# BMM EVALUATION TEST REPORT

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| **Report Issue Date:** | 5th February, 2015 |
| **Issued To:** | Interprod S.A. |
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| **Evaluation By:** | BMM Testlabs<br>815 Pilot Road, Suite G<br>Las Vegas, NV 89119 |
| **Manufacturer:** | Interprod S.A.<br>Nogoyá. 4839<br>CP 1417, Ciudad Autónoma de Buenos Aires<br>Argentina |
| **Evaluation for:** | Interprod RNG v1.0.5512 |
| **Reference Numbers:** | |
| **BMM:** | ITP.1002 |
| **Report Number:** | ITP10021_E |

## 1. STANDARD

| Technical Standard used for Compliance Evaluation: | Test Result | |
|---|---|---|
| | Pass | Fail |
| GLI-11, Standards for Gaming Devices in Casinos v2.1, dated August 25, 2011 | ☑ | ☐ |

## 2. PURPOSE

Interprod S.A. has requested BMM to perform an evaluation of the Interprod RNG v1.0.5512. The evaluation was conducted against the aforementioned industry recognized standards for Random Number Generator (RNG) testing.

This evaluation includes an assessment of the algorithm implemented within the Interprod RNG v1.0.5512.

## 3. SCOPE OF WORK

The evaluation of the Interprod RNG v1.0.5512 consisted of a source code review and empirical statistical tests. The Interprod RNG v1.0.5512 has a period of $2^{19937} - 1$. The implementation uses the current time as a seeding method.

The source code review confirms the proper usage of the RNG algorithm including:

- That the draw RNG algorithm is capable of generating numbers or values that are scaled accurately for the system design.
- The method of generating these numbers or values is unbiased and unpredictable.
- The RNG itself is implemented into the system source code properly.
- The RNG program does not contain any malicious code that could significantly affect the outcome of the RNG.

The industry recognized standard for statistical testing includes, but is not limited to: Chi-squared, Simple Number Frequency, Correlation tests, Run, Gap, Birthday Spacing, Coupon Collector, and Die Hard suite of tests. BMM also tested samples for generation and use without replacement. These tests are intended to verify the statistical properties of the RNG output and demonstrated the correct use of the RNG. Refer to Appendix 2 for a detailed explanation of the tests performed.

## 4. EVALUATION RESULTS

The source code review of the RNG and empirical statistical RNG testing of the Interprod RNG v1.0.5512 confirms:

- No secondary decision within the overall Interprod RNG v1.0.5512.
- That the draw RNG algorithm is capable of generating numbers or values that are scaled accurately for the system design.
- The method of generating these numbers or values is unbiased and unpredictable.
- The RNG itself is implemented into the system source code properly.
- The RNG program does not contain any malicious code that could significantly affect the outcome of the RNG.
- The overall results of the statistical tests are probabilities that are expected to be uniformly distributed between zero (0) and one (1). Refer to Appendix 3, which contains a chart showing the distribution of the overall test results as well as specific charts for the Frequency, Gap, and Coupon tests.

## 5. EVALUATION DETAILS

### 5.1. Software Version Details:

The following table details the relevant information for the Interprod RNG v1.0.5512 that has been evaluated as compliant to aforementioned RNG Technical Standard:

| Version* | File Name | SHA-1 Signature | Validation Program Used |
|---|---|---|---|
| Release | MersenneTwister.dll | 277AA6D1925963EA487F81915D7A7220E17DC848 | BMM Signatures v2.0 |
| Debug | | 57C8020EAF3508485D4B11B0AB6025EA3040C731 | |

**Version represents the two (2) methods of compilation; Release for a production environment and Debug for error checking.*

***Note**: Refer to Section 5.2 for verification tools used.*

### 5.2. Software Signature Verification Information:

**Signature Verification Application:**

(1) The SHA-1 signatures were calculated and verified using the BMM Signatures proprietary verification tool, which has been calibrated in accordance with ISO/IEC 17025 sections 5.5.2, 5.5.a, 5.5.c, and 5.5.8; as well as ISO/IEC 17020 sections 9.4, 9.6.b, 9.13.a, and 9.15.

