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Specifying Holdover for OCP-TAP Oscillator Classes in Data Centers

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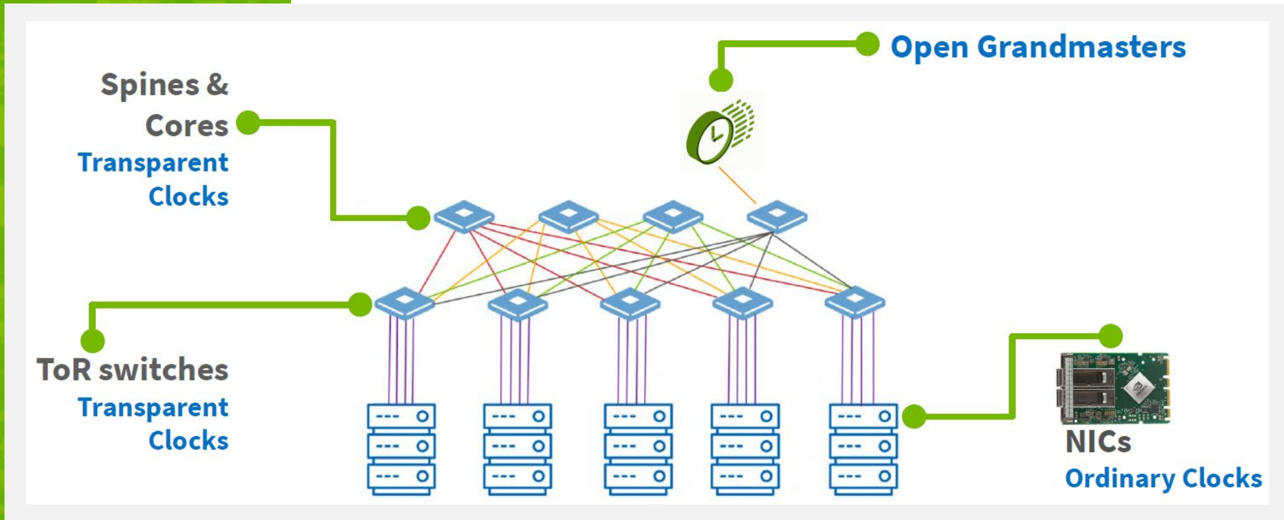
Agenda

1. Motivation
2. Test parameters – use case dependent
3. Test method – use case independent
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, τ_h
- Specify a holdover test methodology

OCP-TAP Specifies Test Parameters

Use Case Dependent

TIME APPLIANCES

- Holdover time, τ_h
- Thermal profile – target starting temperature, 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
  - 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

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OCP-TAP Specifies Test Method

Use Case Independent

TIME APPLIANCES

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 $E_{max}(\tau_h)$ up to holdover time τ_h and derived from Gaussian distributions for
    - *Aging* – $m_a(\tau_h), \sigma_a(\tau_h)$
    - *Thermal drift* – $m_T(\tau_h), \sigma_T(\tau_h)$
    - *Wander* – $m_w(\tau_h), \sigma_w(\tau_h)$

Report

- $E_{max}(\tau_h)$
- Vendor-specific test conditions and restrictions needed to reproduce results

