Affordable hardware random number generators (HRNGs)

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27-NOV-2015
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Executive summary: USE HRNG NOW

— For all host systems
— For all smartphones
— For all IoT systems
— And use a trustable HRNG

Isn't HRNG expensive?

NO

It's already affordable!

A JPY1500 board will make a host computer secure enough

Affordable?

- Cheaper than JPY10000 per each
- Preferably cheaper than JPY3000
- Or even more cheaper
- *Price now: JPY1500 for each*

Why HRNG?
Mandatory for security!

- Keys: TLS, SSH, DNSSEC, passwords
- Load balancing with minimal bias
- Fairness for gambling applications

Isn't /dev/urandom enough?

NO

(if without HRNG)

Why /dev/urandom is not enough?

- Insufficient seeding
- Harvestable entropy too small
- Harvested entropy is spent by too many applications simultaneously

Why Intel's rdrand (or similar HRNG of other chip vendors) is not enough?

- — *PROPRIETARY* hardware
- — Possible *BACKDOORS*
- — Might be too *SLOW* (taking hundreds of system clocks for each call)

Why *original* HRNG?

- Required for *sufficient strength* of seeding /dev/[u]random
- Fast and more unpredictable seeding
- Fast enough to feed all applications through making /dev/[u]random sufficiently random

Obtaining statistically sound result

- Periodic measurement of output statistical characteristics is required
- The same measurement for *raw* output is recommended for early failure detection
- Whitening by cryptographic hash functions (SHA256, SHA512, etc) is necessary to obrain statistically good and sound result

"OK then show us what you've got"