(2) Where requested, BMM will supply the regulator/operator with BMM's proprietary verification tool "BMM Signatures" for verifying the SHA-1 details above. A user manual will also be supplied.

**Signature Verification Procedure:**

- Install BMM Signatures v2.0 on the computer to be used for software verification and double click on the "BMM Signatures 2.0" icon.
- The BMM Signatures program will open.
- Copy the files listed in Section 5.1 to a location of your choosing.
- Select the "browse files" icon in BMM Signatures and browse to the location of the files saved from the previous step.
- Select the "Open" button from the window. The file(s) will appear on the right side of the screen.
- Click the desired algorithm to use (e.g. SHA-1). When the program is completed, the signatures will be displayed in the Output window.

## 6. ADDITIONAL NOTES

- Appendix 1 Table of RNG Statistical Tests Results gives the results of the different RNG tests.
- Appendix 2 Definition of Statistical Tests gives the details of tests performed during the RNG evaluation.
- Appendix 3 Overall RNG Statistical Tests, Frequency, GAP, Coupon Test Results contains a chart showing the distribution of test results.

## 7. TERMS AND CONDITIONS

BMM Testlabs (BMM) has conducted a level of testing of the gaming product which has historically been adequate for a submission of this type. This evaluation report is for use by the named manufacturer and only evaluates the gaming product described in the report and is subject to any conditions or limitations set out in the report.

The manufacturer named in the report is solely responsible for holding the appropriate licensing within any gaming jurisdiction in which they intend to use this gaming product in the supply of gaming products or services. It is the responsibility of the manufacturer and operators to ensure that the gaming product evaluated in this report is maintained and operated correctly, without defects and safely within the venue environment.

This report shall not be reproduced, except in full, without the written approval of BMM. Upon request by an authorized party, BMM will send this evaluation report via email as directed. BMM takes the precautionary measures to secure the "PDF" document but BMM does not send the email via any encrypted methodology when requested by an authorized party.

Please feel free to contact BMM Testlabs if you have any questions in regards to this evaluation report.

Yours sincerely,

Travis Foley
Executive Vice President, Operations
BMM Testlabs

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**Appendix 1:**

## Table of RNG Statistical Tests Results

| Random Number Statistical Tests | Test Result | | | |
|---|---|---|---|---|
| | Pass | Fail | Not Tested | N/A |
| Chi-Square Analysis | ☑ | ☐ | ☐ | ☐ |
| Frequency Test | ☑ | ☐ | ☐ | ☐ |
| Pair Correlation Test | ☑ | ☐ | ☐ | ☐ |
| Triples Correlation Test | ☑ | ☐ | ☐ | ☐ |
| Quads Correlation Test | ☑ | ☐ | ☐ | ☐ |
| Runs Up Test | ☑ | ☐ | ☐ | ☐ |
| Runs Down Test | ☑ | ☐ | ☐ | ☐ |
| Serial Correlation Test | ☑ | ☐ | ☐ | ☐ |
| Gap Test | ☑ | ☐ | ☐ | ☐ |
| Coupon Test | ☑ | ☐ | ☐ | ☐ |
| Birthday Spacing Test | ☑ | ☐ | ☐ | ☐ |
| Overlapping 5-Permutation Test | ☑ | ☐ | ☐ | ☐ |
| Binary Rank Test | ☑ | ☐ | ☐ | ☐ |
| Bitstream Test | ☑ | ☐ | ☐ | ☐ |
| OPSO (Overlapping Pairs Sparse Occupancy) Test | ☑ | ☐ | ☐ | ☐ |
| OQSO (Overlapping-Quadruples-Sparse-Occupancy) Test | ☑ | ☐ | ☐ | ☐ |
| DNA Test | ☑ | ☐ | ☐ | ☐ |
| Count-The-1's Test | ☑ | ☐ | ☐ | ☐ |
| Parking Lot Test | ☑ | ☐ | ☐ | ☐ |
| Minimum Distance Test | ☑ | ☐ | ☐ | ☐ |
| 3D Spheres Test | ☑ | ☐ | ☐ | ☐ |
| Squeeze Test | ☑ | ☐ | ☐ | ☐ |
| Overlapping Sums Test | ☑ | ☐ | ☐ | ☐ |
| Craps Test | ☑ | ☐ | ☐ | ☐ |
| Kolmogorov–Smirnov (KS) Test | ☑ | ☐ | ☐ | ☐ |

