1.4. Hardware Random Number Generator

Preston Maness

Motivation

Why?

- Familiarize myself with an important aspect of modern cryptographic systems.
- Gain experience with signal shaping.
- Explore the interface between hardware and software and how it can be both exploited and hardened.

On the Shoulders of Giants

Google hardware random number generator schematic

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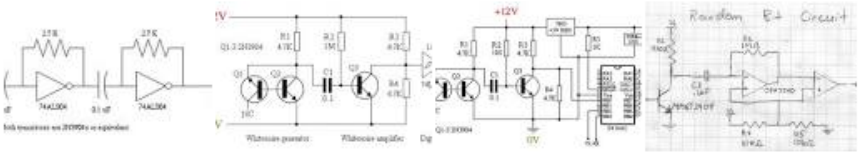
Images for **hardware random number generator schematic** - Report images



Rob Seward :: True **Random Number Generator**
robseward.com/itp/adv_tech/**random_generator**/
I've included **circuit diagrams** as well as links to instructions for fabricating **...** True **random number generators** create sequences that are impossible to predict.

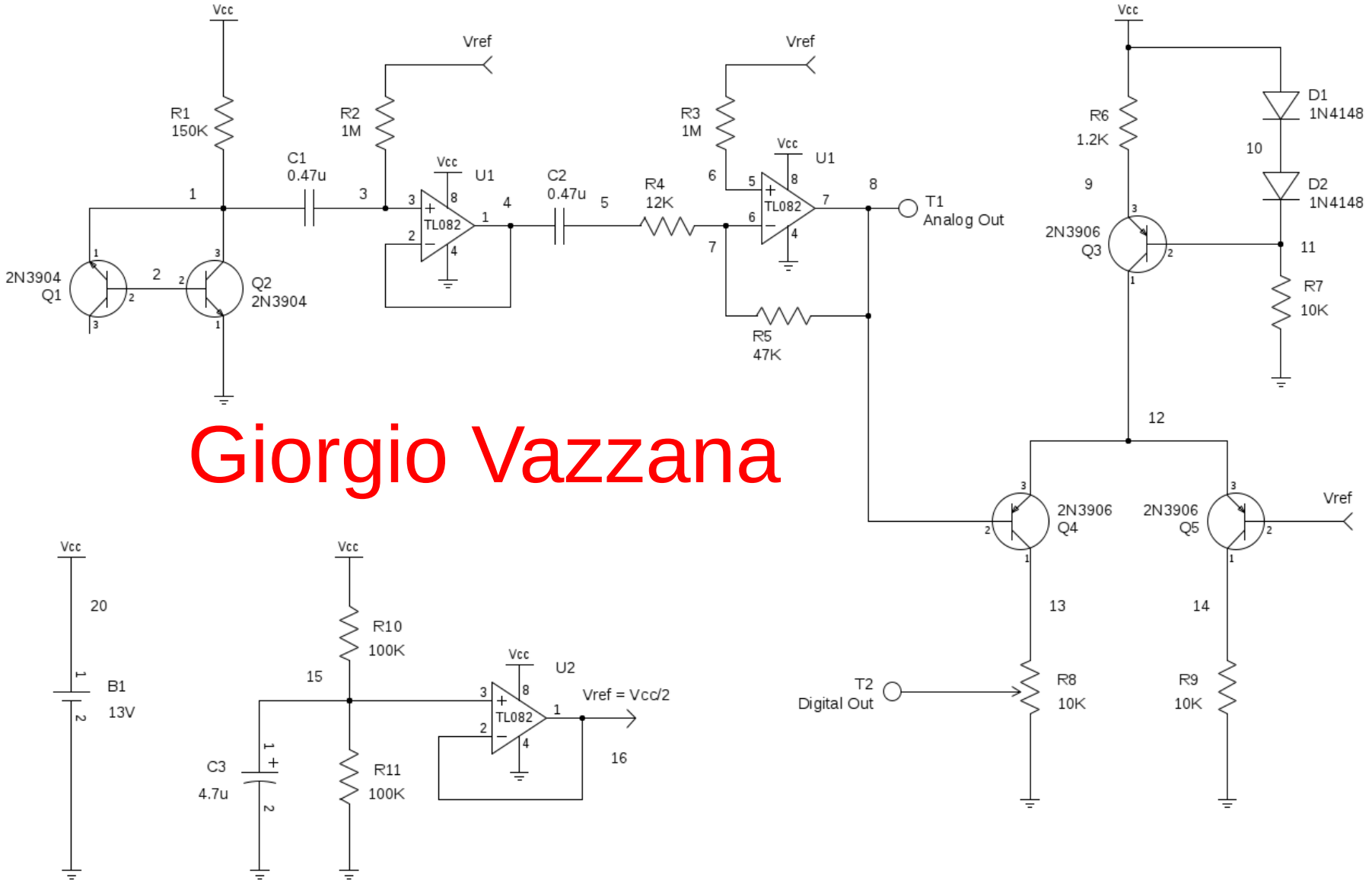
Hardware Random Bit **Generator** - Jfet.org
web.jfet.org/hw-rng.html
These are some notes about building a **hardware** random bit **generator**. **...** who contemplates arithmetic methods for the generation of **random numbers** is in a state of sin. **...** This **circuit** uses avalanche noise in a reverse-biased PN junction, the **...**

