This document will discuss the results from running the NIST tests for the FPGA-produced data. The experimental setup is from Chapter 6 in this paper:

https://brage.bibsys.no/xmlui//handle/11250/144360

The design under test is of 50 parallel ring oscillators on a Cyclone V operating at a sampling frequency of 275 MHz. Currently, a contiguous chunk of data is collected at a Linux host from the FPGA via UDP-packets until packets are re-ordered or dropped. The FPGA is then reset and the process is repeated until all of the collected data sets sum up to the necessary size for testing. A program concatenates these sets together into one file, then this is processed by the NIST testing script.

These tests and the NIST Special Publication 800-22rev1a documentation are provided at this link:

http://csrc.nist.gov/groups/ST/toolkit/rng/documentation_software.html

From the script options, you can select which input file/PRNG generator to use, which tests to perform, the option to change from some of the default parameters for the various tests, the amount of samples to analyze, and finally the individual sample size. After selecting these options, the individual tests will be run and a report will be given on the results for the uniformity of P-values and the proportion of passing sequences. To make sense of that statement, I will give a brief overview of the underlying statistics.

Page 15 of the NIST document provides information on Null&Alternative Hypotheses/Type I&II errors. The Null Hypothesis under test is that the data under test from the FPGA is truly random. Two unwanted results could occur from the statistical test on the Null Hypothesis of RNG data output, false negatives (reject the Null Hypothesis when the data is truly random, that would be the Type I error) or false positives (reject the Alternative Hypothesis of non-randomness when the data is not random, that would be the Type II error).

The NIST document describes how the frequency of a Type I error is set by us. This is the level of significance of the test, a visualization of that concept can be found here:

http://blog.minitab.com/blog/adventures-in-statistics-2/understanding-hypothesis-tests:-significance-levels-alpha-and-p-values-in-statistics

The NIST document also describes that the sample size, frequency of a Type I error, and frequency of a Type II error are related. On page 16, it claims that if the sample size and probability of a Type I error are fixed, then the probability of a Type II error is automatically determined. This link has a visualization of the relationship between the Type I and Type II error interactions for a particular statistical distribution, of note is that the alternative hypothesis can take many different forms (in our case, there are an infinite number of ways that a RNG can be non-random) which makes the calcuation of the Type II error probability challenging:

http://stats.stackexchange.com/questions/59202/stats-relationship-between-alpha-and-beta

It is claimed by the NIST paper that a goal of these statistical tests is to minimize the Type II error. It is also claimed that this goal will be met if a particular test's recommended sample size is met when using the default level of significance of 0.01. For now, I will take this assertion at face value.

Preliminary results were generated from analyzing FPGA data sets with the default script settings, 1000000 bits/sample, and 1000 samples. The NIST paper describes the minimum input size recommendation for each test – I believe that 1000000 bits/sample is the minimum to satisfy the requirement for most if not all of the tests.

With all of the above in mind, I'll talk about the script's reporting of the proportion of passing sequences. For all of the tests, P-values are generated for each provided sample. Each value is to be interpreted as the probability that a perfect random number generator would generate a sample that is less random than what was provided in the particular sample. When this P-value is less than the significance level, this is a rejection of the Null Hypothesis. The implication here is that, assuming that the FPGA is actually providing random data, we expect to reject the Null Hypothesis 1% of the time due to our setting of the Type I error rate. From this observation, page 90 of the NIST document describes how to contruct a confidence interval around the expected 99% pass rate using the significance level of the test and the number of samples. If the pass rate falls out of the confidence interval, the report will flag the test's aggregate result as evidence of non-randomness.

The final report of the script will also analyze the uniformity of P-values under the Null Hypothesis. A histogram of these P-values could be enlightening, this link describes how to interpret the shape at a glance:

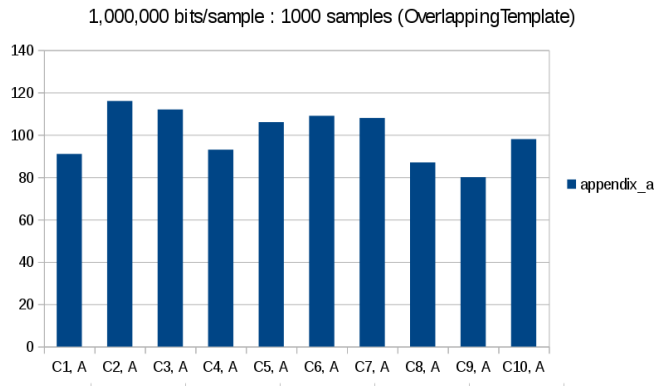
http://varianceexplained.org/statistics/interpreting-pvalue-histogram/

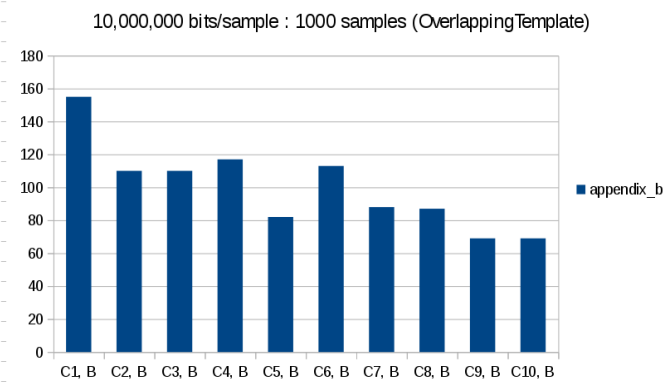
If the FPGA is providing sufficiently random data, the histogram of P-values should look like Scenario B from the link. If the Null Hypothesis of randomness is incorrect, we should expect Scenario A. As an alternative to the eyeball test, page 91 of the NIST document describes how to use a Goodness-of-Fit Distributional Test to determine if the P-value histogram is sufficiently uniform. If it is not, the report will flag the test's nonuniformity as evidence of non-randomness.

Results (Updated: 12jan2017)

Three complete report files are in the Appendices at the end of this paper. Appendix A reflects my typical experiment: 1,000,000 bits/sample and 1000 samples. I have performed 6 tests where the sampling frequency changes and different choices of postprocessing and they all perform similarly. Either every test passes on both the proportion and uniformity tests or there exists one test where a proportion test value is observed to be slightly outside of the confidence interval.

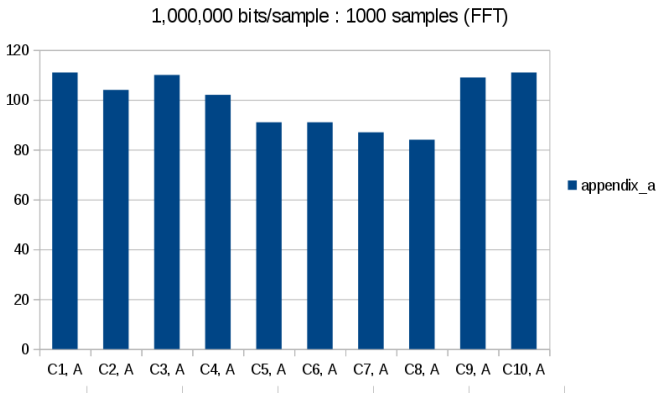
Appendix B shows a test where I test on 10,000,000 bits/sample and 1000 samples. The NIST document provides the minimum input size recommendation for each test, so I assumed that I would obtain a similar result if I increased the former number. For the OverlappingTemplate test, however, I failed the proportion test and the uniformity test. Comparing the histogram of that test from the result in Appendix A, it looks like statistically significant evidence exists for rejecting the Null Hypothesis:

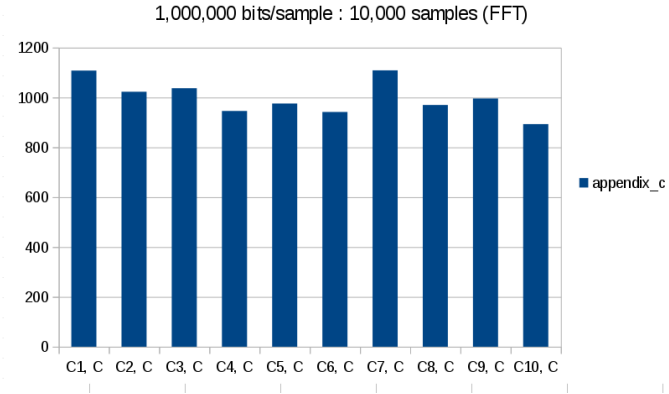




I have performed two additional tests on different data sets with the same parameters as used in Appendix B. The results are similar – failure in the proportion test and the uniformity test for the OverlappingTemplate test with histograms that behave similarly to the previous 10,000,000 bits/sample trials.

Appendix C shows an experiment where I test on 1,000,000 bits/sample and 10,000 samples. I assumed that these additional trials would cause a similar result to the one obtained in Appendix A. For the FFT test, however, I slightly failed the proportion test and the uniformity test. Comparing the histogram of that test from the result in Appendix A, it looks uniform enough but somewhat strange compared to the six expected histogram distributions in the previous link:





I have performed two additional tests on different data sets with the same parameters as used in Appendix C. The end results are similar in that one or a few narrow failures are observed. No uniformity tests failed, however, and pass proportion failures were observed on different tests for the new data sets. For one data set, one of the pass ratios of the NonOverlappingTemplate tests was judged to be narrowly above the confidence interval. The other data set had pass ratios that were a bit too low for the FFT, OverlappingTemplate, and Universal tests.

