**3GPP TSG- Meeting # *draft***

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **x** | Core Network |  |

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| ***Title:***  |  |
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| ***Source to WG:*** |  |
| ***Source to TSG:*** | R4 |
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| ***Work item code:*** |  |  | ***Date:*** |  |
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| ***Category:*** |  |  | ***Release:*** |  |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
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| ***Reason for change:*** | The WF [R4-2012646] requested to provide a detailed description of the test methodology in the BS conformance specification |
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| ***Summary of change:*** | Added new appendix detailing testing methodology of PUSCH performance requirements with 0.001% BLER. |
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| ***Consequences if not approved:*** | The ulta-low PUSCH conformance testing methods of different companies are at risk to not be comparable |
|  |  |
| ***Clauses affected:*** | Annex I (new) |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **x** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** | **x** |  |  Test specifications | TS 38.141-2 |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** | Sumitted to AI: 7.8.1.1.3 |
|  |  |
| ***This CR's revision history:*** | R4-2015098 |

Annex I (normative):
General rules for statistical testing

# I.1 Testing methodology of PUSCH performance requirements with 0.001% BLER

## I.1.1 General

The test framework for the 0.001% BLER test is based upon examining received blocks and determining pass, fail or continue each time a block error occurs.

The pass/fail decision is made based on so-called decision co-ordinates (ne, ns). ne is the number of block errors encountered during the test and ns is the total number of received blocks during the test, up to the current block error. The ns is compared with the nsp and nsf entries corresponding to ne in table I.1.1-1. If ns is greater than the nsp value in I.1.1-1, a pass may be declared. If ns is lower than the nsf value, a fail may be declared. Otherwise, the test continues.

The objective of the approach is to minimize testing time and the basis of the approach is an early termination statistical framework described in section I.1.3.1. The minimum testing time is defined by the possible decision coordinates detailed in section I.1.2.

As with all statistical tests, there is a non-zero risk of the test result being incorrect due to statistical variations. There are two possibilities for an incorrect decision:

- As BS, whose BLER is greater than the requirement (i.e., the BS does not comply to the requirement), is declared to pass the test.

- A BS, whose BLER is lower than the requirement (i.e., a BS that does comply to the requirement), is declared to fail the test.

The outcome of the statistical test is a decision. This decision may be correct with confidence level of 99.999%, i.e., BSs whose BLER is greater than 0.001% being declared to fail, and BSs whose BLER is smaller or equal to 0.001% being declared to pass, or in-correct (as detailed above).

