

# **Turbo Coding, Turbo Equalisation and Space-Time Coding**

by

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# Contents

<b>Preface</b>	<b>xiii</b>
<b>Acknowledgments</b>	<b>xxv</b>
<b>I Convolutional and Block Coding</b>	<b>1</b>
<b>1 Convolutional Channel Coding</b>	<b>3</b>
1.1 Brief Channel Coding History . . . . .	3
1.2 Convolutional Encoding . . . . .	4
1.3 State and Trellis Transitions . . . . .	6
1.4 The Viterbi Algorithm . . . . .	7
1.4.1 Error-Free Hard-Decision Viterbi Decoding . . . . .	7
1.4.2 Erroneous Hard-Decision Viterbi Decoding . . . . .	11
1.4.3 Error-Free Soft-Decision Viterbi Decoding . . . . .	13
1.5 Summary and Conclusions . . . . .	15
<b>2 Block-Based Channel Coding</b>	<b>17</b>
2.1 Introduction . . . . .	17
2.2 Finite Fields . . . . .	18
2.2.1 Definitions . . . . .	18
2.2.2 Galois Field Construction . . . . .	21
2.2.3 Galois Field Arithmetic . . . . .	23
2.3 Reed-Solomon and Bose-Chaudhuri-Hocquenghem Block Codes . . . . .	24
2.3.1 Definitions . . . . .	24
2.3.2 RS Encoding . . . . .	26
2.3.3 RS Encoding Example . . . . .	28
2.3.4 Linear Shift-Register Circuits for Cyclic Encoders . . . . .	32
2.3.4.1 Polynomial Multiplication . . . . .	32
2.3.4.2 Systematic Cyclic Shift-Register Encoding Example . . . . .	33
2.3.5 RS Decoding . . . . .	35

2.3.5.1	Formulation of the Key Equations [1–9]	35
2.3.5.2	Peterson-Gorenstein-Zierler Decoder	40
2.3.5.3	PGZ Decoding Example	42
2.3.5.4	Berlekamp-Massey Algorithm [1–9]	48
2.3.5.5	Berlekamp-Massey Decoding Example	54
2.3.5.6	Computation of the Error Magnitudes by the Forney Algorithm	57
2.3.5.7	Forney Algorithm Example	61
2.3.5.8	Error Evaluator Polynomial Computation	63
2.4	Summary and Conclusions	66
<b>3</b>	<b>Soft-Decoding and Performance of BCH Codes</b>	<b>67</b>
3.1	Introduction	67
3.2	BCH codes	67
3.2.1	BCH Encoder	69
3.2.2	State and Trellis Diagrams	71
3.3	Trellis Decoding	73
3.3.1	Introduction	73
3.3.2	Viterbi Algorithm	73
3.3.3	Hard Decision Viterbi Decoding	76
3.3.3.1	Correct Hard Decision Decoding	76
3.3.3.2	Incorrect Hard Decision Decoding	76
3.3.4	Soft Decision Viterbi Decoding	77
3.3.5	Simulation Results	79
3.3.5.1	The Berlekamp-Massey Algorithm	79
3.3.5.2	Hard Decision Viterbi Decoding	82
3.3.5.3	Soft Decision Viterbi Decoding	82
3.3.6	Conclusion On Block Coding	84
3.4	Soft Input Algebraic Decoding	84
3.4.1	Introduction	84
3.4.2	Chase Algorithms	89
3.4.2.1	Chase Algorithm 1	92
3.4.2.2	Chase Algorithm 2	94
3.4.3	Simulation Results	95
3.5	Summary and Conclusions	96
<b>II</b>	<b>Turbo Convolutional and Turbo Block Coding</b>	<b>99</b>
<b>4</b>	<b>Turbo Convolutional Coding</b>	<b>101</b>
4.1	Introduction	101
4.2	Turbo Encoder	102
4.3	Turbo Decoder	104
4.3.1	Introduction	104
4.3.2	Log Likelihood Ratios	105
4.3.3	The Maximum A-Posteriori Algorithm	108

