**TSG-RAN Working Group1 Meeting #8** *TSGR1#7(99)f27*
**New York, United States, 12-15 October, 1999**

Agenda Item:
**Source:** SAMSUNG Electronics Co. and LGIC
**Title:** Additional simulation results of rate matching algorithm in uplink
**Document for:** Discussion

# 1. Introduction

This document supplements Tdocs[1]-[4] proposed by Samsung and LGIC with some additional simulation results for uplink over AWGN channel. According to the requirements on Ad Hoc 5 report[5], it is required to provide additional simulation results regarding uplink performance for 80 ms 1st interleaver span. Performance should be compared with corresponding downlink performance as well as the combination of Berrou code puncturing plus the Samsung/LGIC rate matching algorithm. Therefore in this contribution, performance comparison is provided. First, BER and FER comparison of turbo codes are given in uplink and downlink with a lot of puncturing rates. Second, BER and FER comparison of turbo codes in uplink are given for Berrou's code puncturing and rate matching puncturing, respectively.

# 2. Simulation conditions

For turbo codes, the simulation conditions are as follows

- Block sizes: 320, 324, 640, 644, 960, 964, 5116
- Puncturing rates:
  Case 1. P=33%, 20%, 15%, 10% for block sizes of 324, 644, 964.
  Case 2. P=19.5%(=192bits), 18.7%(=184bits), 10.6%(=104bits) for block size of 324.
  Case 3. P=19.75%(=384bits) for block size of 644.
  Case 4. P=19.83%(=576bits), 10.19%(=296bits) for block size of 964.
  Case 5. P=20%(=3072bits) for block size of 5116.
  Case 6. P=33% for block sizes of 320, 640, 960.
- Decoding algorithm:
  Log MAP decoder: Case 1,
  Linear MAP decoder : Case 2,3,4,5, and 6.
- Rate matching algorithm: Given in [4].
- Turbo interleaver: PIL
- Number of iterations: 8
- (a,b,a,b) parameter for RMB1 and RMB2: (2,1,1,1)
- Number of frame errors: greater than 100
- Channel model: AWGN
- TTI: 80msec

# 3. Results and conclusion

In Figure 1-16, with interleaver sizes of 324, 644, 964, and 5116, it was shown that the proposed rate matching scheme provides very similar performance in uplink compared with performance in downlink. Also, the performance of high rate code decreases in proportion to the puncturing rate P. In Figure 17-25, with interleaver sizes of 320, 324, 640, 644, 960, and 964, it is shown that performance of Berrou code puncturing is very similar to the performance of rate matching puncturing. In fact, performance difference between them is less than 0.05dB. In addition, comparing performance in Figure1 through Figure 25, it

was also shown that the performance decrease in proportion to the puncturing rate P in both of uplink and downlink. Therefore it is concluded that rate matching puncturing scheme for both of uplink and downlink should be preferred in terms of implementation complexity and practical performance.

# 4. References


[1] “Unified rate matching scheme for turbo codes in both uplink and downlink”, Samsung Electronics Co. and LGIC, TSGR1#6(99)a30.
[2] "Additional simulation results of rate matching algorithm", Samsung Electronics Co., TSGR1#7 (99)b02.
[3] “Simulation results of puncturing algorithm for Turbo code”, LGIC, TSGR1#7(99)b89.
[4] “Text proposal for turbo codes and rate matching in TS 25.212, TS 25.222 (Rev. of R1-99d56)", Samsung Electronics Co. and LGIC, TSGR1#7(99)d84.
[5] “Report on AH5 meeting of 31 August 1999”, Ad Hoc 5 Chair, TSGR1#7(99)d46.


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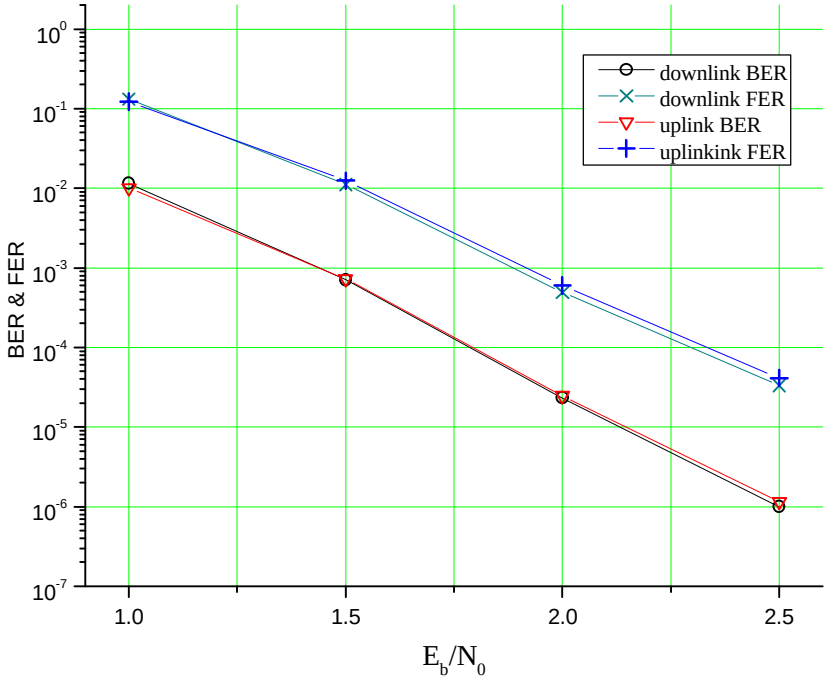


Fig. 1. BER and FER performance comparison of turbo codes in downlink and uplink. (N=324, P= 20%).

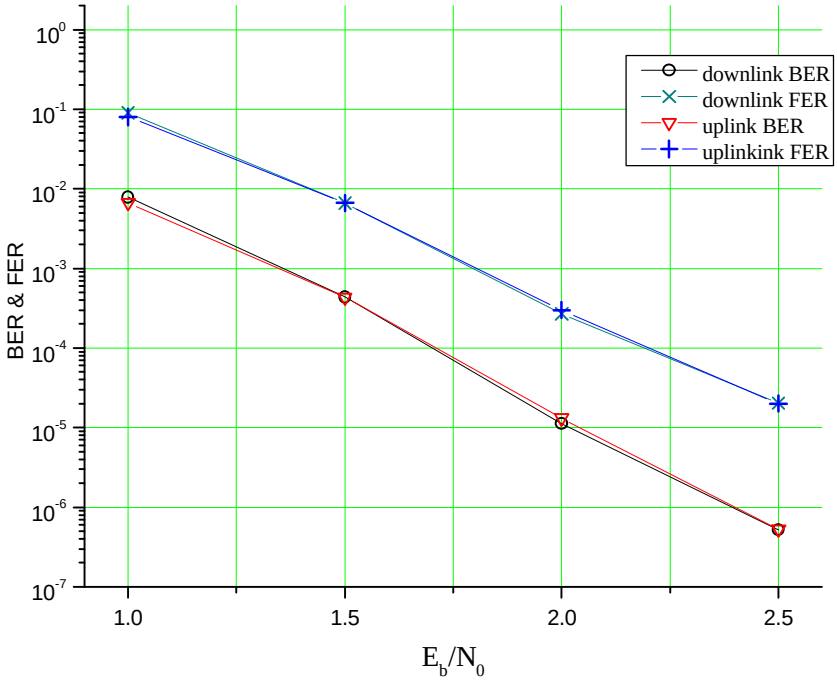


Fig. 2. BER and FER performance comparison of turbo codes in downlink and uplink. (N=324, P= 15%).

