M-ary symbol bit error rate is higher than bit error rate

Article Overview

The bit error rate (BER) of M-ary modulation schemes is higher than that of binary modulation because each symbol represents multiple bits, reducing the distance between constellation points and making the system more error-prone at the same SNR.

Explanation

In M-ary modulation (such as M-ary PSK or M-ary QAM), each symbol encodes $\log_2(M)$ bits by varying the phase, amplitude, or both of the carrier signal . As the modulation order M increases, more bits are packed into a single symbol, which reduces the Euclidean distance between adjacent constellation points. This smaller spacing makes the symbols more susceptible to noise and interference, leading to a higher probability of symbol errors, and consequently, a higher BER . For example, in M-ary PSK, the phase difference between adjacent symbols decreases as M increases. A 16-PSK system has smaller phase separation than an 8-PSK system, so at the same SNR, the likelihood of misinterpreting a symbol is higher . Similarly, in M-ary QAM, higher-order constellations like 64-QAM or 256-QAM are more spectrally efficient but exhibit higher BER because the amplitude and phase points are closer together .

Relationship Between BER and SNR

The BER decreases as SNR increases, but for higher-order M-ary schemes, achieving the same BER as a lower-order scheme requires a higher SNR . This trade-off is fun...

Article Content

May 25, 2026

Performance Analysis of Different M-ARY Modulation Techniques in ...

M-ary QAM does not have constant energy per symbol, nor does it have constant distribution between possible symbol states. It is

Oct 02, 2025

Analysis of Bit Error Rate of different M-ary PSK ...

High data rate High spectral efficiency (minimum bandwidth occupancy) High power efficiency (minimum required transmit power)

Jun 15, 2026

(PDF) BIT ERROR RATE ANALYSIS OF M-ARY PSK AND M-ARY

BIT ERROR RATE ANALYSIS OF M-ARY PSK AND M-ARY QAM OVER RICIAN FADING CHANNEL 1Subrato Bharati,

Oct 03, 2025

Error Performance Analysis of --ary --QAM

In this paper, we derive new exact and general expressions for the symbol error rate (SER) and bit error rate (BER) of

Feb 16, 2026

Microsoft Word

M-ary modulations schemes in wireless communication systems are analyzed using voice signal as a function of bit error rate (BER).

Nov 15, 2025

Performance Comparison of M-ary Phase Shift Keying and M-ary

The MATLAB simulation results demonstrated that, for the same degree of signal-to-noise ratio, the bit error rate for

Aug 13, 2025

Theoretical BER vs SNR for m-ary PSK and QAM

M-ary PSK is a modulation technique where each symbol represents $\log_2(M)$ bits by shifting the phase of a carrier. The phases are

May 26, 2026

Bit Error Rate of Coherent M-ary PSK

When BER is the performance measure, the bit assignment for each M-ary symbol is important. The best bits-to-symbol mapping for

Aug 20, 2025

BER Performance of Gray-Coded PSK-Modulated and QAM

Higher data rate modulation scheme is one of the significant criteria but minimizing the bit error rate is one of the major aspects in

Jan 08, 2026

Comparative Response Evaluation of Multilevel PSK and QAM Schemes

The performance is compared by way of bit error probability and bandwidth efficiency. The simulated bit error rate

Feb 21, 2026

BER and SER for uncoded data over AWGN channels

The berawgn function returns the bit error rate (BER) and symbol error rate (SER) in an additive white Gaussian noise (AWGN)

Jul 01, 2026

(PDF) BIT ERROR RATE ANALYSIS OF M-ARY PSK AND M-ARY

Simulation results demonstrate BER variations for M-ary PSK with SNR ranging from 0 to 10 dB. M-ary PSK shows increased BER

Jan 26, 2026

Symbol Error Rate

Symbol Error Rate (SER) refers to the probability of errors in the received symbols, assuming a certain level of noise and channel

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International Journal of Innovative Technology and Exploring ...

Analysis of Bit Error Rate on M-ary QAM over Gaussian and Rayleigh Fading Channel

May 09, 2026

Comparative Study of Bit Error Rate of Different M-ary Modulation ...

More spectrally efficient digital modulation scheme, such as M-ary quadrature amplitude modulation (QAM), is an

May 19, 2026

BER vs SNR for M-ary QAM, M-ary PSK, QPSK, BPSK, ... (MATLAB

We distinguish between Bit Error Rate (BER) —the probability of a single bit being wrong—and Symbol Error Rate (SER) —the

Feb 15, 2026

(PDF) Bit Error Rate Analysis of M-ARY PSK and M-ARY QAM Over

Abstract and Figures This paper mainly illustrates the Bit error rate performance of M-ary QAM and M-ary PSK for

Oct 02, 2025

Theoretical BER vs SNR for m-ary PSK and QAM

Higher-order schemes (e.g., 8-PSK, 16-PSK) have higher BER for same SNR. M-ary PSK is a modulation technique where each

Oct 09, 2025

Performance Analysis of Different M-ARY Modulation Techniques over ...

M-ary modulation schemes are one of most efficient digital data transmission systems as it achieves better bandwidth efficiency than

Dec 09, 2025

Symbol Error Rate

The bit error rate is the same as the symbol error rate for binary transmission (i.e., we have P S E R = P B E R). We see that different

Apr 24, 2026

(PDF) BIT ERROR RATE ANALYSIS OF M-ARY PSK AND M-ARY

The paper analyzes Bit Error Rate (BER) of M-ary PSK and M-ary QAM over Rician Fading channels. BER decreases as Signal to

Jan 16, 2026

Comparative Study of Bit Error Rate of Different M-ary Modulation ...

Therefore, as the error rate increases with increasing M; lower level should be used for long distance communication

Oct 05, 2025

Computing Error Rates

Observe that the constellation points come closer to each other for higher-order modulation and normalized average

Aug 28, 2025

BER Performance for M-ARY Digital Communication

For designers of digital terrestrial microwave radios, their highest priority is good bandwidth efficiency with low bit-error-rate. The RF

Dec 05, 2025

Symbol Error Rate

We observe that for modulations higher than 8-PSK it is preferable to move to QAM modulations. Note that 2-QAM and 4-QAM

Oct 04, 2025

Comparative Study of Bit Error Rate of Different M-ary Modulation ...

The desired expression of bit error rate (BER) is obtained by modeling the turbulence as gamma-gamma distributed

Jun 19, 2026

Performance Comparison of M-ary Phase Shift Keying and M-ary

To reduce errors during data transmission, an effective communication system must be developed. Most of the

Nov 03, 2025

The exact symbol and bit error probabilities of coherent M-ary PSK

Efficient computation of the bit error rate (BER) for the coherent M -ary PSK signals with Gray code bit mapping is

Mar 04, 2026

Analytical Computation Of The Error Probability Of Coherent M-Ary ...

2.1 The Symbol Error Probability of Coherent M-Ary FSK (M-co-FSK) Modulation Let the modulation order be denoted as M, energy

May 31, 2026

Relation between bit and symbol error probabilities for frequency shift ...

Abstract: In M-ary, Gray coded digital communication, the bit error probability is usually approximated by the symbol error probability

Mar 22, 2026

A First Course in Digital Communications

Comparison of M-ary Signaling Techniques A compact and meaningful comparison is based on the bit rate-to bandwidth ratio, rb/W

Jun 30, 2026

Paper Title (use style: paper title)

From this paper, it can be observed that the value of Bit error rate decreases when signal to noise ratio increases in decibel for M

Nov 24, 2025

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M-ary Quadrature Amplitude Modulation (QAM) is a widely used modulation technique that provides high transmission rates with

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