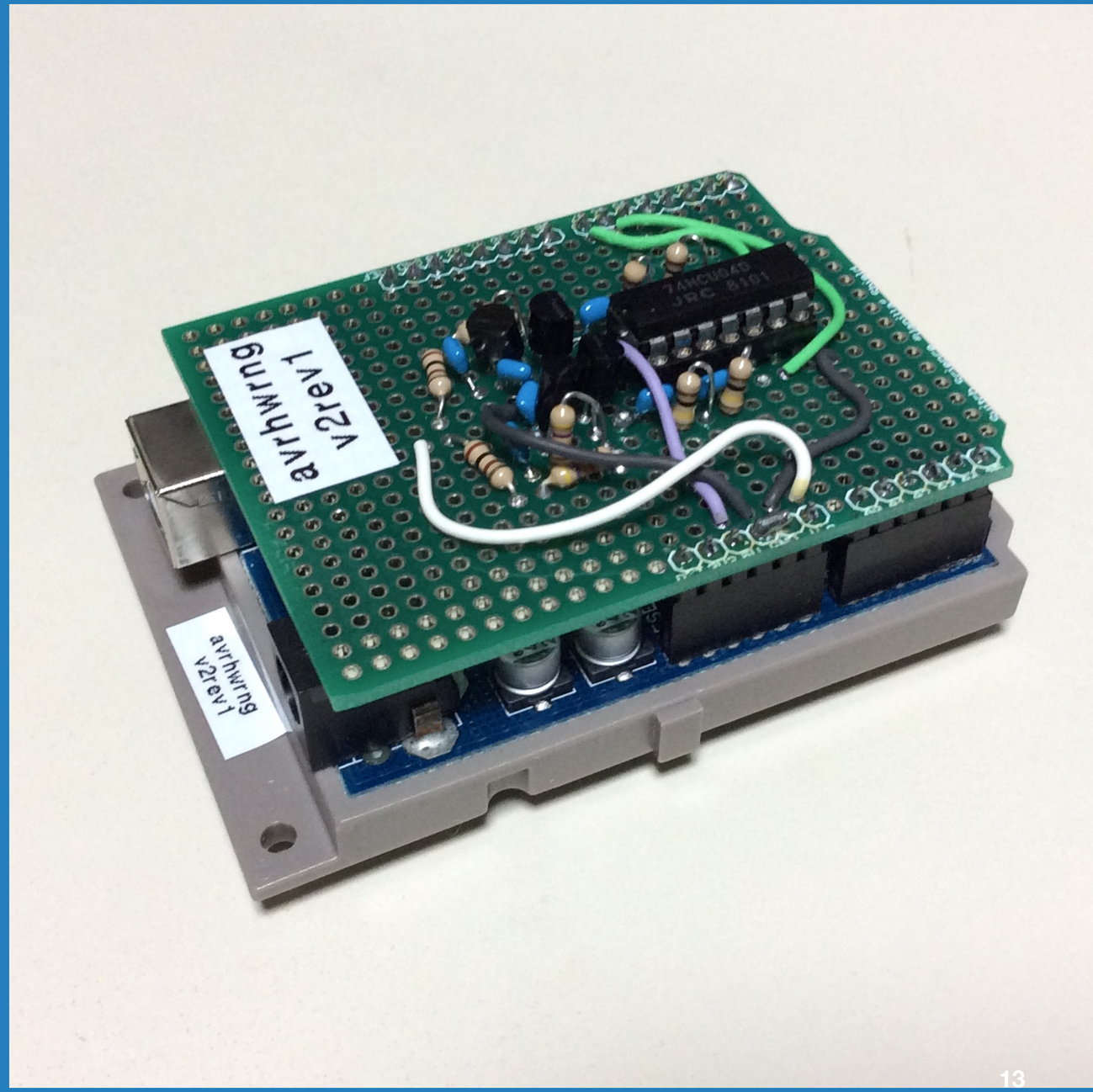
— avrhwrng
— ST Dongle for NeuG

Both are USB CDC-ACM devices

— Accessible as modem/tty devices

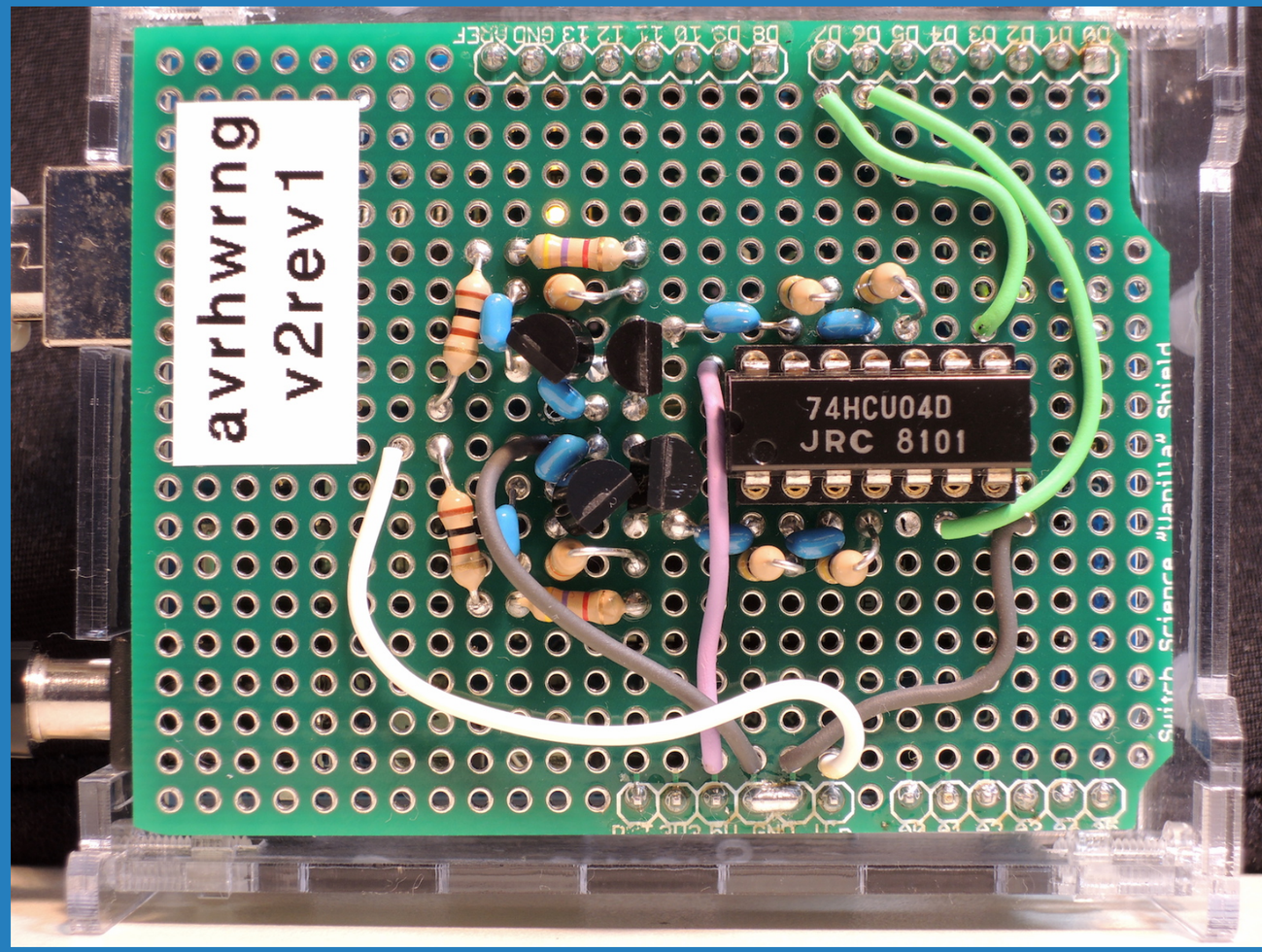
avrhwrng

— With 8bit AVR Arduino
— Reverse biased diodes
— ~10kbytes/sec (raw output: ~80kbytes/sec)
— DC 12V required
— Arduino shield



avrhwrng parts

- 74HCU04 x 1
- 2N3904 x 4
- All available in Akizuki Denshi
  秋月電子通商
- Parts cost: ~JPY500