4.3.3.1	Introduction and Mathematical Preliminaries . . . . .	108
4.3.3.2	Forward Recursive Calculation of the $\alpha_k(s)$ Values . . . . .	112
4.3.3.3	Backward Recursive Calculation of the $\beta_k(s)$ Values . . . . .	113
4.3.3.4	Calculation of the $\gamma_k(\hat{s}, s)$ Values . . . . .	114
4.3.3.5	Summary of the MAP Algorithm . . . . .	117
4.3.4	Iterative Turbo Decoding Principles . . . . .	118
4.3.4.1	Turbo Decoding Mathematical Preliminaries . . . . .	118
4.3.4.2	Iterative Turbo Decoding . . . . .	120
4.3.5	Modifications of the MAP algorithm . . . . .	124
4.3.5.1	Introduction . . . . .	124
4.3.5.2	Mathematical Description of the Max-Log-MAP Algorithm . . . . .	124
4.3.5.3	Correcting the Approximation – the Log-MAP Algorithm . . . . .	128
4.3.6	The Soft-Output Viterbi Algorithm . . . . .	128
4.3.6.1	Mathematical Description of the SOVA Algorithm . . . . .	128
4.3.6.2	Implementation of the SOVA Algorithm . . . . .	131
4.3.7	Turbo Decoding Example . . . . .	133
4.3.8	Comparison of the Component Decoder Algorithms . . . . .	141
4.3.9	Conclusions . . . . .	145
4.4	Turbo Coded BPSK Performance Over Gaussian Channels . . . . .	146
4.4.1	Effect of the Number of Iterations Used . . . . .	146
4.4.2	Effects of Puncturing . . . . .	148
4.4.3	Effect of the Component Decoder Used . . . . .	149
4.4.4	Effect of the Frame-Length of the Code . . . . .	150
4.4.5	The Component Codes . . . . .	152
4.4.6	Effect of the Interleaver . . . . .	155
4.4.7	Effect of Estimating the Channel Reliability Value $L_c$ . . . . .	159
4.5	Turbo Coding Performance Over Rayleigh Channels . . . . .	164
4.5.1	Introduction . . . . .	164
4.5.2	Performance Over Perfectly Interleaved Narrow-Band Rayleigh Channels . . . . .	164
4.5.3	Performance Over Correlated Narrow-Band Rayleigh Channels . . . . .	166
4.6	Summary and Conclusions . . . . .	167
<b>5</b>	<b>The Super-Trellis Structure of Convolutional Turbo Codes</b> . . . . .	<b>171</b>
5.1	Introduction . . . . .	171
5.2	System model and terminology . . . . .	172
5.3	Introducing the turbo code super-trellis . . . . .	175
5.3.1	Turbo encoder super-state . . . . .	175
5.3.2	Turbo encoder super-trellis . . . . .	177
5.3.3	Generalised Definition of the Turbo Encoder Super-States . . . . .	178
5.3.4	Example of a super-trellis . . . . .	182
5.4	Complexity of the turbo code super-trellis . . . . .	186
5.4.1	Rectangular interleavers . . . . .	186
5.4.2	Uniform interleaver . . . . .	187
5.5	Optimum decoding of turbo codes . . . . .	189
5.5.1	Comparison with iterative decoding . . . . .	189