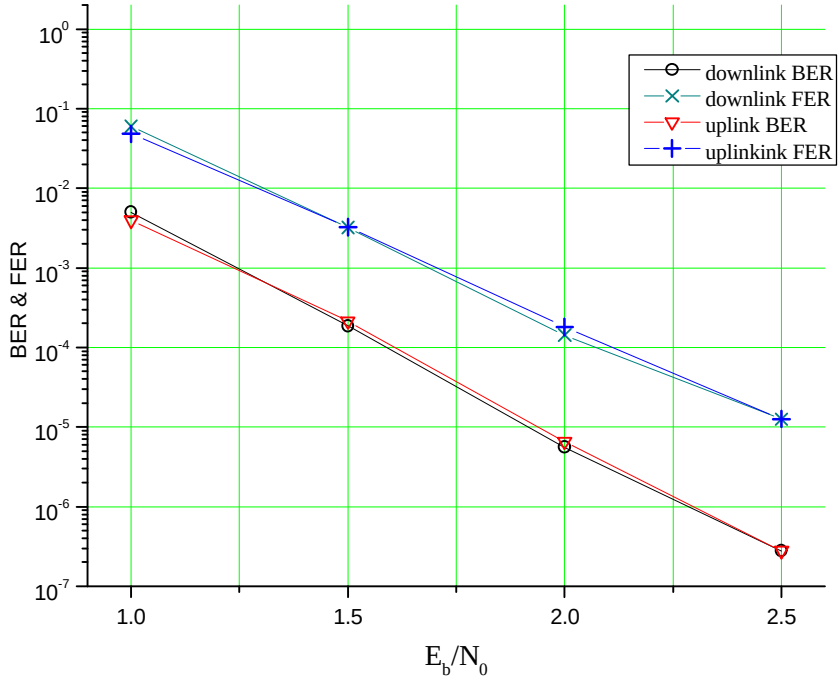


Fig. 3. BER and FER performance comparison of turbo codes in downlink and uplink. (N=324, P= 10%).

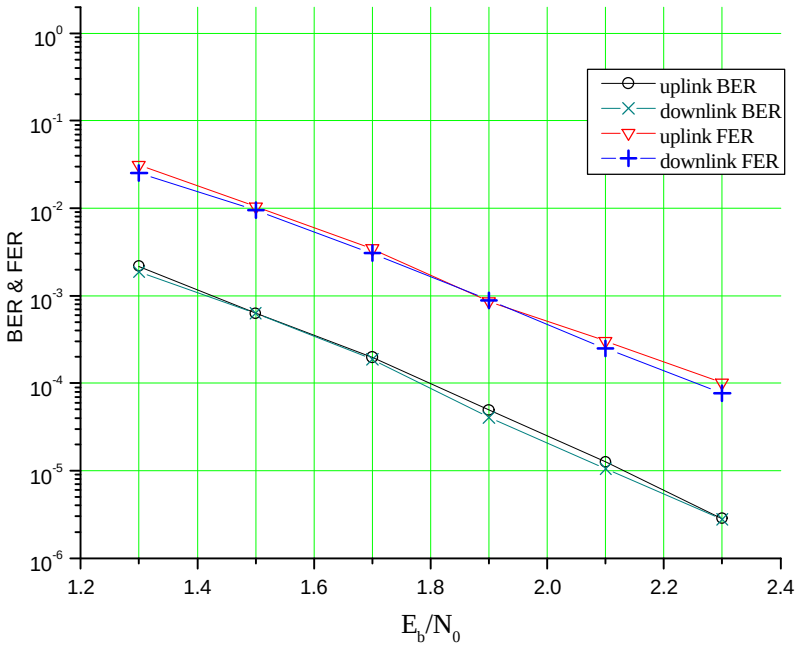


Fig. 4. BER and FER performance comparison of turbo codes in downlink and uplink. (N=324, P= 19.5%(=192bits)).

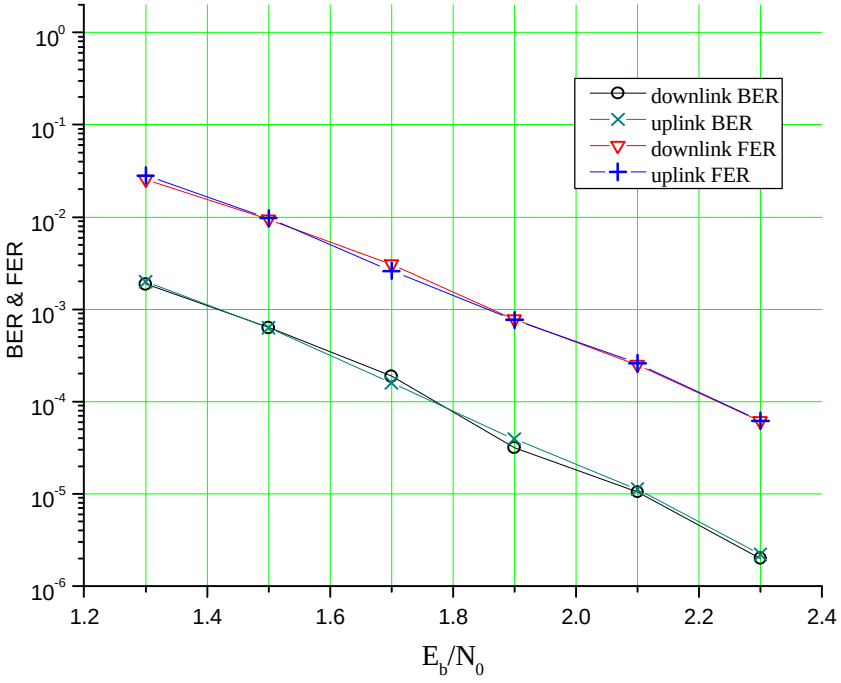


Fig. 5. BER and FER performance comparison of turbo codes in downlink and uplink. (N=324, P= 18.7%(=184bits)).