avrhwrng: Arduino 2009/UNO shield schematics
for a hardware random number generator
by Kenji Rikitake / v2rev1 / 25-SEP-2015
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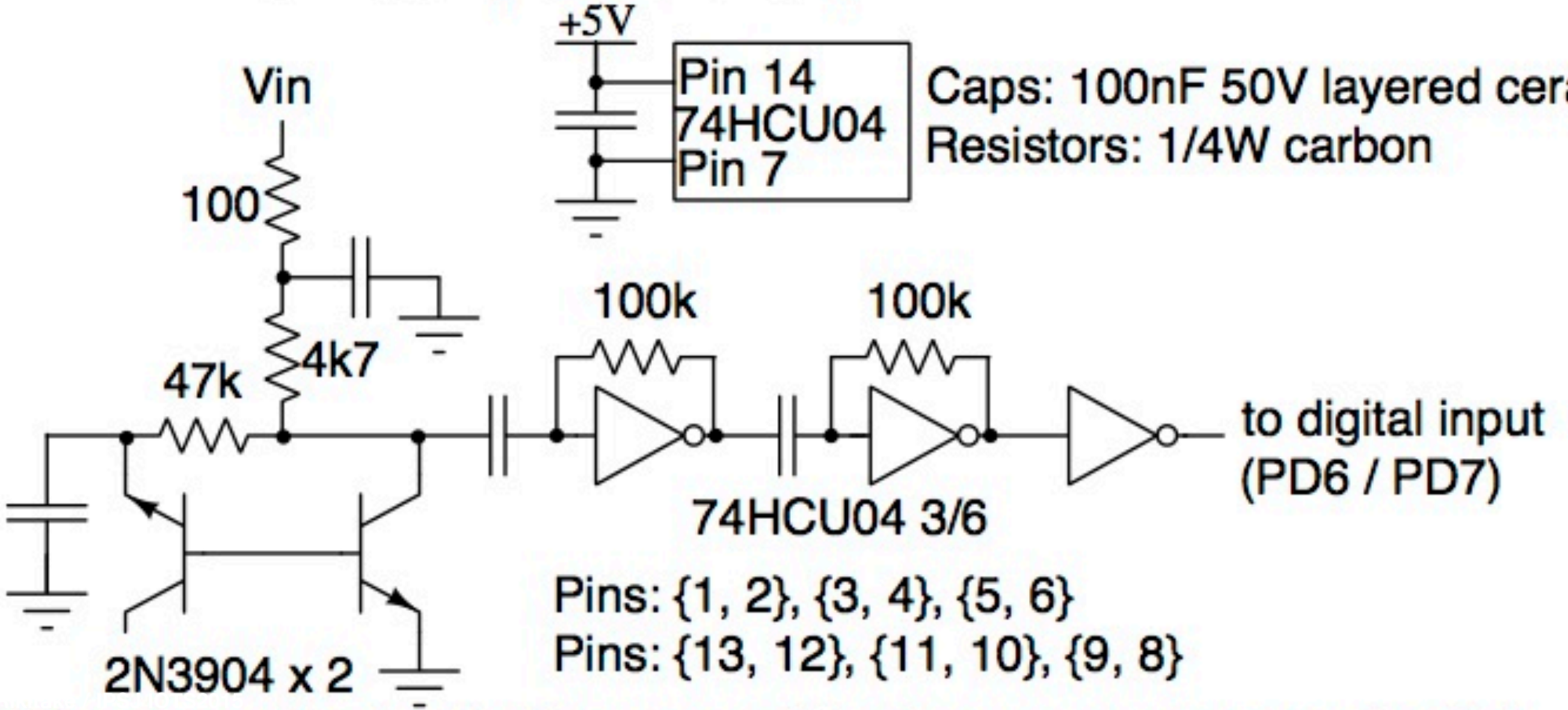
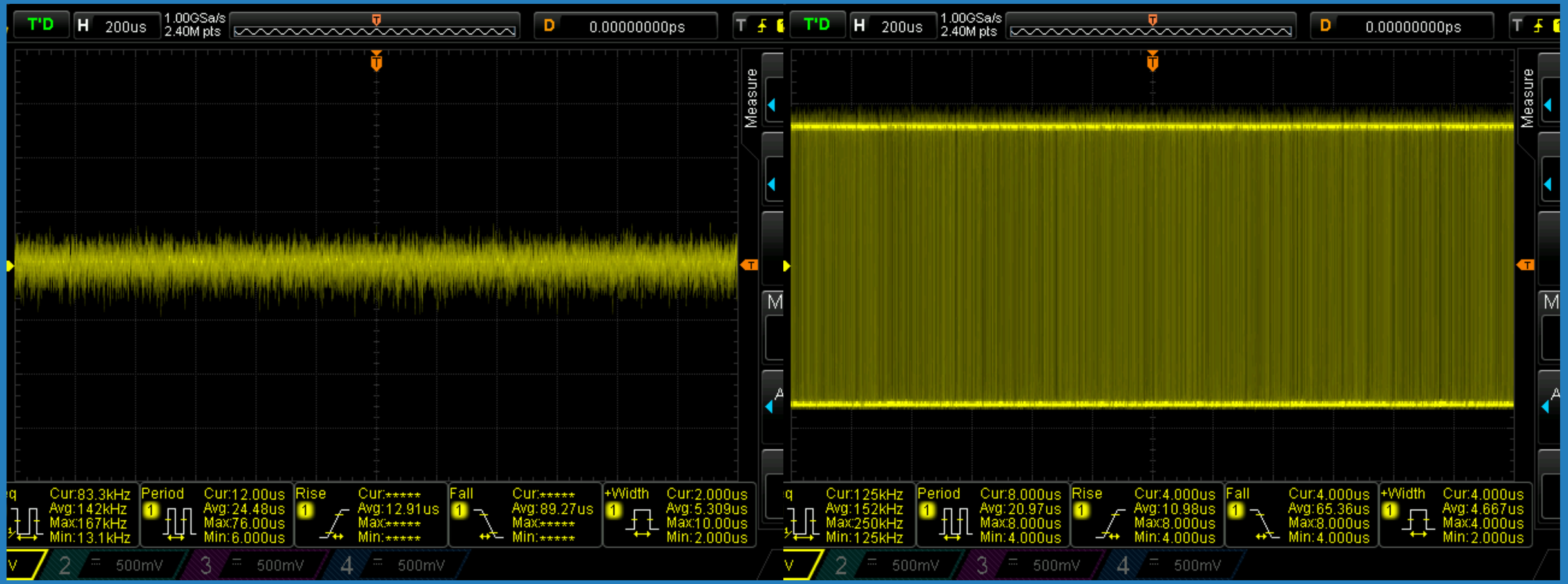
Vin = +12V or +13.8V (+9V didn't work)