HOW TO – Build your own "True **Random Number Generator**" | MAKE

makezine.com/2006/10/06/how-to-build-your-own-tru/
by Phillip Torrone
Oct 6, 2006 - I've included **circuit diagrams** as well as links to instructions for fabricating your **...** True **random number generators** create sequences that are **...**

Building a **Hardware Random** Bit **Generator** for EVPmaker
www.tonbandstimmen.de › Start › Software › EVPmaker
I have built the **circuit** on a piece of perforated **circuit** board. **...** To get a 32-bit **random number**, the port has to be queried 32 times, while each retrieved bit is **...**

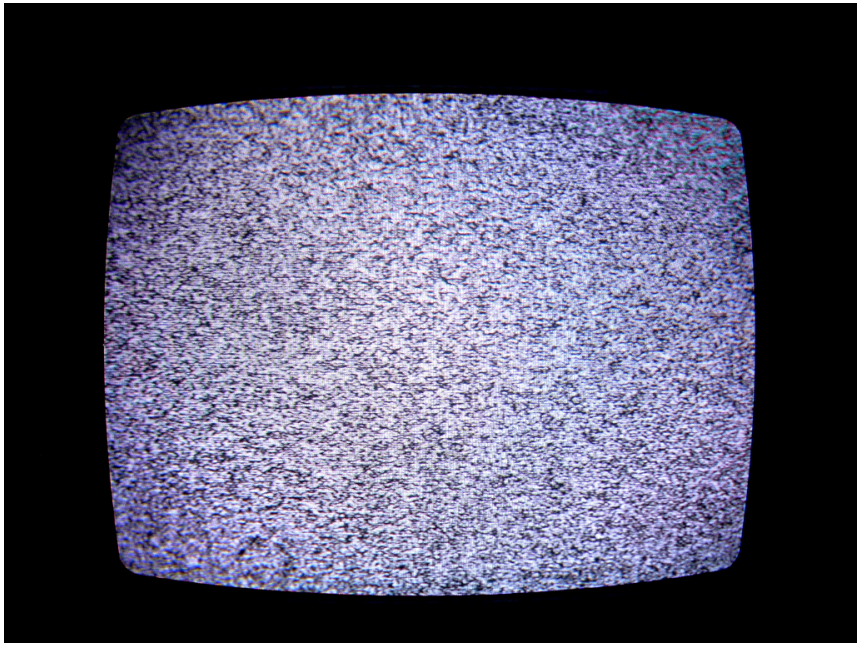
Random Sequence **Generator** based on Avalanche Noise
holdenc.altervista.org/avalanche/
After my experiments with a random sequence **generator** based on Chua **Circuit**, I started investigating other methods for building **hardware random number ...**



