

Real Random LLC

Independent Testing & Validation Results

Physical True Random Number Generation

September 2026

0.003001 Serial Correlation

0.999996 Bits Per Byte

Independently evaluated by Rochester Institute of Technology

Executive Summary

Real Random LLC's physical true random number generation technology has undergone independent testing using industry-standard randomness test suites. The results show entropy quality comparable to established commercial TRNG services.

Key Findings

- **NIST SP 800-90B ESV in process** at atsec, anticipated by the end of October 2026
- **0.999996 bits per byte entropy** (essentially perfect) verified by Fourmilab ENT testing
- **Near-zero serial correlation (0.003001)** consistent with independent output bits
- **Performance comparable to Random.org** - an established commercial TRNG leader
- **Independent academic evaluation** by Rochester Institute of Technology, using the DieHarder suite developed at Duke University
- **Comprehensive testing** across DieHarder, Fourmilab ENT, and NIST Statistical Test Suite

DieHarder Test Suite Results

The DieHarder suite is a comprehensive collection of randomness tests developed by Robert G. Brown at Duke University. Real Random's hardware was tested across multiple sensors with the following representative results:

Sample Sensor Performance (Sensor pi1)

Test Name	p-value	Result
Diehard Birthday Spacings	0.233	PASSED
Count-the-1s (Stream)	0.056	PASSED
Diehard Parking Lot	0.469	PASSED
RGB Permutations	0.216	PASSED
RGB Kolmogorov-Smirnov	0.512	PASSED
Longest Run of Ones	0.378	PASSED

Interpretation: All p-values fall within acceptable ranges (typically $0.01 < p < 0.99$), indicating the data exhibits no detectable patterns and behaves as truly random output. Multiple sensors were tested with consistent high-quality results.

Fourmilab ENT Test Results

The Fourmilab ENT test provides a comprehensive entropy analysis including chi-square distribution, arithmetic mean, Monte Carlo Pi estimation, and serial correlation. Real Random's performance was compared directly with Random.org, a leading commercial TRNG service.

Real Random vs. Random.org

Metric	Real Random	Random.org
Entropy (bits/byte)	0.999996	0.999998
Serial Correlation	0.003001	0.000760
Arithmetic Mean	48.499	48.501
Overall Assessment	RANDOM	RANDOM

Key Finding: Real Random's entropy quality is comparable to Random.org on these measures, and both are consistent with random data. The ideal serial correlation is 0.0 (uncorrelated); Real Random's 0.003001 is near zero.

Independent Academic Evaluation

Real Random's entropy output has been evaluated by researchers at Rochester Institute of Technology and tested with the DieHarder suite developed at Duke University.

Rochester Institute of Technology (RIT)

RIT authors independently evaluated Real Random's entropy source in "Entropy in the Physical World" (2022), applying NIST statistical test methodologies.

Duke University

The DieHarder test suite, developed by Professor Robert G. Brown at Duke University, is the framework used to test Real Random's output. It now runs continuously in Real Random's production pipeline.

Technology Overview

Real Random generates entropy through physical dice tumbling in viscous fluid, captured via high-speed computer vision. This macroscopic physical process provides several key advantages:

- **Observable Randomness:** Unlike semiconductor noise or radioactive decay, dice tumbling is directly visible and verifiable
- **Multiple Entropy Dimensions:** Computer vision extracts randomness from position, orientation, rotation, trajectory, and collisions
- **Prediction-Resistant:** Output comes from chaotic fluid dynamics and mechanical collisions rather than a mathematical algorithm, so there is no algorithm for a classical or quantum computer to reverse-engineer
- **Supply Chain Independent:** No reliance on potentially compromised hardware RNGs or semiconductor manufacturing
- **Continuous Quality Monitoring:** The DieHarder battery runs live in the production pipeline, ensuring consistent entropy quality

Testing Methodology

Test Environment

- **Multiple Hardware Sensors:** Seven independent physical entropy generation units (pi1-pi7) tested
- **Large Sample Sizes:** Hundreds of thousands to millions of bits analyzed per test
- **Industry-Standard Tools:** DieHarder (developed at Duke University), Fourmilab ENT, NIST Statistical Test Suite

Test Coverage

- Frequency analysis and bit distribution
- Run length and pattern detection
- Serial correlation and independence testing
- Chi-square distribution analysis
- Template matching and complexity measures
- Kolmogorov-Smirnov distribution testing

Quality Assurance & Continuous Improvement

Testing identified minor variations in specific sensors that are being addressed through ongoing calibration and hardware optimization:

- **Sensor pi3:** Dab DCT test showed frequency domain irregularities - hardware recalibration in progress
- **Sensor pi4:** RGB KSTest indicated minor distribution variations - environmental controls enhanced

Important Context: These anomalies are characteristic of physical entropy sources and confirm that **Real Random does not rely on deterministic algorithms.**

Continuous DieHarder monitoring in the production pipeline flags variations like these as they occur.

Conclusion

Real Random LLC's physical true random number generation technology has demonstrated high entropy quality in independent testing. A measured 0.999996 bits per byte of entropy, a serial correlation of 0.003001, and performance comparable to established commercial TRNG services support Real Random's position in quantum-secure cryptographic random number generation. NIST SP 800-90B entropy source validation (ESV) is in process at atsec, anticipated by the end of October 2026.

The observable, physics-based approach provides transparency and verifiability that semiconductor-based hardware RNGs cannot match, making Real Random ideal for intelligence community, military, financial services, and other high-security applications where trust in the entropy source is paramount.

About Real Random LLC

Real Random LLC is a quantum-secure cryptography company founded in 2014 and headquartered in Tampa, Florida. Our patented electromechanical true random number generators create entropy from physical dice tumbling in viscous fluid, read optically. We license hardware and software placed inside the customer's own security stack. Entropy to enhance your digital security.

Recognition

Gartner Cool Vendor in Data Security 2025

Gartner, "Cool Vendors in Data Security 2025: Securing Your Data in the Age of GenAI and Quantum Computing," 25 August 2025. Gartner does not endorse any company, vendor, product or service depicted in its publications, and does not advise technology users to select only those vendors with the highest ratings or other designation. Gartner publications consist of the opinions of Gartner's business and technology insights organization and should not be construed as statements of fact. Gartner disclaims all warranties, expressed or implied, with respect to this research, including any warranties of merchantability or fitness for a particular purpose. GARTNER is a registered trademark and service mark of Gartner, Inc. and/or its affiliates.

Intellectual Property

7 Granted U.S. Patents | 36 Patent Rights Across 10 Countries | IP Active Through 2042

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