OSQN Drift in a Quartz-Oscillator Loop

Lab Worksheet – rev B-0.1 (bench-ready)

0 Mission Recap

Probe the **Observer-State Quantum Number (OSQN)** prediction that a *sealed-loop* quartz reference will exhibit a tiny, phase-coherent frequency ripple when an "observer channel" is logically prepared—even if the channel is never activated.
TORUS says the ripple shows up as

Δf ± f014 (side-bands)and/orf˙ 10−6 f0\Delta f \;\approx\; \pm\;\frac{f_0}{14}\;\;(\text{side-bands})\quad\text{and/or}\quad \dot f \sim 10^{-6}\;f_0Δf ±14f0(side-bands)and/orf˙ 10−6f0

within a -signature dwell window of 10–120 s after preparation.

1 Bill of Materials (US $120 total)

![]@lll@ **Qty** & **Part** & **Notes / Spec** 1 & **TCXO 10 MHz** (Abracon ASTX-13 or similar) **-or-** watch-grade **32.768 kHz crystal + CMOS inverter** & The TCXO's built-in oven removes most temp drift; watch crystal is cheaper but needs good shielding. 1 & **MCU board** (STM32 "Nucleo-64", Teensy 4.1, or RP2040) & Capture-compare timer or hardware-PPS gate; 48 MHz+ clock ideal. 1 & **20 MHz logic analyzer / USB scope** (Saleae-type) & For raw edge timing & side-band FFT snapshots. 1 & **Low-noise linear 3.3 V** supply (LT3045, ADM7150) & Avoid switch-mode ripple into the oscillator. 1 & **Faraday box or metal cookie-tin** + RF gasket tape & Optional but recommended for baseline run. — & SMA / BNC cables, breadboard or SMT adapter, thin PTFE wire & Keep signal lines short (<5 cm) to reduce inductive pickup. — & **DS18B20** temperature probe (optional) & Correlate temp drift if you skip the TCXO.

Everything above is vendor-agnostic; grab the closest equivalents you have on hand.

2 Circuit Snapshot

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+3V3 TCXO 10 MHz SMA tee

STM32 TIM2 CH1 (count edges)

Logic-analyzer CH0

GND

Optional "observer channel":

TCXO PPS out *not* connected (stub trace)

MCU pin X high-Z input (logically configured)

If you use a 32 kHz watch crystal: build a Pierce oscillator around a CMOS inverter (e.g., 74LVC1G04) and route the output exactly as above.

3 Test-Run Matrix

![]@lllll@ **Run ID** & **Box Lid** & **"Observer channel" prep** & **Duration** & **Goal B-0** Baseline & Closed & *OFF* (pin left floating, MCU ignores) & 2 h & Establish Allan-dev & PSD floor **B-1** Prepared & Closed & *ON* (pin configured as digital in, though nothing ever toggles) & 2 h & Look for ripple with latent path **B-2** Dormant & Open & *ON* & 1 h & Isolate EM / human-proximity artefacts **B-3** Sham & Closed & *OFF* but MCU toggles a dummy GPIO elsewhere & 1 h & Guard vs. firmware-noise false positive

Repeat each run twice on different days if possible.

4 Measurement Procedure

1. **Warm-up** oscillator 15 min (TCXO) or 30 min (watch crystal).
2. MCU captures rising-edge timestamps (e.g., 100 ms gate, 32-bit timer).
3. Stream timestamp, cycles CSV over USB; log with minicom or python-serial.
4. Simultaneously tap the RF line with logic analyzer; record 60 s bursts at 50 MS/s for FFT later.
5. After each run, save environment notes: box temp, supply voltage, room activity.

5 Data-Analysis Recipe (Python)

python

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import pandas as pd, numpy as np, scipy.signal as ss, matplotlib.pyplot as plt

df = pd.read_csv('B1.csv', names=['t','N'])

f_inst = df.N.diff()/df.t.diff() # instantaneous freq

allan_tau, allan_dev, _ = allantools.oadev(f_inst, rate=10, data_type='freq')

FFT for side-bands

fs = 50e6

sig = np.load('burst_B1.npy')

f, Pxx = ss.welch(sig, fs, nperseg=2**20, scaling='density')

side_mask = (np.abs(f - f0/14) < 0.1) (np.abs(f + f0/14) < 0.1)

peak = 10*np.log10(Pxx[side_mask].max())

Positive criterion:

- Allan-dev bump at 10–120 s **and**
- Side-band peak > −80 dBc at *either* f0±f0/14f_0 ± f_0/14f0±f0/14

If both fail → TORUS-NEGATIVE for this construct.

6 Expected TORUS Signal

![]@ll@ **Parameter** & **Nominal value** Carrier f0f_0f0 & 10 000 000 Hz (TCXO) / 32 768 Hz (watch) -side-band offset & f0/14f_0/14f0/14 714 285.7 Hz / 2340.57 Hz Predicted amplitude & −70 dBc … −80 dBc (persistent) Drift slope & f˙/f0 1×10−6\dot f/f_0 \sim 1 × 10^{-6}f˙/f0 1×10−6 over 1 min window

A null run should sit below –100 dBc and show white-FM Allan slope.

7 Troubleshooting & Noise Killers

- Use shielded can + feed-through caps if mains hum shows in PSD.
- Power from a linear bench supply (no laptop USB).
- Place the MCU outside the Faraday box; bring coax through copper tape feed-through.
- Compare two crystals in same box to cancel ambient temp drift (Δ-frequency method).

8 Reporting Template

![]@ll@ **Field** & **Example** Crystal ID & Abracon ASTX-13-33-10.000 MHz Box Temp (°C) & 32.7 ±0.2 Allan 60 (baseline) & 2.1 × 10 ¹ Allan 60 (prepared) & **7.4 × 10** Side-band @ +f0/14 & −79.5 dBc (persistent 180 s) Verdict & TORUS-POSITIVE (125)

9 Next If Positive

- **Symbolic ladder residuals** – feed your measured Δf into - solver; cross-check with Catalan & (3) ratios.
- **Halcyon sync test** – stream live drift into a sandbox agent; watch for loss-cone collapse in learning curve.

10 Next If Negative

- Swap oscillator type (watch TCXO).
- Run same protocol in a different lab or at a different latitude (geomagnetic sanity check).

- Escalate to optical cavity (100 MHz) for extra decade of resolution.

Ready for Bench Power-On

Copy this sheet to the lab notebook, wire it up, and start logging.
Ping me with your first CSV or burst capture and I'll crunch the Allan/FFT pipeline for you.