Caps: 100nF 50V layered ceramic
Resistors: 1/4W carbon

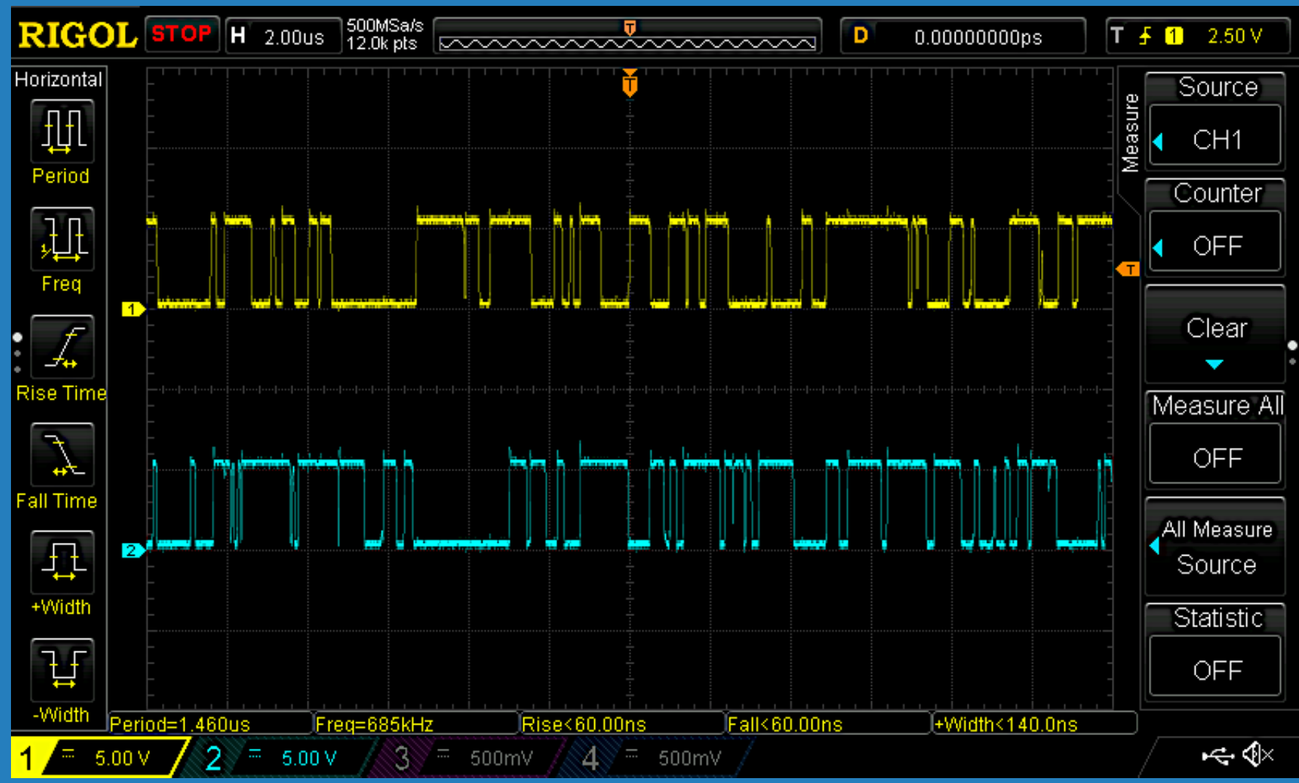
(The above circuit only shows one of the two same necessary circuits)

avrhwrng amplifiers



Why *two* diodes?