Giorgio Vazzana

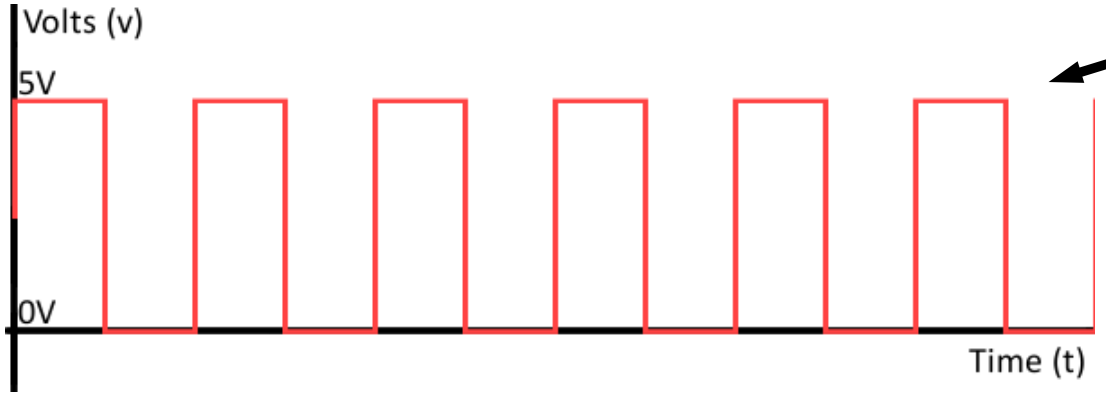
TITLE	Random Bit Generator based on Avalanche Noise		
FILE:		REVISION:	1.0
PAGE	1 OF 1	DRAWN BY:	Giorgio Vazzana