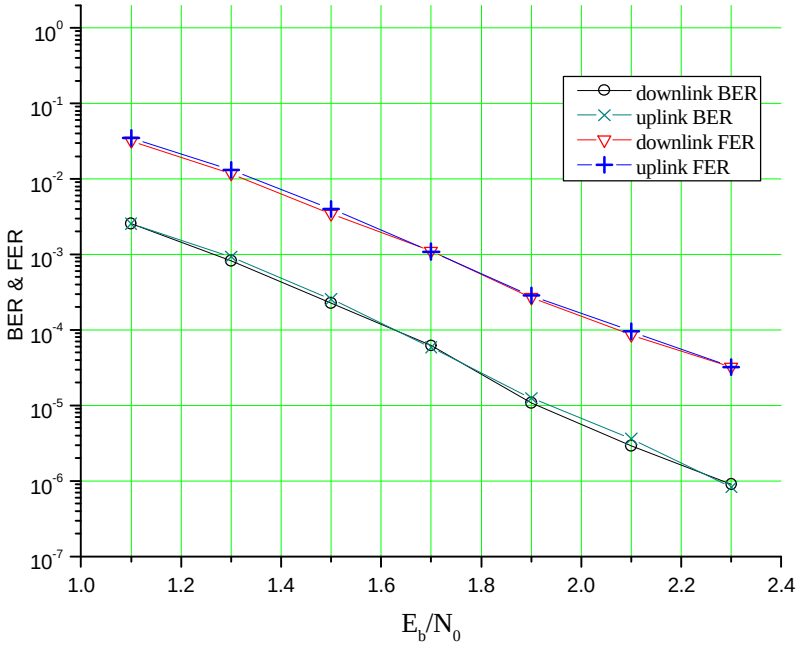


Fig. 6. BER and FER performance comparison of turbo codes in downlink and uplink. (N=324, P= 10.6%(=104bits)).

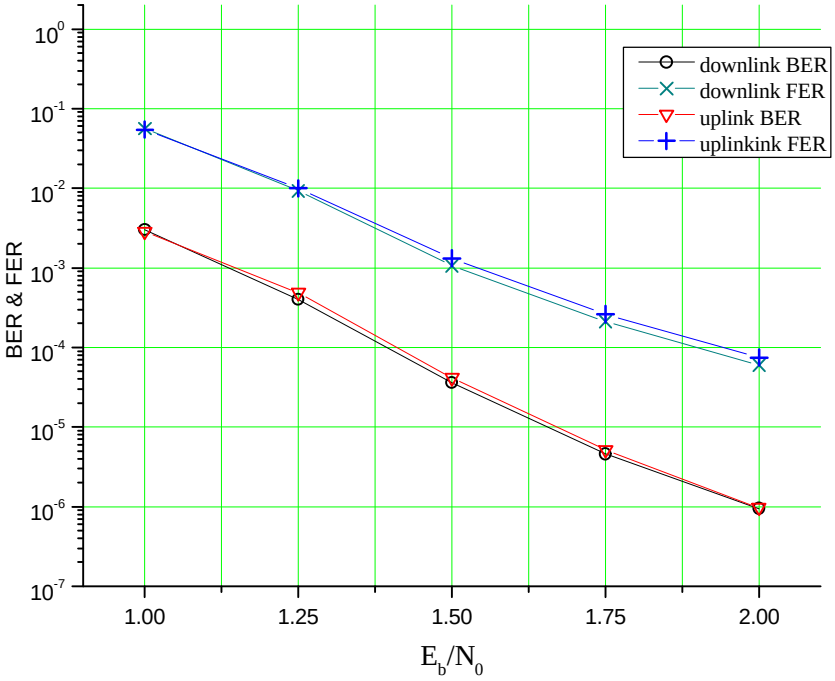


Fig. 7. BER and FER performance comparison of turbo codes in downlink and uplink. (N=644, P= 20%).

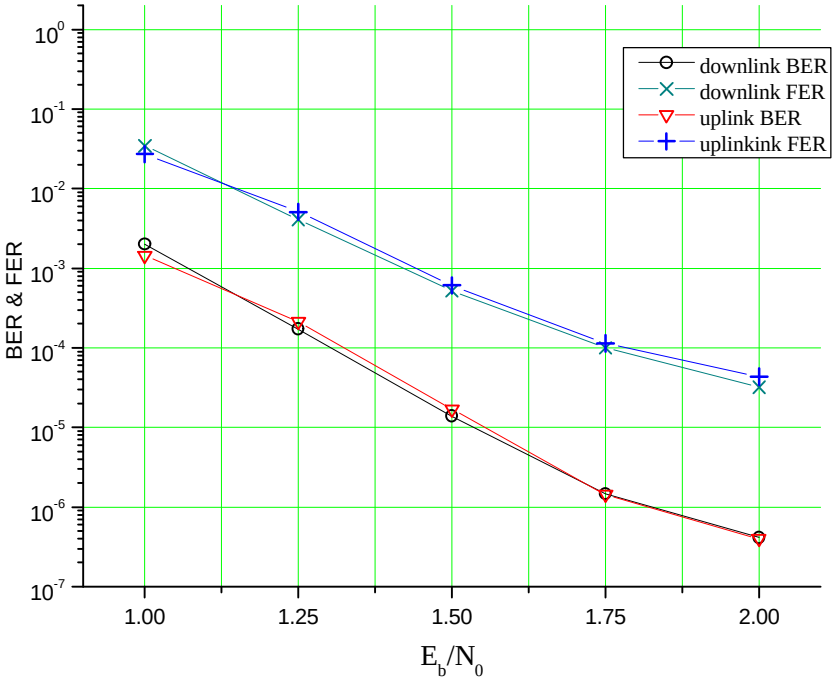


Fig. 8. BER and FER performance comparison of turbo codes in downlink and uplink. (N=644, P= 15%).

