**QR Code Tutorial**

**Structure Final Message**

In the error correction coding section, the Reed-Solomon error correction process was explained. You should now have the data codewords and their corresponding error correction codewords. As mentioned in the previous step, larger QR codes require you to break the data codewords into smaller blocks, and generate error correction codewords separately for each block. When this is the case, the data blocks and error correction codewords must be interleaved according to the QR code specification. This page explains the interleaving process in detail.

**Step 1: Determine How Many Blocks and Error Correction Codewords are Required**

The error correction table shows how many data blocks and error correction codewords per block are required for each version and error correction level.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Version and EC Level** | **Total Number of Data Codewords for this Version and EC Level** | **EC Codewords Per Block** | **Number of Blocks in Group 1** | **Number of Data Codewords in Each of Group 1's Blocks** | **Number of Blocks in Group 2** | **Number of Data Codewords in Each of Group 2's Blocks** | **Total Data Codewords** |
| 1-L | 19 | 7 | 1 | 19 |  |  | (19\*1) = 19 |
| 1-M | 16 | 10 | 1 | 16 |  |  | (16\*1) = 16 |
| 1-Q | 13 | 13 | 1 | 13 |  |  | (13\*1) = 13 |
| 1-H | 9 | 17 | 1 | 9 |  |  | (9\*1) = 9 |
| 2-L | 34 | 10 | 1 | 34 |  |  | (34\*1) = 34 |
| 2-M | 28 | 16 | 1 | 28 |  |  | (28\*1) = 28 |
| 2-Q | 22 | 22 | 1 | 22 |  |  | (22\*1) = 22 |
| 2-H | 16 | 28 | 1 | 16 |  |  | (16\*1) = 16 |
| 3-L | 55 | 15 | 1 | 55 |  |  | (55\*1) = 55 |
| 3-M | 44 | 26 | 1 | 44 |  |  | (44\*1) = 44 |
| 3-Q | 34 | 18 | 2 | 17 |  |  | (17\*2) = 34 |
| 3-H | 26 | 22 | 2 | 13 |  |  | (13\*2) = 26 |
| 4-L | 80 | 20 | 1 | 80 |  |  | (80\*1) = 80 |
| 4-M | 64 | 18 | 2 | 32 |  |  | (32\*2) = 64 |
| 4-Q | 48 | 26 | 2 | 24 |  |  | (24\*2) = 48 |

**Step 2: Interleave the Blocks**

**Step 3: Convert to Binary**

The final message is converted to 8-bit binary. In our example, the first four codewords are 67, 246, 182, and 70. Converted to binary, these are:

67 = 01000011

246 = 11110110

182 = 10110110

70 = 01000110

The 8-bit binary numbers are put together in an unbroken string. Using the first four codewords from above, the first 32 bits of the final message are:

01000011111101101011011001000110

For completeness, if the interleaved error correction codewords are as follows:

213, 87, 148, 235, 199, 204, 116, 159, 11, 96, 177, 5, 45, 60, 212, 173, 115, 202, 76, 24, 247, 182, 133, 147, 241, 124, 75, 59, 223, 157, 242, 33, 229, 200, 238, 106, 248, 134, 76, 40, 154, 27, 195, 255, 117, 129, 230, 172, 154, 209, 189, 82, 111, 17, 10, 2, 86, 163, 108, 131, 161, 163, 240, 32, 111, 120, 192, 178, 39, 133, 141, 236,

then the entire final message in binary is in the text box below:

0100001111110110101101100100011001010101111101101110011011110111010001100100001011110111011101101000011000000111011101110101011001010111011101100011001011000010001001101000011000000111000001100101010111110010011101101001011111000010000001111000011000110010011101110010011001010111000100000011001001010110001001101110110000000110000101100101001000010001000100101100011000000110111011000000011011000111100001100001000101100111100100101001011111101100001001100000011000110010000100010000011111101100110101010101011110010100111010111100011111001100011101001001111100001011011000001011000100000101001011010011110011010100101011010111001111001010010011000001100011110111101101101000010110010011111100010111110001001011001110111101111110011101111100100010000111100101110010001110111001101010111110001000011001001100001010001001101000011011110000111111111101110101100000011110011010101100100110101101000110111101010100100110111100010001000010100000001001010110101000110110110010000011101000011010001111110000001000000110111101111000110000001011001000100111100001011000110111101100

**List of Versions and Required Remainder Bits**

The following table lists the 40 QR versions and the number of remainder bits that must be added to the end of the final message string. Note that the remainder bits specified for each version are required no matter which error correction level is in use. Also note that some versions, such as versions 7 through 13, do not require any remainder bits to be added.

|  |  |
| --- | --- |
| **QR Version** | **Required Remainder Bits** |
| 1 | 0 |
| 2 | 7 |
| 3 | 7 |
| 4 | 7 |
| 5 | 7 |
| 6 | 7 |
| 7 | 0 |
| 8 | 0 |
| 9 | 0 |
| 10 | 0 |