### What is Parity Bit?

To proceed further we need to know about **parity bit**, which is a bit appended to the data bits which ensures that the total number of 1's are even (even parity) or odd (odd parity).

**Hamming code structure**

Hamming code is basically a linear block code name after its inventor. It is an error correcting code. The Binary bits are inserted in data bits.

**7 Bit Hamming code**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| D7 | D6 | D5 | P4 | D3 | P2 | P1 |

**D: Data bits**

**P: Parity bits**

|  |  |
| --- | --- |
| **Parity Bit** | **Bit to be checked** |
| **P1** | **1,3,5,7** |
| **P2** | **2,3,6,7** |
| **P4** | **4,5,6,7** |

**Example:**

Bit word: 1011

Parity: Even

**Sender side**

**Step 1:**

Code word format

The 7 bit code word format:

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 |  | 1 |  |  |

**Step 2:**

Decide P1

P1 sets parity of bits

Bits to be check: 1,3,5,7

D3: 1 D5:1 D7: 1

So this is Odd no. of 1’s.

As per Even parity P1= 1

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 |  | 1 |  | 1 |

**Step 3:**

Decide P2

P2 sets parity of bits

Bits to be check: 2,3,6,7

D3: 1 D6:0 D7: 1

As per Even parity P2= 0

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 |  | 1 | 0 | 1 |

**Step 4:**

Decide P4

P2 sets parity of bits

Bits to be check: 4,5,6,7

D5: 1 D6:0 D7: 1

As per Even parity P2= 0

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 |

**Frame ready to send:**

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 |

**Receiver side:**

**Original frame:**

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 |

**After attack by attacker frame received:**

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 |

**Step 1:**

Analyze the 4,5,6,7 bit

P4, D5, D6, D7= 0001----- ODD parity

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 |

So put P4=1

**Step 2:**

Analyze the 2,3,6,7 bit

P2, D3, D6, D7= 0101----- Even parity

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 |

So put P2=0

**Step 3:**

Analyze the 1,3,5,7 bit

P1, D3, D5, D7= 1101----- ODD parity

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 |

So put P1=1

**Step 4: Write the error word**

|  |  |  |
| --- | --- | --- |
| **P4** | **P2** | **P1** |

|  |  |  |
| --- | --- | --- |
| **1** | **0** | **1** |

**E =   
 E = 5**

Hence in the 5th bit of the received frame is an error

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 |

**Step 4: Correct the error**

D7 D6 D5 P4 D3 P2 P1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 |