Welcome to Pericom's PCIe and USB3 ReDriver/Repeater Product Training Module.

Pericom ReDriver Background

- **A Leader in Signal Integrity:**
  - >60 million units shipped since 2005
  - Key applications include smart phones, NB, TV, servers/storage, networking, embedded, consumer, and more
  - Key partnerships with major CPU vendors

- **Broadest protocol offering in the industry:**
  - PCIe Gen1/2/3
  - USB3
  - SATA 2/3 and SAS 2/3
  - XAUI
  - HDMI and Display Port
  - 10Gb/40Gb Ethernet

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Pericom has been a leader in providing Signal Integrity Solutions since 2005, with over 60 million units shipped

Platforms like smart phone, servers, notebooks, networking, storage, embedded, any many more, show that Pericom ReDrivers have been successfully used in a very broad range of applications for both PCB trace and cable extension.

Key CPU vendor partnerships are critical to insuring proper interoperability, compliance, and future product development.

While this training module focuses on our PCI Express and USB3 ReDriver solutions, Pericom offers Signal Integrity products covering all popular high speed serial protocols.

ReDrivers and System Performance

➔ **Communication errors reduce system performance, poor signal quality results in communication errors**

➔ **Signal quality is reduced by noise (jitter) and attenuation, but can be restored with signal conditioners**

Source   Receiver

Design Performance Capacity, %

Bit Error Rate
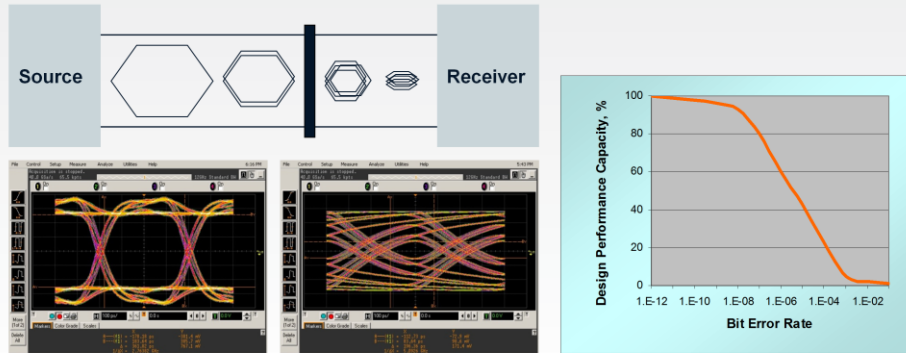
A ReDriver is basically a high bandwidth analog amplifier with frequency shaping and other features to extend the length of the high speed PCB signal trace or cable, and open the 'eye' of the signal at the end point of the channel.

This is critical at system level to prevent data bits from being dropped (errors), which causes performance reduction.

The ReDriver operates at the PHY layer only in the high speed channel, and does not need an external clock.

Therefore, it is a very cost effective way to extend high speed signals on a PCB in almost all channel applications.

Tuning Nomenclature:

EQ = Equalization = Receiver (Rx) channel frequency boost settings, commonly called Rx EQ

DE = DeEmphasis = Transmitter (Tx) channel frequency cut settings, commonly called Tx DE

OS = Output Swing = controls the total voltage level of the output signal.

EQ, DE, and OS are adjusted to provide the best eye opening at the end point when extending the channel
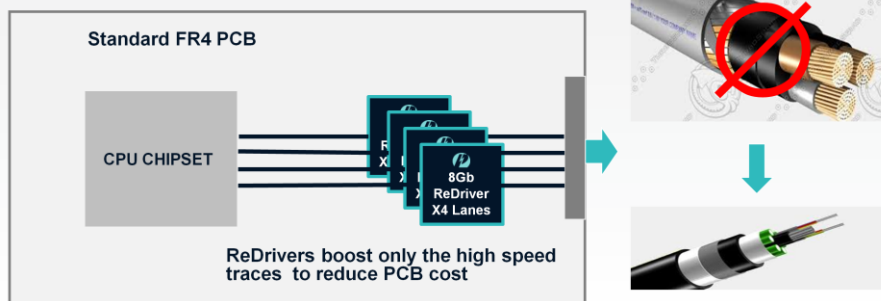
These adjustments can be made by I2C bus to the IC internal registers, or by

using pin strap settings, or both.

ReDrivers – a Versatile Cost Saver!

ReDrivers can help reduce system cost in many ways:

- Replace the need for more expensive 'retimer' based products
- Replace the need for more expensive PCB board material - it is much more cost effective to use ReDrivers than pay for entire PCB upgrade.
- Allow use of lower cost / smaller gauge cable by using ReDriver

Standard FR4 PCB

CPU CHIPSET

8Gb ReDriver X4 Lanes

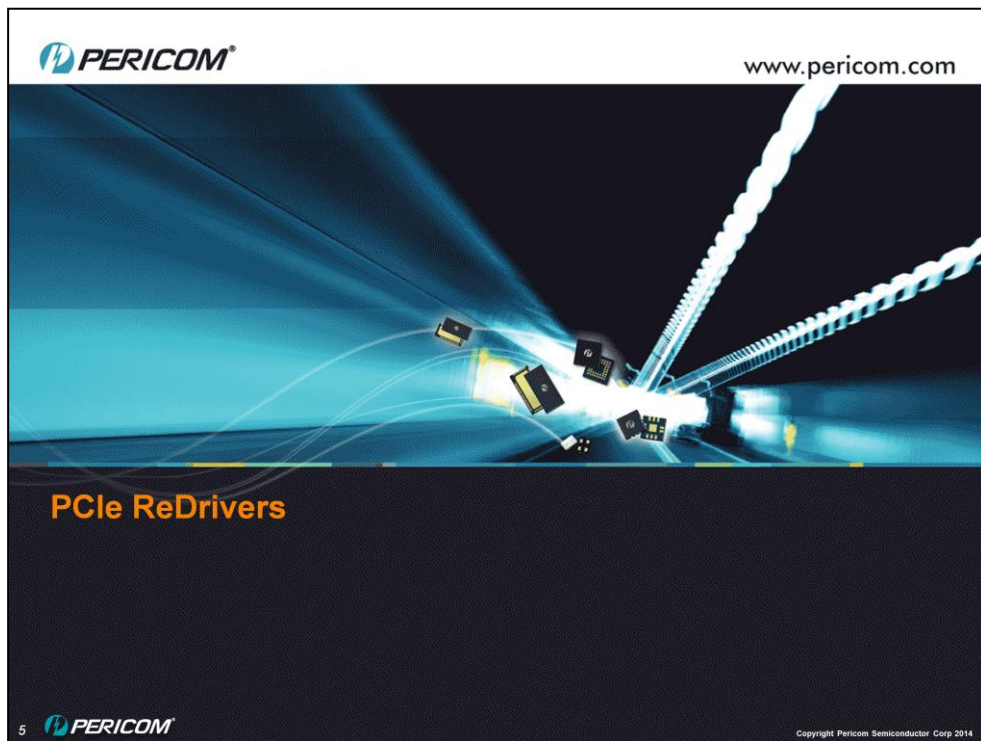ReDrivers boost only the high speed traces to reduce PCB cost

