GLI®

GLI Europe BV
Diakenhuisweg 29-35
2033 AP Haarlem
The Netherlands

Tel +31 (0)88 220 6600
www.gaminglabs.com

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Report Type Evaluation and Certification

Report Date 12 July 2024

Issuing Laboratory GLI Europe B.V.

Evaluating Laboratories
GLI Europe B.V.
Diakenhuisweg 29-35
2033 AP Haarlem
The Netherlands
RvA L372

Gaming Laboratories International, LLC
600 Airport Rd.
Lakewood, NJ, 08701
USA
A2LA 2428.01

Recipient
Microslot
[redacted]

Tested against Requirements GLI-19 Interactive Gaming Systems v3.0 - Chapter 3: Random Number Generator (RNG) Requirements

Jurisdiction Non-Jurisdictional

Manufacturer
Microslot
[redacted]

Submitter
Microslot
[redacted]

Product Name **Microslot RNG**

Description of the Product Tested
CSPRNG.js
simulator.js

Evaluation Period 10 June 2024 / 08 July 2024

Internal Reference RN-120-QSP-24-01

Result Pass (See Comments and Conditions on the following pages)

Internal methods used reference
Random Number Generator (RNG) Analysis
WI-MA-006*
PC-TC-001*
*The evaluation was conducted fully or partially by a subcontracted GLI office. Please refer to the abovementioned “Evaluating Laboratories”.

Technical Evaluation authorized by:

James Boje
Managing Director EMEA
Executive

Worldwide Locations

World Headquarters
Lakewood, New Jersey

International Offices
GLI Africa
GLI Asia
GLI Australia Pty Ltd
GLI Austria GmbH
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GLI South America

U.S. Regional Offices
Colorado
Nevada

RANDOMNESS REPORT FOR THE MICROSLOT RNG

The intent of this report is to indicate that **GLI** has completed its evaluation of the Microslot RNG random number generator, provided by Quantum soft PLT.

SECTION I — SCOPE OF TESTING

GLI was provided the required materials to conduct a randomness evaluation on the Microslot RNG. The scope of this evaluation was limited to software verification, source code review, and data analysis. The RNG was tested for its ability to randomly produce outcomes for the parameters in Section IV – Statistical Testing.

The Microslot RNG was evaluated against the RNG-specific requirements of the following technical standard:

- GLI-19 Interactive Gaming Systems v3.0 – Chapter 3: Random Number Generator (RNG) Requirements

SECTION II — SOFTWARE VERIFICATION

Verify+ by Kobetron™ signatures for the Microslot RNG are as follows:

File	Version	Type	Signature
CSPRNG.js	N/A	Kobe4	9U03
		MD5	9757F46FCE994AC28E7BF8C367ECD982
		SHA-1	5E79F95BCBDC5C0B0ABA63D013103BC3728F7776
		Kobe40	U89PCHH0H298C196H814HUC4824C86U0H6679046
		CDCK	E1F2
simulator.js	N/A	Kobe4	5736
		MD5	EEC5D5A0B7CC7F1FFC7CDA22B7604C0D
		SHA-1	DD75A571412C146C12DB5028D2FC7B5805C89DE5
		Kobe40	788UF7593A92F981PC733FU6365C23A012813F27
		CDCK	0474

Table 1. Digital Signatures

SECTION III — SOURCE CODE REVIEW

GLI received the appropriate documentation and full source code which pertains to the generation of random numbers. GLI reviewed the source code provided by tracing the path of the RNG application from the initiation of the draw to the selected output of random numbers. GLI inspected the source code, where practicable, in an attempt to find any undisclosed switches or parameters having a possible influence on randomness and fair play. GLI assessed the ability of the RNG to produce all numbers within the desired range.

RANDOMNESS REPORT FOR THE MICROSLOT RNG

SECTION IV — STATISTICAL TESTING

The RNG parameters tested are listed in Table 2. GLI performed a data format check on each data set listed in order to confirm that these parameters were correctly represented in the data analyzed.