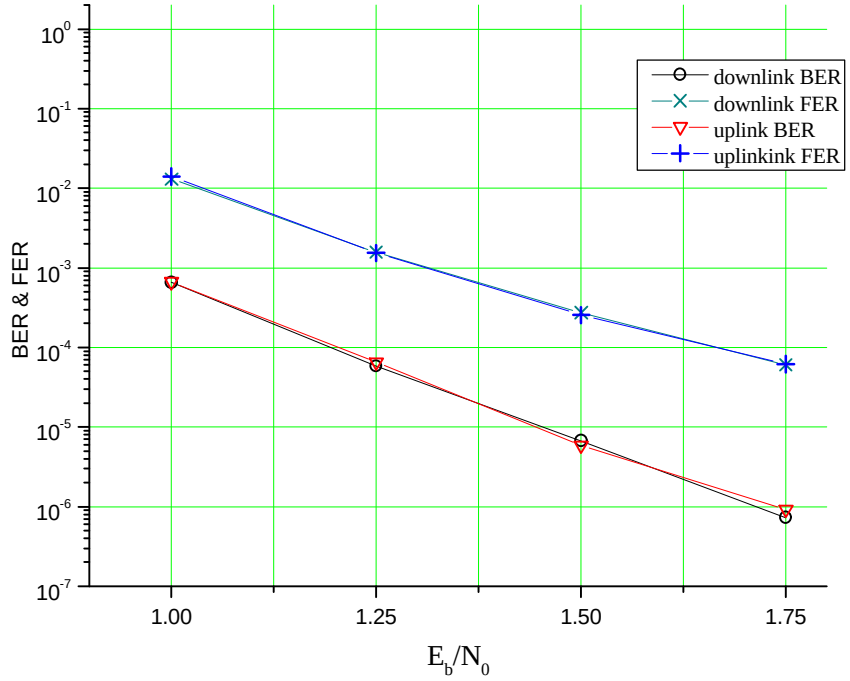


Fig. 9. BER and FER performance comparison of turbo codes in downlink and uplink. (N=644, P= 10%).

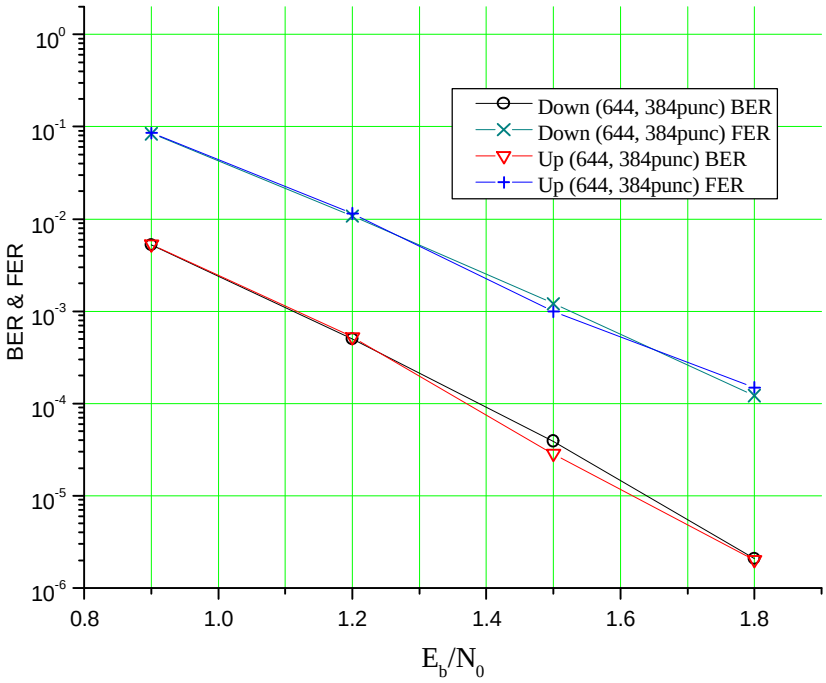


Fig. 10. BER and FER performance comparison of turbo codes in downlink and uplink. (N=644, P= 19.75%(=384bits)).

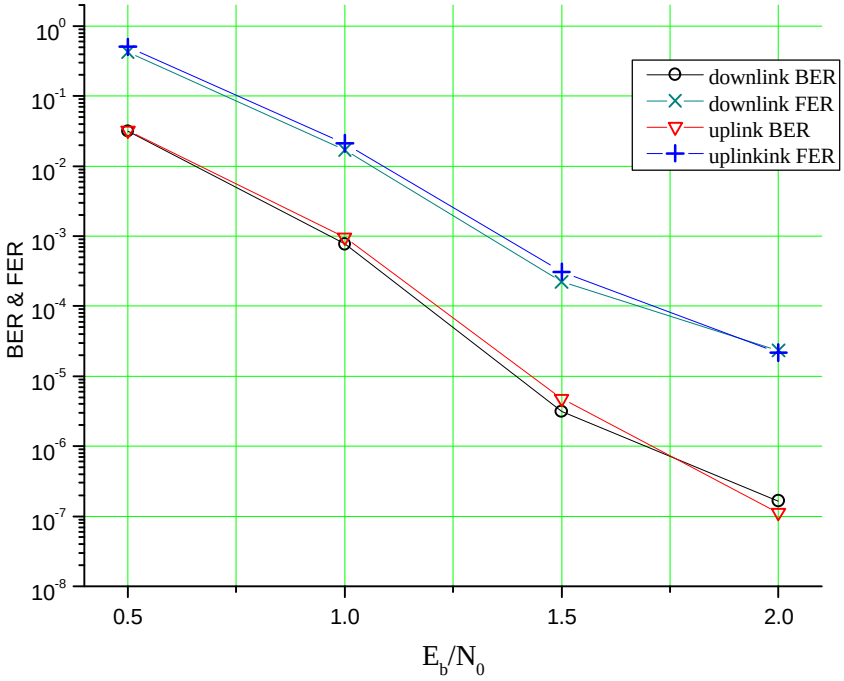


Fig. 11. BER and FER performance comparison of turbo codes in downlink and uplink. (N=964, P= 20%).

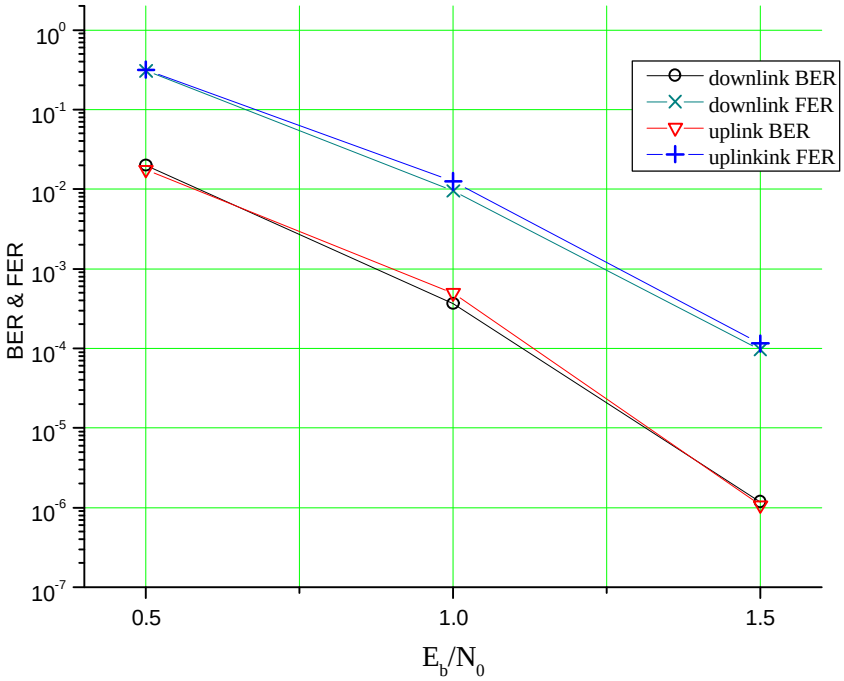


Fig. 12. BER and FER performance comparison of turbo codes in downlink and uplink. (N=964, P= 15%).