5.5.2	Comparison with conventional convolutional codes . . . . .	194
5.6	Discussion of the results . . . . .	194
5.7	Summary and Conclusions . . . . .	198
5.8	Appendix: Proof of algorithmic optimality . . . . .	199
<b>6</b>	<b>Turbo BCH Coding . . . . .</b>	<b>203</b>
6.1	Introduction . . . . .	203
6.2	Turbo Encoder . . . . .	204
6.3	Turbo Decoder . . . . .	205
6.3.1	Log Likelihood Ratio . . . . .	206
6.3.2	Soft Channel Output . . . . .	208
6.3.3	The Maximum A-Posteriori Algorithm . . . . .	209
6.3.3.1	Calculation of the $\gamma_k(\hat{s}, s)$ Values . . . . .	212
6.3.3.2	Forward Recursion . . . . .	213
6.3.3.3	Backward Recursion . . . . .	214
6.3.3.4	Summary of the MAP Algorithm . . . . .	215
6.3.4	Modifications of the MAP algorithm . . . . .	218
6.3.4.1	Introduction . . . . .	218
6.3.4.2	Max-Log-MAP Algorithm . . . . .	218
6.3.4.3	Log-MAP Algorithm . . . . .	220
6.3.5	The Soft Output Viterbi Algorithm . . . . .	220
6.3.5.1	SOVA Decoding Example . . . . .	223
6.4	Turbo Decoding Example . . . . .	226
6.5	MAP Algorithm For Extended BCH codes . . . . .	233
6.5.1	Introduction . . . . .	233
6.5.2	Modified MAP Algorithm . . . . .	235
6.5.2.1	The Forward and Backward Recursion . . . . .	235
6.5.2.2	Transition Probability . . . . .	236
6.5.2.3	A-Posteriori Information . . . . .	237
6.5.3	Max-Log-MAP and Log-MAP Algorithm for Extended BCH codes . . . . .	238
6.6	Simulation Results . . . . .	240
6.6.1	Number of Iterations Used . . . . .	241
6.6.2	The Decoding Algorithm . . . . .	242
6.6.3	The Effect of Estimating the Channel Reliability Value $L_c$ . . . . .	244
6.6.4	The Effect of Puncturing . . . . .	245
6.6.5	The Effect of the Interleaver Length of the Turbo Code . . . . .	246
6.6.6	The Effect of the Interleaver Design . . . . .	248
6.6.7	The Component Codes . . . . .	250
6.6.8	BCH(31, $k$ , $d_{min}$ ) Family Members . . . . .	253
6.6.9	Mixed Component Codes . . . . .	254
6.6.10	Extended BCH codes . . . . .	255
6.6.11	BCH Product codes . . . . .	256
6.7	Summary and Conclusion . . . . .	257

<b>7</b>	<b>Redundant Residue Number System Codes</b>	<b>259</b>
7.1	Introduction . . . . .	259
7.2	Background . . . . .	261
7.2.1	Conventional Number System . . . . .	261
7.2.2	Residue Number System . . . . .	262
7.2.3	Mixed Radix Number System . . . . .	263
7.2.4	Residue Arithmetic Operations . . . . .	264
7.2.4.1	Multiplicative Inverse . . . . .	265
7.2.5	Residue to Decimal Conversion . . . . .	266
7.2.5.1	Chinese Remainder Theorem . . . . .	266
7.2.5.2	Mixed Radix Conversion . . . . .	268
7.2.6	Redundant Residue Number System . . . . .	270
7.2.7	Base Extension . . . . .	271
7.3	Coding Theory of Redundant Residue Number Systems . . . . .	273
7.3.1	Minimum Free Distance of RRNS Based Codes . . . . .	273
7.3.2	Linearity of RRNS Codes . . . . .	276
7.3.3	Error Detection and Correction in RRNS Codes . . . . .	277
7.4	Multiple Error Correction Procedure . . . . .	279
7.5	RRNS Encoder . . . . .	286
7.5.1	Non-systematic RRNS Code . . . . .	286
7.5.2	Systematic RRNS Code . . . . .	289
7.5.2.1	Modified Systematic RRNS Code . . . . .	290
7.6	RRNS Decoder . . . . .	291
7.7	Soft Input and Soft Output RRNS Decoder . . . . .	292
7.7.1	Soft Input RRNS Decoder . . . . .	292
7.7.2	Soft Output RRNS Decoder . . . . .	294
7.7.3	Algorithm Implementation . . . . .	297
7.8	Complexity . . . . .	299
7.9	Simulation Results . . . . .	303
7.9.1	Hard Decision Decoding . . . . .	305
7.9.1.1	Encoder Types . . . . .	305
7.9.1.2	Comparison of Redundant Residue Number System codes and Reed-Solomon Codes . . . . .	306
7.9.1.3	Comparison Between Different Error Correction Capabili- ties $t$ . . . . .	306
7.9.2	Soft Decision Decoding . . . . .	309
7.9.2.1	Effect of the Number of Test Positions . . . . .	309
7.9.2.2	Soft Decision RRNS(10,8) Decoder . . . . .	310
7.9.3	Turbo RRNS Decoding . . . . .	310
7.9.3.1	Algorithm Comparison . . . . .	310
7.9.3.2	Number of Iterations Used . . . . .	313
7.9.3.3	Imperfect Estimation of the Channel Reliability Value $L_c$ . . . . .	315
7.9.3.4	The Effect of the Turbo Interleaver . . . . .	317
7.9.3.5	The Effect of the Number of Bits Per Symbol . . . . .	319
7.9.3.6	Coding Gain Versus Estimated Complexity . . . . .	319
7.10	Summary and Conclusions . . . . .	322