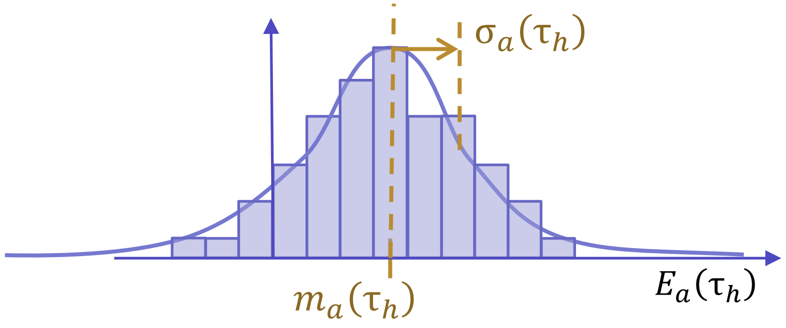
Model Contributions to Time Error

TIME APPLIANCES

POPULATION | TIME ERROR HISTOGRAM | TOTAL TIME ERROR

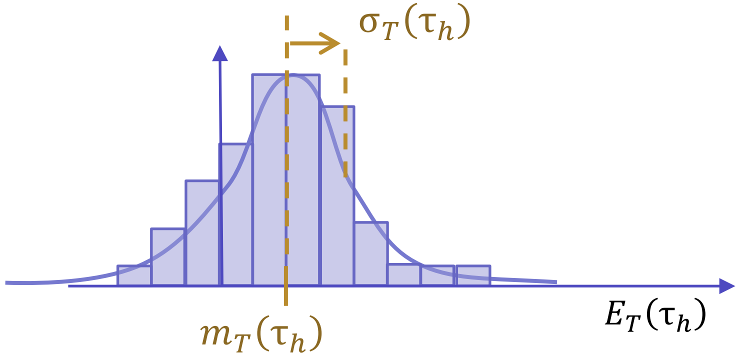
Aging

N units



Thermal Drift

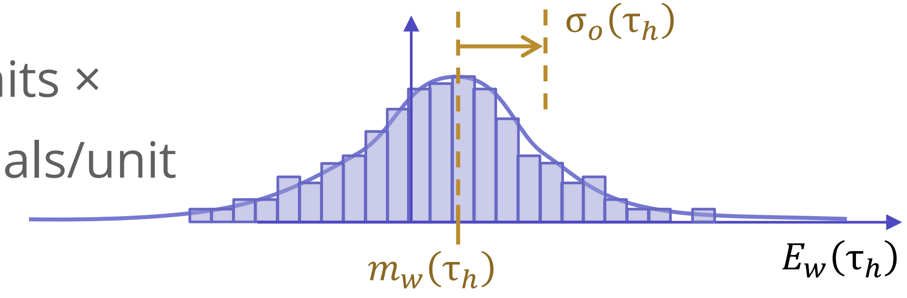
N units



Wander

N units ×

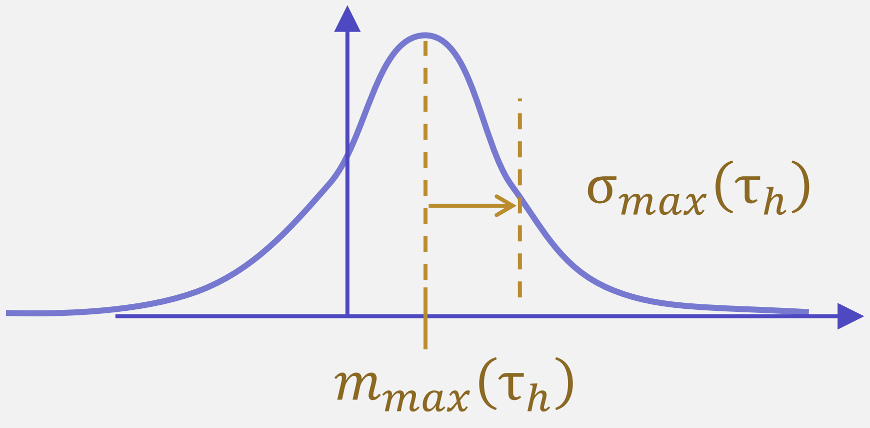
M trials/unit



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

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

Total Distribution of Time Error at τ_h



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Compute Max Time Error

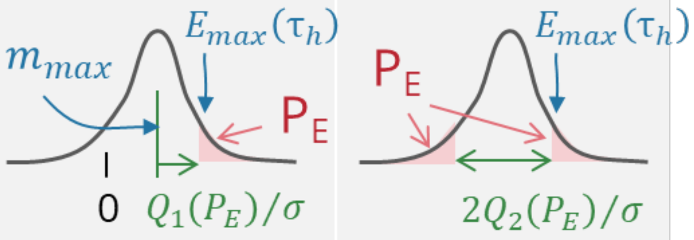
TIME APPLIANCES

$$E_{max}(\tau_h) = m_{max}(\tau_h) + Q_x(P_E)\sigma_{max}(\tau_h)$$

Q converts RMS to Peak for a specified error rate, P_E

<u>2 Possibilities</u>

$\lvert m_{max}\rvert \gg 0$	$m_{max} \cong 0$
1-Sided	2-Sided
$x = 1$	$x = 2$



1-P_E	$Q_1(P_E)/\sigma(\tau_h)$	$Q_2(P_E)/\sigma(\tau_h)$
0.682689	0.475	1.000
0.954499	1.690	2.000
0.997300	2.782	3.000
0.999002	3.091	3.291
0.999900	3.720	3.891
0.999937	3.833	4.000
0.9999990	4.754	4.892
0.9999994	4.865	5.000

Interpretation

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

OCP-TAP Welcomes Your Feedback

- Participate in weekly OCP-TAP Oscillator Workstream
  - Contact Gary Giust (email in Wiki page below)
  - Nov 17, OCP-TAP Main Meeting will review Oscillator Workstream work
- View recordings of Oscillator Workstream meetings on Wiki page
  - https://www.opencompute.org/wiki/Time_Appliances_Project
- Subscribe to OCP-TAP mailing list
  - https://ocp-all.groups.io/g/OCP-TAP
- "Open Time Server" Github page
  - https://github.com/opencomputeproject/Time-Appliance-Project/tree/master/Open-Time-Server

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Thank you!