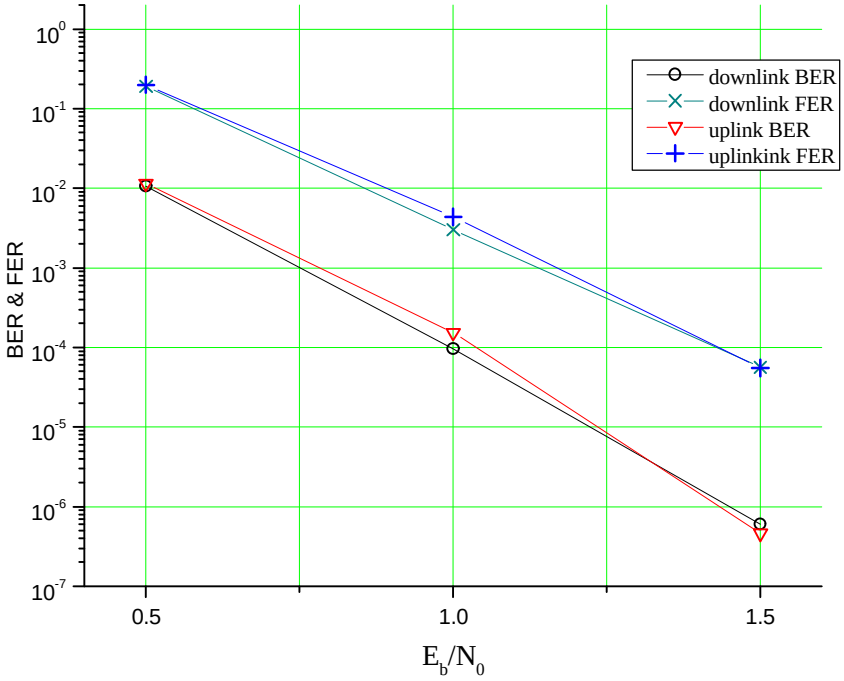


Fig. 13. BER and FER performance comparison of turbo codes in downlink and uplink. (N=964, P= 10%).

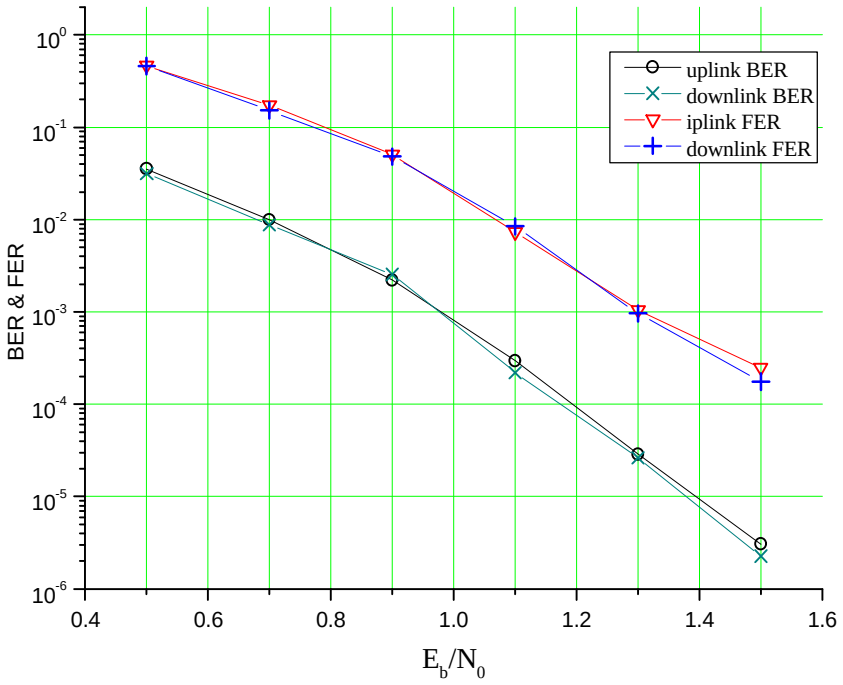


Fig. 14. BER and FER performance comparison of turbo codes in downlink and uplink. (N=964, P= 19.83%(=576bits)).

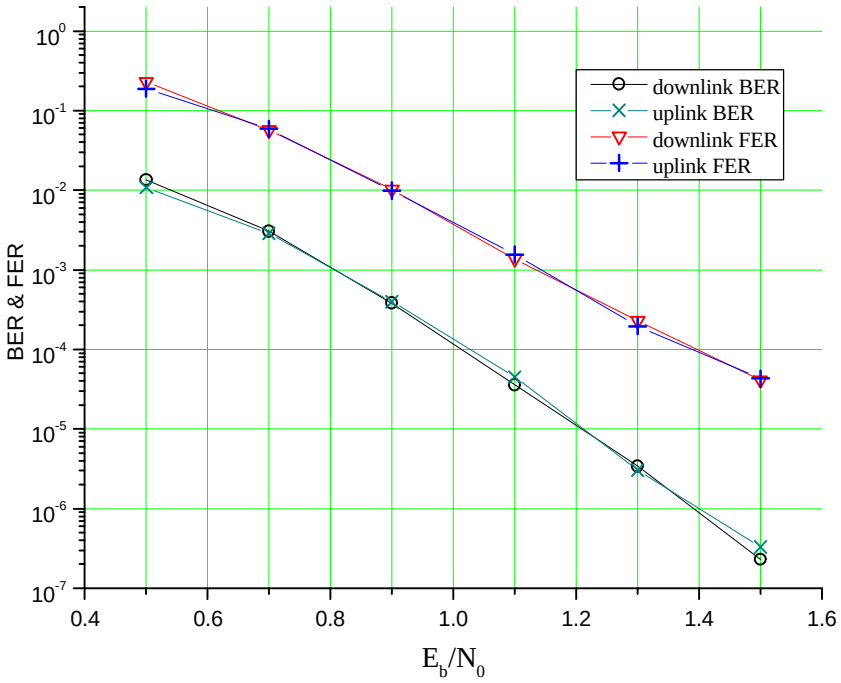


Fig. 15. BER and FER performance comparison of turbo codes in downlink and uplink. (N=964, P= 10.19%(=296bits)).

