Timing References for 5G Small Cells

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Table of Contents

Introduction

The introduction of 5G challenged many component manufacturers who serve the telecom industry. Timing and Synchronization is certainly one of them. Implementing features such as beam steering and millimeter wave communication called for much more accurate timing solutions. These solutions would also have to be robust given the varying environmental condition where the small cells would be installed.

General 5G Architecture

As the industry shifts towards a more complex Radio Access Network (RAN), it is expected to see more of a cohesive and standardized approach to its implementation. The Open RAN architecture (O-RAN) is on the forefront of this initiative.

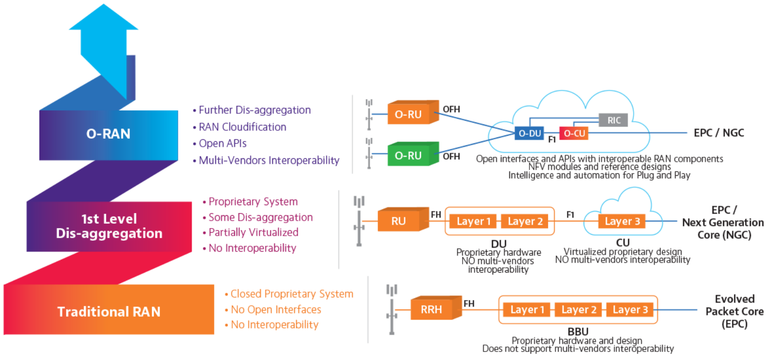

Figure 1: The general architecture of the radio access networks

Within O-RAN, the remote radio unit (RRU) serves as the access point to the network. A user will connect to the RRU, the data will reach a front haul switch, and then proceed to an edge server or distributed unit (DU). The DU will then pass information to the central unit. Synchronization between these stages is critical for 4G, but even more critical for new 5G applications. This is accomplished using a synchronization method governed by a Precision Clock Synchronization Protocol called IEEE 1588.

IEEE 1588 provides precise synchronization of clocks in a packet-based network system and is the backbone of 5G synchronization. IEEE 1588 is a Precision Timing Protocol (PTP) that enables heterogeneous systems of which include clocks of various inherent precision, resolution, and stability that synchronizes to a grandmaster clock. The protocol supports system-wide synchronization accuracy in the sub-microsecond range with minimal network and local clock computing resources.

The PTP can react to clocking disruptions on the network, like losing a master clock. Within the standard is a ranking algorithm that chooses the highest-ranking timing packet when a synchronization error is invoked in the network. This warrants special attention to the reference oscillators employed at each stage of the network.

Small Cell Remote Radio Unit Densification

One of the most challenging aspects of 5G's implementation will be the numerous RRUs that are needed to compete with the current 4G coverage. The plethora of RRUs is necessary for the easily obstructable millimeter waves. These units will be installed at light posts, roadways, intersections, roof tops, etc. This densification of RRUs lends itself to varying environmental conditions that may have not been a concern before and may pose a threat to the stringent timing requirements of 5G.

Abracon's Solution

Abracon meets these requirements by supporting the release of Qualcomm's Open RAN Platform for Small Cells, denoted as FSM100xx and FSM200xx, with the introduction of the AST3TDA-0000-T5. The AST3TDA-0000-T5 is a 38.400MHz temperature compensated voltage controlled crystal oscillator (TCVCXO) and has been specifically designed for this platform and guarantees exceptional performance under the varied conditions seen by RRUs.

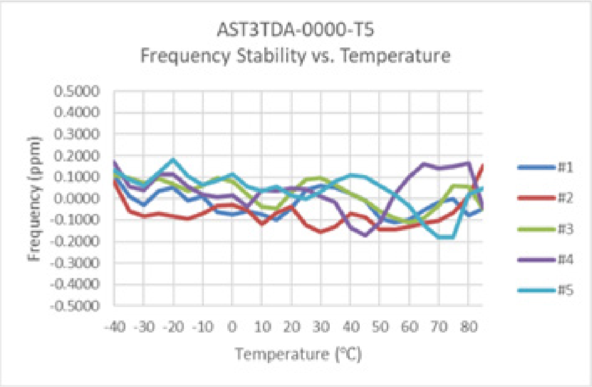

Figure 2: Frequency Stability vs. Temperature of the AST3TDA-0000-T5

The AST3TDA-0000-T5 has a tight frequency stability with a typical performance of ±200ppb and a maximum limit of ±280ppb for the wide array of operating temperatures ranges that the RRUs are expected to face.

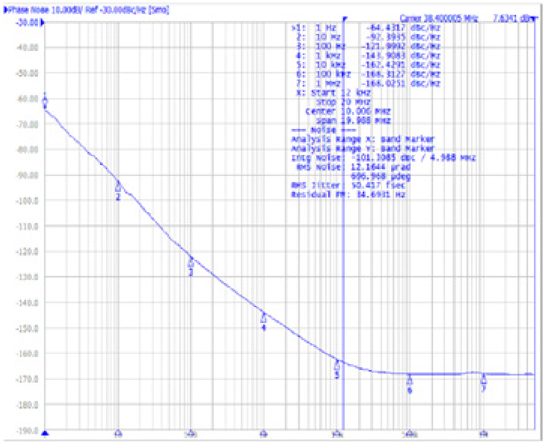

Figure 3: Phase Noise of AST3TDA-0000-T5 @ 25°C

The phase noise performance of the TCVCXO is well suited for the Small Cell Platform as its worst case rms phase jitter is specified at 100fs where the typical performance is 50fs, easily supporting the IEEE 1588 PTP.

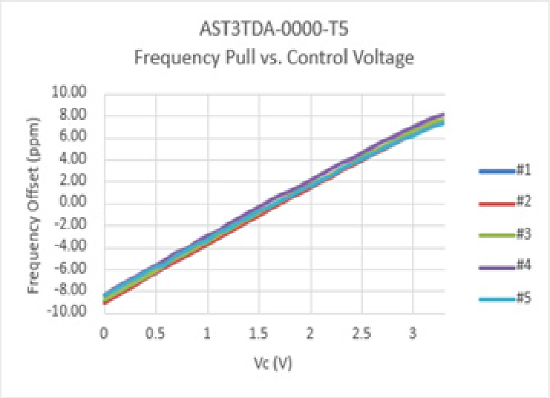

Figure 4: Frequency Pull vs. Control Voltage of the AST3TDA-0000-T5

It is crucial that the frequency pull is monotonic ensuring a reliable frequency lock within the Small Cell Platform and the AST3TDA-0000-T5 does just that. The frequency pull rage typically performs at ±7ppm and is specified at ±5ppm minimum.

Conclusion

In an effort to minimize synchronization misalignment and maintain a consistent reference across the 5G infrastructure, putting focus on the timing and synchronization aspects of the architecture will be well rewarded. Each stage of the architecture needs some resilience with respect to unpredictable environmental conditions and network failures. The most vulnerable failure points of the network are the RRUs while also being the most sought-after component to add for 5G. Abracon helps ensure that the stringent timing requirements of 5G are met with the introduction of the AST3TDA-0000-T5 at the RRUs.

References

(1) Picture courtesy VIAVI solutions. “ORAN explained.” 5G Networks, 23 November 2020, https://www.5g-networks.net/5g-technology/openran-o-ran-for-5g-explained/

(2) Institute of Electrical and Electronics Engineers, Inc. (2011, December) APA Citation. I*EEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.* Retrived from https://standards.ieee.org/ieee/1588/4355/

(3) *Abracon AST3TDA Datasheet.* Retrived from https://abracon.com/datasheets/AST3TDA.pdf