<b>III</b>	<b>Coded Modulation: TCM, TTCM, BICM, BICM-ID</b>	<b>325</b>
<b>8</b>	<b>Coded Modulation Theory and Performance</b>	<b>327</b>
8.1	Introduction . . . . .	327
8.2	Trellis Coded Modulation . . . . .	328
8.2.1	TCM Principle . . . . .	329
8.2.2	Optimum TCM Codes . . . . .	334
8.2.3	TCM Code Design for Fading Channels . . . . .	336
8.2.4	Set-Partitioning . . . . .	337
8.3	The Symbol-based MAP Algorithm . . . . .	339
8.3.1	Problem Description . . . . .	339
8.3.2	The MAP Algorithm . . . . .	341
8.3.3	Recursive Metric Update Formulae . . . . .	344
8.3.3.1	Backward Recursive Computation of $\beta_k(i)$ . . . . .	345
8.3.3.2	Forward Recursive Computation of $\alpha_k(i)$ . . . . .	347
8.3.4	The MAP Algorithm in the Logarithmic-Domain . . . . .	348
8.3.5	MAP Algorithm Summary . . . . .	349
8.4	Turbo Trellis Coded Modulation . . . . .	351
8.4.1	TTCM Encoder . . . . .	351
8.4.2	TTCM Decoder . . . . .	353
8.5	Bit-Interleaved Coded Modulation . . . . .	356
8.5.1	BICM Principle . . . . .	356
8.5.2	BICM Coding Example . . . . .	359
8.6	Bit-Interleaved Coded Modulation with Iterative Decoding . . . . .	361
8.6.1	Labelling Method . . . . .	361
8.6.2	Interleaver Design . . . . .	365
8.6.3	BICM-ID Coding Example . . . . .	365
8.7	Coded Modulation Performance . . . . .	368
8.7.1	Introduction . . . . .	368
8.7.2	Coded Modulation in Narrowband Channels . . . . .	368
8.7.2.1	System Overview . . . . .	368
8.7.2.2	Simulation Results and Discussions . . . . .	371
8.7.2.2.1	Coded Modulation Performance over AWGN Channels . . . . .	371
8.7.2.2.2	Performance over Uncorrelated Narrowband Rayleigh Fading Channels . . . . .	375
8.7.2.2.3	Coding Gain Versus Complexity and Interleaver Block Length . . . . .	377
8.7.2.3	Conclusion . . . . .	381
8.7.3	Coded Modulation in Wideband Channels . . . . .	382
8.7.3.1	Intersymbol Interference . . . . .	382
8.7.3.2	Decision Feedback Equalizer . . . . .	383
8.7.3.2.1	Decision Feedback Equalizer Principle . . . . .	383
8.7.3.2.2	Equalizer Signal To Noise Ratio Loss . . . . .	385
8.7.3.3	Decision Feedback Equalizer Aided Adaptive Coded Modulation . . . . .	386

8.7.3.3.1	Introduction . . . . .	387
8.7.3.3.2	System Overview . . . . .	387
8.7.3.3.3	Fixed-Mode Based Performance . . . . .	391
8.7.3.3.4	System I and System II Performance . . . . .	392
8.7.3.3.5	Overall Performance . . . . .	396
8.7.3.3.6	Conclusions . . . . .	397
8.7.3.4	Orthogonal Frequency Division Multiplexing . . . . .	398
8.7.3.4.1	Orthogonal Frequency Division Multiplexing Principle . . . . .	398
8.7.3.5	Orthogonal Frequency Division Multiplexing Aided Coded Modulation . . . . .	401
8.7.3.5.1	Introduction . . . . .	401
8.7.3.5.2	System Overview . . . . .	403
8.7.3.5.3	Simulation Parameters . . . . .	404
8.7.3.5.4	Simulation Results And Discussions . . . . .	404
8.7.3.5.5	Conclusions . . . . .	407
8.8	Summary and Conclusions . . . . .	407

