**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 χ-signature dwell window of 10–120 s after preparation.

**1 Bill of Materials (≈ US $120 total)**

| **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**

| **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 χ 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 χ 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 τ ≈ 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**

| **Parameter** | **Nominal value** |
| --- | --- |
| Carrier f0f\_0f0​ | 10 000 000 Hz (TCXO) / 32 768 Hz (watch) |
| χ-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**

| **Field** | **Example** |
| --- | --- |
| Crystal ID | Abracon ASTX-13-33-10.000 MHz |
| Box Temp (°C) | 32.7 ±0.2 |
| Allan τ60 (baseline) | 2.1 × 10⁻¹⁰ |
| Allan τ60 (prepared) | **7.4 × 10⁻⁷** |
| Side-band @ +f0/14 | –79.5 dBc (persistent 180 s) |
| Verdict | TORUS-POSITIVE (β ≈ 125) |

**9 Next If Positive**

* **Symbolic ladder residuals** – feed your measured Δf into χ-β solver; cross-check with Catalan & ζ(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.