Specifying Oscillator Holdover for Data Centers
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Agenda

1. Motivation
2. Test parameters
3. Test method
4. Call to action
OCP-TAP Simplifying Oscillator Selection

Problem
• Difficult to understand holdover performance from oscillator datasheet
• Difficult to select oscillator for a use case

Goal
• Enable transparent, apples-to-apples comparison of oscillator holdover

Proposed Solution
• Specify max time error at holdover time, $\tau_h$
• Specify a holdover test methodology
OCP-TAP Specifies Test Parameters
Use Case Dependent

• Holdover time, $\tau_h$
• Thermal profile – target starting temperature(s), ramp rate, soak time
• Operating ambient-temperature range
• Ambient temperature to measure aging
• Ambient temperature to measure frequency versus time trend
• Acceptable probability of error, $P_E$, required by system
• Training time before entering holdover, $\tau_{Training}$
• Sample-unit population, N, and distribution
  o For example: 10 random units from each of 3 lots, each with a different process and assembly
• Trial population, M, to capture random variations per unit
• Whether the system compensates for aging
OCP-TAP Specifies Test Method
Use Case Independent

Measure
• Frequency stability over the specified operating ambient temperature range
• Frequency versus time at the specified ambient temperature

Compute
• Extract daily aging, thermal drift and wander from measured data
• Max time error $E_{\text{max}}(\tau_h)$ up to holdover time $\tau_h$ and derived from Gaussian distributions for
  o Aging – $m_a(\tau_h), \sigma_a(\tau_h)$
  o Thermal drift – $m_T(\tau_h), \sigma_T(\tau_h)$
  o Wander – $m_w(\tau_h), \sigma_w(\tau_h)$

Report
• $E_{\text{max}}(\tau_h)$
• Vendor-specific test conditions and restrictions needed to reproduce results
Model Contributions to Time Error

**POPULATION**

- **Aging**
  - N units

- **Thermal Drift**
  - N units

- **Wander**
  - N units × M trials/unit

**TIME ERROR HISTOGRAM**

- \( \sigma_a(\tau_h) \)

- \( \sigma_T(\tau_h) \)

- \( \sigma_o(\tau_h) \)

**TOTAL TIME ERROR**

- \( m_{max}(\tau_h) = m_a(\tau_h) + m_T(\tau_h) + m_w(\tau_h) \)

- \( \sigma^2_{max}(\tau_h) = \sigma^2_a(\tau_h) + \sigma^2_T(\tau_h) + \sigma^2_w(\tau_h) \)

**Total Distribution of Time Error at \( \tau_h \)**

- \( m_{max}(\tau_h) \)

- \( \sigma_{max}(\tau_h) \)
Compute Max Time Error

\[ E_{\text{max}}(\tau_h) = m_{\text{max}}(\tau_h) + Q_x(P_E)\sigma_{\text{max}}(\tau_h) \]

Interpretation
- All units shipped will not exceed \( E_{\text{max}}(\tau_h) \) up to holdover time \( \tau_h \) with at most probability of error \( P_E \)

\[ Q \text{ converts RMS to Peak for a specified error rate, } P_E \]

\[ |m_{\text{max}}| \gg 0 \quad m_{\text{max}} \approx 0 \]

2 Possibilities

1-Sided
- \( x = 1 \)

2-Sided
- \( x = 2 \)

<table>
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<th>1-( P_E )</th>
<th>( Q_1(P_E)/\sigma(\tau_h) )</th>
<th>( Q_2(P_E)/\sigma(\tau_h) )</th>
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OCP-TAP Welcomes Your Feedback

• Participate in weekly OCP-TAP Oscillator Workstream
  o Contact Gary Giust (email in Wiki page below)
  o Nov 17, OCP-TAP Main Meeting will review Oscillator Workstream work

• View recordings of Oscillator Workstream meetings on Wiki page
  o https://www.opencompute.org/wiki/Time_Appliances_Project

• Subscribe to OCP-TAP mailing list
  o https://ocp-all.groups.io/g/OCP-TAP

• “Open Time Server” Github page
  o https://github.com/opencomputeproject/Time-Appliance-Project/tree/master/Open-Time-Server
Thank you!