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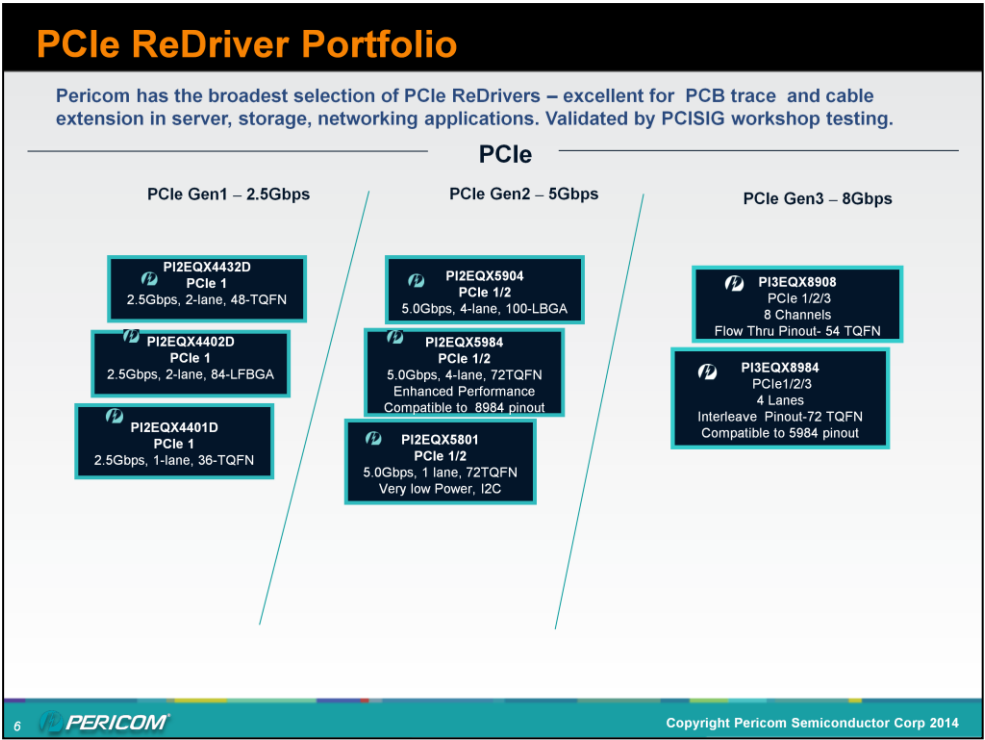ReDrivers can do much more than just boost signal to extend PCB trace.

For most channels, ReDrivers can be used instead of more costly 'retimer' type IC's that also burn more power.

ReDrivers also are much more cost effective way to reduce channel attenuation than upgrading the entire PCB to a more expensive type of material. Only the high speed channels need signal boost – not the entire PCB!

Finally, ReDrivers can allow use of thinner/smaller gauge cables, since the signals are actively boosted prior to the cable connector. Some cables use ReDrivers embedded in the connector, and are called 'Active Cables'. Even these active cables can be less expensive than the passive cable equivalent.

PCIe ReDrivers

Let's take a look at what Pericom offers for PCI Express

PCIe ReDriver Portfolio

Pericom has the broadest selection of PCIe ReDrivers – excellent for PCB trace and cable extension in server, storage, networking applications. Validated by PCISIG workshop testing.

PCIe

PCIe Gen1 – 2.5Gbps

PI2EQX4432D
PCIe 1
2.5Gbps, 2-lane, 48-TQFN

PI2EQX4402D
PCIe 1
2.5Gbps, 2-lane, 84-LFBGA

PI2EQX4401D
PCIe 1
2.5Gbps, 1-lane, 36-TQFN

PCIe Gen2 – 5Gbps

PI2EQX5904
PCIe 1/2
5.0Gbps, 4-lane, 100-LBGA

PI2EQX5984
PCIe 1/2
5.0Gbps, 4-lane, 72TQFN
Enhanced Performance
Compatible to 8984 pinout

PI2EQX5801
PCIe 1/2
5.0Gbps, 1 lane, 72TQFN
Very low Power, I2C

PCIe Gen3 – 8Gbps

PI3EQX8908
PCIe 1/2/3
8 Channels
Flow Thru Pinout- 54 TQFN

PI3EQX8984
PCIe1/2/3
4 Lanes
Interleave Pinout-72 TQFN
Compatible to 5984 pinout

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Pericom offers PCI Express (PCIe) ReDrivers at 3 speed levels and has a 'family' for each speed:

PCIe GEN1 = 2.5Gb/s (Gigabits per second)

PCIe GEN2 = 5.0Gb/s

PCIe GEN3 = 8.0Gb/s

It is recommended that if the designer thinks the system will upgrade to a faster speed in the future, then use the higher speed ReDriver. They are all fully 'backwards' compatible to the lower speed.