## **IV Space-Time Block and Space-Time Trellis Coding 409**

<b>9</b>	<b>Space-Time Block Codes</b> . . . . .	<b>411</b>
9.1	Introduction . . . . .	411
9.2	Background . . . . .	412
9.2.1	Maximum Ratio Combining . . . . .	413
9.3	Space-Time Block Codes . . . . .	414
9.3.1	A Twin-Transmitter Based Space-Time Block Code . . . . .	415
9.3.1.1	The Space-Time Code $G_2$ Using One Receiver . . . . .	416
9.3.1.2	The Space-Time Code $G_2$ Using Two Receivers . . . . .	418
9.3.2	Other Space-Time Block Codes . . . . .	420
9.3.3	MAP Decoding of Space-Time Block Codes . . . . .	421
9.4	Channel Coded Space-Time Block Codes . . . . .	423
9.4.1	System Overview . . . . .	424
9.4.2	Channel Codec Parameters . . . . .	425
9.4.3	Complexity Issues and Memory Requirements . . . . .	429
9.5	Performance Results . . . . .	431
9.5.1	Performance Comparison Of Various Space-Time Block Codes With- out Channel Codecs . . . . .	433
9.5.1.1	Maximum Ratio Combining and the Space-Time Code $G_2$ . . . . .	433
9.5.1.2	Performance of 1 BPS Schemes . . . . .	434
9.5.1.3	Performance of 2 BPS Schemes . . . . .	434
9.5.1.4	Performance of 3 BPS Schemes . . . . .	436
9.5.1.5	Channel Coded Space-Time Block Codes . . . . .	439
9.5.2	Mapping Binary Channel Codes to Multilevel Modulation . . . . .	440
9.5.2.1	Turbo Convolutional Codes - Data and Parity Bit Mapping . . . . .	440
9.5.2.2	Turbo Convolutional Codes – Interleaver Effects . . . . .	443



9.5.2.3	Turbo BCH Codes . . . . .	446
9.5.2.4	Convolutional Codes . . . . .	448
9.5.3	Performance Comparison of Various Channel Codecs Using the $G_2$ Space-time Code and Multi-level Modulation . . . . .	449
9.5.3.1	Comparison of Turbo Convolutional Codes . . . . .	450
9.5.3.2	Comparison of Different Rate TC(2,1,4) Codes . . . . .	451
9.5.3.3	Convolutional Codes . . . . .	453
9.5.3.4	$G_2$ Coded Channel Codec Comparison – Throughput of 2 BPS . . . . .	453
9.5.3.5	$G_2$ -Coded Channel Codec Comparison – Throughput of 3 BPS . . . . .	455
9.5.3.6	Comparison of $G_2$ -Coded High-Rate TC and TBCH Codes . . . . .	456
9.5.3.7	Comparison of High-Rate TC and Convolutional Codes . . . . .	457
9.5.4	Coding Gain Versus Complexity . . . . .	457
9.5.4.1	Complexity Comparison of Turbo Convolutional Codes . . . . .	458
9.5.4.2	Complexity Comparison of Channel Codes . . . . .	458
9.6	Summary and Conclusions . . . . .	461
<b>10</b>	<b>Space-Time Trellis Codes</b> . . . . .	<b>465</b>
10.1	Introduction . . . . .	465
10.2	Space-Time Trellis Codes . . . . .	466
10.2.1	The 4-State, 4PSK Space-Time Trellis Encoder . . . . .	466
10.2.1.1	The 4-State, 4PSK Space-Time Trellis Decoder . . . . .	468
10.2.2	Other Space-Time Trellis Codes . . . . .	470
10.3	Space-Time Coded Transmission Over Wideband Channels . . . . .	472
10.3.1	System Overview . . . . .	473
10.3.2	Space-Time and Channel Codec Parameters . . . . .	475
10.3.3	Complexity Issues . . . . .	477
10.4	Simulation Results . . . . .	478
10.4.1	Space-Time Coding Comparison – Throughput of 2 BPS . . . . .	480
10.4.2	Space-Time Coding Comparison – Throughput of 3 BPS . . . . .	483
10.4.3	The Effect of Maximum Doppler Frequency . . . . .	488
10.4.4	The Effect of Delay Spreads . . . . .	489
10.4.5	Delay Non-sensitive System . . . . .	493
10.4.6	The Wireless Asynchronous Transfer Mode System . . . . .	496
10.4.6.1	Channel Coded Space-Time Codes – Throughput of 1 BPS . . . . .	497
10.4.6.2	Channel Coded Space-Time Codes – Throughput of 2 BPS . . . . .	498
10.5	Space-Time Coded Adaptive Modulation for OFDM . . . . .	499
10.5.1	Introduction . . . . .	499
10.5.2	Turbo-Coded and Space-Time-Coded Adaptive OFDM . . . . .	500
10.5.3	Simulation Results . . . . .	501
10.5.3.1	Space-Time Coded Adaptive OFDM . . . . .	501
10.5.3.2	Turbo and Space-Time Coded Adaptive OFDM . . . . .	507
10.6	Summary and Conclusions . . . . .	509