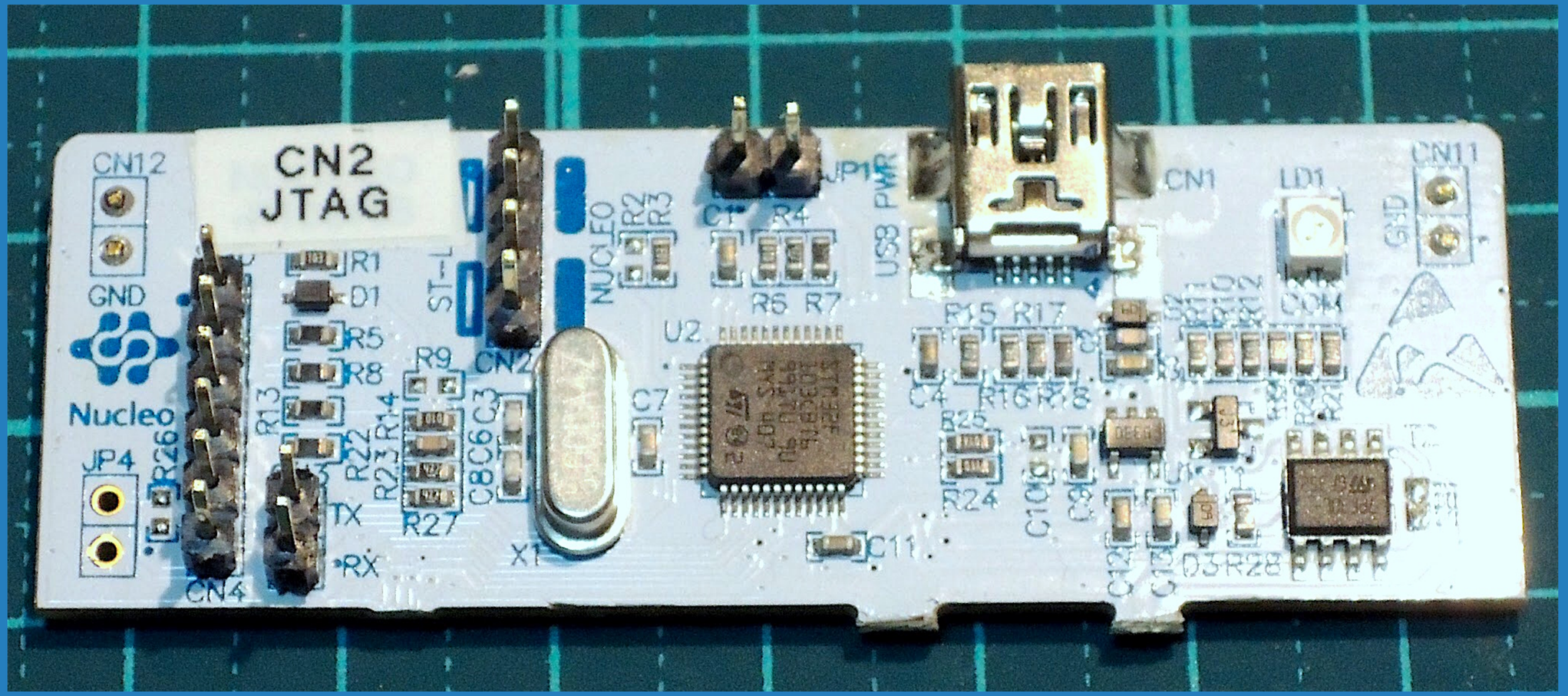
— Differential input for removing environmental common-mode effects
— ... Or simply two-bit parallelism
— Can be extended to more bits/sample