Potential Pitfalls of Using Only P-value Analysis with Large Sample Sizes

For the failing tests described above, the experiment as set up by NIST Special Publication 800-22rev1a is evidence that the Null Hypothesis of *perfect* randomness does not hold. No statement is made of the *magnitude* of the difference between reality and the theoretical expectation, however. With the larger sample size, though, it is claimed that statistical tests are more sensitive to smaller differences between expectation and reality. In other words, a larger sample provides a smaller effect

size.

The NIST script performs tests on statistical significance – where it detects whether the provided data sequence from the FPGA is likely due to chance. This is only one part of performing proper statistical analysis, however, according to this resource:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3444174/

This link discusses the importance of understanding the effect size as well to determine the magnitude of the difference between expectation and reality. Unfortunately, the NIST document provides no guidance to adapt the test suite to measure this. Effect sizes are related to the power of the test which is found from the knowledge of the Type II error rate. No information was given to perform the calculation of that rate.

Two strategies could be used, using the above observations. Using 1000000 bits/sample and 1000 samples for the tests satisfies all of the concerns in the NIST document, but there is an unknown amount of deviation from perfect randomness that will be allowed for those sizes (the former for the individual tests, the latter for the uniformity test). These allowed deviations are not quantified by the NIST paper. Either we aren't bothered by this (1000000 bits/sample is the minimum size required for some tests and 1000 samples were selected in the example analysis of the confidence interval), or we'll have to calculate the power level of the individual tests in order to make sense of the results from using the larger sample sizes.

Open Concerns/Questions

Would it be important to find a way to continuously collect the whole block of data to be tested from the FPGA? I am currently making sure that I'm using a multiple of the 1000000 bits/sample number per file to ensure that I'm not making a discontiguous block of FPGA-produced numbers. It seems that if the circuit in the FPGA is behaving like a TRNG, there shouldn't be any introduction of a deterministic, repeated element when I reset and collect more data (but I can't be absolutely confident of this).

For the Goodness-of-Fit Distributional Test for uniformity on page 91, how did they decide on the P-value to use for this?

Appendices

```
Interpret C1...C10 as a histogram of P-values from [0.0-0.1 …. 0.9-1.0].  If an asterisk is by the P-
value or Proportion, interpret this as evidence of nonuniformity.
```

Appendix A

```
Report file generated from 1,000,000 bits/sample, 1000 samples (125 MB)
275 MHz fs, 2 registers at outputs of ring oscillators, XOR postprocessing
I have run this test for six different data sets, they all either completely pass like this or have ~1
failure on a proportion test.

------------------------------------------------------------------------------
RESULTS FOR THE UNIFORMITY OF P-VALUES AND THE PROPORTION OF PASSING SEQUENCES
------------------------------------------------------------------------------
   generator is <DataToAnalyze.dat>
------------------------------------------------------------------------------
 C1  C2  C3  C4  C5  C6  C7  C8  C9 C10  P-VALUE  PROPORTION  STATISTICAL TEST
------------------------------------------------------------------------------
109  86 103  96 106  81 103 104 106 106  0.538182    991/1000    Frequency
```

97	108	104	92	114	83	101	96	96	109	0.583145	993/1000	BlockFrequency
106	88	108	86	106	96	105	86	114	105	0.406499	993/1000	CumulativeSums
101	90	113	89	109	96	94	104	113	91	0.544254	993/1000	CumulativeSums
94	123	105	95	93	88	109	89	114	90	0.159910	988/1000	Runs
97	95	104	95	100	104	107	118	87	93	0.655854	991/1000	LongestRun
112	88	111	93	102	99	79	108	90	118	0.125200	990/1000	Rank
111	104	110	102	91	91	87	84	109	111	0.326749	991/1000	FFT
102	79	98	110	95	106	114	85	106	105	0.281232	993/1000	NonOverlappingTemplate
100	90	113	89	92	114	88	110	101	103	0.433590	990/1000	NonOverlappingTemplate
102	105	88	101	92	119	102	86	105	100	0.510153	986/1000	NonOverlappingTemplate
109	88	86	90	111	111	93	94	109	109	0.342451	987/1000	NonOverlappingTemplate
106	106	106	106	83	97	75	122	95	104	0.068571	987/1000	NonOverlappingTemplate
121	101	91	84	105	89	110	94	118	87	0.077131	994/1000	NonOverlappingTemplate
108	98	100	84	110	105	82	105	98	110	0.435430	995/1000	NonOverlappingTemplate
108	90	104	97	94	115	97	99	95	101	0.846338	987/1000	NonOverlappingTemplate
101	63	94	81	96	119	114	109	106	117	0.001173	988/1000	NonOverlappingTemplate
93	114	106	102	115	106	93	97	93	81	0.339271	993/1000	NonOverlappingTemplate
109	102	96	87	103	113	92	88	90	120	0.239266	988/1000	NonOverlappingTemplate
111	86	112	76	102	96	128	95	104	90	0.019056	994/1000	NonOverlappingTemplate
104	93	89	99	94	116	91	108	107	99	0.664168	994/1000	NonOverlappingTemplate
99	92	71	97	112	119	103	96	111	100	0.074330	994/1000	NonOverlappingTemplate
85	92	93	107	99	102	101	115	96	110	0.601766	993/1000	NonOverlappingTemplate
115	94	101	100	106	93	99	99	86	107	0.745908	985/1000	NonOverlappingTemplate
83	109	106	109	99	103	88	102	107	94	0.605916	994/1000	NonOverlappingTemplate
95	108	127	91	116	86	101	91	81	104	0.034031	998/1000	NonOverlappingTemplate
96	96	103	110	88	107	85	107	91	117	0.368587	989/1000	NonOverlappingTemplate
105	89	104	112	94	95	94	96	107	104	0.848027	984/1000	NonOverlappingTemplate
97	108	94	98	96	107	105	101	100	94	0.983453	993/1000	NonOverlappingTemplate
96	98	112	101	106	86	109	116	87	89	0.331408	988/1000	NonOverlappingTemplate
106	112	103	87	82	115	108	104	91	92	0.254411	991/1000	NonOverlappingTemplate
88	90	105	120	113	99	100	103	95	87	0.317565	988/1000	NonOverlappingTemplate
102	98	106	92	116	107	84	100	103	92	0.593478	990/1000	NonOverlappingTemplate
99	84	90	95	102	91	111	120	97	111	0.263572	989/1000	NonOverlappingTemplate
86	98	101	95	100	100	119	90	116	95	0.377007	993/1000	NonOverlappingTemplate
107	103	88	92	103	106	102	102	108	89	0.830808	992/1000	NonOverlappingTemplate
101	95	88	106	130	103	100	87	96	94	0.146982	987/1000	NonOverlappingTemplate
102	105	88	108	121	96	93	86	101	100	0.401199	991/1000	NonOverlappingTemplate
101	92	107	81	112	104	103	108	95	97	0.593478	991/1000	NonOverlappingTemplate
97	98	113	98	106	100	95	111	97	85	0.737915	992/1000	NonOverlappingTemplate
108	95	100	99	93	94	121	108	86	96	0.444691	993/1000	NonOverlappingTemplate
101	105	98	96	103	103	104	101	80	109	0.777265	994/1000	NonOverlappingTemplate
99	95	93	109	107	109	84	106	97	101	0.751866	992/1000	NonOverlappingTemplate
84	97	93	98	95	103	109	99	109	113	0.653773	995/1000	NonOverlappingTemplate
93	102	86	105	95	94	103	98	109	115	0.684890	988/1000	NonOverlappingTemplate
95	91	101	91	101	98	101	107	99	116	0.834308	994/1000	NonOverlappingTemplate
88	101	104	101	119	91	109	91	90	106	0.435430	988/1000	NonOverlappingTemplate
101	112	104	105	89	94	94	104	104	93	0.867692	989/1000	NonOverlappingTemplate
113	97	114	87	100	107	99	85	108	90	0.365253	986/1000	NonOverlappingTemplate
96	99	91	116	103	111	96	104	94	90	0.686955	991/1000	NonOverlappingTemplate
106	112	103	95	89	95	119	81	102	98	0.282626	981/1000	NonOverlappingTemplate
100	87	89	101	100	92	95	115	103	118	0.402962	991/1000	NonOverlappingTemplate
110	102	96	101	103	90	111	87	99	101	0.814724	990/1000	NonOverlappingTemplate
102	96	106	97	106	97	86	109	93	108	0.834308	992/1000	NonOverlappingTemplate
111	77	108	96	95	103	109	91	105	105	0.370262	990/1000	NonOverlappingTemplate
97	101	111	98	109	94	95	96	96	103	0.956729	989/1000	NonOverlappingTemplate
82	103	105	108	102	94	115	100	98	93	0.595549	992/1000	NonOverlappingTemplate
128	103	91	95	106	88	101	86	91	111	0.097159	983/1000	NonOverlappingTemplate
96	123	108	90	88	120	106	90	92	87	0.062427	991/1000	NonOverlappingTemplate
103	100	99	117	106	87	91	110	91	96	0.552383	990/1000	NonOverlappingTemplate
98	96	99	91	104	105	98	109	97	103	0.981940	995/1000	NonOverlappingTemplate
111	110	99	99	94	88	94	96	108	101	0.816537	990/1000	NonOverlappingTemplate
92	100	105	97	101	112	105	90	88	110	0.727851	993/1000	NonOverlappingTemplate
102	101	113	114	78	103	96	96	100	97	0.433590	990/1000	NonOverlappingTemplate
93	104	104	100	111	88	112	99	80	109	0.373625	991/1000	NonOverlappingTemplate
108	81	117	75	103	108	106	95	97	110	0.070737	987/1000	NonOverlappingTemplate
97	79	105	116	105	84	118	101	98	97	0.141256	998/1000	NonOverlappingTemplate
94	86	97	103	113	105	100	116	93	93	0.536163	989/1000	NonOverlappingTemplate
103	88	92	109	100	98	108	96	103	103	0.911413	992/1000	NonOverlappingTemplate
103	104	86	116	93	116	97	102	93	90	0.397688	987/1000	NonOverlappingTemplate
82	93	112	101	116	92	101	106	99	98	0.455937	993/1000	NonOverlappingTemplate
107	98	110	97	103	92	86	97	108	102	0.827279	989/1000	NonOverlappingTemplate
85	94	99	104	90	97	106	90	121	114	0.236810	989/1000	NonOverlappingTemplate
102	93	121	103	101	94	93	97	111	85	0.397688	989/1000	NonOverlappingTemplate
112	88	104	107	96	108	99	94	100	92	0.803720	991/1000	NonOverlappingTemplate

