Complementary Transmitter and Receiver Jitter Test Methodology

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Overview

- During Beijing meeting CL83D jitter tolerance was change from inverse of transmitter tracking to only 2 points
  - This unfortunate change may result in interoperability issues
- Overview of FC-MJS jitter methodology
- Allocating jitter burden from the transmitter to the receiver through Golden PLL jitter tracking
- Decoupling of receiver stress sensitivity and receiver jitter tolerance

Fundamental Issue

802.3aq (LRM) receiver jitter tolerance introduced an inconsistent set of specifications by separating stress receiver testing and transmitter jitter tracking

- Transmitter jitter relief through MJS Golden PLL was maintained
  - Compliant transmitters may have low frequency jitter present, but not observed due to by the Golden PLL tracking effect
- Receivers currently tested at two spot frequencies without additional stress
- Full stress with the addition of SJ can result in broken links that is not observed with stress and SJ imposed in independent tests
- Testing the receiver at only two discrete frequencies may not guarantee the receiver can actually tolerate transmitters with jitter tracked “masked” out by the Golden PLL
- Transmitter tracked “masked” jitter actually propagates through the link and could break CAUI-4 host receiver!

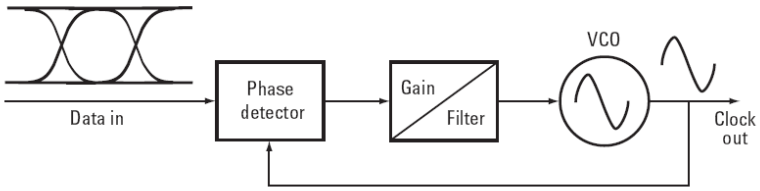
Receiver test should complement transmitter test

Reliable link operation requires that the receiver test complements transmitter test. The receiver test should be extended to include SJ as allowed in the current transmitter spec. Alternatively, the transmitter test could be more stringent, but it is not practical to force the transmitter to produce low or no jitter over regions where the receiver is not tested

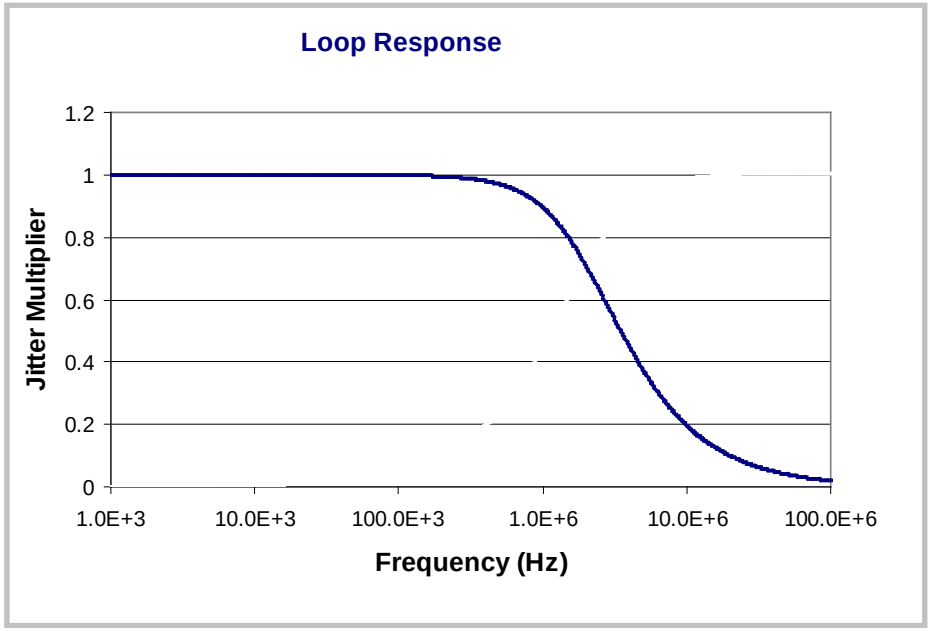
PLL concepts: PLL jitter transfer indicates how *recovered clock* (jitter out) tracks the data (jitter in)

The response of the PLL is generally a low-pass function, sometimes referred to as the jitter transfer response or JTF

$$\text{Closed loop gain} = \frac{\phi_{out}}{\phi_{in}} = \frac{A(s)}{1 + A(s)} = G(s) = |G(s)|e^{j\phi(s)}$$