NeuG

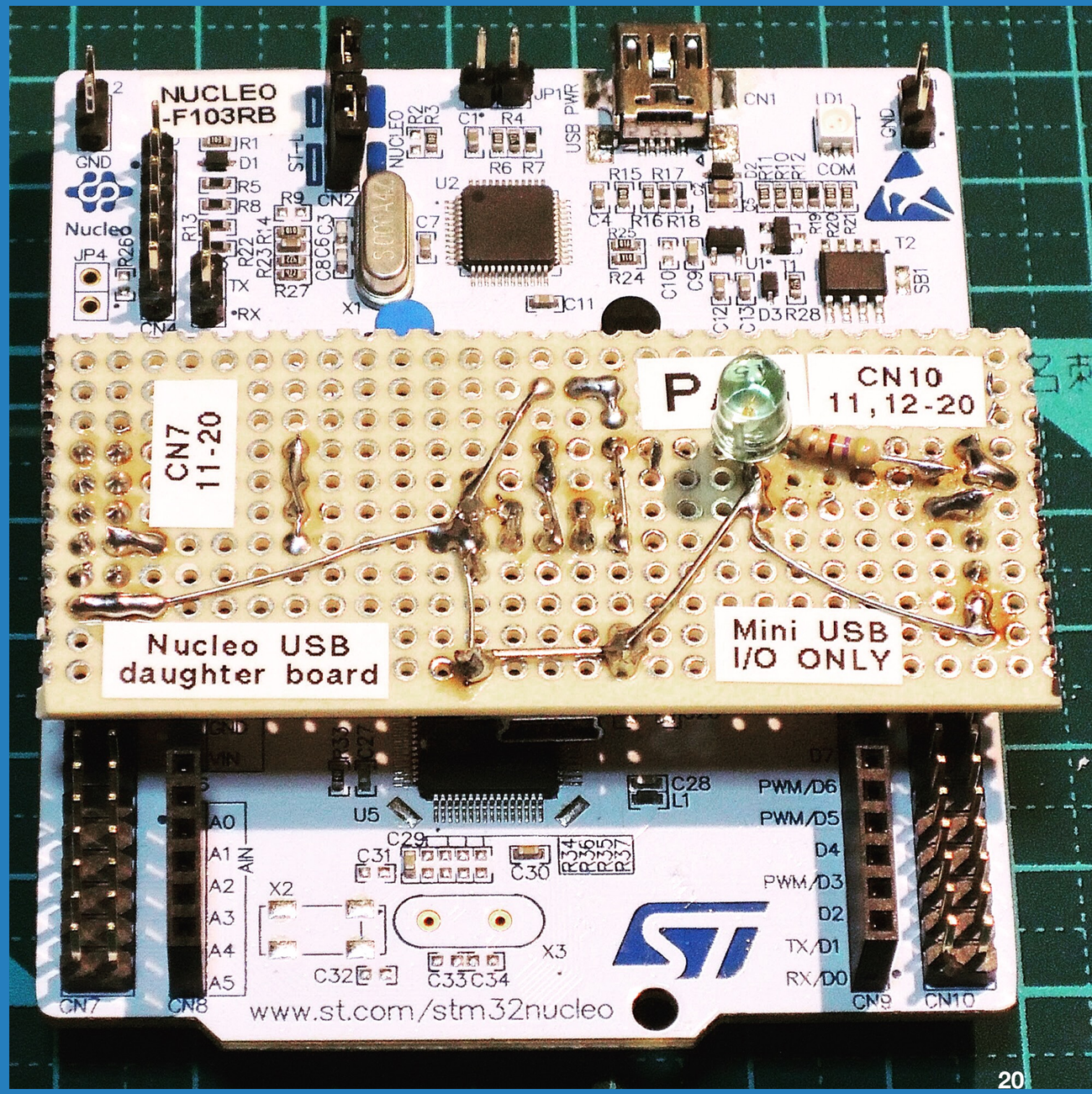
- Yutaka Niibe's GPLv3 HRNG software for ARM Cortex-M3 including Flying Stone's FST-01
- RNG for GnuK, a secure cryptographic token hardware usable on GnuPG and OpenSSH
- No external power required
- Using internal A/D converter noise as the randomness source
- ~80kbytes/sec (with internal whitening)

ST Dongle for NeuG



STM32 Nucleo-64

— ST-LINK/V2-1 part: reconfigurable for NeuG
— And STM32F103 target: *also* reconfigurable as a NeuG
— JPY1500/board for *TWO* NeuGs



FreeBSD HRNG code

- Requires a device driver to use random_harvest(9) and rndtest(4)
- ... so I wrote a driver and feeder for FreeBSD 10.2-STABLE
- Working stably for months

On choosing hardware

Japanese semiconductors are no longer available **for prototyping: use (American) well-known semiconductors instead (e.g., 2SC1815 -> 2N3904)**

For more bandwidth

- Parallelism (bits/sample): a simple I/O with FTDI FT232R/245R?
- More sampling speed: R820T SDR + rtl_entropy?

For more applications

- Stable operation infrastructure needed for fault tolerance
- Expertise on production-level cases (e.g., DNSSEC, PKI key generation)
- We need more internal information for seeding the system PRNG by the external devices: Windows? OS X? Android? iOS? Other proprietary platforms?

My codes and docs in GitHub

- https://github.com/jj1bdx/avrhwrng
- https://github.com/jj1bdx/freebsd-dev-trng
- https://github.com/jj1bdx/osx-devrandom-feeder

NeuG codes and docs

- http://git.gniibe.org/gitweb/
- http://www.gniibe.org/memo/development/gnuk/rng/neug.html
- 日本語: http://www.gniibe.org/memo/development/gnuk/hardware/stm32-nucleo-f103.html

Other projects

— See Wikipedia entry called Comparison of Hardware Random Number Generators

Thanks

Questions?