98	104	105	104	106	88	108	100	107	80	0.581082	988/1000	NonOverlappingTemplate
100	100	112	96	97	91	95	97	100	112	0.892036	992/1000	NonOverlappingTemplate
104	89	108	83	96	92	100	105	101	122	0.289667	990/1000	NonOverlappingTemplate
111	96	93	88	87	98	100	106	114	107	0.550347	991/1000	NonOverlappingTemplate
92	87	92	93	107	106	111	103	96	113	0.589341	988/1000	NonOverlappingTemplate
91	110	95	86	102	95	113	101	101	106	0.701366	994/1000	NonOverlappingTemplate
104	95	111	93	81	97	97	112	99	111	0.478839	988/1000	NonOverlappingTemplate
102	79	98	109	96	108	112	83	108	105	0.254411	994/1000	NonOverlappingTemplate
99	76	93	112	117	101	91	109	88	114	0.075254	989/1000	NonOverlappingTemplate
104	100	83	86	110	91	95	110	105	116	0.284024	993/1000	NonOverlappingTemplate
96	110	100	114	102	99	99	98	91	91	0.848027	993/1000	NonOverlappingTemplate
96	96	101	107	98	102	98	116	93	93	0.877083	984/1000	NonOverlappingTemplate
114	104	93	107	109	93	75	94	94	117	0.113372	993/1000	NonOverlappingTemplate
112	91	79	119	104	102	113	89	92	99	0.121616	986/1000	NonOverlappingTemplate
116	95	93	93	84	88	113	95	105	118	0.152902	985/1000	NonOverlappingTemplate
108	108	92	100	110	108	83	107	96	88	0.480771	989/1000	NonOverlappingTemplate
96	93	106	117	116	88	100	96	100	88	0.392456	987/1000	NonOverlappingTemplate
93	90	111	82	105	108	118	94	94	105	0.272977	990/1000	NonOverlappingTemplate
116	84	82	99	88	125	88	93	102	123	0.005516	986/1000	NonOverlappingTemplate
105	100	105	96	94	84	106	100	102	108	0.866097	987/1000	NonOverlappingTemplate
96	109	91	84	108	88	108	105	106	105	0.542228	990/1000	NonOverlappingTemplate
106	104	107	107	104	88	94	96	94	100	0.912724	992/1000	NonOverlappingTemplate
102	93	104	79	97	104	110	101	93	117	0.371941	988/1000	NonOverlappingTemplate
89	95	103	107	106	104	95	103	96	102	0.960198	997/1000	NonOverlappingTemplate
130	96	102	86	87	103	96	107	104	89	0.092041	985/1000	NonOverlappingTemplate
105	101	109	94	76	119	106	101	88	101	0.180568	992/1000	NonOverlappingTemplate
92	109	119	106	106	93	91	99	96	89	0.488534	982/1000	NonOverlappingTemplate
95	103	96	96	96	98	109	101	108	98	0.984415	990/1000	NonOverlappingTemplate
91	109	81	107	104	97	111	111	91	98	0.415422	989/1000	NonOverlappingTemplate
105	89	87	104	89	97	107	97	123	102	0.310049	995/1000	NonOverlappingTemplate
122	98	102	100	93	99	91	99	102	94	0.674543	993/1000	NonOverlappingTemplate
100	119	87	106	84	84	98	96	104	122	0.067300	990/1000	NonOverlappingTemplate
108	112	90	92	94	89	107	101	94	113	0.550347	988/1000	NonOverlappingTemplate
94	124	90	89	104	96	94	119	91	99	0.143686	994/1000	NonOverlappingTemplate
63	108	104	100	123	87	111	120	89	95	0.000904	987/1000	NonOverlappingTemplate
108	103	103	82	92	96	102	86	110	118	0.268917	989/1000	NonOverlappingTemplate
114	97	103	92	88	106	102	112	98	88	0.581082	991/1000	NonOverlappingTemplate
97	112	112	93	117	108	77	105	81	98	0.063217	987/1000	NonOverlappingTemplate
101	98	86	110	97	99	103	100	108	98	0.919131	989/1000	NonOverlappingTemplate
86	95	100	112	101	99	84	107	106	110	0.526105	995/1000	NonOverlappingTemplate
124	111	106	97	80	105	88	106	91	92	0.093157	987/1000	NonOverlappingTemplate
84	98	100	106	107	105	97	94	102	107	0.861264	992/1000	NonOverlappingTemplate
107	98	84	99	102	112	94	86	115	103	0.415422	989/1000	NonOverlappingTemplate
108	96	104	79	96	121	74	105	105	112	0.028434	988/1000	NonOverlappingTemplate
89	105	103	91	89	97	124	114	90	98	0.190654	991/1000	NonOverlappingTemplate
114	105	78	90	98	98	103	97	114	103	0.322135	990/1000	NonOverlappingTemplate
96	98	93	105	103	110	102	104	91	98	0.961039	990/1000	NonOverlappingTemplate
98	84	94	119	98	107	107	98	94	101	0.534146	995/1000	NonOverlappingTemplate
83	112	97	111	107	98	102	96	94	100	0.666245	995/1000	NonOverlappingTemplate
98	107	102	93	96	92	116	96	90	110	0.680755	992/1000	NonOverlappingTemplate
107	99	100	88	94	95	105	97	92	123	0.454053	990/1000	NonOverlappingTemplate
88	99	113	104	100	94	98	101	105	98	0.911413	986/1000	NonOverlappingTemplate
100	97	90	103	117	97	112	83	100	101	0.484646	993/1000	NonOverlappingTemplate
93	91	100	112	96	104	101	100	87	116	0.603841	991/1000	NonOverlappingTemplate
109	98	92	106	103	108	84	87	107	106	0.566688	987/1000	NonOverlappingTemplate
95	99	91	104	104	85	99	93	117	113	0.463512	995/1000	NonOverlappingTemplate
101	107	99	111	101	100	102	105	96	78	0.635037	991/1000	NonOverlappingTemplate
112	91	104	107	103	90	110	91	98	94	0.719747	988/1000	NonOverlappingTemplate
88	97	107	116	87	97	111	90	114	93	0.274341	990/1000	NonOverlappingTemplate
107	95	101	97	104	87	93	110	92	114	0.660012	994/1000	NonOverlappingTemplate
100	98	105	106	108	86	105	108	96	88	0.765632	993/1000	NonOverlappingTemplate
92	110	90	102	100	101	108	97	103	97	0.935716	990/1000	NonOverlappingTemplate
107	108	108	104	110	97	85	86	99	96	0.595549	987/1000	NonOverlappingTemplate
96	91	116	117	97	80	105	99	105	94	0.250558	988/1000	NonOverlappingTemplate
104	91	103	114	109	110	94	95	89	91	0.589341	990/1000	NonOverlappingTemplate
110	112	109	83	118	89	98	81	89	111	0.054314	995/1000	NonOverlappingTemplate
91	108	106	82	92	119	106	93	106	97	0.304126	990/1000	NonOverlappingTemplate
93	89	103	84	95	126	106	94	101	109	0.167184	993/1000	NonOverlappingTemplate
107	110	112	99	93	90	96	96	98	99	0.851383	993/1000	NonOverlappingTemplate
107	99	94	93	123	100	103	93	87	101	0.444691	991/1000	NonOverlappingTemplate
94	108	99	93	90	100	98	116	88	114	0.484646	986/1000	NonOverlappingTemplate
98	102	103	84	103	100	100	97	102	111	0.900569	988/1000	NonOverlappingTemplate
93	106	114	78	102	111	103	93	95	105	0.352107	993/1000	NonOverlappingTemplate
112	102	101	93	112	92	104	89	94	101	0.759756	987/1000	NonOverlappingTemplate

```
106 106  95 110  85 106 108 102  96  86  0.597620    994/1000    NonOverlappingTemplate
 85 101  88  95 100 111 108 102 102 108  0.686955    992/1000    NonOverlappingTemplate
 98 108  89 108 101  94  97 106  93 106  0.897763    989/1000    NonOverlappingTemplate
109 101 102 103 104 110  96  87 103  85  0.709558    989/1000    NonOverlappingTemplate
101  82 115  99  89 117 104  81 107 105  0.118120    990/1000    NonOverlappingTemplate
 98 122 101  79  85 101 123  94  95 102  0.041438    989/1000    NonOverlappingTemplate
105  94 111  92  82  97  98 111  99 111  0.508172    988/1000    NonOverlappingTemplate
 91 116 112  93 106 109 108  87  80  98  0.169981    993/1000    OverlappingTemplate
123 114  92  92  93 102 100  98  93  93  0.344048    987/1000    Universal
 98 107 105 102 107  95  96 101  94  95  0.984881    992/1000    ApproximateEntropy
 78  66  49  68  44  65  53  68  61  53  0.057449    595/605     RandomExcursions
 59  60  54  65  70  57  71  50  62  57  0.663130    591/605     RandomExcursions
 51  60  69  56  57  65  65  54  63  65  0.824022    600/605     RandomExcursions
 56  48  74  59  44  72  57  60  67  68  0.101010    599/605     RandomExcursions
 64  47  60  73  61  57  58  58  68  59  0.607646    598/605     RandomExcursions
 63  64  69  68  53  63  54  54  54  63  0.764655    599/605     RandomExcursions
 60  62  56  59  62  47  70  57  66  66  0.714660    597/605     RandomExcursions
 59  52  64  52  71  63  78  65  47  54  0.128998    595/605     RandomExcursions
 52  60  61  53  78  80  63  56  54  47  0.037566    600/604     RandomExcursionsVariant
 49  65  61  63  63  74  63  49  72  46  0.127762    600/605     RandomExcursionsVariant
 54  51  69  59  61  62  74  61  54  60  0.607646    601/605     RandomExcursionsVariant
 50  58  59  70  55  62  68  53  72  58  0.509162    603/605     RandomExcursionsVariant
 51  63  65  64  61  61  57  69  63  51  0.815027    602/605     RandomExcursionsVariant
 50  61  65  67  65  63  61  68  53  52  0.694171    598/605     RandomExcursionsVariant
 50  59  70  58  62  64  62  54  58  68  0.783973    598/605     RandomExcursionsVariant
 39  70  62  67  56  63  54  67  61  66  0.194289    602/605     RandomExcursionsVariant
 48  69  56  58  56  65  69  56  70  58  0.522433    602/605     RandomExcursionsVariant
 45  56  73  67  51  64  77  60  54  58  0.098036    601/605     RandomExcursionsVariant
 55  62  50  60  51  80  62  60  63  62  0.315297    601/605     RandomExcursionsVariant
 47  61  67  43  65  65  71  63  59  64  0.227773    601/605     RandomExcursionsVariant
 55  56  48  57  67  70  53  72  63  64  0.405613    599/605     RandomExcursionsVariant
 62  55  55  56  62  59  69  54  70  63  0.832853    597/605     RandomExcursionsVariant
 58  63  54  64  55  70  66  63  54  58  0.869014    598/605     RandomExcursionsVariant
 53  64  67  61  61  57  61  60  62  59  0.988225    601/605     RandomExcursionsVariant
 61  63  58  62  64  63  40  62  67  65  0.467004    599/605     RandomExcursionsVariant
 67  56  65  52  58  62  51  79  49  66  0.177466    600/605     RandomExcursionsVariant
108 104  95 102  97  91 112 105  88  98  0.820143    988/1000    Serial
105 104  97  87 100 108  86 103 111  99  0.729870    991/1000    Serial
104 100 109  93 102 102 109  81 104  96  0.711601    993/1000    LinearComplexity


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
The minimum pass rate for each statistical test with the exception of the
random excursion (variant) test is approximately = 980 for a
sample size = 1000 binary sequences.

The minimum pass rate for the random excursion (variant) test
is approximately = 591 for a sample size = 605 binary sequences.

For further guidelines construct a probability table using the MAPLE program
provided in the addendum section of the documentation.
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -.
```

