

# Universal Latin Square Codes

## Performance Tables

Codework Italia srl — [www.codework.it](http://www.codework.it)

### Legenda

- **D**: cardinality of alphabet (D=2 for bits, D=256 for bytes)
- **n**: codeword length (in symbols)
- **k**: payload - number of information symbols per codeword
- **p**: channel error probability on a symbol
- **rate**:  $k/n$
- **pb**: residual error probability on a symbol - obtained via simulation
- **delta**: confidence interval - assume pb is between (pb-delta) and (pb+delta)
- **CPU**: decoding time per payload *bit*. This is in arbitrary units, so that only ratios between CPU times are meaningful. To ease comparison, the codeword decoding time has been divided by k and reduced to bit equivalents (e.g. decoding times for D=256 have been divided by 8).

D=2 One symbol = 1 bit

D	n	k	p	rate	pb	delta	CPU
2	1206	335	0.1000	0.2778	4.64E-4	1.86E-5	62.4
2	1340	335	0.1000	0.2500	9.91E-5	8.60E-6	69.5
2	1474	335	0.1000	0.2273	5.73E-5	6.54E-6	76.8
2	1608	335	0.1000	0.2083	1.15E-5	9.26E-7	84.9
2	938	536	0.0316	0.5714	3.76E-4	1.33E-5	15.5
2	1072	536	0.0316	0.5000	4.76E-6	4.71E-7	19.2
2	1206	536	0.0316	0.4444	3.92E-7	1.35E-7	23.4
2	1340	536	0.0316	0.4000	7.46E-8		26.7
2	1474	536	0.0316	0.3636	0.00E0		30.5
2	2010	1608	0.0100	0.8000	3.21E-4	7.06E-6	9.9
2	2278	1608	0.0100	0.7059	2.61E-7	6.37E-8	15.4
2	2680	1608	0.0100	0.6000	0.00E0		23.0
2	10605	10100	0.0010	0.9524	1.10E-5	5.23E-7	5.4
2	10706	10100	0.0010	0.9434	1.47E-7	1.90E-8	6.1
2	10807	10100	0.0010	0.9346	0.00E0		7.0

D=8 One symbol = 3 bit

D	n	k	p	rate	pb	delta	CPU
8	670	335	0.1000	0.5000	1.02E-3	2.76E-5	28.0
8	737	335	0.1000	0.4545	2.19E-4	1.28E-5	29.7
8	804	335	0.1000	0.4167	6.87E-5	7.16E-6	32.0
8	871	335	0.1000	0.3846	1.52E-5	3.37E-6	34.3
8	938	335	0.1000	0.3571	9.61E-6	8.47E-7	36.4
8	3149	2814	0.0100	0.8936	1.13E-5	1.00E-6	7.8
8	3216	2814	0.0100	0.8750	1.78E-7	3.97E-8	8.4
8	3350	2814	0.0100	0.8400	0.00E0		10.1
8	3484	2814	0.0100	0.8077	0.00E0		11.9
8	10200	10000	0.0010	0.9804	3.12E-5	8.83E-7	2.9
8	10280	10000	0.0010	0.9728	1.92E-7	2.19E-8	3.6
8	10360	10000	0.0010	0.9653	6.00E-9		4.4

D=256 One symbol = 8 bit

D	n	k	p	rate	pb	delta	CPU
256	670	335	0.1000	0.5000	6.51E-5	6.97E-6	12.4
256	804	335	0.1000	0.4167	1.37E-6	3.20E-7	13.7
256	938	335	0.1000	0.3571	2.99E-7		14.8
256	2680	2345	0.0100	0.8750	4.18E-7	6.67E-8	2.6
256	2814	2345	0.0100	0.8333	0.00E0		3.1
256	2948	2345	0.0100	0.7955	0.00E0		3.7
256	10180	10000	0.0010	0.9823	2.40E-7	7.75E-8	2.1
256	10220	10000	0.0010	0.9785	7.00E-8	1.32E-8	2.4
256	10260	10000	0.0010	0.9747	6.00E-9		2.7

D=65536 One symbol = 16 bit

D	n	k	p	rate	pb	delta	CPU
65536	603	335	0.0771	0.5556	1.65E-4	1.11E-5	3.59
65536	670	335	0.0771	0.5000	1.13E-5	1.68E-6	3.93
65536	737	335	0.0771	0.4545	1.04E-6	2.79E-7	4.28
65536	1206	1005	0.0159	0.8333	1.24E-4	1.01E-5	0.86
65536	1273	1005	0.0159	0.7895	2.32E-7		0.97
65536	1340	1005	0.0159	0.7500	0.00E0		1.10
65536	2211	2010	0.0080	0.9091	4.38E-5	4.26E-6	0.69
65536	2278	2010	0.0080	0.8824	1.66E-8		0.77
65536	2345	2010	0.0080	0.8571	0.00E0		0.88
65536	4620	4500	0.0016	0.9740	3.46E-5	1.39E-6	0.38
65536	4650	4500	0.0016	0.9677	5.93E-8	3.31E-8	0.43
65536	4680	4500	0.0016	0.9615	2.22E-8		0.48
65536	4710	4500	0.0016	0.9554	0.00E0		0.54

The four values of p correspond to error probabilities on a bit:  
0.005 0.001 0.0005 0.0001

### Trade-offs available to the designer

1. The most common trade-off is between rate and pb. For example

D	n	k	p	rate	pb	delta	CPU
2	1206	335	0.1000	0.2778	4.64E-4	1.86E-5	62.4
2	1340	335	0.1000	0.2500	9.91E-5	8.60E-6	69.5

2. If you keep p and rate constant, increasing n consistently decreases pb and moderately increases CPU time. For example

D	n	k	p	rate	pb	delta	CPU
2	558	155	0.1000	0.2778	3.18E-3	7.16E-5	51.5
2	1206	335	0.1000	0.2778	4.64E-4	1.86E-5	62.4

3. In case of very low p, it may be advantageous to increase D. Code performance is slightly worse but CPU time drops dramatically. Note that n k p pb must be recomputed for a straight comparison of the two cases. For example

D	n	k	p	rate	pb	delta	CPU
2	10706	10100	0.0010	0.9434	1.47E-7	1.90E-8	6.1 [case A]
1024	2948	2680	0.0100	0.9091	3.13E-7	7.65E-8	2.1 [case B]
	29480	26800	0.0010	0.9091	3.13E-8	7.65E-9	[case B]

Note that the third line is case B repeated, with length and probabilities recomputed on a bit, not a symbol.