**Appendix 2:**

## Definition of Statistical Tests

The Chi-Square statistical analysis verifies the distribution of the sum of the squared deviations.

The Frequency statistical analysis consists of the categorization of data. In an RNG sense, it is the number of times a specific number occurs over the entire sample of data.

The Pair Correlation statistical test analyzes the relationship between two (2) numbers. In an RNG sense, the first two (2) numbers produced by the RNG are tested to see if there is a relationship between the two. Then the second number and the third are compared. And so on.

The Triples Correlation statistical test analyzes the relationship between three (3) numbers. In an RNG sense, the first three (3) numbers produced by the RNG are tested to see if there is a relationship between the three. Then the second, third, and fourth numbers are compared. And so on.

The Quads Correlation statistical test analyzes the relationship between four (4) numbers. In an RNG sense, the first four (4) numbers produced by the RNG are tested to see if there is a relationship between the four. Then the second, third, fourth, and fifth numbers are compared. And so on.

The Runs Up statistical analysis looks for trends in the sequence of numbers produced by the RNG. For example, if the first numbers are 0, 6, 9, 11, 12, and 10, then there is a run up of five (5) numbers and the count starts over again, the total number of runs-up are then compared to the total samples produced.

The Runs Down statistical analysis looks for trends in the sequence of numbers produced by the RNG in the opposite directions of the Runs Up test.

The Gap Test counts the number of gaps between numbers produced by the RNG and then compares it to the total sample size.

The Birthday Spacing Test counts how many times there are any equal spacing in groups of numbers.

The Coupon Test counts how many numbers it takes to complete a set. The RNG output is analyzed for this type of trend.

The Serial Correlation Test looks for repeating patterns within the RNG output.

The Overlapping 5-Permutation Test divides the input data into a stream of bytes, and it considers five (5) bytes at a time. It compares the ordering of the five (5) numbers. There are 120 (5!) possible arrangements of ordering of these and each ordering should be equally probable.

The Binary Rank Test is for different sizes of matrices of the RNG output. Depending on the matrix size, a thirty-two (32) bit random integer from the RNG output creates the matrix. The ranks of the different matrices are determined. A chi-square analysis is performed on the counts of the ranks. This is performed with 32x32, 31x31, and 6x8 matrices.

The Bitstream Test looks at the files as a stream of bits. When broken into twenty (20) bit overlapping words, the test counts the number of missing twenty (20) bit words.

The OPSO (Overlapping Pairs Sparse Occupancy) Test looks at the RNG output files in a sense of two (2) letter words from an alphabet of 1024 letters and looks for the missing letters.

## Definition of Statistical Tests (Appendix 2 continued)

The OQSO (Overlapping-Quadruples-Sparse-Occupancy) Test looks at the RNG output files in a sense of four (4) letter words from an alphabet of thirty-two (32) letters. The test then looks for the missing letters.

The DNA Test considers an alphabet of four (4) letters C, G, A, and T. Two (2) designated bits determine these letters in the sequence from the RNG output files. It considers ten (10) letter words and looks for the missing words similar to the OPSO and OQSO tests.

The Count-The-1's Test looks at the files as a stream of bytes. Each byte may contain a number from zero (0) to eight (8) ones, with given probabilities. When these bytes are overlapping they can be put into five (5) letter words where each letter could be A, B, C, D or E. The test then verifies the frequencies of each word. This test is then repeated on designated bytes.

The Parking Lot Test considers a square with a side of 100. Then the file is read and each value is attempted to "park" within the square. The number of success verses attempts is then analyzed.