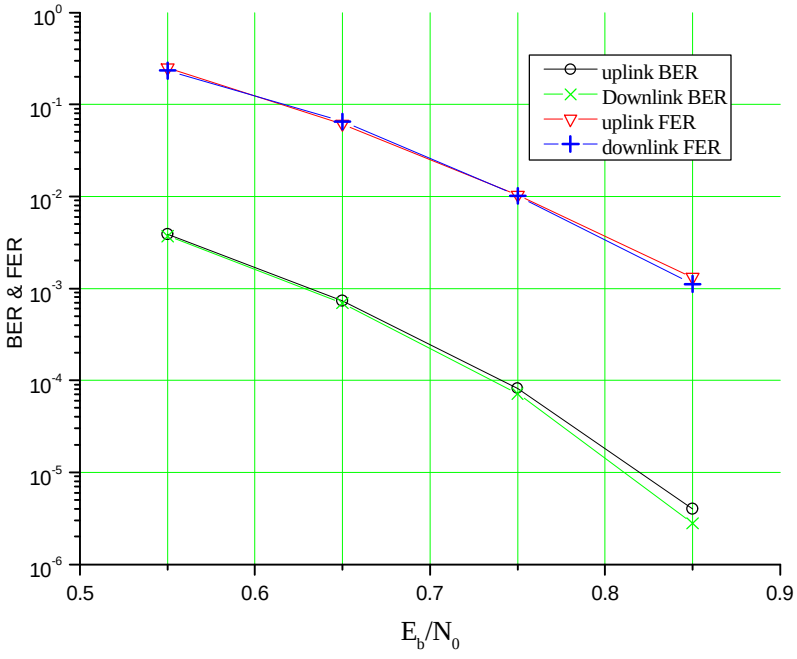


Fig. 16. BER and FER performance comparison of turbo codes in downlink and uplink. (N=5116, P= 20%(=3072bits)).

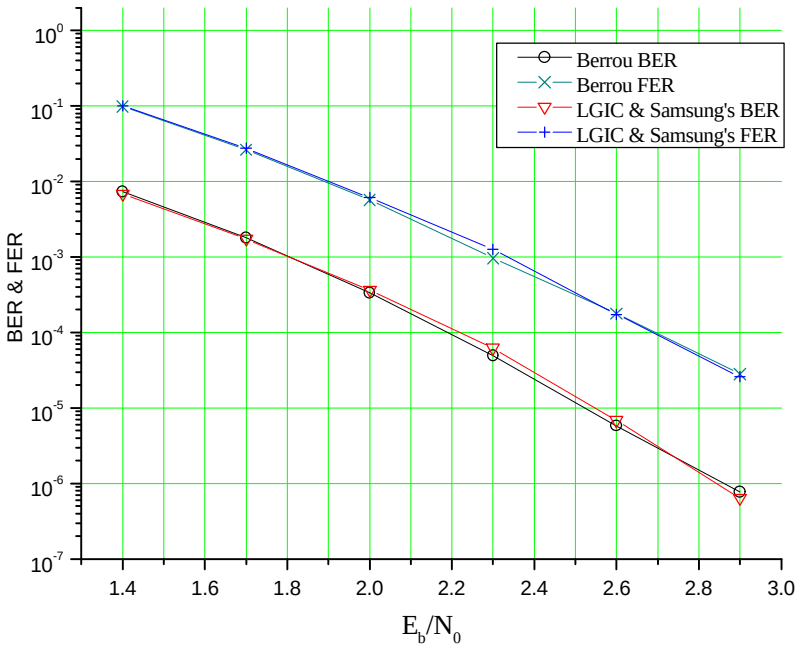


Fig. 17. BER and FER performance comparison of turbo codes in Berrou code puncturing and rate matching puncturing in uplink. (N=320, P= 33%).

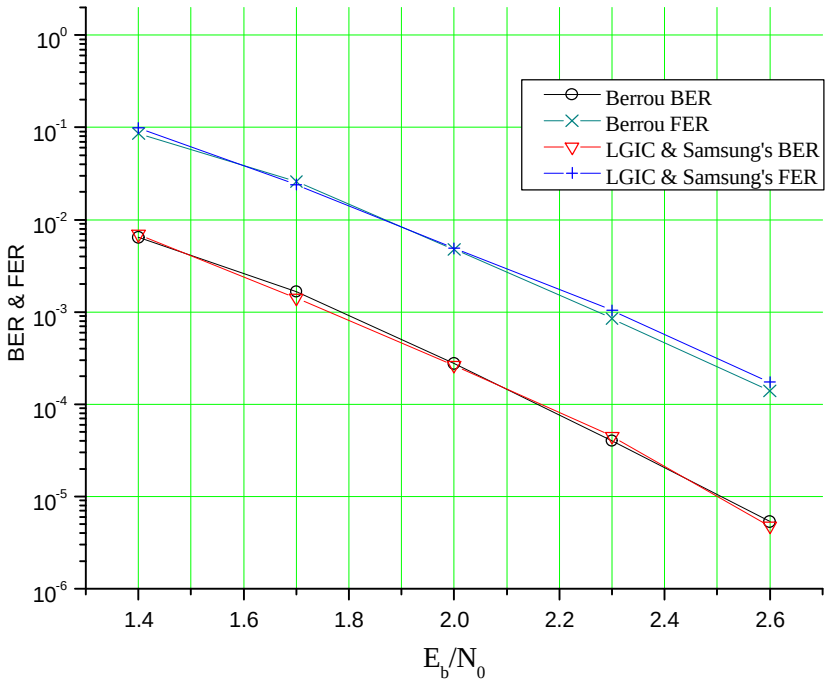


Fig. 18. BER and FER performance comparison of turbo codes in Berrou code puncturing and rate matching puncturing in uplink. (N=324, P= 33%).

