What Is a Signal Conditioner?

TI Precision Labs - Signal Conditioning

Prepared by Mike Campbell
Presented by Nicholaus Malone
High-speed, multi-gigabit standards

The higher the speed, the more prone to signal integrity degradation.
Multi-gigabit signal integrity challenges

- **Insertion loss**
- **Crosstalk**
- **Inter-symbol interference**
- **Noise**
- **Incoming signal**
- **TX signal**
- **Reflection**
- **Jitter**

Signal integrity degradation

6G

8G

8.1G

10G/20G
Signal conditioners come to the rescue

**PURPOSE**
A signal conditioner, in the form of a redriver or retimer, is used to correct signal integrity issues that produce less than desired bit error rate (BER).

**USE CASES**
- Extending a device’s operating range to meet system form-factor requirements
  - Example: Increase trace from 4-inches to 8-inches
- Correct a device’s short-comings
  - Example: ASIC TX has higher than allowed random jitter
Example: Extending a device’s operating range

USB host

Connector

4 inches

USB host

Connector

8 inches

USB host

Signal conditioner

Connector

8 inches
System jitter & causes

- **Total jitter**
  - **Deterministic jitter** (DJ)
  - **Random jitter** (RJ)

**Deterministic jitter** (DJ)
- **Data-dependent jitter** (DDJ)
  - Cause: Freq dependent attenuation, signal reflection
- **Inter-symbol interference** (ISI)
  - Cause: Freq dependent attenuation, signal reflection
- **Duty cycle distortion** (DCD)
  - Cause: TX rise/fall time mismatch

**Random jitter** (RJ)
- **Periodic jitter** (PJ)
  - Cause: External noise, like from DC/DC regulators
- **Unbounded Gaussian Distribution**
  - Cause: Thermal noise
What are redrivers & retimers?

**What is a redriver?**
Analog component to restore an attenuated input signal through equalization and gain adjustment, and re-transmit the signal based on signal specification.

**What is a retimer?**
A mixed-signal component to recover an attenuated input signal with a clock data recovery circuit, attenuate the phase and filter the random jitter, and then retransmit the signal based on a “clean” clock.
Why redrivers & retimers?

- Maintain signal integrity
- Improve signal quality over long trace or cable
- Enable design flexibility
- Improve system performance
- Enable broad range of interoperability
- Help system pass compliance
- Extend signal distances across cable or trace runs
Jitter each signal conditioner can address

Total jitter

Deterministic jitter

Data-dependent jitter (DDJ)

Cause: external noise such from DC/DC regulators

Bounded uncorrelated

Cause: Crosstalk

Inter-symbol interference (ISI)

Cause: Freq dependent attenuation, signal reflection

Duty cycle distortion (DCD)

Cause: TX rise/fall time mismatch

Periodic jitter (PJ)

Random jitter

RETIMER

REDRIVER
Short quiz

• True or False: Random jitter can be eliminated by using a signal conditioner such as a retimer.  **FALSE**

• True or False: One purpose of a signal conditioner is to correct a particular component’s short-comings.  **TRUE**

• True or False: A redriver can fix random and ISI issues in a system.  **FALSE**

• True or False: A retimer can compensate for both random and deterministic jitter and provide a jitter free signal at its output.  **FALSE**
Thank you

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