The Minimum Distance Test is performed one hundred (100) times. From the RNG output file 8,000 random points in a square 10,000x10,000 are chosen. The minimum distance between the pairs of points is analyzed.

The 3D Spheres Test picks 4,000 random points from the RNG output file within a cube 1,000x1,000x1,000. At each point, a sphere is mapped to be large enough to reach the next point. The radius of each sphere is cubed and should be within the mean of thirty (30).

The Squeeze Test finds out how many iterations of k are required to reduce k to one (1). The starting value of k equals $231^{-1}$. The iteration process uses the formula *k=k*uni()+1* where uni() is a sequence of random integers from the RNG output file. The number of iterations is found to reduce k to 1 and then the reduction over again 100,000 times with a different sequence of random integers from the RNG output file. The number of iterations is then analyzed with a chi-square test for cell frequencies.

The Overlapping Sums Test uses a series of integers from the RNG output file and then they are made into floating point numbers over a range of (0, 1). Then they are summed in an overlapping series of 100. The sums are normalized with a specified covariance matrix. These values are then converted to uniform variables for the Kolmogorov–Smirnov (KS) test.

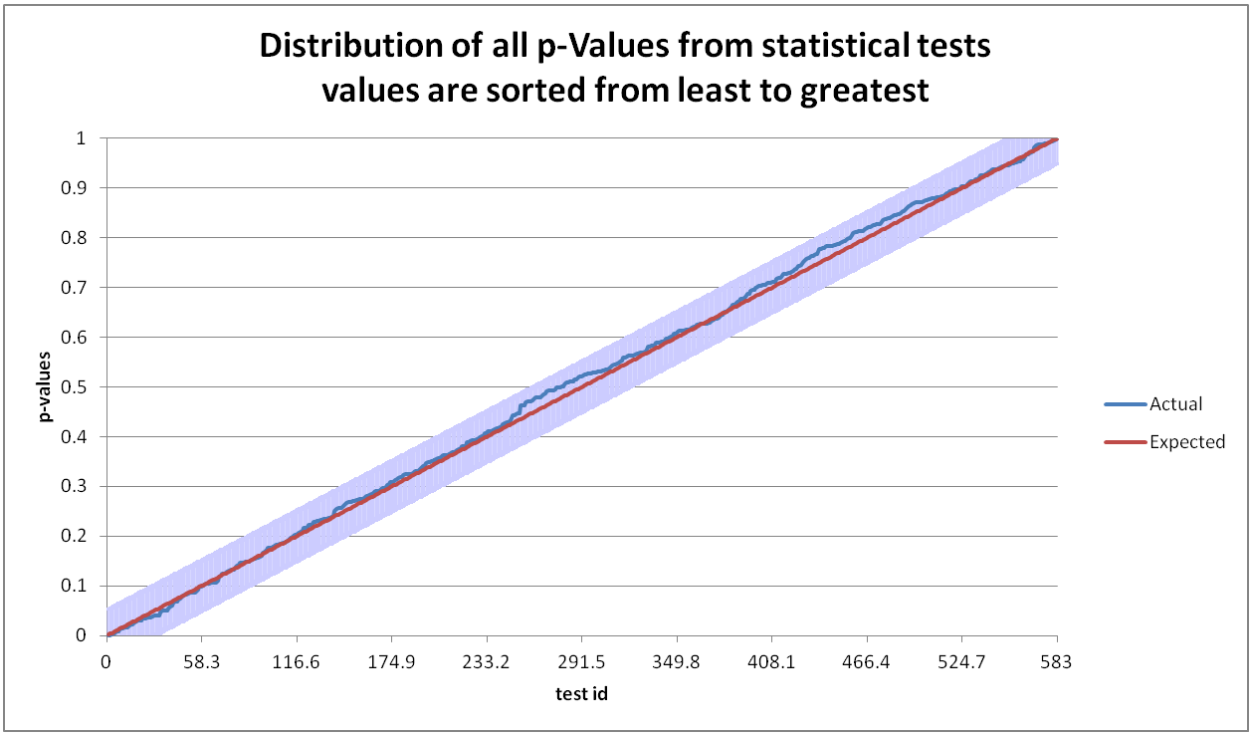
The Craps Test uses thirty-two (32) bit values from the RNG output files as the results of 200,000 games of craps. The number of wins should have a normal with a mean of 200,000p and variance of 200,000(1-p) where p= 244/495. The throws necessary to complete the game can vary from one to infinity, but counts for all throws greater than twenty-one (21) are lumped with twenty-one (21). A chi-square test is conducted over the number of throws frequency counts.