Appendix B

Report file generated from **10,000,000** bits/sample, 1000 samples (1.25 GB)
275 MHz fs, 2 registers at outputs of ring oscillators, XOR postprocessing
The double failure of the proportion test and the P-value uniformity on the OverlappingTemplate test is concerning.

```
------------------------------------------------------------------------------
RESULTS FOR THE UNIFORMITY OF P-VALUES AND THE PROPORTION OF PASSING SEQUENCES
------------------------------------------------------------------------------
   generator is <DataToAnalyze.dat>
------------------------------------------------------------------------------
 C1  C2  C3  C4  C5  C6  C7  C8  C9 C10  P-VALUE  PROPORTION  STATISTICAL TEST
------------------------------------------------------------------------------
 98 104  91 106  95  87 109 117 108  85  0.358641    990/1000    Frequency
113 111  98  86  79 100 107 107 103  96  0.308561    986/1000    BlockFrequency
101 101 114  93 100  84  88 100 102 117  0.401199    991/1000    CumulativeSums
109  87 104  92 113  94 105 102  88 106  0.591409    992/1000    CumulativeSums
104  93 101 111 110  88  91 105  98  99  0.796268    992/1000    Runs
 92 108 108 112  85 101  95 103 108  88  0.530120    988/1000    LongestRun
 89  89 105 121  95  97 100 103  99 102  0.579021    991/1000    Rank
```