All Pericom ReDrivers are rated across the full Industrial Temp Range (-40 to+85C)

PCIe1 and PCIe2 ReDriver Portfolio

PCIe Gen1 – 2.5Gbps

PCIe Gen2 – 5Gbps

PI2EQX4432D
PCIe 1
2.5Gbps, 2-lane, 48-TQFN

PI2EQX4402D
PCIe 1
2.5Gbps, 2-lane, 84-LFBGA

PI2EQX4401D
PCIe 1
2.5Gbps, 1-lane, 36-TQFN

PI2EQX5904
PCIe 1/2
5.0Gbps, 4-lane, 100-LBGA

PI2EQX5984
PCIe 1/2
5.0Gbps, 4-lane, 72TQFN
Enhanced Performance
Compatible to 8984 pinout

PI2EQX5801
PCIe 1/2
5.0Gbps, 1 lane, 72TQFN
Very low Power, I2C

- PCIe 1 only speeds
- Pin Strap programming only (no I2C)
- 1 Lane and 2 lane options
- Also good for GMII Networking Apps

- PCIe 1 and 2 speeds
- Both I2C and Pin Strap Programming
- 4 Lane and 1 Lane Options
- 5801 – lowest power 1 Lane in industry
- 5984 - pin compatible to GEN3 8984

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Let's take a closer look at Pericom's PCIe GEN1 and GEN2 offerings.
For GEN1, we have both 2 Lane and 1 Lane options. These parts also work well for GMII and proprietary PHY / serdes extension in networking applications. Many embedded, telecom, and networking applications still operate at GEN1 speed.
The GEN1 family parts all use pin strapping for EQ, DE, OS settings.
Although PCIe GEN1 speed (2.5Gb) is older, some customers still only need this lowest speed PCIe ReDriver.

For GEN2, we offer both 4 Lane and 1 Lane options. This speed family offers both I2C and pin strap programming options for EQ, DE, OS, and other parameters to help tune the ReDriver for best eye opening.
Most Networking and Embedded CPU/FPGA are at least PCIe GEN2 capable (Freescale, Cavium, Altera, Xilinx, etc).
The 4 Lane option works well in server, networking, and graphics applications where there are typically 8 or 16 lanes of PCIe.
I2C register access is very helpful for bigger platforms where BIOS can control the EQ, DE, and OS of the ReDriver.

The 1 Lane option is a very low power (lowest Pd for 1 Lane ReDriver in the industry) IC that works well to extend traces in Notebook, Docking, and other mobile applications where battery life is important, as well as embedded, and

other 1 Lane PCIe applications.

Pericom is the first vendor to receive official PCI-SIG workshop compliance for a PCIe GEN2 redriver and is listed on the PCISIG website Integrator's List.

Now let's take a closer look at Pericom's latest and most advanced PCIe Redrivers – the GEN3 family.

This new family offers the highest bandwidth, lowest power, most EQ settings, and most linear analog amplifiers for best signal reproduction.

For PCIe GEN3, Pericom is the ONLY vendor to offer both flow through and interleave pinout options. This gives PCB designers another pinout option to optimize their layout.

This family is aimed mainly for server and storage applications, where PCIe GEN3 is available on the CPU chipset, however, higher end FPGA and some non server CPU chipsets now have PCIe GEN3 capability.

Remember – All Pericom PCIe ReDrivers are backward compatible, so even if your design is running at GEN2 today, but you think that in the future your platform will move to GEN3, then using a GEN3 capable ReDriver should be strongly considered.

Other key features include a master I2C option, allowing up to 16 IC's to be programmed by a low cost EEPROM as an alternative to software BIOS programming.

Another key feature unique to Pericom is the programmable linear gain of the analog amplifier. This can help to fine tune the 'eye' to offer the best performance and offer best performance for link training signals.

For this new and advanced family, please contact Pericom directly for more

information, datasheet, and sample availability.

Note that Pericom also offers a 10Gb version of this family, aimed at 10Gb/40Gb Ethernet XFI, SFI, KR applications. This part is capable of running at up to 11.3Gb speeds (Some Ethernet KR options require this)

Pinout Options – Interleave & Flow-Thru
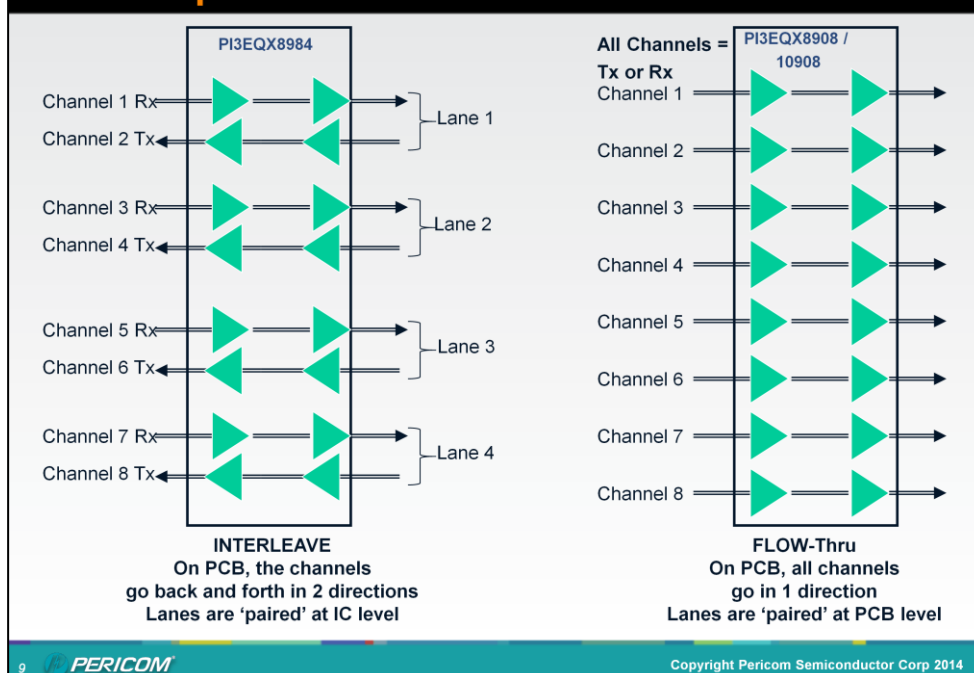
Pericom is the only PCIe GEN3 ReDriver vendor to offer both interleave and flow through pinouts.