The Kolmogorov–Smirnov (KS) Test determines if two datasets differ significantly in the form of minimum distance estimation.

**Appendix 3:**

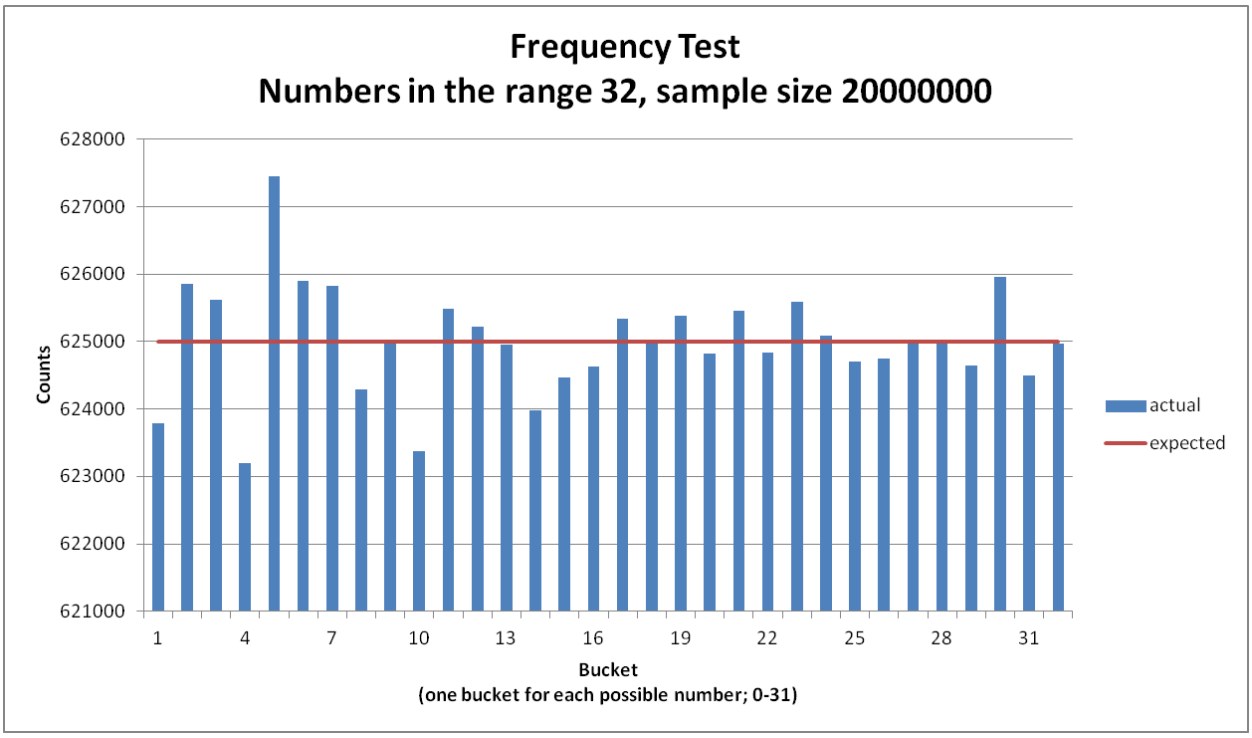
## Overall RNG Statistical Tests, Frequency, GAP, Coupon Test Results

The results of the Statistical tests are probabilities that are expected to be uniformly distributed between zero (0) and one (1). This chart shows those test results plotted against an expected result indicator of perfect distribution from zero (0) to one (1) with error bars for a fixed 0.05 error shown. This shows that the RNG stays within the expected outcome and produces statistically strong random numbers.