GLI conducted a statistical analysis of sufficient scope to test the RNG for selecting as many as 10 winners from a pool size as large as 1000 as described in Table 2. To provide this level of assessment, GLI selected different test cases for statistical testing. The selection of test cases took into account broad coverage of the RNG parameters listed. A set of numbers is said to be drawn *with replacement* if a number can be selected multiple times within the same draw.

Data Set	Range	Positions	Replacement
General Testing 1	Up to and including 1,000	Up to and including 10	Yes

Table 2. RNG Parameters

For a summary of the statistical tests applied to each data set, see *Appendix A*. For a description of the overall test methodology and a description of each test used, see *Appendix B*.

Overall, the RNG passed the battery of tests for each configuration at the 95%, 98% and 99% confidence levels.

SECTION V — SUMMARY

Overall Evaluation of the Random Number Generator

GLI's conclusion based upon the tests applied to the Microslot RNG data is that this random number generator has exhibited random behavior and is suitable for the applications as described herein. If a game utilizes different RNG parameters than the ones listed in this report, the RNG should be resubmitted to test that set of parameters.

APPENDIX A: STATISTICAL TEST SUMMARY

					Test Names											
Data Set	**Range**	**Positions**	**Replacement**	**Draws**	**Runs**	**Serial Corr.**	**Interplay Corr.**	**Adj. Max-Min**	**Adj. High-Low**	**Coupon**	**Duplicates**	**Overlaps**	**Tot. Dist.**	**Tot. Dist. by Pos.**	**Count of Counts**	**Diehard**
General Testing 1	Up to and including 1,000	Up to and including 10	Yes	①	X	X	X	X	X	X	X	X	X	X	X	
Binary	Not applicable															X

Table 1. Tests Applied

① Different test cases were used for statistical testing while taking into account broad coverage of the RNG parameters listed.

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APPENDIX B: TEST DESCRIPTIONS

1 **Definitions.** The following terms apply to the below test descriptions. Randomness Device or Random Number Generator (RNG) output may be collected multiple numbers at a time. Each set of numbers is called a draw. Each individual number has a particular order within the *draw*. This is referred to as the number *position*.

2 **Distribution Comparisons.** Many of the tests compare an observed numerical distribution with an expected distribution. Unless otherwise specified, this is done by means of a statistical chi-square goodness-of-fit test. The value chi-square is computed in the standard way. If k is a possible value, o_k is the observed count of that value, and e_k is the expected count:

$$\chi^2 = \sum_k \frac{(o_k - e_k)^2}{e_k}$$

In the case where expected counts are too small for accurate use of the above formula, values are 'binned' together to ensure an appropriate minimum expected count. The resultant value for chi-square is compared against the distribution for the appropriate number of degrees of freedom. Unusually high (distribution mismatch) or unusually low (insufficient randomness) chi-square values can be causes for data failure.

3 **Meta-testing**. Evaluation of groups of *p*-values may include a meta-test for extremity of high or low *p*-values, a meta-test for frequency of high or low *p*-values, and a meta-test for uniformity of *p*-values, as appropriate.

4 **Confidence Level**. The statistical tests conducted by GLI are done at a particular *confidence level*. Common confidence levels used include 95%, 98%, and 99%, depending on jurisdictional requirements, and intended use of the RNG. High confidence level testing has low risk of mistakenly failing a good RNG, but higher risk of passing a bad RNG. Lower confidence level testing has increased power of detecting bad RNGs, while also increasing the risk of false failures of good RNGs. Specifically, the confidence level represents the probability that an ideal source of randomness would pass the testing. If an RNG passes statistical tests at a given confidence level, passage at all *higher* confidence levels is implied.

5 **Tests**. Some tests are only applicable to certain types of data. Some tests may be applied only to a portion of the data. Some tests may require that the data be parsed, binned, or otherwise transformed, as necessitated by data format.

APPENDIX B: TEST DESCRIPTIONS

Adjacency High-Low:

For each draw, the number of local extrema ('highs' and 'lows') in the data is recorded and compared with the expected distribution. These are also referred to as 'turning points'. For example, if a draw consists of the numbers

$$1, 3, 5, 7, 2, 9$$

there would be one local maximum (7) and one local minimum (2). The resulting statistic would be 2.

