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/orḟ 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/orḟ 10−6f0

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

1 Bill of Materials (US $120 total)

Qty	Part
1	**TCXO 10 MHz** (Abracon ASTX-13 or similar) **-or-** watch-grade **32.768 kHz crystal + CMOS i**
1	**MCU board** (STM32 "Nucleo-64", Teensy 4.1, or RP2040)
1	**20 MHz logic analyzer / USB scope** (Saleae-type)
1	**Low-noise linear 3.3 V** supply (LT3045, ADM7150)
1	**Faraday box or metal cookie-tin** + RF gasket tape
—	SMA / BNC cables, breadboard or SMT adapter, thin PTFE wire
—	**DS18B20** temperature probe (optional)

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

2 Circuit Snapshot

markdown

CopyEdit

+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	Go
B-0 Baseline	Closed	*OFF* (pin left floating, MCU ignores)	2 h	Est
B-1 Prepared	Closed	*ON* (pin configured as digital in, though nothing ever toggles)	2 h	Loc
B-2 Dormant	Open	*ON*	1 h	Iso
B-3 Sham	Closed	*OFF* but MCU toggles a dummy GPIO elsewhere	1 h	Gu

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

CopyEdit

```
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

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

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.