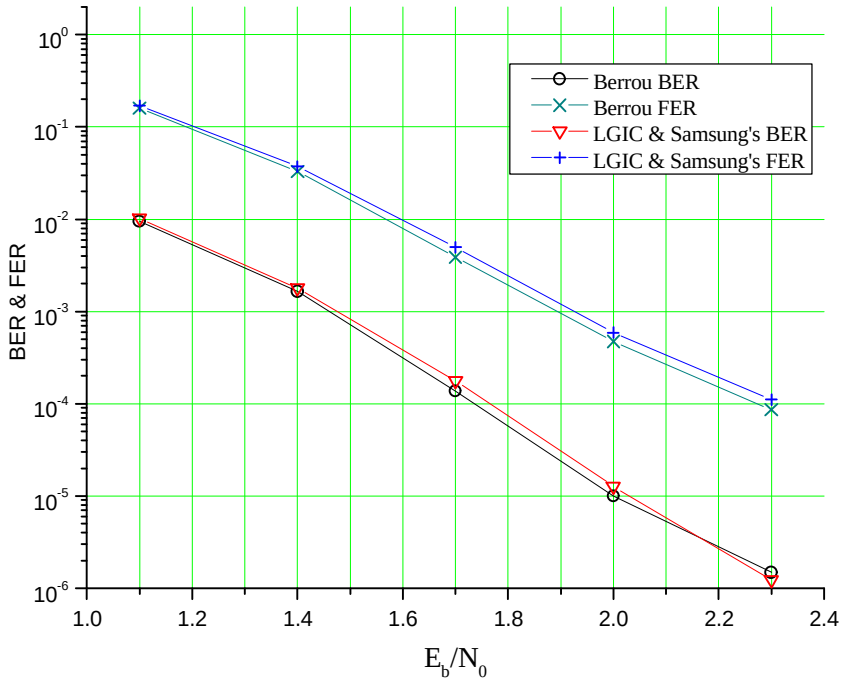


Fig. 19. BER and FER performance comparison of turbo codes in Berrou code puncturing and rate matching puncturing in uplink. (N=640, P= 33%).

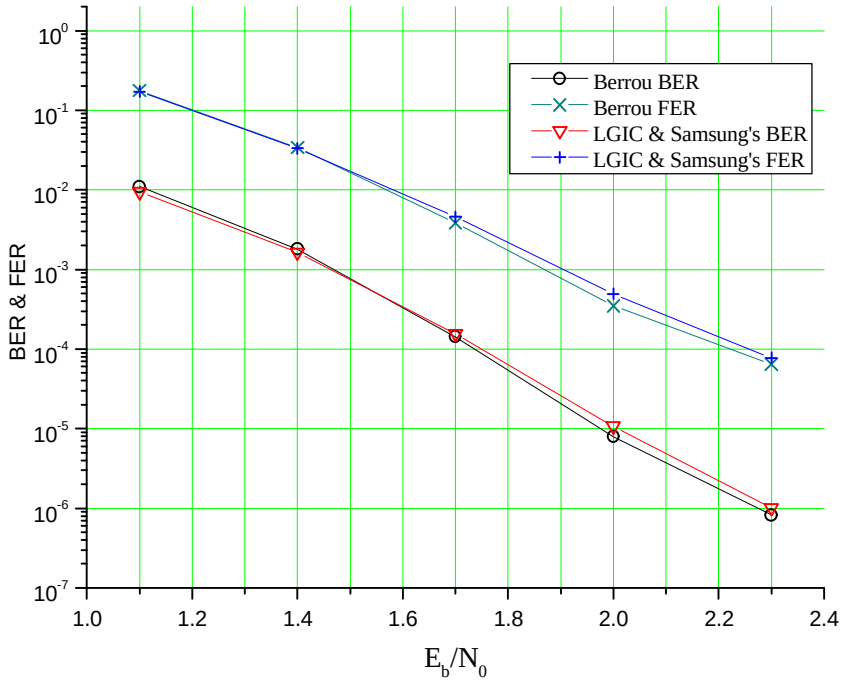


Fig. 20. BER and FER performance comparison of turbo codes in Berrou code puncturing and rate matching puncturing in uplink. (N=644, P= 33%).

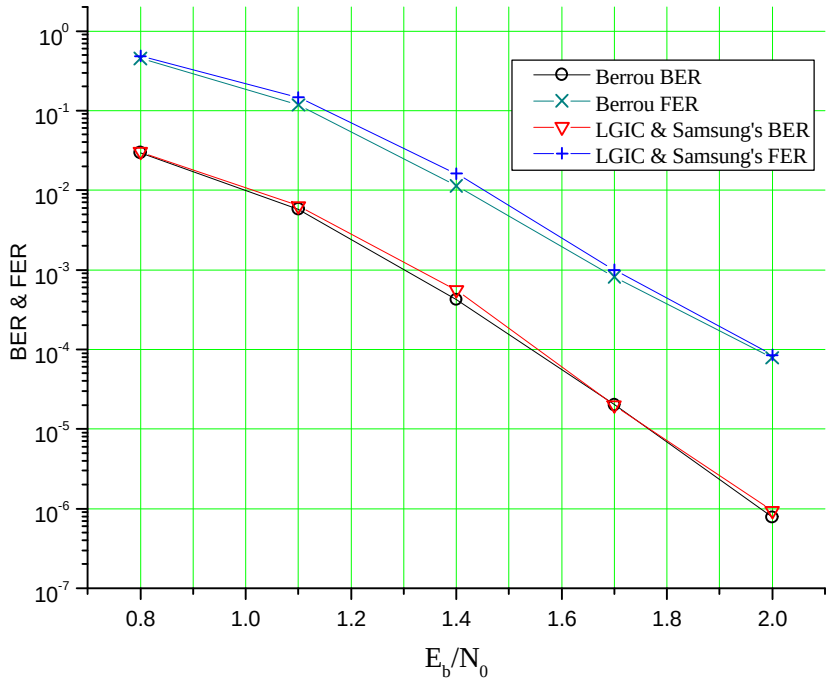


Fig. 21. BER and FER performance comparison of turbo codes in Berrou code puncturing and rate matching puncturing in uplink. (N=960, P= 33%).

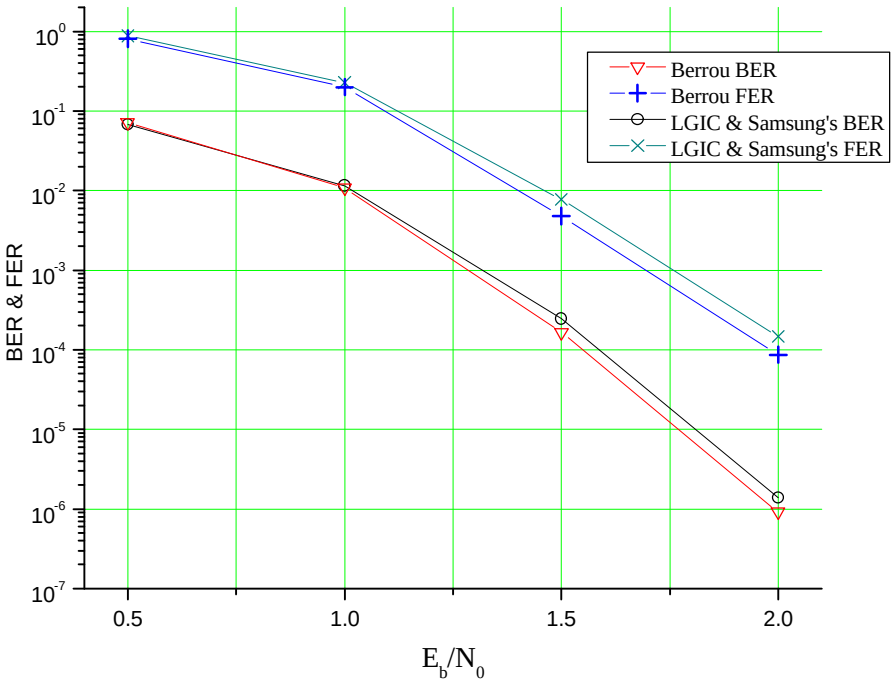


Fig. 22. BER and FER performance comparison of turbo codes in Berrou code puncturing and rate matching puncturing in uplink. (N=964, P= 33%).