This gives the PCB designer more options for best layout in the application.

Flow through pinout is typically used on riser cards where Tx and Rx channels can be separated at the connector.

Interleave pinout is typically used on the planar MB where Tx and Rx channels are already paired from the CPU.
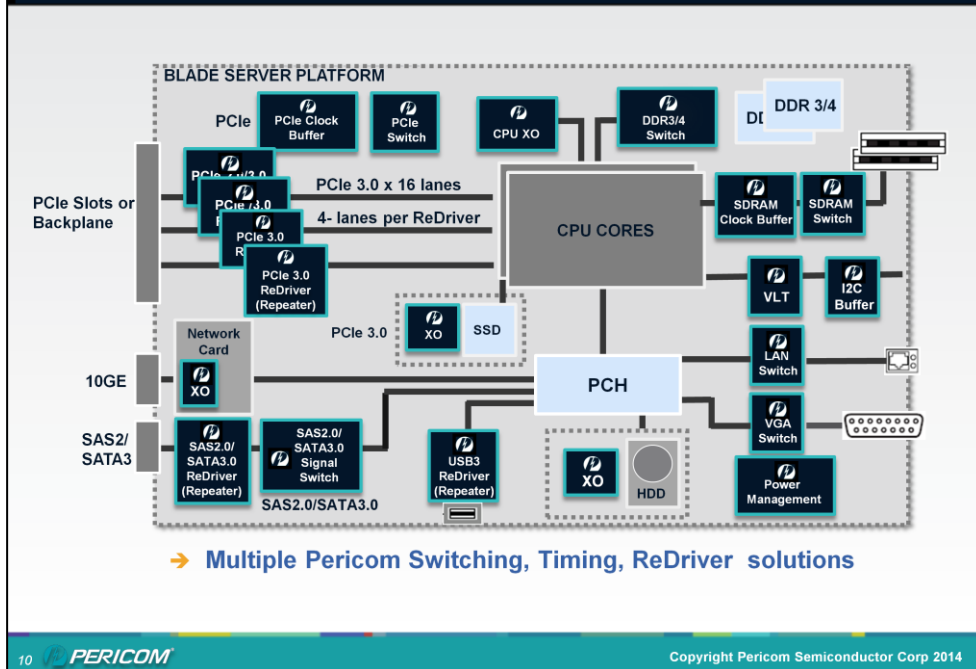
Example of a blade server using Pericom PCIe GEN3 redrivers and other Pericom products targeted to server platforms.

In latest generation high speed CPU chipsets, the PCIe signals are not as strong, so ReDrivers are commonly used.

They are lower overall cost compared to using more expensive PCB material for the whole platform.

They are lower overall cost compared to using more expensive 'Retimer' CDR solutions.
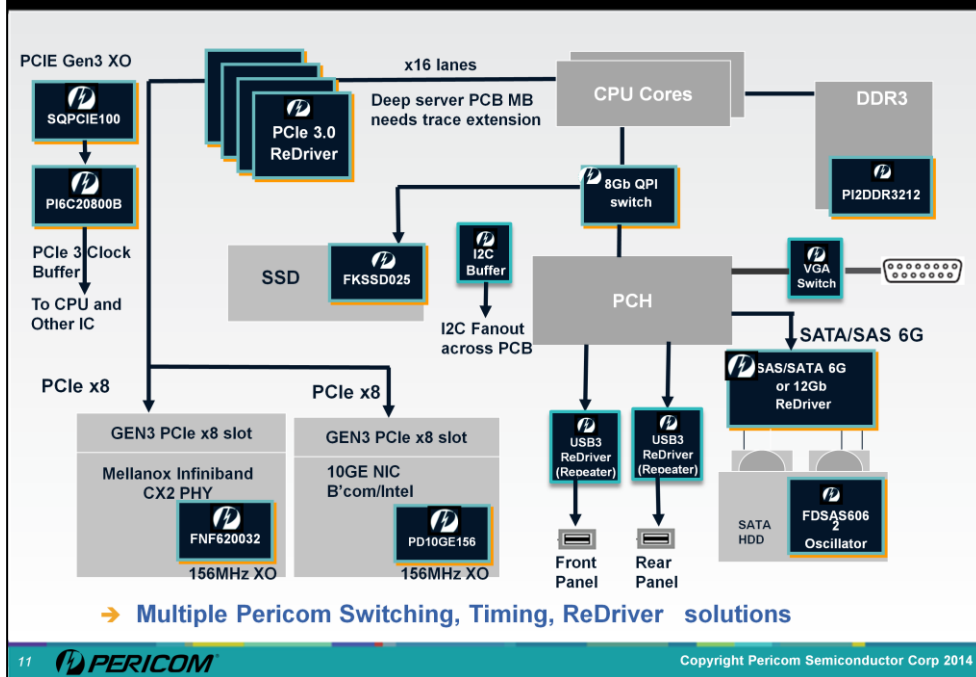
Example of PCIe GEN3 ReDriver in a volume rack server application. Again, note all the other essential functions that Pericom covers for these applications: Timing, Switching, and Connectivity product families as well as Signal Integrity. Pericom can provide a complete platform solution, no matter what the end application.

