (9 mm x 9 mm) (TBD: 3QCY2012)
uPD720230K8-BAE-A	USB 3.0	Bridge Controller	SATA3	0 to +85°C	48-pin QFN (6 mm x 6 mm)
µPD720101GJ-UEN-A	USB 2.0	Host Controller	5-port	0 to +70°C	144-pin Plastic LQFP (Fine Pitch) (20 mm x 20 mm)
µPD720101F1-EA8-A	USB 2.0	Host Controller	5-port	0 to +70°C	144-pin Plastic FBGA (12 mm x 12 mm)
µPD720102GC-YEB-A	USB 2.0	Host Controller	3-port	-20 to +70°C	120-pin Plastic TQFP (Fine Pitch) (14 mm x 14 mm)
µPD720102F1-CA7-A	USB 2.0	Host Controller	3-port	-20 to +70°C	121-pin Plastic FBGA (8 mm x 8 mm)
µPD720113GK-9EU-A	USB 2.0	Hub	7-port	0 to +70°C	80-pin Plastic TQFP (12 mm x 12 mm)
µPD720114GA-YEU-A	USB 2.0	Hub	4-port	0 to +85°C	48-pin Plastic TQFP (7 mm x 7 mm)
µPD720114K9-4E4-A	USB 2.0	Hub	4-port	0 to +85°C	40-pin Plastic QFN (6 mm x 6 mm)
R8A66597FP#RF1S	USB 2.0	Host Controller	2-port	-20 to +85°C	80-pin LQFP (10 mm x 10 mm, 0.4 mm pitch) (Tray)
		Peripheral Controller	1-port		
R8A66597DFP#RB1S	USB 2.0	Host Controller	2-port	-40 to +85°C	80-pin LQFP (10 mm x 10 mm, 0.4 mm pitch) (Tray)
		Peripheral Controller	1-port		
R8A66597BG#DF1S	USB 2.0	Host Controller	2-port	-20 to +85°C	81-pin FBGA (5 mm x 5 mm, 0.5 mm pitch) (Tape and Reel)
		Peripheral Controller	1-port		

Typical Applications for USB Devices

Application		Host	Hub	SATA
Speed up File Transfer	NASs	✓		
	PCs	✓	✓	
	Servers	✓	✓	
	Tablets (Netbook/top)	✓		
Extension of Interfaces	Docking Stations	✓	✓	
	Monitors		✓	
	Motherboards	✓	✓	
	Single Board Computers *Note: Requires PCIe (Gen 1 or 2 and Linux for Host Controller)*	✓	✓	
	Add-in Cards	✓		
	Hub-Boxes		✓	
PVR	Set-top boxes	✓		
	Home-Gateway	✓		
External Storage	Hard and Solid State Disk Drives			✓

USB website and technical support

Quick links to USB 3.0 and 2.0 product documentation:

http://www.renesas.eu/usb

USB Technical Support

USB_support-eu@lm.renesas.com

(This email alias is covered by a team of USB technical experts within our engineering group.)

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Document No. R19CP0003EE0100