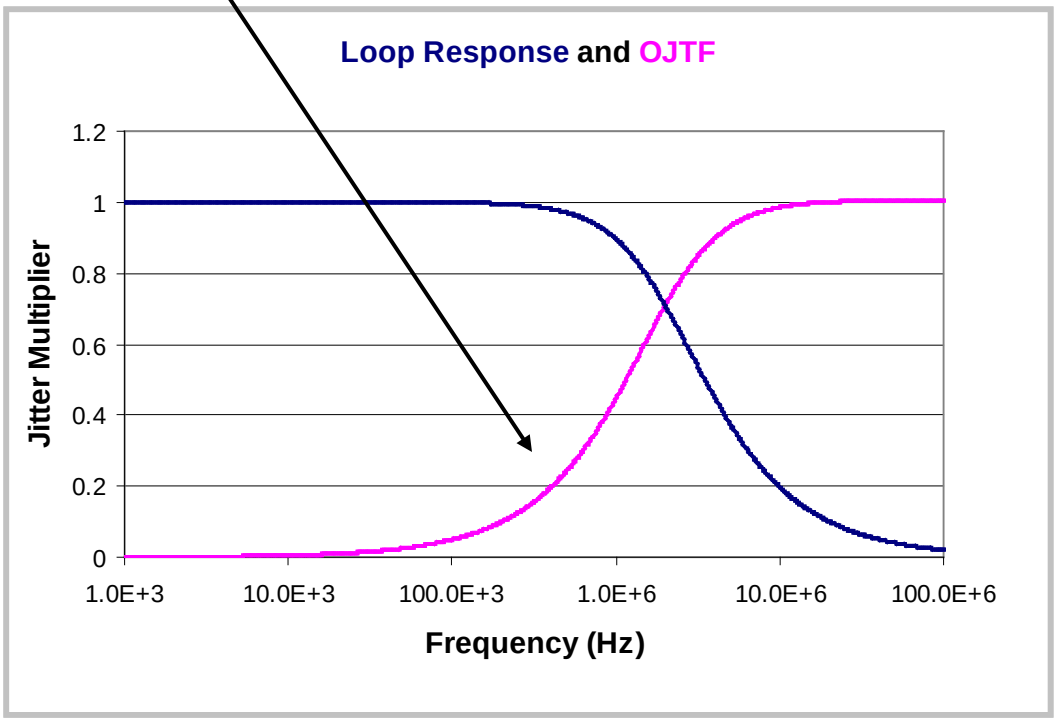


Low frequency jitter is transferred to the clock, high frequency jitter is not



The observed jitter transfer function (OJTF, the jitter that is observed by a receiver, or on the instrument clocked/triggered by the recovered clock)

$$\mathrm{OJTF} = 1 - G(s) = 1 - |G(s)| e^{j\phi(s)}$$



The observed jitter is a complement to the PLL jitter transfer response

OJTF=1-JTF (Phase matters!)

As the jitter on the recovered clock trigger rolls off, common mode effect is reduced

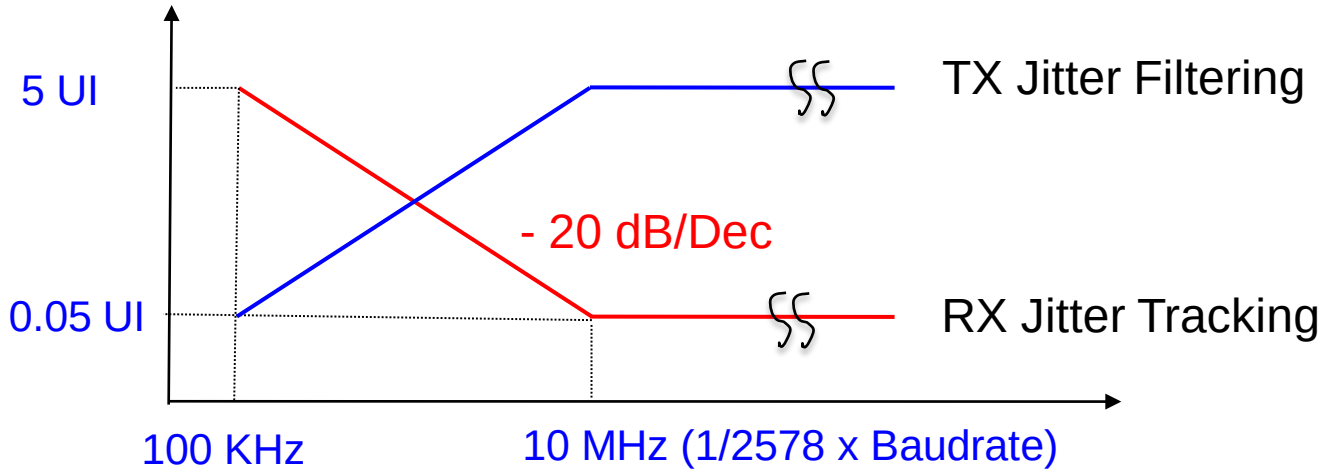
As jitter frequency gets large, eventually there is no jitter on the recovered clock and all the higher frequency jitter on the data stream is observed

Comprehensive Jitter Methodology

A comprehensive methodology to test transmitters and receivers for jitter was developed during 1 GFC standardization in the FC-MJS project and has become the basis for data communications system specification

This methodology was based on systems using low cost oscillators and a reduction in power supply filtering to enable low-cost high-volume applications

- Transmitter test assumes low frequency jitter should be tracked by a receiver, thus transmitter specs are relaxed by observing the transmitter using a reference PLL with OJTF defined as a high pass single pole filter with -20 dB/dec rolloff and -3dB corner frequency at 1/1667 Baudrate (changed to 1/2578*baudrate since 10 GbE)
- Receiver test should complement transmitter test by verifying low frequency jitter is tolerated.



Receiver Must Tolerate all Jitter Components Propagating Down the Link

Testing at just two frequencies is not an option if there is potential interoperability issues!