Pericom PI3EQX5801 (1-Lane PCIe2.0 ReDriver)

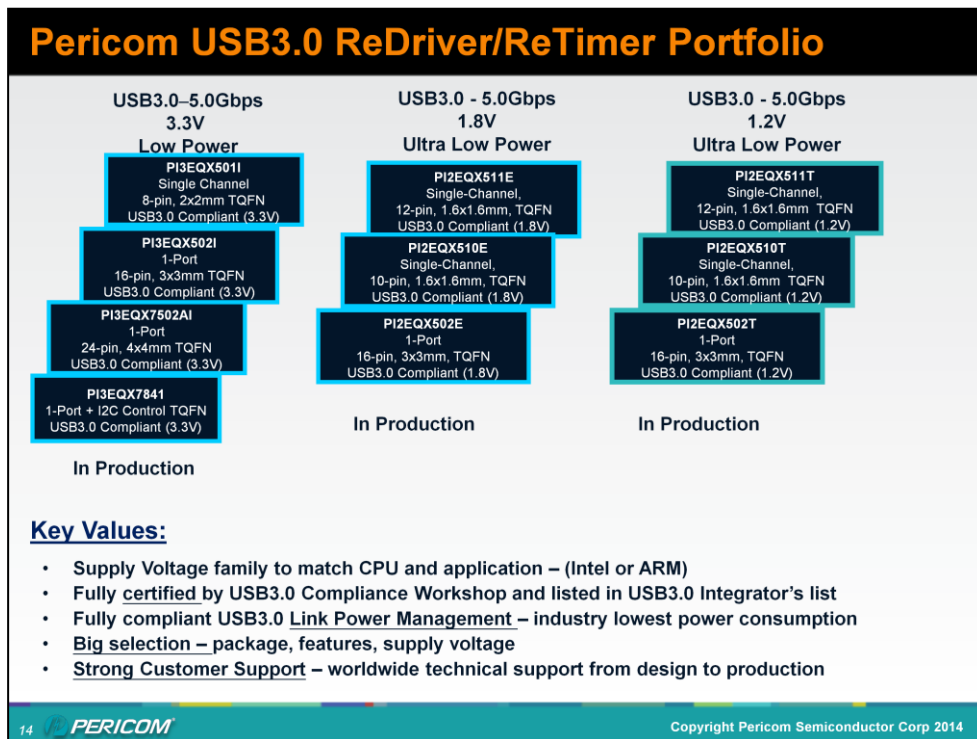**App: Haswell AIO PC/Workstation or Notebook/Dock**
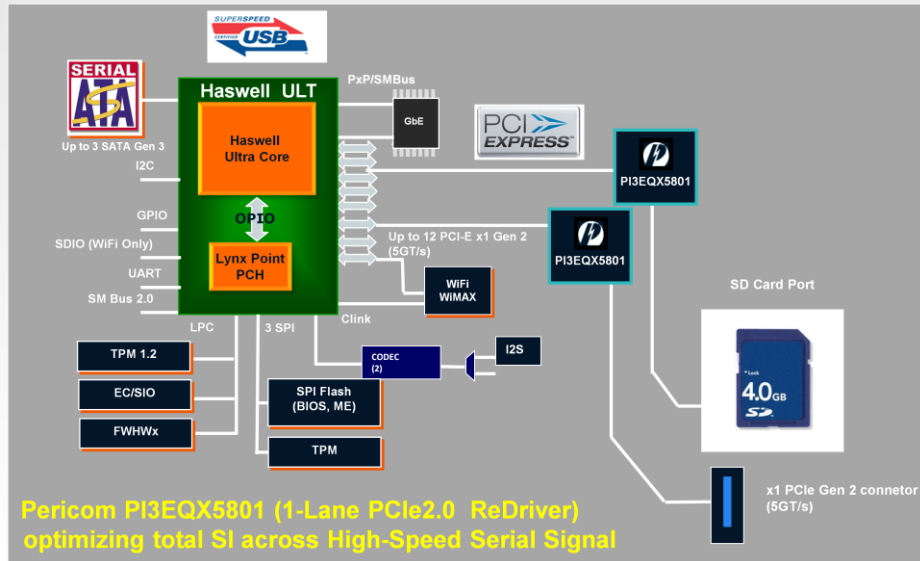
Example of a mobile NB (NoteBook) or WS (WorkStation) application using the 1 Lane PI3EQX5801 PCIe GEN2 ReDriver. The ReDriver is used to extend PCIe traces out to a PCIe internal mini-connector, and also a docking port. Again, in order to reduce overall power, and as CPU process technology continues to shrink, the latest generation CPU chipsets have decreased output drive.

This IC is very popular for this application due to the very low power and large amount of EQ, DE, and OS tuning options.

USB3 ReDrivers

Let's take a look at what Pericom offers for USB3 – by far the most widely used serial protocol in the world

Pericom USB3.0 ReDriver/ReTimer Portfolio

USB3.0–5.0Gbps 3.3V Low Power	USB3.0 - 5.0Gbps 1.8V Ultra Low Power	USB3.0 - 5.0Gbps 1.2V Ultra Low Power
PI3EQX501I Single Channel 8-pin, 2x2mm TQFN USB3.0 Compliant (3.3V)	**PI2EQX511E** Single-Channel, 12-pin, 1.6x1.6mm, TQFN USB3.0 Compliant (1.8V)	**PI2EQX511T** Single-Channel, 12-pin, 1.6x1.6mm TQFN USB3.0 Compliant (1.2V)
PI3EQX502I 1-Port 16-pin, 3x3mm TQFN USB3.0 Compliant (3.3V)	**PI2EQX510E** Single-Channel, 10-pin, 1.6x1.6mm, TQFN USB3.0 Compliant (1.8V)	**PI2EQX510T** Single-Channel, 10-pin, 1.6x1.6mm TQFN USB3.0 Compliant (1.2V)
PI3EQX7502AI 1-Port 24-pin, 4x4mm TQFN USB3.0 Compliant (3.3V)	**PI2EQX502E** 1-Port 16-pin, 3x3mm, TQFN USB3.0 Compliant (1.8V)	**PI2EQX502T** 1-Port 16-pin, 3x3mm, TQFN USB3.0 Compliant (1.2V)
PI3EQX7841 1-Port + I2C Control TQFN USB3.0 Compliant (3.3V)	In Production	In Production
In Production		

Key Values:

- Supply Voltage family to match CPU and application – (Intel or ARM)
- Fully certified by USB3.0 Compliance Workshop and listed in USB3.0 Integrator's list
- Fully compliant USB3.0 Link Power Management – industry lowest power consumption
- Big selection – package, features, supply voltage
- Strong Customer Support – worldwide technical support from design to production

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Here are 3 Pericom USB3 ReDriver families across 3 popular Vdd rail voltages: 3.3V, 1.8V, and 1.2V

Each voltage family offers both 1 Channel (Tx or Rx only channel) and 1 Port (bothTx and Rx channels).