General Principle

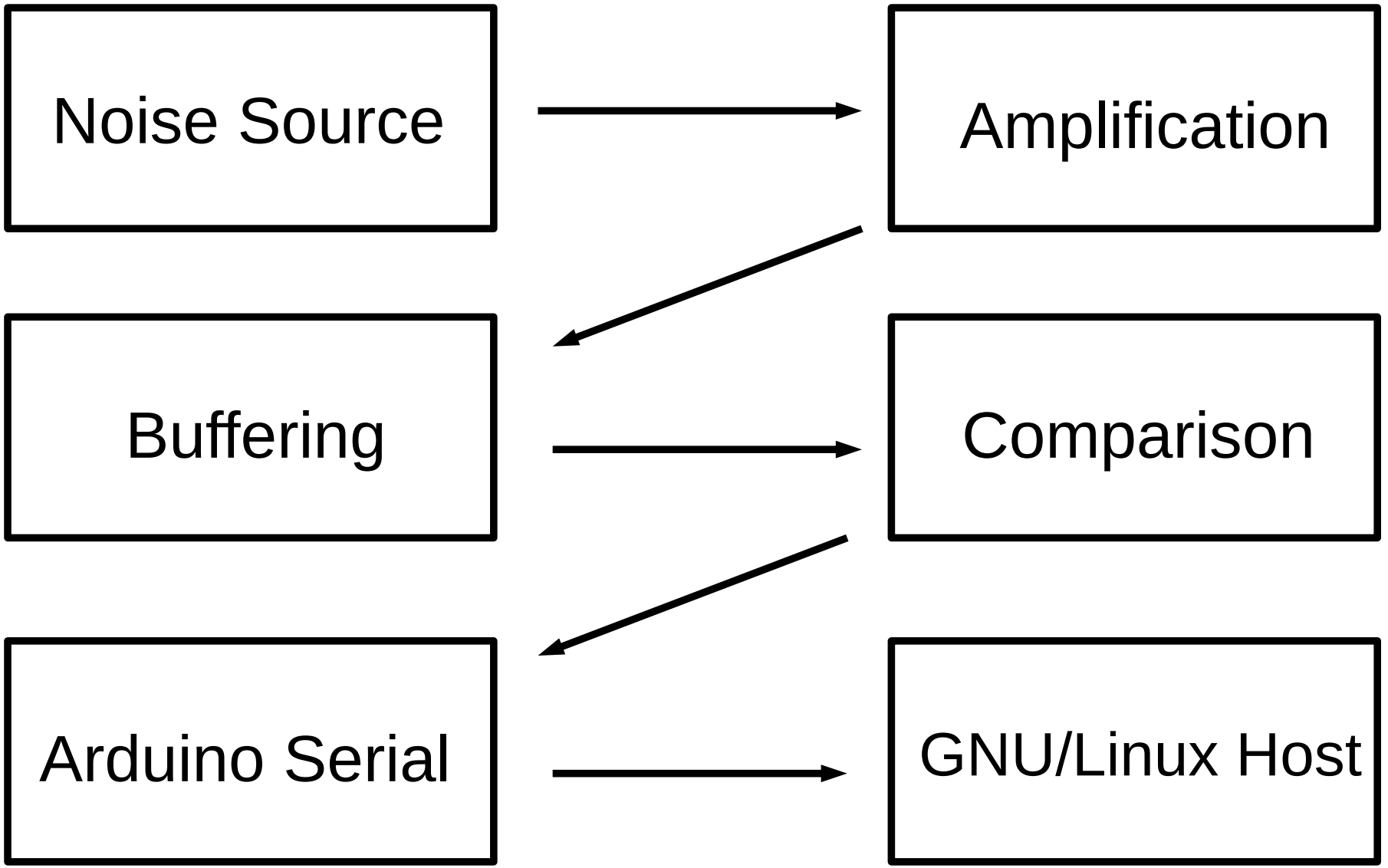


Amplify

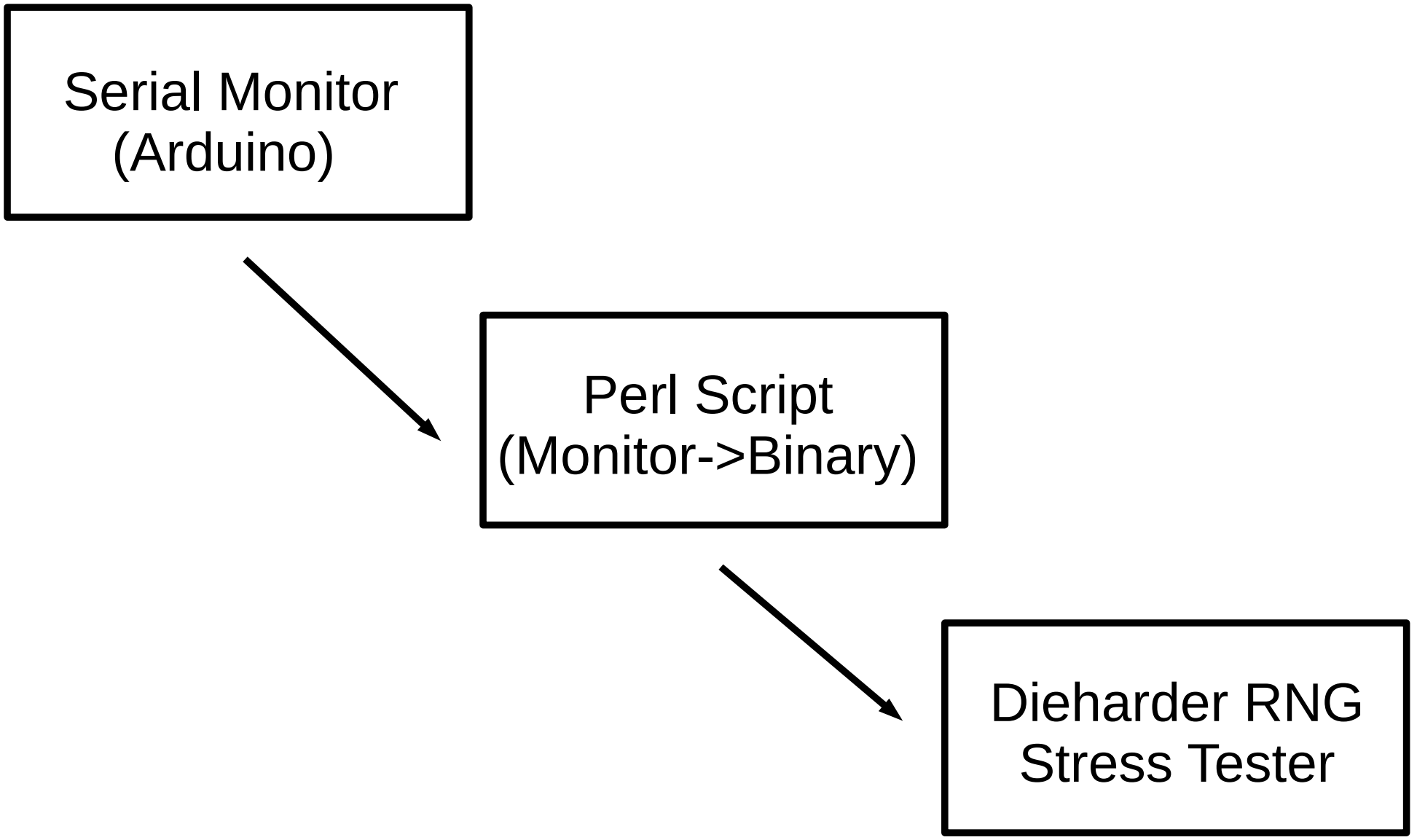
Digitize



Hardware Block Diagram



Software Stack



Deliverables

- Functioning prototype that outputs bits to the host.
- Host is able to read this bitstream.
- Host tests the randomness of bitstream.
- Inclusion of verified bitstream into entropy pool.
- Hardware-side verification.
- Automated testing.