Adjacency Max-Min:

For each draw, the difference between the maximum and minimum values is calculated and recorded. This is compared with the expected theoretical distribution. For example, if a draw consists of the numbers

$$2, 3, 6, 7, 4$$

the resulting statistic would be 5, the difference between the maximum value (7) and the minimum value (2).

Count of Counts:

The Count of Counts test first counts the occurrences of each value in each position of the data. These counts are then tallied and compared with the expected distribution of counts for the draw size and range of values.

Coupon Collector's:

The Coupon Collector's Test is applied positionally. The data is parsed until all possible values have been observed, then the number of values checked is recorded and the count is restarted. This is compared with the expected distribution. For example, if the set of all possible values is {0, 1, 2} and the first position of each draw is

$$1, 0, 1, 0, 2, 0, 1, 2, \ldots$$

then all values are observed in the first position by the fifth draw. All values are then observed within the next 3 draws, so the first two statistics for the first position would be 5 and 3.

DieHard:

The DieHard Battery of Tests is a standard assessment of the randomness in raw outcomes generated from an RNG. The collection, designed by George Marsaglia, tests for a variety of patterns in the individual binary bits of RNG output. GLI uses a custom implementation to conduct DieHard testing.

Duplicates:

The Duplicates Test counts the number of times a draw is exactly duplicated in the data. In the case that a particular draw is repeated more than twice, every possible way to generate a duplicate is counted. This is compared against the theoretical distribution to verify that the number of duplicate draws falls within expected bounds. For example, consider the dataset consisting of the following draws of two numbers each.

$$a)\ 1, 3$$
$$b)\ 4, 1$$
$$c)\ 1, 3$$
$$d)\ 1, 3$$
$$e)\ 4, 1$$
$$f)\ 3, 1$$

The duplicate pairs are (*a,c*), (*a, d*), (*c, d*), and (*b, e*), for a total of 4 duplicates. *(f)* is not counted as a duplicate since the draw must match in order as well as values.

APPENDIX B: TEST DESCRIPTIONS

Interplay Correlation:

The Interplay Correlation Test measures statistical correlation between different positions of the same draw. For each pair of positions, statistical correlation is calculated as in the Serial Correlation Test. In the case of without replacement data, an adjustment is made to account for the expected resulting negative correlation.

Overlaps:

The Overlaps Test compares consecutive draws for overlapping values. The number of overlapping values is recorded for each pair of draws. This observed distribution of overlaps is then compared against the expected distribution. For example, if the following draws are observed consecutively,

$$a)\ 1,4,5,6$$
$$b)\ 4,1,7,6$$

the number of overlaps would be 3, representing the values 1, 4, and 6.

Runs:

The Wald-Wolfowitz Runs Test is applied to each position within the draw. A center is established, typically the data median, and the number of 'runs' above and below the center are tallied. Values exactly equal to the center are discarded. This is compared to the expected distribution, which depends on the number of values above and below the center. For example, if the numbers drawn at a particular position were

$$2,3,1,5,4,7,3,2,3,2,3,2,6,7,3,5$$

and the established center were the data median of 3, the data would be parsed for runs above 3 and runs below 3.

$$\underbrace{2,3,1},\overbrace{5,4,7,3},\underbrace{2,3,2,3,2},\overbrace{6,7,3,5}$$

This would be counted as 4 runs.

Serial Correlation:

The Serial Correlation Test measures statistical correlation between consecutive draws of the same position. For each position, the sample Pearson correlation coefficient is calculated. If *X* represents the first number, and *Y* the number that follows, then the coefficient is

$$r = \frac{cov(X,Y)}{s_X s_Y}$$

where *s* denotes the sample standard deviation. The coefficients are used to generate a *p*-value for each position.

Total Distribution:

The Total Distribution Test is a simple tally of all observed values throughout the data. This is compared with the expected distribution. Typically the expected distribution is a uniform distribution. In the case of unequal weighting of values, an appropriate discrete distribution is used.

Total Distribution by Position:

The Total Distribution by Position Test tallies the observed distribution of values for each position within the draw. Each of these distributions is then compared with the expected.