For most applications such as NB, TAB, etc that uses Intel chipset, 1 Port versions would be used, since the platform is on the host side, and needs both Tx and Rx support.

For some applications that are end points (not hosts), such as smart phones, then 1 Channel versions can be used. If an end point has host mode enabled, which is a future trend, then a 1 port ReDriver should be considered.

All Pericom USB3 ReDrivers, regardless of voltage or channels, are designed to pass all the USB-IF compliance

Specifications – ESPECIALLY - the Power Management specifications. This means that a Pericom USB3 ReDriver

can save battery power by going into the lowest power state possible as specified by the chipset signaling.
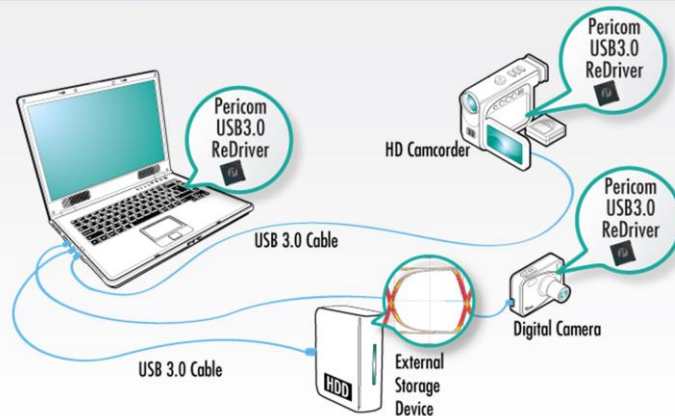
Pericom is the ONLY USB3 ReDriver vendor to pass USBIF compliance testing and earn a spot on their integrator's list.

Pericom also has a new family of even lower voltage products – contact Pericom directly for more information.

An example of a few of the mobile platforms that Pericom's USB3 ReDriver has been designed into.

Small mobile platforms especially need ReDrivers for high speed serial signals, due to the very low power CPU chipsets used sacrifice their output drive for low power. Therefore, an external ReDriver is used to boost the output signal and provide proper signal integrity to the connector, down the cable, and into the host device.

Many small mobile platforms use ARM based CPU chipsets. Pericom has a complete USB3 ReDriver offerings for these chipsets as well as chipsets for NB, WS, TAB, PC, and host side applications.

Pericom USB3.0 ReDriver on Smart Handheld Device
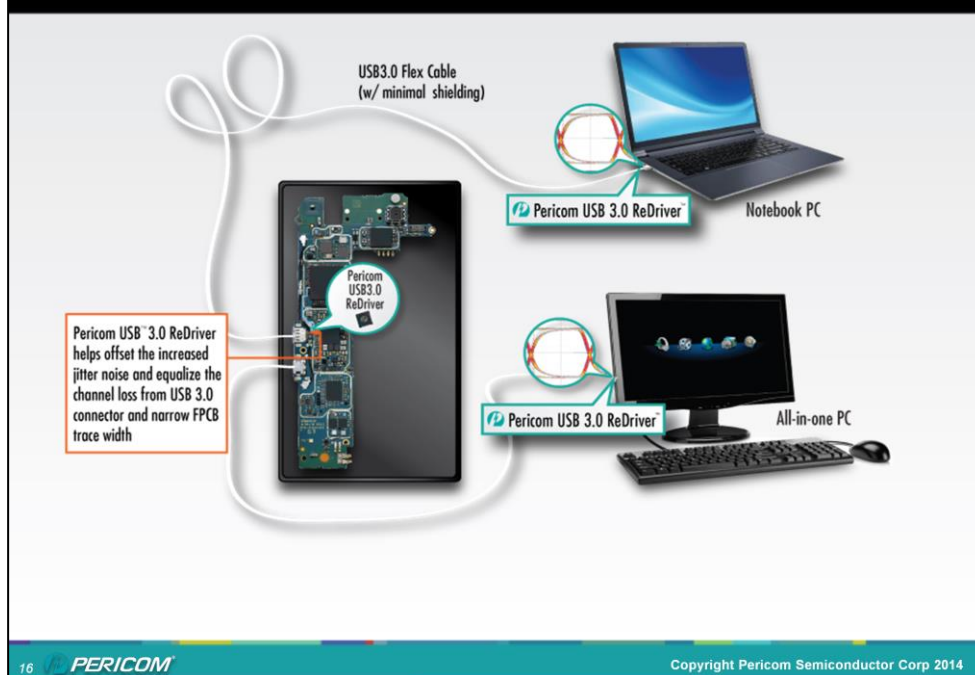
For Smart Phone applications, Pericom's single channel PI2EQX501/510/511 ReDrivers are a perfect fit.

Another advantage to use ReDriver in Smart Phone is to help reduce EMI. Contact Pericom for more information about how ReDrivers can do more in your application than just extend trace length!