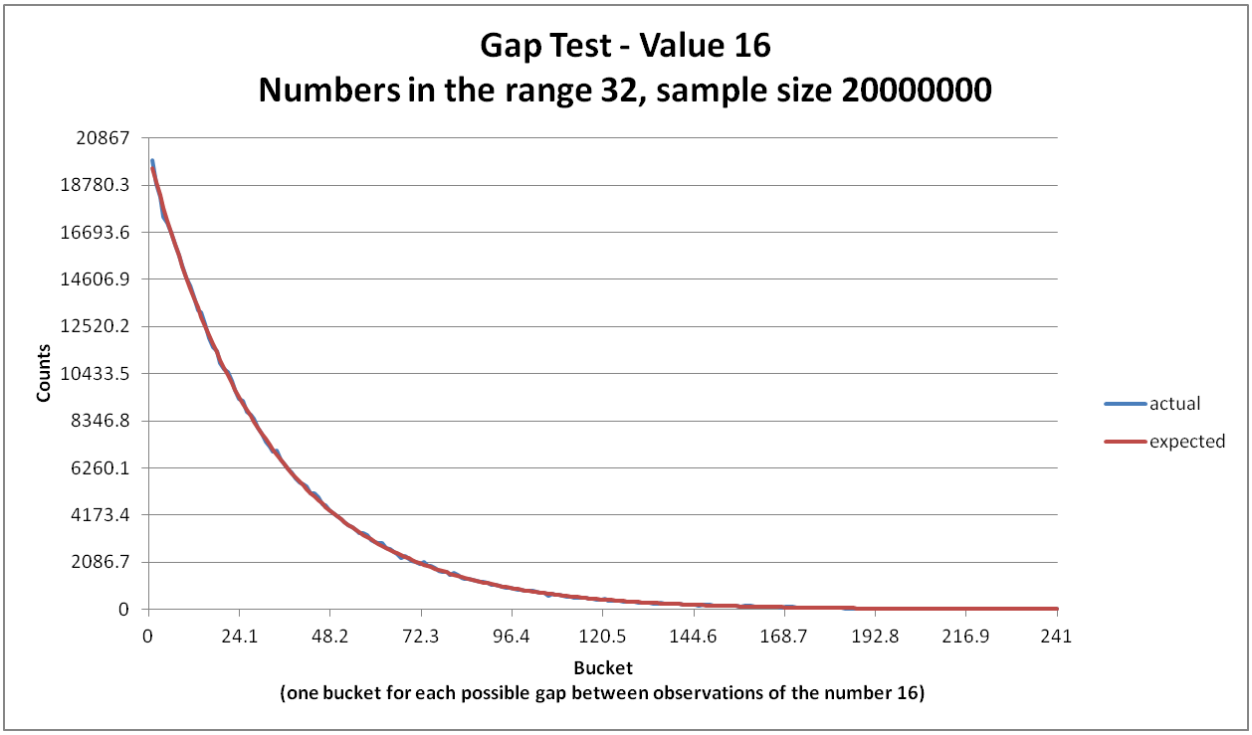
**Appendix 3 Continued (Frequency Test):**

The Frequency test chart for the range of numbers from zero (0) to 31 with 20,000,000 samples displays the possible total count of each number and the actual total count of each number.



**Appendix 3 Continued (Gap Test):**

The Gap test chart for the number sixteen for 20,000,000 RNG samples generated with a range between zero (0) and 31. This test measures the expected distance between each occurrence of the number sixteen (16) and the actual distance between each occurrence over 20,000,000 RNG samples.



**Appendix 3 Continued (Coupon Test):**

The Coupon test chart is for the range of numbers from zero (0) to 31 with 20,000,000 samples displays the possible number of selections required for a full set of numbers of zero (0) through 31.