## I.1.2 Numerical definition of the pass-fail limits for testing PUSCH 0.001% BLER

Table I.1.2-1: Pass fail limits

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ne | nsp | nsf | ne | nsp | nsf | ne | nsp | nsf |
| 0 | 1074532 | 1067 | 39 | 5369517 | 1508043 | (\*) | (\*) | (\*) |
| 1 | 1074532 | 1067 | 40 | 5463478 | 1568438 | 608 | 49669522 | 49113220 |
| 2 | 1274645 | 1067 | 41 | 5557107 | 1629304 | 609 | 49743206 | 49202955 |
| 3 | 1444583 | 1067 | 42 | 5650414 | 1690627 | 610 | 49816884 | 49292699 |
| 4 | 1599072 | 4727 | 43 | 5743410 | 1752389 | 611 | 49890556 | 49382451 |
| 5 | 1743641 | 12160 | 44 | 5836108 | 1814577 | 612 | 49964222 | 49472211 |
| 6 | 1881111 | 23683 | 45 | 5928516 | 1877177 | 613 | 50037883 | 49561980 |
| 7 | 2013164 | 39190 | 46 | 6020643 | 1940175 | 614 | 50111538 | 49651757 |
| 8 | 2140902 | 58403 | 47 | 6112500 | 2003560 | 615 | 50185187 | 49741542 |
| 9 | 2265092 | 81000 | 48 | 6204094 | 2067319 | 616 | 50258831 | 49831335 |
| 10 | 2386297 | 106667 | 49 | 6295434 | 2131442 | 617 | 50332469 | 49921137 |
| 11 | 2504945 | 135116 | 50 | 6386526 | 2195916 | 618 | 50406101 | 50010947 |
| 12 | 2621369 | 166089 | 51 | 6477380 | 2260734 | 619 | 50479728 | 50100765 |
| 13 | 2735834 | 199360 | 52 | 6568000 | 2325884 | 620 | 50553349 | 50190592 |
| 14 | 2848557 | 234730 | 53 | 6658395 | 2391358 | 621 | 50626965 | 50280427 |
| 15 | 2959718 | 272025 | 54 | 6748569 | 2457146 | 622 | 50700575 | 50370269 |
| 16 | 3069467 | 311091 | 55 | 6838530 | 2523241 | 623 | 50774179 | 50460120 |
| 17 | 3177931 | 351792 | 56 | 6928283 | 2589634 | 624 | 50847778 | 50549980 |
| 18 | 3285220 | 394009 | 57 | 7017834 | 2656318 | 625 | 50921372 | 50639847 |
| 19 | 3391428 | 437636 | 58 | 7107187 | 2723285 | 626 | 50994959 | 50729722 |
| 20 | 3496637 | 482577 | 59 | 7196348 | 2790528 | 627 | 51068542 | 50819605 |
| 21 | 3600921 | 528746 | 60 | 7285321 | 2858041 | 628 | 51142119 | 50909497 |
| 22 | 3704343 | 576068 | 61 | 7374112 | 2925816 | 629 | 51215690 | 50999396 |
| 23 | 3806960 | 624473 | 62 | 7462724 | 2993848 | 630 | 51289256 | 51089304 |
| 24 | 3908823 | 673898 | 63 | 7551162 | 3062130 | 631 | 51362816 | 51179219 |
| 25 | 4009977 | 724286 | 64 | 7639430 | 3130657 | 632 | 51436371 | 51269143 |
| 26 | 4110465 | 775585 | 65 | 7727532 | 3199424 | 633 | 51509921 | 51359074 |
| 27 | 4210324 | 827748 | 66 | 7815471 | 3268424 | 634 | 51583465 | 51449013 |
| 28 | 4309587 | 880730 | 67 | 7903252 | 3337653 | 635 | 51657003 | 51538961 |
| 29 | 4408285 | 934492 | 68 | 7990878 | 3407105 | 636 | 51730537 | 51628916 |
| 30 | 4506448 | 988997 | 69 | 8078352 | 3476777 | 637 | 51804065 | 51718879 |
| 31 | 4604101 | 1044211 | 70 | 8165677 | 3546663 | 638 | 51877587 | 51808850 |
| 32 | 4701268 | 1100101 | 71 | 8252857 | 3616759 | 639 | 51951104 | 51898828 |
| 33 | 4797972 | 1156638 | 72 | 8339894 | 3687060 | 640 | 52024616 | 51988815 |
| 34 | 4894232 | 1213795 | 73 | 8426792 | 3757563 | 641 | 52098123 | 52078809 |
| 35 | 4990069 | 1271547 | 74 | 8513553 | 3828263 | 642 | 52171624 | 52168811 |
| 36 | 5085500 | 1329869 | 75 | 8600181 | 3899156 |  |  |  |
| 37 | 5180542 | 1388740 | 76 | 8686677 | 3970239 |  |  |  |
| 38 | 5275209 | 1448137 | 77 | 8773044 | 4041508 | \*) Follow I.1.3.2 to derive |

NOTE 1: The first column is the number of errors (ne = number of NACK)

NOTE 2: The second column is the number of samples for the pass limit (nsp, ns=Number of Samples= number of NACK + ACK)

NOTE 3: The third column is the number of samples for the fail limit (nsf)

NOTE 4: An ideal DUT passes after 1074532 samples. The maximum test time is 52171625 samples. A DUT passes, if the maximum number of samples is reached and it did not fail before.

## I.1.3 Theory to derive the early pass/fail limits in I.1.2 (informative)

Editor's note: This clause of the Annex I is for information only and it describes the background theory and information for statistical testing.

### I.1.3.1 Numerical definition of the pass-fail limits for testing PUSCH 0.001% BLER

A statistical test is characterized by test time, selectivity and confidence level. The outcome of the statistical test is a decision. This decision may be correct, i.e., BSs whose BLER is greater than 0.001% being declared to fail, and BSs whose BLER is smaller or equal to 0.001% being declared to pass, or in-correct (as detailed above). The Confidence Level (CL) describes the probability that the decision is a correct one. The complement is the wrong decision probability (risk) D = 1-CL.

