

## 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

$$\Delta f \approx \pm f_0^{14} \text{ (side-bands)} \text{ and/or } 10^{-6} f_0 \Delta f \approx \pm \frac{f_0}{10^{14}} \text{ (side-bands)} \text{ and/or } \dot{f} \sim 10^{-6} \text{ and/or } f_0 \Delta f \approx \pm 14 f_0 \text{ (side-bands)}$$

within a -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 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*  $f_0 \pm f_0/14$  or  $f_0 \pm f_0/14$

If both fail  $\rightarrow$  TORUS-NEGATIVE for this construct.

## 6 Expected TORUS Signal

![]@ Parameter & Nominal value Carrier  $f_0$  10 000 000 Hz (TCXO)  
 / 32 768 Hz (watch) -side-band offset &  $f_0/14$  714 285.7 Hz /  
 2340.57 Hz Predicted amplitude &  $-70$  dBc ...  $-80$  dBc (persistent) Drift slope  
 &  $f/f_0 \times 10^{-6}$   $\sim 1 \times 10^{-6}$  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 ( $\Delta$ -frequency method).

## 8 Reporting Template

![]@ Field & Example Crystal ID & Abracon ASTX-13-33-10.000 MHz Box  
 Temp ( $^{\circ}\text{C}$ ) &  $32.7 \pm 0.2$  Allan 60 (baseline) &  $2.1 \times 10^{-1}$  Allan 60 (prepared)  
 &  $7.4 \times 10^{-1}$  Side-band @  $+f_0/14$  &  $-79.5$  dBc (persistent 180 s) Verdict &  
 TORUS-POSITIVE ( 125)

## 9 Next If Positive

- **Symbolic ladder residuals** – feed your measured  $\Delta f$  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.