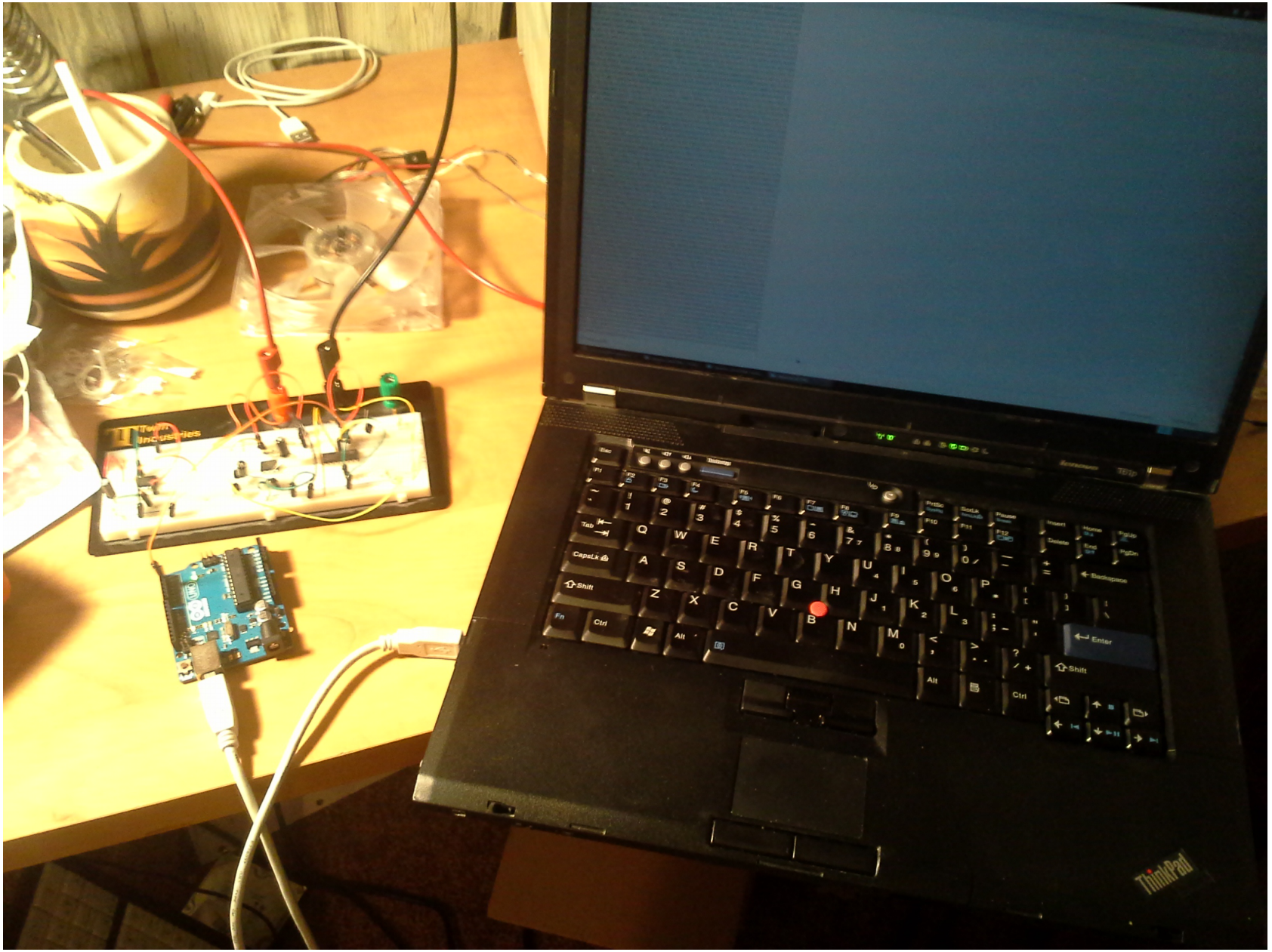
Timeline

Timeframe	Goals
Continuous	• Research, Verify, Research, and Research some more.
By end of September	• Verification pipeline determined (dieharder). • Hardware to host communication.
By end of October	• Verification pipeline functional and providing results of its tests.
By end of semester	• Verified bitstream. • Automated testing.