115	99	113	94	101	93	99	109	79	98	0.344048	985/1000	FFT
96	96	108	93	101	103	101	100	106	96	0.990138	985/1000	NonOverlappingTemplate
97	93	105	103	111	102	103	102	93	91	0.935716	991/1000	NonOverlappingTemplate
97	111	104	91	84	99	114	97	103	100	0.639202	997/1000	NonOverlappingTemplate
95	113	100	107	94	114	89	96	105	87	0.528111	990/1000	NonOverlappingTemplate
85	109	113	89	95	106	90	90	116	107	0.235589	990/1000	NonOverlappingTemplate
105	105	94	109	100	100	95	95	100	97	0.986658	984/1000	NonOverlappingTemplate
95	107	93	97	99	98	97	101	105	108	0.984415	992/1000	NonOverlappingTemplate
105	103	106	102	98	89	99	104	99	95	0.982958	990/1000	NonOverlappingTemplate
100	105	100	104	107	79	115	94	101	95	0.516113	993/1000	NonOverlappingTemplate
96	105	100	104	83	88	96	107	108	113	0.546283	992/1000	NonOverlappingTemplate
106	98	83	103	106	99	95	119	103	88	0.424453	989/1000	NonOverlappingTemplate
93	100	101	88	101	92	116	97	109	103	0.725829	986/1000	NonOverlappingTemplate
120	119	119	97	97	88	85	84	85	106	0.016374	985/1000	NonOverlappingTemplate
98	107	100	105	88	99	97	100	117	89	0.697257	986/1000	NonOverlappingTemplate
108	85	98	89	107	115	91	98	104	105	0.520102	989/1000	NonOverlappingTemplate
101	105	93	104	104	107	93	105	101	87	0.911413	987/1000	NonOverlappingTemplate
98	96	97	116	88	86	107	107	105	100	0.587274	991/1000	NonOverlappingTemplate
109	102	95	109	106	88	99	84	104	104	0.678686	992/1000	NonOverlappingTemplate
105	87	107	108	112	92	99	107	92	91	0.626709	993/1000	NonOverlappingTemplate
84	92	106	98	103	106	107	98	95	111	0.735908	998/1000	NonOverlappingTemplate
116	101	90	127	91	99	88	87	101	100	0.096000	985/1000	NonOverlappingTemplate
106	102	103	95	105	91	116	96	86	100	0.691081	989/1000	NonOverlappingTemplate
98	96	92	106	110	119	105	99	94	81	0.347257	994/1000	NonOverlappingTemplate
81	112	91	101	107	90	106	114	100	98	0.373625	985/1000	NonOverlappingTemplate
101	100	93	100	102	111	111	103	91	88	0.807412	988/1000	NonOverlappingTemplate
109	105	102	107	96	97	80	98	104	102	0.731886	986/1000	NonOverlappingTemplate
98	115	97	104	83	99	98	93	114	99	0.540204	986/1000	NonOverlappingTemplate
103	99	89	110	99	107	89	113	94	97	0.723804	990/1000	NonOverlappingTemplate
91	121	85	89	96	90	122	92	108	106	0.060492	995/1000	NonOverlappingTemplate
97	95	91	89	100	130	110	99	85	104	0.097159	990/1000	NonOverlappingTemplate
102	91	108	103	108	106	84	98	106	94	0.749884	982/1000	NonOverlappingTemplate
99	95	120	104	92	100	103	82	108	97	0.426272	987/1000	NonOverlappingTemplate
94	98	108	106	106	101	89	94	97	107	0.916599	994/1000	NonOverlappingTemplate
107	98	100	104	103	84	92	93	101	118	0.562591	992/1000	NonOverlappingTemplate
94	92	96	109	94	105	105	100	109	96	0.924076	991/1000	NonOverlappingTemplate
108	112	104	98	94	84	90	97	96	117	0.406499	984/1000	NonOverlappingTemplate
98	86	92	116	115	82	96	118	105	92	0.091487	996/1000	NonOverlappingTemplate
97	117	114	95	100	113	109	88	81	86	0.099513	989/1000	NonOverlappingTemplate
109	100	101	90	107	102	112	111	77	91	0.268917	987/1000	NonOverlappingTemplate
91	101	115	97	104	93	83	102	118	96	0.339271	989/1000	NonOverlappingTemplate
100	91	108	91	101	98	100	92	107	112	0.844641	990/1000	NonOverlappingTemplate
98	87	105	105	104	105	113	93	94	96	0.803720	991/1000	NonOverlappingTemplate
126	105	104	79	91	88	82	101	111	113	0.018036	987/1000	NonOverlappingTemplate
103	91	97	117	90	107	101	100	95	99	0.775337	995/1000	NonOverlappingTemplate
102	110	104	101	90	83	103	107	104	96	0.739918	989/1000	NonOverlappingTemplate
105	93	91	109	102	87	96	91	127	99	0.193767	992/1000	NonOverlappingTemplate
82	115	112	91	92	102	107	125	95	79	0.019056	989/1000	NonOverlappingTemplate
99	95	101	106	102	101	81	112	106	97	0.721777	989/1000	NonOverlappingTemplate
107	102	103	101	113	86	89	106	88	105	0.581082	992/1000	NonOverlappingTemplate
104	103	91	111	104	97	92	110	94	94	0.844641	995/1000	NonOverlappingTemplate
106	100	98	98	106	95	105	96	104	92	0.986658	985/1000	NonOverlappingTemplate
96	106	100	104	103	98	94	92	108	99	0.981940	992/1000	NonOverlappingTemplate
97	87	91	91	93	118	96	108	100	119	0.240501	993/1000	NonOverlappingTemplate
107	85	114	122	115	82	102	84	90	99	0.028434	987/1000	NonOverlappingTemplate
101	99	91	107	126	95	94	97	99	91	0.383827	985/1000	NonOverlappingTemplate
98	88	94	109	104	98	108	88	116	97	0.576961	993/1000	NonOverlappingTemplate
100	107	93	94	103	104	99	94	106	100	0.985339	988/1000	NonOverlappingTemplate
106	111	97	105	108	96	87	102	90	98	0.790621	990/1000	NonOverlappingTemplate
104	97	109	108	106	102	98	94	88	94	0.890582	986/1000	NonOverlappingTemplate
110	102	89	99	100	92	111	98	104	95	0.870856	987/1000	NonOverlappingTemplate
100	91	98	111	89	95	103	121	97	95	0.498313	992/1000	NonOverlappingTemplate
98	116	85	114	103	91	97	96	90	110	0.353733	988/1000	NonOverlappingTemplate
100	106	96	105	95	97	100	99	98	104	0.998275	990/1000	NonOverlappingTemplate
99	98	125	101	102	87	97	99	99	93	0.471146	986/1000	NonOverlappingTemplate
98	94	104	102	92	115	94	88	101	112	0.664168	992/1000	NonOverlappingTemplate
96	105	100	116	101	103	92	101	96	90	0.844641	993/1000	NonOverlappingTemplate
103	95	95	104	94	108	99	98	101	103	0.992952	990/1000	NonOverlappingTemplate
96	100	110	96	85	119	100	96	98	100	0.597620	989/1000	NonOverlappingTemplate
107	88	110	103	100	101	106	93	87	105	0.757790	990/1000	NonOverlappingTemplate
91	94	89	105	107	104	105	98	111	96	0.839507	993/1000	NonOverlappingTemplate
87	109	92	116	98	93	90	99	109	107	0.480771	994/1000	NonOverlappingTemplate
96	111	101	107	91	104	102	90	97	101	0.912724	991/1000	NonOverlappingTemplate
107	109	97	82	87	87	114	100	107	110	0.245490	988/1000	NonOverlappingTemplate

