SP 800-90B Non-Proprietary Public Use Document for Samsung Elroy TRNG

Hard Macro Version:
sf_crypt_samsung_trng_ln05lpe_4007000_v2.10
Soft Macro Version:
sf_crypt_samsung_trng_system_sss_v9.20

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1 Description

The Samsung Elroy TRNG is a physical (P) entropy source based on Meta-RO (metastable ring oscillator). The entropy source version is hard macro: sf_crypt_samsung_trng_ln05lpe_4007000_v2.10 and soft macro: sf_crypt_samsung_trng_system_sss_v9.20. Table 1 provides details of the Operational Environment of the entropy source. The entropy source was assessed against SP800-90B, IG D.J, IG D.K and IG D.O.

Characteristic	Description
Vendor	Samsung Electronics Co., Ltd.
Entropy source name	Samsung Elroy TRNG
Standard, IGs	SP800-90B (2018) IG D.J (2021-11-05) IG D.K (2026-04-16) IG D.O (2021-05-04): N/A
Entropy category	Physical (P)
Entropy source version	Hard macro version: sf_crypt_samsung_trng_ln05lpe_4007000_v2.10 Soft macro version: sf_crypt_samsung_trng_system_sss_v9.20
Operational environment	Samsung Elroy S4LY044
Embodiment and type	Sub-chip, hardware

Table 1: Entropy source and operational environment information

2 Security Boundary

The Security Boundary of the entropy source is depicted in Figure 1:

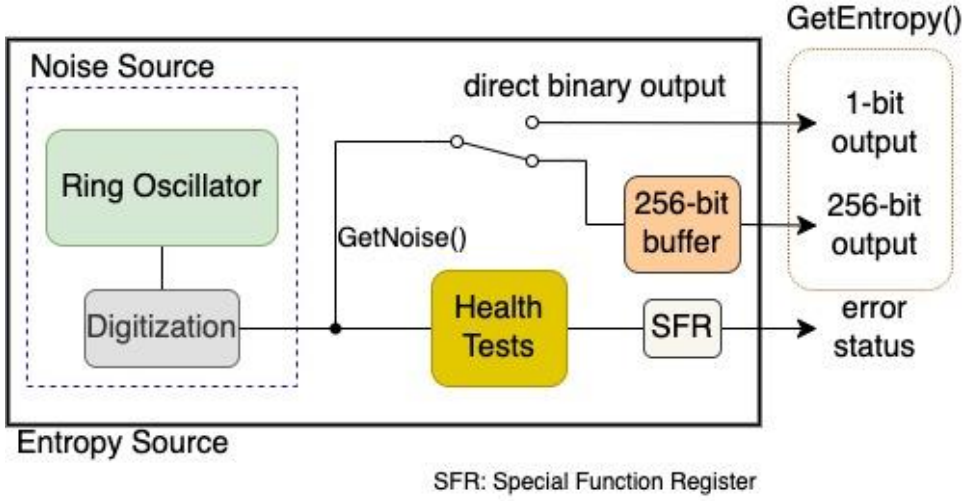


Figure 1: Security Boundary

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The noise source includes the Ring Oscillator and digitization circuitry. Health tests are applied to the output of the digitization circuitry and an error status is returned in case of failure of a health test.

3 Operating Conditions

The entropy source operating conditions are provided in Table 2:

Parameter	Value
Operating Temperature Range	-25°C to 105°C
Operating Voltage Range	0.75 V ±10%

Table 2: Operating Conditions.

4 Configuration Settings

The operator of the entropy source does not have the ability to modify the entropy source configuration settings.

5 Physical Security Mechanisms

The entropy source resides within the Elroy Controller chip, which is a single-chip cryptographic module enclosed in an opaque package. The chip contains other hardware and firmware components besides the entropy source. The packaging is of type FCPBGA with solder ball, production grade. This package cannot be removed or penetrated without causing serious damage to the chip.