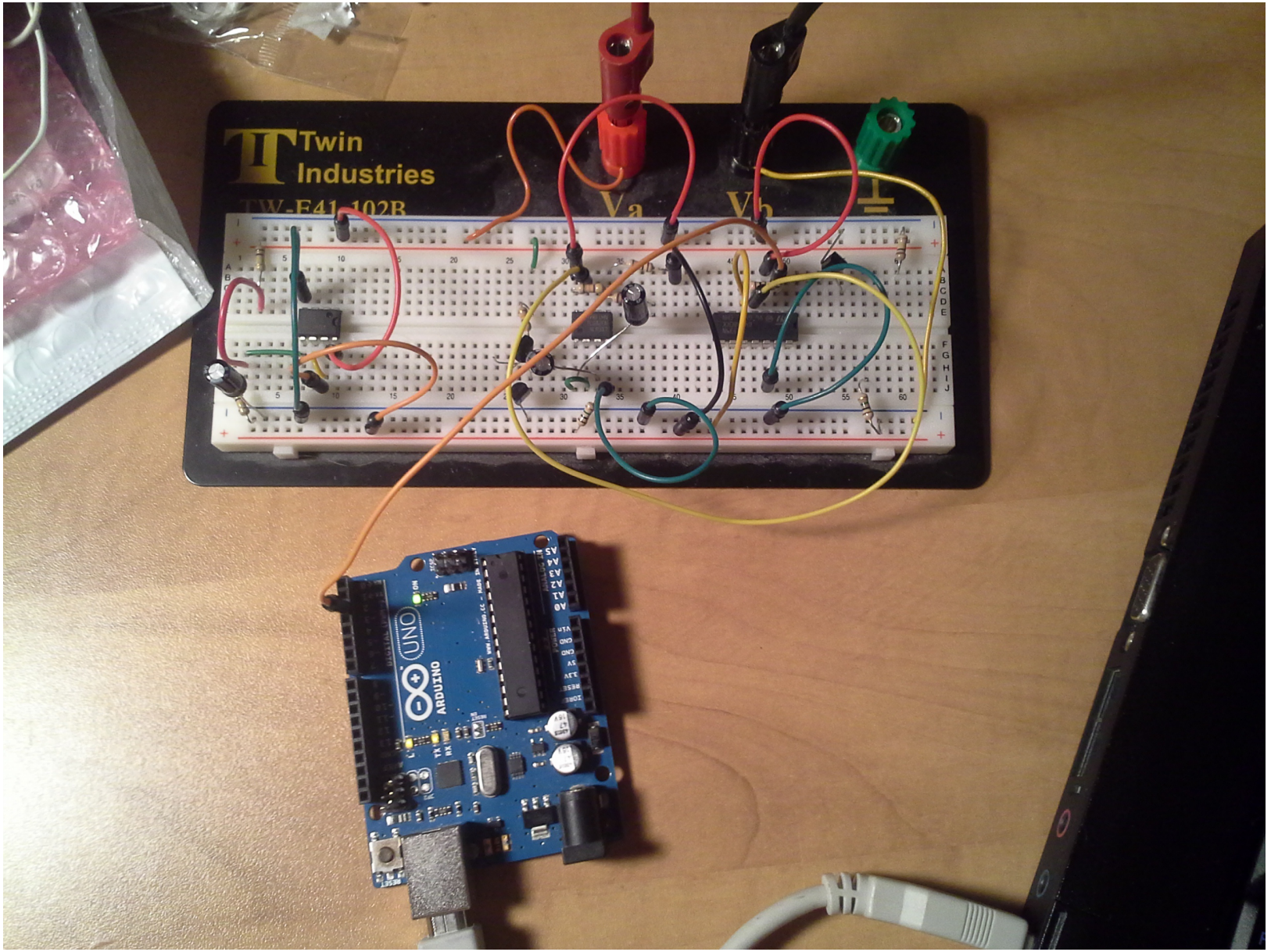
Expense Report

Item	Quantity	Cost
Op-Amp (TL082)	50	$9.99
BJT (2N3904)	50	$4.98
Comparator (LM339N)	10	$3.50
Arduino Uno	1	$25 (Already Owned)
Resistors	100	~$5 (Already Owned)
Capacitors	20	~$5 (Already Owned)
Wiring	Varied	$2.98
	TOTAL: **OUT OF POCKET:**	$56.45 **$21.45**

Messy Lab Benches!



Messy Breadboards!

