All-Silicon Frequency Sources for Ethernet

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Overview

- Timing considerations for Ethernet
- Timing references and requirements for Ethernet
- All-silicon frequency sources for Ethernet
- Summary
Timing is critical in Ethernet

- Eye-opening template for a Gb Ethernet TX
- Eye-closure originates from several sources, but timing quality is one of the main determinants of link performance
Frequency multiplication & eye-closure

- Fundamental-mode BAW XTAL reference oscillators exhibit low phase noise, but support frequencies up to only ~50MHz; a PLL is required.

- The channel-rate PLL multiplies frequency by $N$ and noise by $N^2$.

- Outside the PLL loop BW, the VCO is tracked.

$$\text{Phase noise PSD (dBc/Hz)} = +10\log_{10}(N^2)$$

Additional details and graphical representation.
- Low loop multiplication, $N$, is desired to reduce accumulated noise and prevent eye-closure.
- To maintain low $N$, each new generation of Ethernet requires a reference at a higher frequency.
Timing references for Ethernet

10/100 Ethernet PHY

25MHz XTAL Resonator

1G Ethernet PHY

125MHz XO+LC-PLL Module

10G Ethernet PHY

155-644MHz XO+LC-PLL Module

XTAL Resonator

XO+LC-PLL Module
Key Ethernet timing requirements

<table>
<thead>
<tr>
<th>Ethernet Rate</th>
<th>Accuracy (ppm)</th>
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<tbody>
<tr>
<td>10/100M</td>
<td>100</td>
</tr>
<tr>
<td>1G</td>
<td>100</td>
</tr>
<tr>
<td>10G</td>
<td>50</td>
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- Eye diagram assumes the presence of only high-frequency jitter components that are not tracked by the clock recovery circuitry.
- Integrated phase jitter is typically measured from 637kHz to 20M.
All-silicon frequency sources for Ethernet

- A frequency-trimmed and temperature-compensated, 3GHz self-referenced LCO
- <2mA unloaded active power with 1.8, 2.5 or 3.3V $V_{DD}$
- Programmable output frequency from 4–150MHz
- Programmable drivers: CMOS, LVPECL, LVDS, HCSL
- Currently meets specification for HS- and SS-USB, S-ATA, PCIe (qualified at ±250ppm)
All-silicon frequency sources for Ethernet

Close-to-carrier phase noise is higher than XO+LC-PLL modules, but not relevant to Ethernet.

- 637k to 20MHz
- 125MHz
- 457fs
All-silicon frequency sources for Ethernet

- ±50ppm frequency error has been demonstrated and samples are available
- Current production is qualified at ±250ppm
- ±100ppm devices available Q3’10
- ±50ppm devices available Q4’10
All-silicon component frequency source

- Silicon oscillators can replace XOs and XO+LC-PLL modules in Ethernet applications
- The device provides a low-power, programmable, high-frequency source w/o a PLL
- Packages are pin-compatible with standard XOs and XO-PLL modules (5x3.2mm pkg shown)

Mobius was acquired by IDT so these packages will be inked IDT soon!
All-silicon die frequency source

- Die can be integrated into MCP or MCM or can be assembled as CoB
- Post-processed Faraday shield prevents frequency shift from packaging and environmental effects
- Die can be used in place of resonators or XOs
- <2mA unloaded power dissipation
- Higher frequencies will be supported in future devices
Summary

- Timing is critical to Ethernet link performance
- Each new generation of Ethernet requires a higher frequency reference, but fundamental-mode BAW XTALS are limited to ~50MHz
- Silicon oscillators are low-power, programmable and high-frequency references that can meet the timing specs for current & future generations of Ethernet
- Silicon oscillators can replace XO+LC-PLL modules as a component
- Silicon oscillators can replace resonators as a die
Thank you
Questions are welcome