When testing BLER, transport blocks or “samples” are observed and the numbers of correctly and erroneously received blocks are recorded. For a “standard” test, a pre-defined number of samples are observed, and a pass/fail decision is made based on the number of observed errors being above/below a threshold. This threshold is based on the targeted BLER and the design target CL. There is always some risk of a statistical variation leading to an incorrect pass/fail decision. The greater the number of samples that are recorded, the lower is the risk of such an error. The number of samples that are observed in a standard test is dimensioned to achieve an acceptable low risk of error (i.e., an acceptable high confidence level) for BS that just meet the BLER limit.

The standard test works well where the BLER level is relatively high and confidence level relatively low (both are chosen to be on a comparable order of magnitude). However, for ultra-low BLER testing the length of time required for observing sufficient samples to achieve a 99.999% confidence level is excessive. In many cases, the BS will in fact have a much lower true BLER than the limit, i.e., design target of the test, (in which case, the number of samples needed to achieve high confidence that the BLER is lower than the limit is much smaller) or, if failing the requirement will have a much higher true BLER (in which case, errors occur more frequently and it can be demonstrated that the BS is above the BLER limit with fewer samples).

To avoid long test times, an alternative test method called early pass/fail is adopted. With the early pass/fail, each time a block error is encountered, a decision is made on whether the BS can be passed/failed with 99.999% CL or the test needs to continue until another error is encountered. In the case of very good BSs, the test can also be passed, when the number of samples permissible for one error event is reached and no error event is recorded. Pass/Fail is decided based on the total number of observed samples and errors, and a statistical calculation based on an inverse binomial cumulative distribution. The calculation involves one parameter, one variable and the result:

- Parameter: d (per step decision probability).

- Variable: ne (number of observed errors).

- Result: ns (number of expected samples for pass/fail, depending on which one is calculated).

The per step decision probability risk, d, expresses the probability of making an incorrect pass/fail decision in the current step (i.e., for the current decision coordinate). d is determined by simulation such that the overall risk of making a wrong decision over all steps of each test of a large number of tests on a large number of BSs that exactly meet the BLER limit is D=0.001% (and hence the CL 99.999%).

It should be noted that d is determined separately considering early pass and early fail testing.

For a marginal BS (i.e., a BS almost exactly meeting the BLER), the unmodified early pass/early fail approach is unable to distinguish whether the BS has just passed or just failed the BLER (ε→0), and can thus terminate with an “undecided” result. To avoid this undecided result and provide selectivity, a so-called “bad device factor” (M) is introduced into the early pass calculation. This factor biases the decision towards avoiding failing good BS.

### I.1.3.2 Simulation to derive the pass-fail limits for testing PUSCH 0.001% BLER

There is freedom to design the decision co-ordinates (ne, ns), as captured in section I.1.2.

The binomial distribution and its inverse are used to design the pass and fail limits. Note that this method is not unique and that other methods exist.



Where

- fail(..) is the error ratio for the fail limit.

- pass(..) is the error ratio for the pass limit.

- ER is the specified error ratio 1e-5.

- ne is the number of bad results. This is the variable in both equations.

- M is the Bad DUT factor M=1.5.

- df is the wrong decision probability of a single (ne, ns) co-ordinate for the fail limit.
It is found by simulation to be df = 2e-7.

- clp is the confidence level of a single (ne, ns) co-ordinate for the pass limit.
It is found by simulation to be clp = 0.9999999.

- qnbinom(..): The inverse cumulative function of the negative binomial distribution.

The simulation works as follows:

- A large population of limit DUTs with true ER = 1e-5 is decided against the pass and fail limits.

- clp and df are tuned such that CL (99.999 %) of the population passes and D (0.001 %) of the population fails.

- A population of Bad DUTs with true ER = M\*1e-5 is decided against the same pass and fail limits.

- clp and df are tuned such that CL (99.999 %) of the population fails and D (0.001 %) of the population passes.

- The number of DUTs decrease during the simulation, as the decided DUTs leave the population. That number decreases with an approximately exponential characteristics. After 642 bad results all DUTs of the population are decided.

NOTE: The exponential decrease of the population is an optimal design goal for the decision co-ordinates (ne, ns), which can be achieved with other formulas or methods as well.

**<<End of change>>**