114	110	109	106	111	107	92	84	94	73	0.053969	990/1000	NonOverlappingTemplate
96	96	108	93	101	103	101	100	106	96	0.990138	985/1000	NonOverlappingTemplate
109	92	77	107	107	106	99	116	98	89	0.219006	985/1000	NonOverlappingTemplate
91	94	97	107	94	108	102	105	105	97	0.947308	989/1000	NonOverlappingTemplate
105	118	94	85	83	102	98	98	112	105	0.289667	990/1000	NonOverlappingTemplate
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123	78	96	105	86	112	103	99	91	107	0.082010	991/1000	NonOverlappingTemplate
108	87	114	94	103	104	91	101	99	99	0.765632	991/1000	NonOverlappingTemplate
108	106	93	79	122	108	92	105	91	96	0.152044	988/1000	NonOverlappingTemplate
107	103	101	101	98	99	106	97	92	96	0.992952	991/1000	NonOverlappingTemplate
74	89	99	106	119	111	100	93	111	98	0.093720	996/1000	NonOverlappingTemplate
93	105	104	100	103	104	100	95	102	94	0.994250	994/1000	NonOverlappingTemplate
86	107	111	87	112	94	101	104	103	95	0.568739	990/1000	NonOverlappingTemplate
110	105	91	96	116	85	101	115	94	87	0.253122	989/1000	NonOverlappingTemplate
94	115	108	94	76	105	106	112	103	87	0.153763	994/1000	NonOverlappingTemplate
84	95	117	88	100	116	104	82	107	107	0.119508	992/1000	NonOverlappingTemplate
105	95	91	81	102	114	104	89	95	124	0.112047	987/1000	NonOverlappingTemplate
89	118	95	108	99	104	99	112	94	82	0.307077	988/1000	NonOverlappingTemplate
103	96	111	89	107	92	100	99	101	102	0.920383	989/1000	NonOverlappingTemplate
95	107	92	110	100	104	97	93	98	104	0.950247	994/1000	NonOverlappingTemplate
92	84	107	114	116	93	91	98	102	103	0.377007	994/1000	NonOverlappingTemplate
88	103	93	100	99	86	107	108	99	117	0.532132	989/1000	NonOverlappingTemplate
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83	100	107	108	87	97	113	100	108	97	0.512137	991/1000	NonOverlappingTemplate
94	110	98	96	94	81	89	113	123	102	0.131122	991/1000	NonOverlappingTemplate
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106	88	106	102	99	93	105	106	111	84	0.628790	991/1000	NonOverlappingTemplate
96	108	103	109	90	99	111	90	92	102	0.779188	986/1000	NonOverlappingTemplate
100	85	98	107	111	107	92	104	114	82	0.313041	990/1000	NonOverlappingTemplate
105	110	89	115	111	84	88	91	106	101	0.268917	989/1000	NonOverlappingTemplate
92	100	117	101	97	91	102	95	109	96	0.769527	995/1000	NonOverlappingTemplate
101	105	95	89	103	104	111	98	93	101	0.928857	988/1000	NonOverlappingTemplate
123	86	94	95	96	97	101	109	87	112	0.209948	988/1000	NonOverlappingTemplate
108	114	96	91	99	110	99	87	90	106	0.570792	988/1000	NonOverlappingTemplate
106	94	109	110	101	105	108	99	91	77	0.388990	985/1000	NonOverlappingTemplate
107	94	87	113	93	92	102	116	105	91	0.435430	989/1000	NonOverlappingTemplate
123	105	105	99	88	87	87	96	108	102	0.245490	986/1000	NonOverlappingTemplate
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98	93	104	100	97	109	91	97	110	101	0.941144	991/1000	NonOverlappingTemplate
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93	103	103	86	100	100	110	111	99	95	0.825505	988/1000	NonOverlappingTemplate
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108	113	98	90	86	112	96	103	92	102	0.564639	990/1000	NonOverlappingTemplate
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101	107	83	97	106	104	111	112	88	91	0.446556	993/1000	NonOverlappingTemplate
119	91	81	110	102	99	103	103	94	98	0.378705	990/1000	NonOverlappingTemplate
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100	92	97	107	105	102	108	91	97	101	0.961869	988/1000	NonOverlappingTemplate
95	107	86	101	122	118	100	95	86	90	0.122325	987/1000	NonOverlappingTemplate
87	120	88	97	91	107	105	98	114	93	0.258307	994/1000	NonOverlappingTemplate
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99	107	83	104	110	100	80	114	98	105	0.289667	997/1000	NonOverlappingTemplate
106	96	108	96	82	98	99	107	102	106	0.788728	992/1000	NonOverlappingTemplate
95	96	94	92	99	101	118	116	95	94	0.550347	989/1000	NonOverlappingTemplate
119	86	110	109	87	100	105	81	102	101	0.163513	990/1000	NonOverlappingTemplate
84	116	112	87	112	97	95	100	107	90	0.241741	991/1000	NonOverlappingTemplate

```
114 110 109 106 111 107  91  85  94  73  0.056426    990/1000    NonOverlappingTemplate
155 110 110 117  82 113  88  87  69  69  0.000000 *  976/1000 *  OverlappingTemplate
107 102  94 108 104  90 100 100 100  95  0.966626    993/1000    Universal
 82 107  90 109 109  96  97  89  96 125  0.114712    995/1000    ApproximateEntropy
 76  91  72  86  90  91  94  83 108  90  0.340461    873/881     RandomExcursions
 88  95  88  94  91  85  81  89  91  79  0.973010    872/881     RandomExcursions
 89  79  94  98  84  96  87  77 109  68  0.111076    871/881     RandomExcursions
 93  79  89  85  84  93  79 100  83  96  0.802582    870/881     RandomExcursions
101  86  85  87 106  92  68  90  91  75  0.183706    869/881     RandomExcursions
 79  85  94  87  96  84  91  85  96  84  0.942934    878/881     RandomExcursions
 68 113  83  98  82  96  76  91  84  90  0.063406    874/881     RandomExcursions
 82  87  94  84 108  82  87  78  90  89  0.619378    876/881     RandomExcursions
 77  78  95 103  92 102  80  78 100  76  0.155044    874/881     RandomExcursionsVariant
 68  96  97  91  83  94 102  84  79  87  0.324471    874/881     RandomExcursionsVariant
 71  89 100  83  88  93  78  97  83  99  0.417587    872/881     RandomExcursionsVariant
 73  90  95  92  77  84  83 109  88  90  0.331514    871/881     RandomExcursionsVariant
 77  88  87  93  91  89  80  94  84  98  0.895016    873/881     RandomExcursionsVariant
 77  86  84  87  87  86  97  90  85 101  0.862957    873/880     RandomExcursionsVariant
 84  85  78  87 108  86  91  99  83  80  0.483544    872/881     RandomExcursionsVariant
 91  85  94  83  73 103  96  84  79  93  0.521600    874/881     RandomExcursionsVariant
 94  85  86  87  78 100 100  84  89  78  0.708861    872/881     RandomExcursionsVariant
 87  82  90  84  87  80 100  89 103  79  0.687847    875/881     RandomExcursionsVariant
 75 101  82  88  81  96  95  78  91  94  0.560685    876/881     RandomExcursionsVariant
 76  90  79  78 107  87  81  92  94  97  0.356963    878/881     RandomExcursionsVariant
 83  76 100  72 100  96  80  90  90  94  0.345905    875/881     RandomExcursionsVariant
 75  91  88  87  94  78  94  86 104  84  0.624107    873/881     RandomExcursionsVariant
 71  99  94  79  87  86  84  92  93  96  0.593431    875/881     RandomExcursionsVariant
 84  88  79  93  94  75  98  80  87 103  0.519330    875/881     RandomExcursionsVariant
 84  95  78  89  86  85  88 100  87  89  0.930422    871/881     RandomExcursionsVariant
 86  95  80  88  84  80 106  92  91  79  0.624107    875/881     RandomExcursionsVariant
103  89 105 105 120  89  97  99  96  97  0.599693    990/1000    Serial
 99 104 107 108  90  95  95 104 103  95  0.951205    986/1000    Serial
 94  97  95 101  94 109  88 113 114  95  0.614226    991/1000    LinearComplexity


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
The minimum pass rate for each statistical test with the exception of the
random excursion (variant) test is approximately = 980 for a
sample size = 1000 binary sequences.

The minimum pass rate for the random excursion (variant) test
is approximately = 863 for a sample size = 881 binary sequences.

For further guidelines construct a probability table using the MAPLE program
provided in the addendum section of the documentation.
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

Appendix C

Report file generated from 1,000,000 bits/sample, **10,000** samples (1.25 GB)
275 MHz fs, 2 registers at outputs of ring oscillators, XOR postprocessing
The double failure of the proportion test and the P-value uniformity on the FFT test is concerning.

