

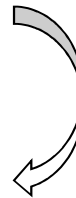
## Notes on Calculating the Hamming Code

Layout of our test marker



MSB LSB

	5	4	3	2	1
1	1	0	0	0	0
2	0	1	1	1	0
3	1	0	1	1	1
4	1	0	1	1	1
5	1	0	1	1	1
	5	4	3	2	1
1	0	0	0	0	0
2	1	1	1	1	0
3	0	0	1	1	1
4	0	0	1	1	1
5	0	0	1	1	1



Flip all bits in the first column (we want to avoid empty rows)

LSB ... Least Significant Bit

MSB ... Most Significant Bit

LSB		MSB			Notes
1	2	3	4	5	Column index
$2^0$	$2^1$	$2^2$	$2^3$	$2^4$	Power of two
P1	P2	D1	P3	D2	Positions of parity and data bits
1	1	1	0	0	Actual word from the 3 <sup>rd</sup> row as an example (denoted as $a_3$ )
—	—	1	—	0	Data bits without parity bits
?	—	1	—	0	First parity bit: 1 + 0 is odd → P1 = 1
1	?	1	—	0	Second parity bit: 1 is odd → P2 = 1
1	1	1	?	0	Third parity bit: 0 is even → P3 = 0
1	1	1	0	0	Expected word (denoted as $b_3$ )

Words are the same and the Hamming distance  $d_H(a_3, b_3) = 0$ , see [1]. Now, we know that the 3<sup>rd</sup> row is a valid Hamming code. If that holds for all rows, we have found the valid marker. Note that our 5×5 field can represent up to  $2^{25} = 1024$  values, i.e. we can generate 1024 different markers. For further reference, see [2].

[1] [https://cs.wikipedia.org/wiki/Hammingova\\_vzd%C3%A1lenost](https://cs.wikipedia.org/wiki/Hammingova_vzd%C3%A1lenost)

[2] <https://users.cs.fiu.edu/~downeyt/cop3402/hamming.html>