Pericom USB3.0 ReDriver on Server Blade or WS
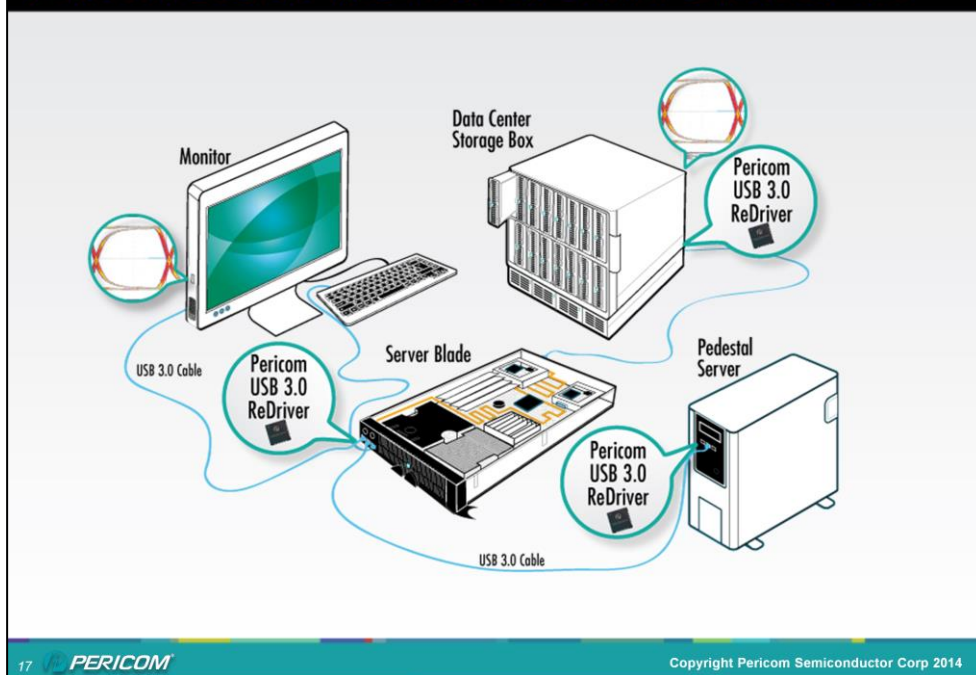
In the server world, many server vendors offer USB3 ports on both front and back of the server. Since the typical server platform is quite large, the CPU chipsets cannot provide enough output drive for the USB3 signal (5Gb/s) to both front and back connectors, so Pericom's USB3 ReDriver is again a perfect fit to this application. Pericom USB3 ReDrivers have also been validated by Intel, and are on the recommended vendor list (Blue Sheet) issued by Intel to its customers.

Pericom USB3.0 ReDriver on HD Set-Top Box
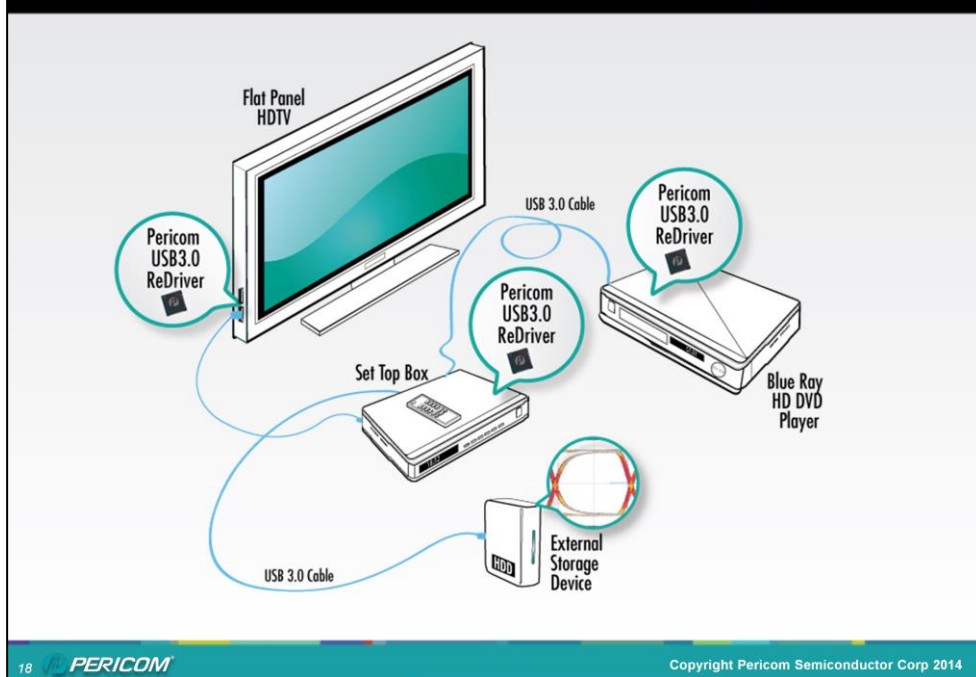
USB is the world's most widely used high speed serial protocol.

All types of mobile and fixed platforms are moving to USB3, and many will need a ReDriver to enable the signal.

This example shows STB (Set Top Box), Blue Ray Player, Flat Panel, and external HDD using USB3 protocol, and Pericom USB3 ReDrivers are used in applications like this worldwide.

Again, latest generation CPU's in these platforms sacrifice output drive for low power.

The USB3 ReDriver makes up this difference in the high speed serial channel to enable the signal quality needed for proper operation and transfer.
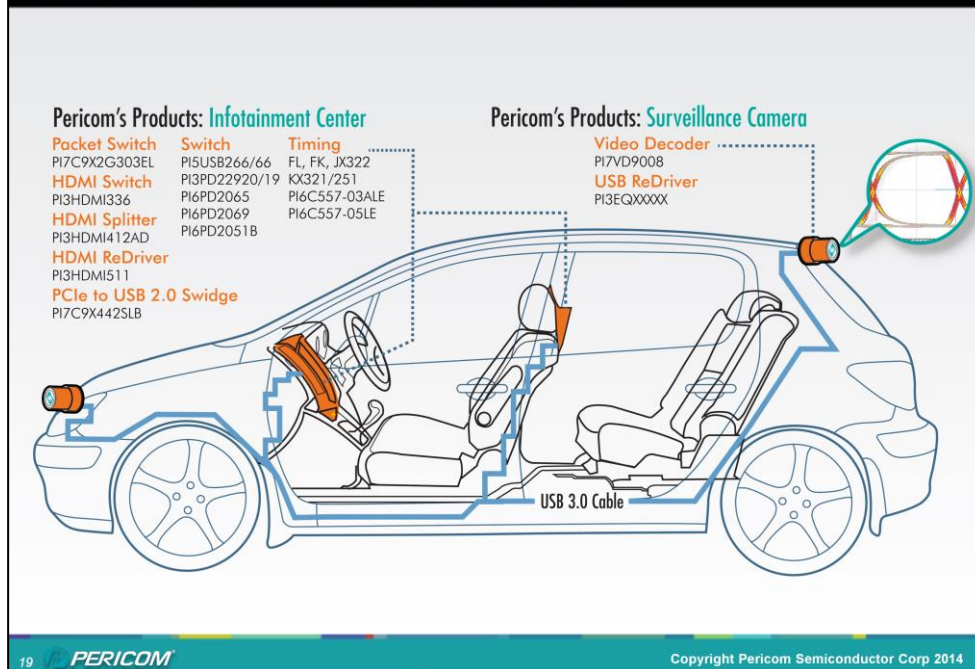
Automotive Infotainment systems are using USB3 to connect AV systems together inside the cabin.