```
------------------------------------------------------------------------------
RESULTS FOR THE UNIFORMITY OF P-VALUES AND THE PROPORTION OF PASSING SEQUENCES
------------------------------------------------------------------------------
   generator is <DataToAnalyze.dat>
------------------------------------------------------------------------------
 C1  C2  C3  C4  C5  C6  C7  C8  C9 C10  P-VALUE  PROPORTION  STATISTICAL TEST
------------------------------------------------------------------------------
977 979 966 995 1034 1025 1018 980 1020 1006  0.826216   9903/10000    Frequency
1036 944 992 1007 1005 1024 1012 1043 965 972  0.423726   9880/10000    BlockFrequency
1016 933 1027 946 1001 1028 1003 981 1052 1013  0.190757   9900/10000    CumulativeSums
965 959 988 994 1000 1029 1017 977 1020 1051  0.559932   9898/10000    CumulativeSums
1033 987 1016 940 986 1020 1022 962 1078 956  0.074376   9887/10000    Runs
1058 998 1056 964 1025 982 1007 1010 986 914  0.057328   9876/10000    LongestRun
1013 938 1032 1013 982 944 1049 1000 988 1041  0.167554   9909/10000    Rank
1108 1023 1037 946 976 942 1109 970 996 893  0.000001 * 9858/10000 *  FFT
1038 991 981 1008 998 1037 917 1036 1020 974  0.182351   9888/10000    NonOverlappingTemplate
973 1020 980 1016 1064 971 1038 976 1009 953  0.273522   9884/10000    NonOverlappingTemplate
998 986 1011 958 1008 970 969 1050 1039 1011  0.518904   9895/10000    NonOverlappingTemplate
1018 958 966 1011 1010 997 1002 1015 991 1032  0.850714   9889/10000    NonOverlappingTemplate
1009 999 993 1007 1022 993 980 989 1033 975  0.966321   9897/10000    NonOverlappingTemplate
960 1016 986 1032 980 967 1025 1030 1014 990  0.700750   9906/10000    NonOverlappingTemplate
```

1046 961 951 1033 1040 1016 989 953 971 1040 0.131349   9903/10000   NonOverlappingTemplate
991 986 960 1054 1092 992 977 948 1008 992 0.053935   9908/10000   NonOverlappingTemplate
997 1041 1024 976 966 988 990 1011 1002 1005 0.883772   9892/10000   NonOverlappingTemplate
978 1013 1043 961 1027 1032 1025 957 992 972 0.428278   9904/10000   NonOverlappingTemplate
1066 986 1007 1012 1007 1037 977 970 989 949 0.325668   9899/10000   NonOverlappingTemplate
999 990 954 1051 968 1029 971 994 1044 1000 0.392803   9879/10000   NonOverlappingTemplate
981 1010 1016 1023 1008 969 1030 1009 999 955 0.809432   9893/10000   NonOverlappingTemplate
1053 1046 1009 933 1009 964 1014 960 1008 1004 0.174344   9905/10000   NonOverlappingTemplate
1040 966 1000 980 1016 1025 1005 992 969 1007 0.822295   9905/10000   NonOverlappingTemplate
1011 1005 1009 977 993 998 989 1005 987 1026 0.994250   9915/10000   NonOverlappingTemplate
999 988 999 1008 999 1028 1045 980 936 1018 0.550347   9895/10000   NonOverlappingTemplate
1014 993 1054 965 1029 936 997 1035 1017 960 0.189317   9901/10000   NonOverlappingTemplate
1029 1032 997 975 1007 984 974 1011 1011 980 0.903201   9893/10000   NonOverlappingTemplate
950 994 1005 923 1003 1013 1052 1051 1002 1007 0.121403   9907/10000   NonOverlappingTemplate
920 1048 1003 960 1014 1002 1043 1015 1050 945 0.033896   9898/10000   NonOverlappingTemplate
1015 1008 995 992 992 999 1015 996 1014 974 0.996710   9894/10000   NonOverlappingTemplate
997 976 960 1000 1003 1022 1034 1003 1055 950 0.404021   9900/10000   NonOverlappingTemplate
1013 993 971 999 963 1018 1042 996 991 1014 0.850546   9903/10000   NonOverlappingTemplate
980 1014 1016 994 1010 1002 1015 960 983 1026 0.925166   9898/10000   NonOverlappingTemplate
996 996 982 966 1022 989 1008 1000 1002 1039 0.929676   9892/10000   NonOverlappingTemplate
1025 962 968 1043 1002 1045 1029 1007 970 949 0.251709   9890/10000   NonOverlappingTemplate
1024 1019 1020 1000 1025 1016 952 977 1004 963 0.695612   9896/10000   NonOverlappingTemplate
1017 968 1024 1027 986 983 1039 969 1004 983 0.750875   9889/10000   NonOverlappingTemplate
948 1039 1035 1036 999 944 1008 976 996 1019 0.282626   9903/10000   NonOverlappingTemplate
1062 1050 1012 930 1003 1020 964 1038 961 960 0.039355   9879/10000   NonOverlappingTemplate
996 983 958 1015 1052 1027 938 993 995 1043 0.243360   9902/10000   NonOverlappingTemplate
974 993 1063 1038 999 976 993 1000 974 990 0.581082   9904/10000   NonOverlappingTemplate
1014 970 958 1016 1054 1036 1021 968 970 993 0.371773   9894/10000   NonOverlappingTemplate
991 1025 1061 961 1024 970 1010 995 959 1004 0.414883   9904/10000   NonOverlappingTemplate
1040 987 1006 990 984 989 972 1023 1024 985 0.883472   9896/10000   NonOverlappingTemplate
1025 926 1067 1005 1043 996 970 987 1022 959 0.073100   9914/10000   NonOverlappingTemplate
1016 979 1043 973 995 979 1022 967 1083 943 0.079245   9882/10000   NonOverlappingTemplate
999 1003 980 1010 967 996 931 1056 989 1069 0.108984   9902/10000   NonOverlappingTemplate
933 1035 1016 994 962 1013 1014 984 1029 1020 0.408987   9916/10000   NonOverlappingTemplate
958 1026 1046 962 1035 1006 952 1037 993 985 0.261721   9904/10000   NonOverlappingTemplate
1046 993 997 939 994 999 1018 991 1001 1022 0.655646   9892/10000   NonOverlappingTemplate
1004 1045 1005 1025 953 983 993 1006 994 992 0.800564   9880/10000   NonOverlappingTemplate
992 1021 1019 978 1011 986 950 976 1058 1009 0.515317   9903/10000   NonOverlappingTemplate
971 1008 996 1004 1009 998 975 1014 1026 999 0.980341   9898/10000   NonOverlappingTemplate
1004 970 990 980 991 1022 990 1074 1014 965 0.439307   9903/10000   NonOverlappingTemplate
992 1015 1050 980 1031 956 1013 994 975 994 0.642117   9890/10000   NonOverlappingTemplate
983 984 1029 1003 1013 1010 996 959 983 1040 0.811993   9905/10000   NonOverlappingTemplate
983 1048 982 1021 1042 998 994 990 986 956 0.596170   9908/10000   NonOverlappingTemplate
1015 1030 997 964 960 1052 1004 1013 966 999 0.526506   9892/10000   NonOverlappingTemplate
953 984 1005 1010 1050 1059 997 950 990 1002 0.263307   9903/10000   NonOverlappingTemplate
1063 974 1023 1007 987 973 973 1008 1034 958 0.364090   9898/10000   NonOverlappingTemplate
1045 973 975 992 989 948 981 1026 1044 1027 0.352919   9896/10000   NonOverlappingTemplate
1017 1036 1012 1024 974 984 1001 1008 984 960 0.820323   9886/10000   NonOverlappingTemplate
1053 1013 996 995 975 994 945 1036 986 1007 0.509558   9898/10000   NonOverlappingTemplate
1010 971 995 968 1032 966 1042 1010 1041 965 0.442831   9890/10000   NonOverlappingTemplate
1031 982 939 1003 1010 1049 1003 976 980 1027 0.416320   9891/10000   NonOverlappingTemplate
1032 986 991 1016 1031 962 978 1012 998 994 0.865297   9890/10000   NonOverlappingTemplate
1028 993 1034 1036 983 985 1008 977 1007 949 0.632746   9903/10000   NonOverlappingTemplate
1025 958 964 1059 1036 1003 964 1000 980 1011 0.327677   9901/10000   NonOverlappingTemplate
993 1027 991 944 990 1007 971 1048 1059 970 0.232559   9889/10000   NonOverlappingTemplate
983 1048 1025 995 941 1011 982 1048 963 1004 0.285568   9922/10000   NonOverlappingTemplate
997 971 1045 999 939 999 1038 1026 990 996 0.452737   9875/10000   NonOverlappingTemplate
1006 972 955 1001 1023 1019 991 990 1021 1022 0.847858   9888/10000   NonOverlappingTemplate
1002 1045 961 975 1002 1067 979 976 995 998 0.374131   9893/10000   NonOverlappingTemplate
1005 1005 927 1005 991 993 1013 1031 1010 1020 0.620049   9899/10000   NonOverlappingTemplate
1026 928 964 984 985 1043 1000 1002 1020 1048 0.202592   9900/10000   NonOverlappingTemplate
1074 1010 999 1004 983 942 979 1032 979 998 0.265167   9877/10000   NonOverlappingTemplate
971 957 1019 949 1039 1014 1007 991 1041 1012 0.407920   9907/10000   NonOverlappingTemplate
1024 999 1007 973 1066 962 963 983 986 1037 0.320759   9888/10000   NonOverlappingTemplate
1019 1025 982 973 931 1026 1034 1021 956 1033 0.207841   9908/10000   NonOverlappingTemplate
1028 966 957 937 1043 1038 1022 969 1025 1015 0.147565   9901/10000   NonOverlappingTemplate
1015 1045 1015 941 1031 970 959 964 1037 1023 0.177045   9878/10000   NonOverlappingTemplate
977 983 968 1018 1051 1009 950 1020 992 1032 0.452549   9910/10000   NonOverlappingTemplate
1037 989 985 1007 995 1036 926 1028 1025 972 0.292949   9887/10000   NonOverlappingTemplate
1010 988 986 990 984 993 982 1013 1031 1023 0.970725   9897/10000   NonOverlappingTemplate
988 1002 1066 1005 975 968 995 963 1038 1000 0.435799   9894/10000   NonOverlappingTemplate
943 1027 1006 1010 937 1016 987 1034 1032 1008 0.293092   9908/10000   NonOverlappingTemplate
970 987 1008 995 1060 1007 986 961 1050 976 0.383827   9913/10000   NonOverlappingTemplate
1041 1015 1007 961 996 961 1018 1015 1021 965 0.613395   9901/10000   NonOverlappingTemplate

1037 995 1022 955 1014 995 930 1030 1052 970 0.140134   9903/10000   NonOverlappingTemplate
984 1050 997 1039 1013 973 986 962 987 1009 0.629415   9899/10000   NonOverlappingTemplate
1003 1005 1031 990 1019 922 968 1065 1010 987 0.159999   9917/10000   NonOverlappingTemplate
1018 1036 976 1001 1027 1024 966 972 1002 978 0.746903   9907/10000   NonOverlappingTemplate
999 997 1017 999 996 981 1026 1032 981 972 0.939973   9905/10000   NonOverlappingTemplate
972 994 984 1003 1083 996 959 1017 1018 974 0.278461   9894/10000   NonOverlappingTemplate
1047 1013 953 1021 976 1000 977 1009 1034 970 0.507182   9894/10000   NonOverlappingTemplate
1004 915 988 993 1024 977 976 1021 1051 1051 0.097801   9907/10000   NonOverlappingTemplate
928 986 1008 1003 1000 1016 994 989 1026 1050 0.433406   9898/10000   NonOverlappingTemplate
1010 969 1092 1021 1015 984 1001 967 976 965 0.147899   9917/10000   NonOverlappingTemplate
1003 1006 1046 1034 993 992 978 968 951 1029 0.516113   9909/10000   NonOverlappingTemplate
998 944 979 1003 1026 1038 1046 1020 956 990 0.329694   9887/10000   NonOverlappingTemplate
984 1004 969 999 988 1011 962 1008 1080 995 0.398389   9900/10000   NonOverlappingTemplate
1011 1009 1011 1047 970 991 983 988 1032 958 0.664792   9906/10000   NonOverlappingTemplate
982 1031 982 1034 1009 993 1014 997 957 1001 0.838645   9905/10000   NonOverlappingTemplate
1001 1028 951 976 994 992 985 1077 1020 976 0.276258   9901/10000   NonOverlappingTemplate
1022 989 989 976 1001 967 1080 1009 992 975 0.387092   9896/10000   NonOverlappingTemplate
1036 1025 1033 995 985 1029 953 982 966 996 0.553809   9900/10000   NonOverlappingTemplate
1009 1005 1014 974 1028 961 1015 1052 999 943 0.395765   9894/10000   NonOverlappingTemplate
1029 1004 971 981 979 961 992 1007 1054 1022 0.581701   9900/10000   NonOverlappingTemplate
991 966 1040 1046 999 972 978 1018 1021 969 0.539395   9905/10000   NonOverlappingTemplate
951 1013 993 1015 1005 1020 1051 995 975 982 0.653357   9910/10000   NonOverlappingTemplate
950 1013 1021 970 984 1031 985 1018 1033 995 0.648571   9905/10000   NonOverlappingTemplate
1050 1004 978 933 985 958 1058 990 1000 1044 0.094342   9903/10000   NonOverlappingTemplate
1025 972 959 1040 1059 945 1032 1008 985 975 0.156636   9898/10000   NonOverlappingTemplate
1001 1013 1036 1011 997 938 1039 991 976 998 0.572641   9903/10000   NonOverlappingTemplate
981 948 1031 1029 1030 976 990 981 1010 1024 0.587274   9888/10000   NonOverlappingTemplate
1006 1065 987 1026 978 973 1002 983 984 996 0.649195   9880/10000   NonOverlappingTemplate
1024 1016 1020 957 1012 1000 985 983 1020 983 0.881056   9895/10000   NonOverlappingTemplate
1040 951 985 984 1000 1024 1017 1045 1003 951 0.368420   9880/10000   NonOverlappingTemplate
969 990 988 1078 1011 967 995 995 1043 964 0.231115   9920/10000   NonOverlappingTemplate
1001 948 1018 936 1013 965 1012 1027 1041 1039 0.181854   9899/10000   NonOverlappingTemplate
1010 1006 1009 981 941 1026 996 1048 1006 977 0.572847   9892/10000   NonOverlappingTemplate
978 972 1031 994 1010 970 1033 1016 964 1032 0.644407   9896/10000   NonOverlappingTemplate
1021 981 1026 1059 1011 985 970 1004 977 966 0.543646   9899/10000   NonOverlappingTemplate
1011 987 1049 996 993 1016 983 952 1047 966 0.440048   9890/10000   NonOverlappingTemplate
989 998 999 1011 1000 991 1001 1046 957 1008 0.886311   9907/10000   NonOverlappingTemplate
1006 964 1069 989 1005 1009 1012 969 978 999 0.543241   9886/10000   NonOverlappingTemplate
1038 992 990 935 991 1040 989 1014 981 1030 0.428826   9901/10000   NonOverlappingTemplate
1013 979 1001 1043 999 1004 967 1002 1003 989 0.930026   9892/10000   NonOverlappingTemplate
1008 999 995 1029 1004 948 993 1042 991 991 0.776687   9902/10000   NonOverlappingTemplate
997 989 1020 979 987 983 972 1009 1009 1055 0.798139   9912/10000   NonOverlappingTemplate
1028 1061 979 1018 952 997 1011 937 998 1019 0.211176   9899/10000   NonOverlappingTemplate
1009 1014 905 1003 990 1106 977 964 1043 989 0.003655   9889/10000   NonOverlappingTemplate
1004 961 1077 993 1004 964 1012 984 982 1019 0.357656   9895/10000   NonOverlappingTemplate
973 1073 981 984 1021 970 953 1010 1007 1028 0.265034   9891/10000   NonOverlappingTemplate
1004 1030 973 988 985 1038 1018 948 1023 993 0.630456   9879/10000   NonOverlappingTemplate
985 1048 1003 980 1039 943 1032 1008 987 975 0.384684   9901/10000   NonOverlappingTemplate
991 983 1010 1035 972 1028 986 932 991 1072 0.147481   9892/10000   NonOverlappingTemplate
942 969 946 1027 1042 1003 945 1060 1040 1026 0.028396   9908/10000   NonOverlappingTemplate
968 981 1038 1052 1007 983 935 1023 1002 1011 0.293235   9892/10000   NonOverlappingTemplate
946 969 982 989 980 1021 1050 1027 1015 1021 0.431938   9900/10000   NonOverlappingTemplate
934 1002 975 993 960 1012 1063 1068 994 999 0.080321   9898/10000   NonOverlappingTemplate
1007 974 1036 1006 974 997 1063 1001 985 957 0.457258   9896/10000   NonOverlappingTemplate
969 967 1045 1013 1010 953 1036 997 1028 982 0.440419   9898/10000   NonOverlappingTemplate
1036 955 957 1019 1035 990 1049 999 942 1018 0.165065   9905/10000   NonOverlappingTemplate
993 998 1023 929 1032 983 999 948 1043 1052 0.115590   9890/10000   NonOverlappingTemplate
982 960 1021 1000 984 977 1041 1004 1021 1010 0.799259   9895/10000   NonOverlappingTemplate
1016 965 1021 1009 1026 977 982 996 1000 1008 0.935047   9900/10000   NonOverlappingTemplate
947 1011 1040 1021 1006 1021 999 1011 1000 944 0.464844   9903/10000   NonOverlappingTemplate
985 974 1034 981 1018 1013 975 1043 976 1001 0.743715   9897/10000   NonOverlappingTemplate
1029 981 956 991 967 973 1051 1009 1016 1027 0.465034   9898/10000   NonOverlappingTemplate
999 976 993 1008 987 1029 1017 989 1018 984 0.975330   9903/10000   NonOverlappingTemplate
1042 1020 971 983 970 1033 1002 973 985 1021 0.670189   9898/10000   NonOverlappingTemplate
991 967 986 1027 1038 967 991 976 1016 1041 0.614018   9902/10000   NonOverlappingTemplate
1015 992 997 945 1011 1040 1032 970 933 1065 0.073827   9906/10000   NonOverlappingTemplate
948 986 1017 1008 1020 996 1007 1007 1011 1000 0.918628   9915/10000   NonOverlappingTemplate
977 979 969 1019 1050 1009 956 1017 993 1031 0.523300   9910/10000   NonOverlappingTemplate
1034 1000 1002 1003 993 1009 1010 993 1006 950 0.912462   9884/10000   OverlappingTemplate
1041 1059 997 977 954 1001 1053 959 935 1024 0.047051   9880/10000   Universal
1000 1054 1078 941 987 1007 978 955 1007 993 0.082866   9909/10000   ApproximateEntropy
644 617 607 612 652 640 592 626 604 611 0.790407   6123/6205   RandomExcursions
619 599 598 608 610 639 644 657 638 593 0.605414   6135/6205   RandomExcursions
649 609 599 596 641 636 637 609 614 615 0.827651   6137/6205   RandomExcursions

