LMK1C110x Key Performance in System Level

When designing clock trees, clock buffers are a cost-effective method for copying and distributing multiple copies of a frequency. Key performance parameters for system designers to consider are propagation delay, skew between buffer outputs, and additive jitter performance.

The TI LMK1C110x device family are high-performance LVCMOS fanout buffers touting low output skew, low additive jitter, and wide operating temperature range while maintaining compatibility with the industry standard TSSOP footprint. The LMK1C1102, LMK1C1103, and LMK1C1104 device family currently supports 2, 3, and 4 output versions. This performance enables system-level benefits that are further discussed in this report.

Low Additive Jitter

The LMK1C110x device offers ultra-low additive jitter performance with only 8 fs, RMS typical (25 fs, RMS maximum) for a 156.25-MHz input when operating from a 3.3-V supply. The low noise floor enables the LMK1C110x to exceed the phase noise requirements for a diverse array of applications, including but not limited to communications, enterprise computing, medical, and industrial.

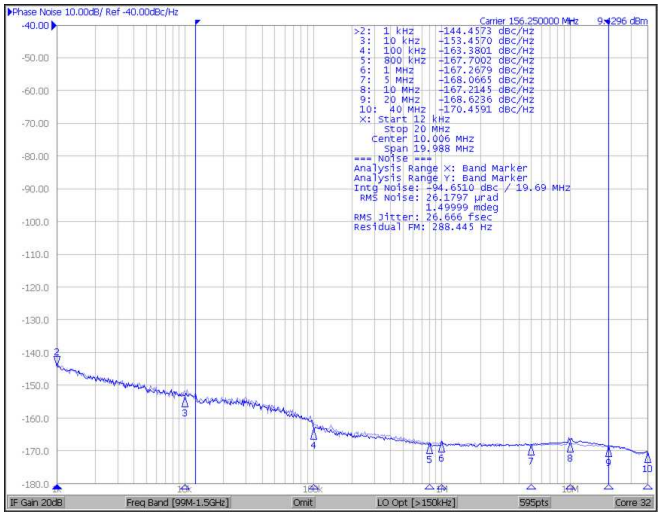

Figure 1. 7.57 fs, RMS Additive Jitter 3.3-V Supply, Room Temperature

The output driver impedance of 50 Ω (typical) optimizes signal integrity when driving matching 50-Ω impedance controlled traces.

The random additive jitter measured by a phase noise analyzer has measurement units of fs, RMS. This can be converted to fs, peak-to-peak based on a target BER for qualifying a serial link.

There is a direct relationship between RMS random additive jitter, RJ_{RMS}, and peak-to-peak random additive jitter, RJ_{PP}. Given target link budget and the BER requirement, RJ_{PP} can be determined using Equation 1 and Equation 2. Due to the convergence of the complementary error function, a larger coefficient n corresponds to a reduction in BER. Low additive jitter consumes less of the link budget for a given BER requirement.

$$RJ_{PP} = n \times RJ_{RMS} \quad (1)$$

$$BER = \frac{1}{2}\text{erfc}\left(\frac{n}{2 \times \sqrt{2}}\right) \quad (2)$$

Table 1. BER Multipliers

BER	n
10^{-3}	6.582
10^{-4}	7.782
10^{-5}	8.834
10^{-6}	9.784
10^{-7}	10.654
10^{-8}	11.462
10^{-9}	12.218
10^{-10}	12.934
10^{-11}	13.614
10^{-12}	14.260
10^{-13}	14.882
10^{-14}	15.478
10^{-15}	16.028

Power Reduction

The LMK1C110x device operates from a single 3.3-, 2.5-, 1.8-V supply. Operation at 1.8 V enables lower power consumption with a minor increase in additive jitter compared to 3.3 V.

Additionally, LMK1C110x clock outputs can be synchronously enabled or disabled using the output enable feature. By driving the 1G pin with an MCU GPIO, the LMK1C110x device can be powered down when not needed for power savings.

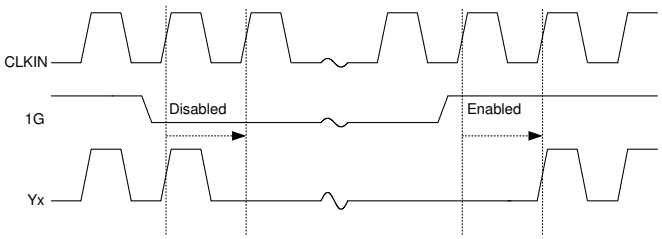

Figure 2. Synchronous Output Enable

Low Output Skew

It is important that reference clocks are well synchronized to each other in communications and networking systems. Clock buffers are used in time-critical systems to distribute a common system reference clock with low output skew.

When using several XOs, there is a non-zero ppm frequency error between XO clocks. XO and XTAL data sheets will specify a frequency tolerance, or frequency stability in ppm, or both. Frequency mismatch can cause systemic issues because the rising edges will not be synchronized which inevitably results in a situation where the device clocked by the faster XO (higher ppm error) becomes one full clock cycle ahead of a slower XO. When distributing an XO output using a fanout buffer, each output frequency exactly equals the input. The LMK1C110x device enables clock synchronization with a maximum output skew of 50 ps.

Higher Operating Temperatures

The LMK1C110x device supports a wide ambient operating temperature range of –40°C to 125°C. The extended operating range is a benefit to system designers who anticipate high ambient temperatures.

For example, the ambient temperature of enterprise systems can exceed 90°C. Fans are typically included inside enterprise machines to cool the system to a safe operating temperature. Many designers prefer using devices rated for the anticipated operating conditions to avoid using fans, or other temperature regulation solutions, which increase the development cost of the system.

Enhanced ESD

The LMK1C110x device includes integrated ESD protection that is rated to ±6-kV HBM, ±1.5-kV CDM. The robust ESD ratings are best in class and reduce the concern of device failure due to an electrical overstress (EOS) event.

Summary

The performance of the LMK1C110x device offers several benefits to various systems such as reduced power consumption, increased link budget, extended operating temperature range, and synchronization.

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (December 2020) to A Revision	Page
• This tech note now supports 2, 3, and 4 output versions. Globally changed device name to LMK1C110x from LMK1C1104. Added the LMK1C1102 and LMK1C1103 devices to the tech note.	1

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