Here is an example of not only USB3 ReDriver for automotive application, but also the many other Pericom products that are being used in Automotive applications.
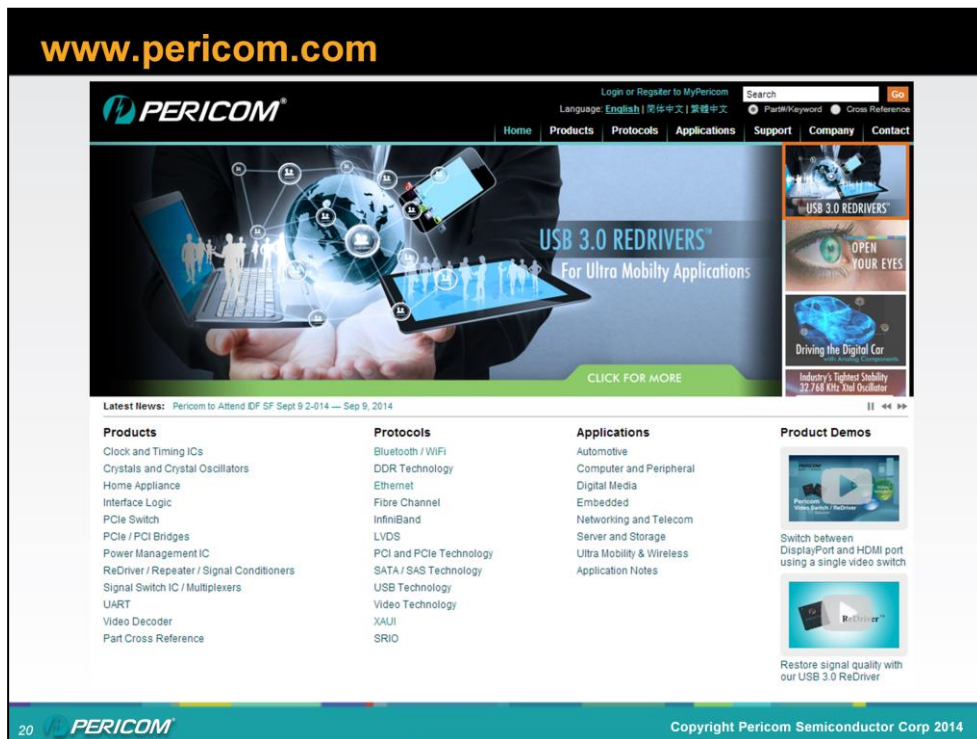
To learn more, please visit the Pericom website at www.pericom.com.

You will find a very user friendly website that shows Pericom products by application, market segment, protocol, and product function, as well as a good search engine.

You can find more info on PCIe and USB3 ReDriver products, download apps notes, white papers, articles, and other product information.

Market Segments

On the Pericom website of particular interest, is the section on Applications, where you will find Pericom products that focus on key market segments, including PCIe and USB3 ReDrivers.
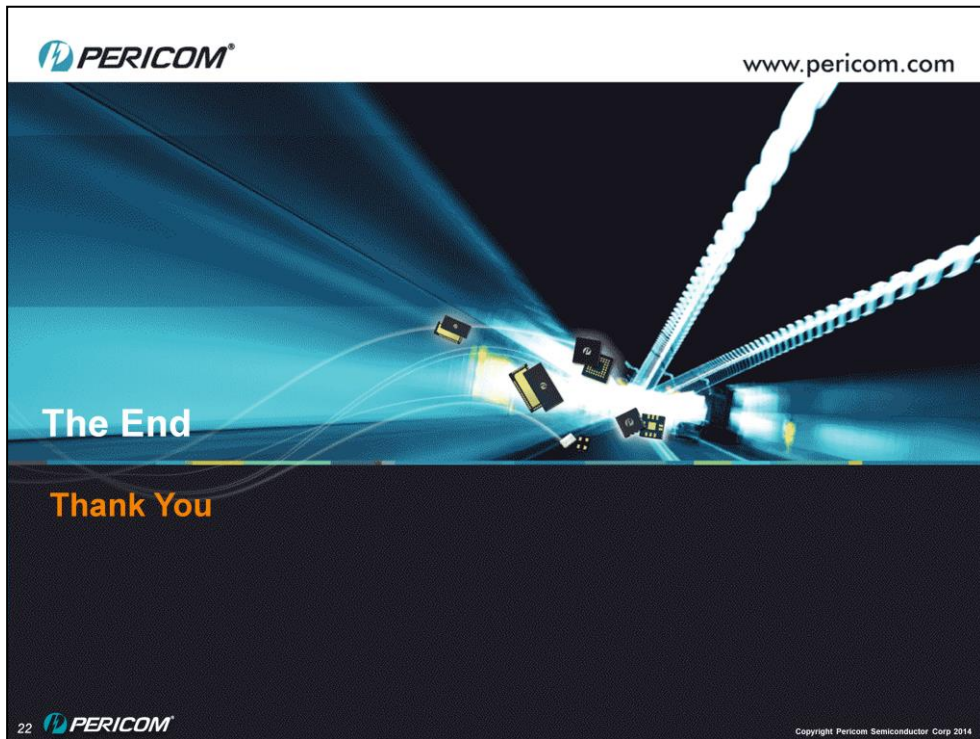
Thank you for taking the time to learn more about Pericom's 'best in class' ReDriver/Repeater products, and also a brief look at the many other Timing, Switching, and Connectivity product families offered by Pericom. Combined with our strong world wide technical support, leading product performance and customer service, we bring key advantages to our customers and work with them closely.

Our mission is to 'Enable Serial Connectivity' and allow designers to bring out the best performance in their platforms.