

Hamming code is a set of error-correction codes that can be used to detect and correct [bit](#) errors that can occur when computer data is moved or stored. Hamming code is named for R. W. Hamming of Bell Labs.

Like other error-correction codes, Hamming code makes use of the concept of [parity](#) and [parity bits](#), which are bits that are added to data so that the validity of the data can be checked when it is read or after it has been received in a data transmission. Using more than one parity bit, an error-correction code can not only identify a single bit error in the data unit, but also its location in the data unit.

In data transmission, the ability of a receiving station to correct errors in the received data is called [forward error correction](#) (FEC) and can increase [throughput](#) on a data link when there is a lot of [noise](#) present. To enable this, a transmitting station must add extra data (called *error correction bits*) to the transmission. However, the correction may not always represent a cost saving over that of simply resending the information. Hamming codes make FEC less expensive to implement through the use of a *block parity* mechanism.

Computing [parity](#) involves counting the number of ones in a unit of data, and adding either a zero or a one (called a *parity bit*) to make the count odd (for odd parity) or even (for even parity). For example, 1001 is a 4-bit data unit containing two one bits; since that is an even number, a zero would be added to maintain even parity, or, if odd parity was being maintained, another one would be added. To calculate even parity, the [XOR](#) operator is used; to calculate odd parity, the [XNOR](#) operator is used. Single bit errors are detected

when the parity count indicates that the number of ones is incorrect, indicating that a data bit has been flipped by noise in the line. Hamming codes detect two bit errors by using more than one parity bit, each of which is computed on different combinations of bits in the data. The number of parity bits required depends on the number of bits in the data transmission, and is calculated by the Hamming rule:

$$p$$

$$d + p + 1 \leq 2^p \quad (1)$$

Where d is the number of data bits and p is the number of parity bits. The total of the two is called the Hamming code word, which is generated by multiplying the data bits by a generator matrix .