```
640 657 664 632 612 616 580 588 586 630  0.181796   6130/6205    RandomExcursions
595 623 602 609 629 646 625 651 608 617  0.851517   6138/6205    RandomExcursions
640 617 591 643 622 622 615 632 597 626  0.907006   6131/6205    RandomExcursions
607 670 613 625 643 636 581 600 640 590  0.283640   6145/6205    RandomExcursions
584 624 562 625 594 620 667 664 644 621  0.061092   6136/6205    RandomExcursions
579 608 622 607 662 586 651 590 685 615  0.037706   6149/6205    RandomExcursionsVariant
559 586 647 665 606 615 618 615 647 647  0.089223   6150/6205    RandomExcursionsVariant
559 596 644 634 679 592 669 599 612 621  0.019563   6140/6205    RandomExcursionsVariant
576 613 634 613 685 642 629 609 626 578  0.108119   6148/6205    RandomExcursionsVariant
561 620 662 652 629 652 608 661 589 571  0.016376   6145/6205    RandomExcursionsVariant
598 620 626 669 641 607 601 608 638 597  0.545727   6146/6205    RandomExcursionsVariant
607 638 637 638 593 615 640 657 577 603  0.409911   6151/6205    RandomExcursionsVariant
626 643 620 630 625 649 573 588 630 621  0.549659   6146/6205    RandomExcursionsVariant
618 642 662 635 608 593 645 562 653 587  0.081760   6137/6205    RandomExcursionsVariant
588 636 617 659 642 624 639 573 589 638  0.239484   6154/6205    RandomExcursionsVariant
608 617 609 643 628 629 607 623 623 618  0.993789   6147/6205    RandomExcursionsVariant
604 593 620 639 668 597 602 610 635 637  0.508842   6149/6205    RandomExcursionsVariant
587 579 643 647 663 618 631 618 621 598  0.313840   6151/6205    RandomExcursionsVariant
575 596 638 687 656 586 617 612 616 622  0.065580   6152/6205    RandomExcursionsVariant
579 603 634 641 669 635 617 586 621 620  0.325131   6148/6205    RandomExcursionsVariant
594 584 668 635 630 640 634 618 609 593  0.370289   6159/6205    RandomExcursionsVariant
579 588 665 630 655 602 618 608 627 633  0.284092   6160/6205    RandomExcursionsVariant
562 616 649 602 662 608 635 627 627 617  0.279598   6153/6205    RandomExcursionsVariant
1012 943 994 1013 1051 991 974 998 1022 1002  0.590582   9901/10000    Serial
1015 1018 985 1046 946 981 1007 983 1034 985  0.545674   9892/10000    Serial
954 1038 981 989 973 986 962 1035 1050 1032  0.264901   9910/10000    LinearComplexity


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
The minimum pass rate for each statistical test with the exception of the
random excursion (variant) test is approximately = 9870 for a
sample size = 10000 binary sequences.

The minimum pass rate for the random excursion (variant) test
is approximately = 6119 for a sample size = 6205 binary sequences.

For further guidelines construct a probability table using the MAPLE program
provided in the addendum section of the documentation.
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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