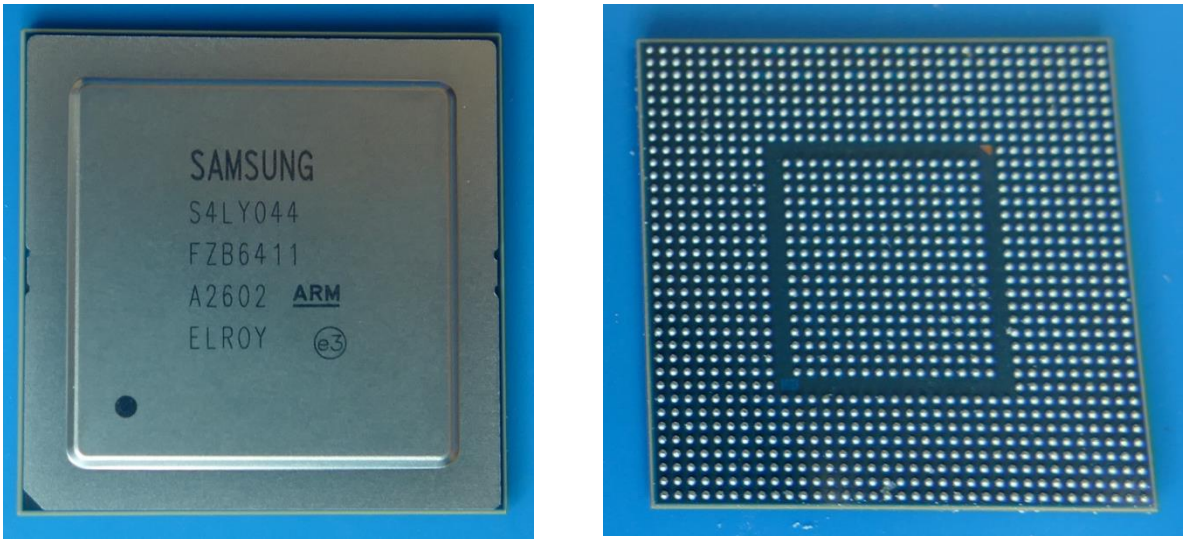


Figure 2: Front and back views of the Elroy chip

6 Conceptual Interfaces

There are two conceptual interfaces as shown in Figure 1:

a) GetNoise() interface receives entropy outputs raw random numbers from the direct binary output. This interface cannot be called directly from the cryptographic module firmware.

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b) GetEntropy() which receives entropy from the noise source. This interface can provide one single bit output, or from the entire 256-bit buffer, which equals to 256 concatenated samples in an output of 256 bits (See Figure 1). The PRNG.GenerateRandomNumber function can be called by the module's firmware to obtain entropy through the GetEntropy() interface. The function parameters consist of the request size and the buffer to hold the generated random number.

7 Min-Entropy Rate

The entropy source provides min-entropy rate of 0.5 bits per one-bit sample, or 128 bits per 256-bit sample. The entropy source does not implement a conditioning function.

8 Health Tests

The entropy source implements both the approved Repetition Count Test (RCT) and Adaptive Proportion Test (APT).

The startup health tests are executed automatically after a reset or power-up. During startup, the health test unit collects 1024 samples of raw data and performs RCT and APT on this data. The collected data samples are discarded and not used for random number generation.

The continuous tests implement both the RCT and APT.

The on-demand health tests are activated by a request of the user or caller by setting the flag TRNG_STARTUP_ONDEMAND_CTRL.STARTUP_HTPASS to 1’b1. This triggers the execution of the startup health tests. The samples for those tests are discarded upon completion.

8.1 Repetition Count Test (RCT)

The entropy source implements the RCT as specified in SP 800-90B.

To comply with the recommendation in IG D.K (National Institute of Standards and Technology, 2021), the RCT uses $\alpha = 2^{-40}$, which lies within the required range of $2^{-20} \leq \alpha \leq 2^{-40}$.

The cut-off value is given by the equation in Section 4.4.1 in SP 800-90B:

$$C = 1 + \left\lceil \frac{-\log_2 \alpha}{H} \right\rceil = 81$$

where,

$$\alpha = 2^{-40};$$

$$H = 0.5$$

8.2 Adaptive Proportion Test (APT)

The entropy source implements the APT as specified in SP 800-90B. The APT is computed over a window size of 1024 samples. The cut-off value is defined as $C = 824$ per the computation of the inverse cumulative binomial distribution and significance level $\alpha = 2^{-40}$ (Section 4.4.2 in SP 800-90B).

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8.3 Status and Error Codes

The health test unit provides the following status codes.

Flag	Value	Description
TRNG_TEST_STATUS.HTDONE	1'b0	Startup health test not yet completed.
TRNG_TEST_STATUS.HTDONE	1'b1	Startup health test completed.
TRNG_ERROR_STATUS.HT_ERROR	1'b0	No failure found in health tests.
TRNG_ERROR_STATUS.HT_ERROR	1'b1	Failure found in health tests.

Table 3: Status and Error Codes

9 Maintenance

There are no maintenance requirements.

10 User Verification

In order to test the entropy source, raw data samples must be collected when the entropy source is in test mode, in which case the health tests are disabled so that the noise data can be collected as is from the GetNoise() interface, with or without failures. This test mode is not available in the user mode of the entropy source.

Raw noise data samples consisting of at least 1,000,000 bits must be collected from the operational environment at is normal operating conditions and processed by the SP 800-90B entropy tool that is provided by NIST. The expected min-entropy rate must approach the one in Section 7.

Restart data must be collected at normal operating conditions when the entropy source is in test mode via the GetNoise() interface following the restart procedure specified in SP 800-90B (i.e. 1,000 samples from 1,000 restarts each). The restart data must be processed by the SP 800-90B entropy tool. The minimum of the row-wise and column-wise entropy rate must be more than half that of the raw noise entropy rate.

11 Vendor Permissions and Relationship

The ESV certificate is “Reuse restricted to vendor”.

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