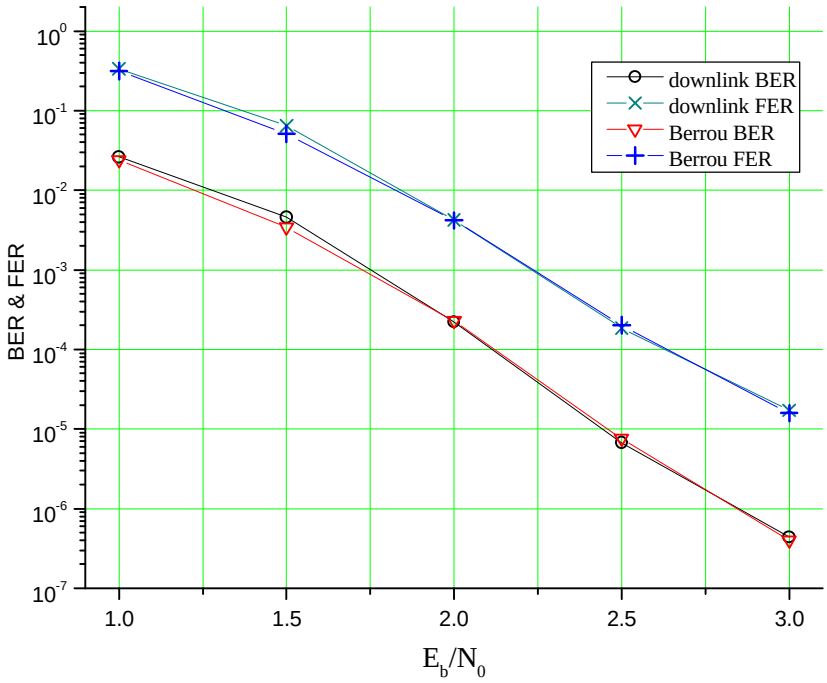


Fig. 23. BER and FER performance comparison of turbo codes in Berrou code puncturing and rate matching puncturing in downlink. (N=324, P= 33%).

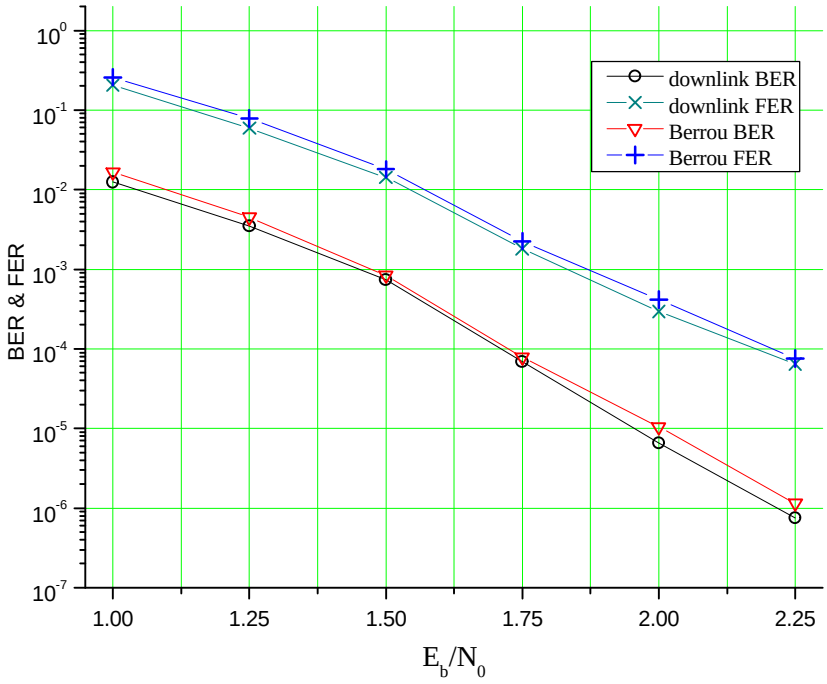


Fig. 24. BER and FER performance comparison of turbo codes in in Berrou code puncturing and rate matching puncturing in down link. (N=644, P= 33%).

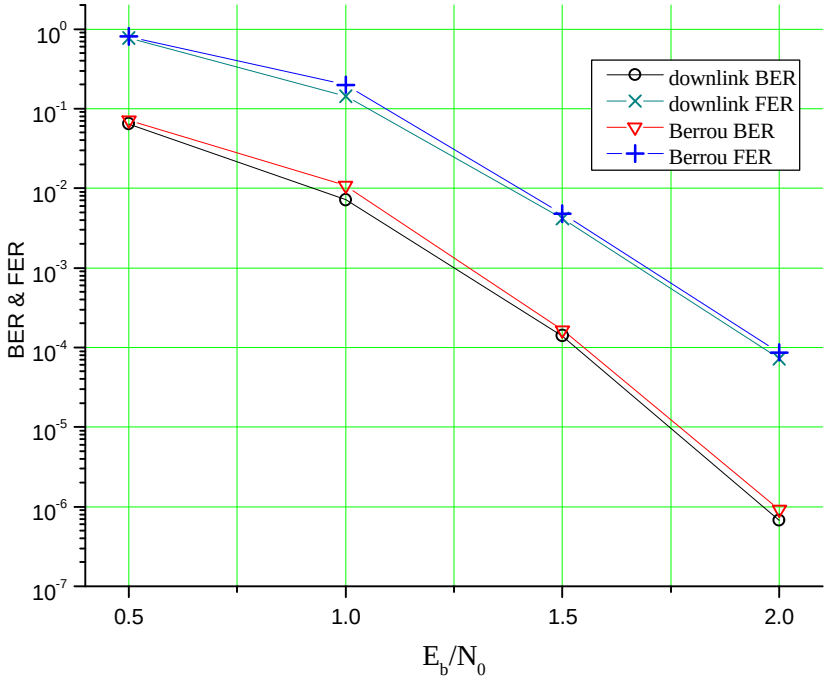


Fig. 25. BER and FER performance comparison of turbo codes in in Berrou code puncturing and rate matching puncturing in downlink. (N=964, P= 33%).