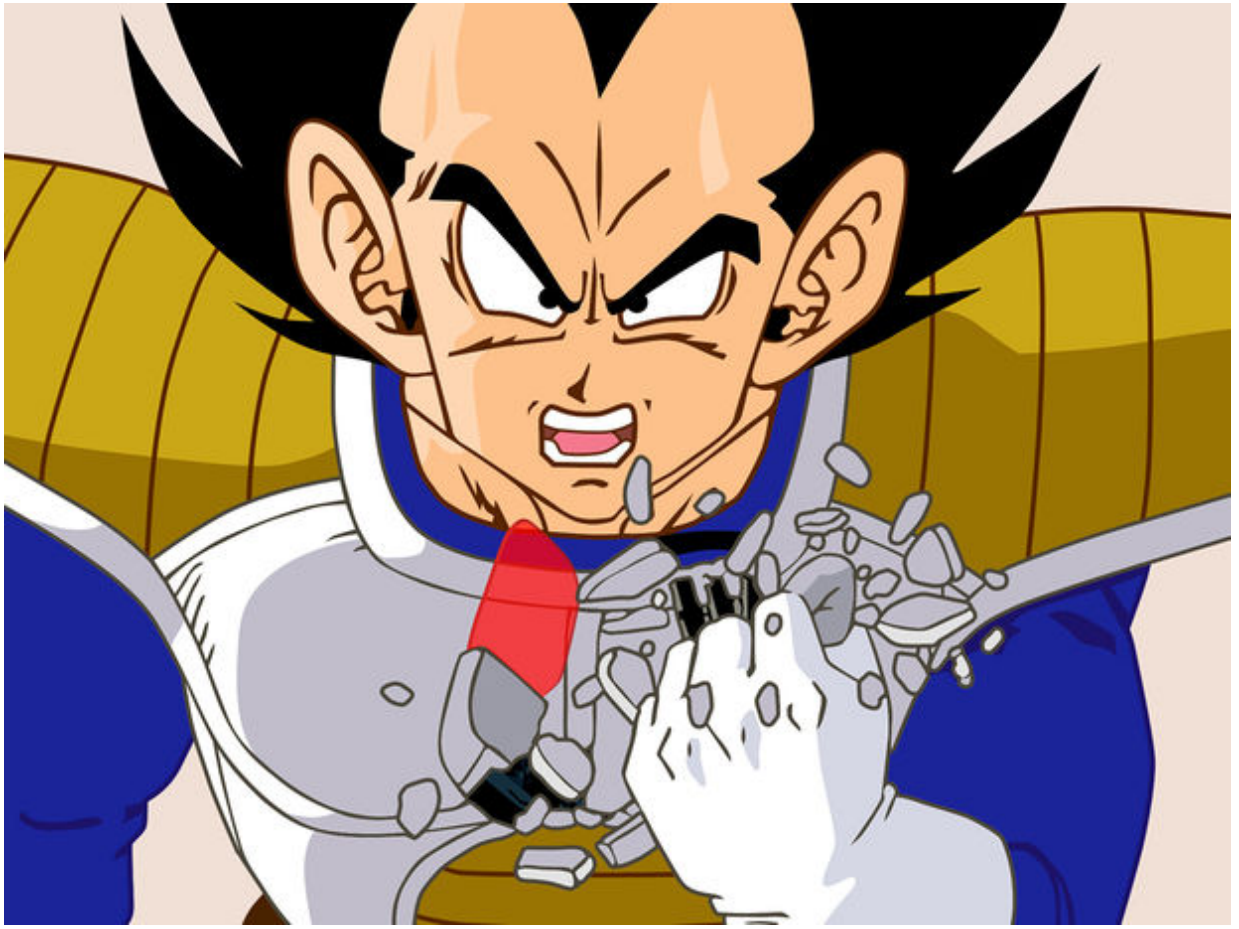


Messy Progress!

D'OH!

```
preston@neo:~/ee4390-senior-design-1/src/dieharder-3.31.1/dieharder$ ./dieharder
 -g 201 -a -f ../../rand-stream.bin
#=============================================================================#
#            dieharder version 3.31.1 Copyright 2003 Robert G. Brown          #
#=============================================================================#
   rng_name    |           filename             |rands/second|
 file_input_raw|           ../../rand-stream.bin|  3.55e+07  |
#=============================================================================#
        test_name   |ntup| tsamples |psamples|  p-value |Assessment
#=============================================================================#
# The file file_input_raw was rewound 288 times
   diehard_birthdays|   0|       100|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 2373 times
      diehard_operm5|   0|   1000000|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 5042 times
  diehard_rank_32x32|   0|     40000|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 6293 times
    diehard_rank_6x8|   0|    100000|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 6840 times
   diehard_bitstream|   0|   2097152|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 11213 times
        diehard_opso|   0|   2097152|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 14128 times
        diehard_oqso|   0|   2097152|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 15495 times
         diehard_dna|   0|   2097152|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 15628 times
diehard_count_1s_str|   0|    256000|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 18297 times
diehard_count_1s_byt|   0|    256000|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 18347 times
 diehard_parking_lot|   0|     12000|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 18381 times
    diehard_2dsphere|   2|      8000|     100|0.00000000|  FAILED
# The file file_input_raw was rewound 18406 times
    diehard_3dsphere|   3|      4000|     100|0.00000000|  FAILED
```

The file was rewound...



OVER 9000 TIMES!

Speed Issues

MY SAMPLING RATE IS BAD

AND I SHOULD FEEL BAD

Looking Forward

- Successful verification via faster sampling.
- Inclusion into kernel entropy pool.
- Automate testing harness.

- Verify with hardware.
- Parallelized implementation with rapid sampling of each stream to increase throughput.

Stalk The Project Manager!

https://github.com/aggroskater?tab=repositories

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Repo for CS4328 OS class with Dr. Ziliang during Fall 2013 at Texas State University.
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ee4390-senior-design-i — Perl ★0 ⑂0
The project is a hardware RNG. The repo holds code, documentation, schematics/netlists/models, and other work for EE4390 Senior Design I with Dr. Stapleton, Fall 2013.