<b>11 Turbo Coded Adaptive QAM versus Space-Time Trellis Coding</b>	<b>511</b>
11.1 Introduction	511
11.2 System Overview	513
11.2.1 SISO Equaliser and AQAM	514
11.2.2 MIMO Equaliser	514
11.3 Simulation Parameters	516
11.4 Simulation Results	520
11.4.1 Turbo-Coded Fixed Modulation Mode Performance	520
11.4.2 Space-Time Trellis Code Performance	522
11.4.3 Adaptive Quadrature Amplitude Modulation Performance	523
11.5 Summary and Conclusions	531
<b>V Turbo Equalisation</b>	<b>535</b>
<b>12 Turbo Coded Partial-Response Modulation</b>	<b>537</b>
12.1 Motivation	537
12.2 The Mobile Radio Channel	538
12.3 Continuous Phase Modulation Theory	540
12.4 Digital Frequency Modulation Systems	540
12.5 State Representation	543
12.5.1 Minimum Shift Keying	547
12.5.2 Gaussian Minimum Shift Keying	552
12.6 Spectral Performance	555
12.6.1 Power Spectral Density	555
12.6.2 Fractional Out-Of-Band Power	558
12.7 Construction of Trellis-based Equaliser States	559
12.8 Soft Output GMSK Equaliser and Turbo Coding	563
12.8.1 Background and Motivation	563
12.8.2 Soft Output GMSK Equaliser	565
12.8.3 The Calculation of the Log Likelihood Ratio	567
12.8.4 Summary of the MAP Algorithm	570
12.8.5 The Log-MAP Algorithm	571
12.8.6 Summary of the Log-MAP Algorithm	575
12.8.7 Complexity of Turbo Decoding and Convolutional Decoding	577
12.8.8 System Parameters	577
12.8.9 Turbo Coding Performance Results	579
12.9 Summary and Conclusions	582
<b>13 Turbo Equalisation for Partial Response Systems</b>	<b>583</b>
13.1 Motivation	585
13.2 Principle of Turbo Equalisation using Single/Multiple Decoder(s)	586
13.3 Soft-In/Soft-Out Equaliser for Turbo Equalisation	591
13.4 Soft-In/Soft-Out Decoder for Turbo Equalisation	591
13.5 Turbo Equalisation Example	596
13.6 Summary of Turbo Equalisation	613

13.7	Performance of Coded GMSK Systems using Turbo Equalisation . . . . .	615
13.7.1	Convolutional-coded GMSK System . . . . .	615
13.7.2	Convolutional-coding Based Turbo-coded GMSK System . . . . .	619
13.7.3	BCH-coding Based Turbo-coded GMSK System . . . . .	620
13.8	Discussion of Results . . . . .	620
13.9	Summary and Conclusions . . . . .	626
<b>14</b>	<b>Turbo Equalisation Performance Bound</b>	<b>629</b>
14.1	Motivation . . . . .	629
14.2	Parallel Concatenated Convolutional Code Analysis . . . . .	630
14.3	Serial Concatenated Convolutional Code Analysis . . . . .	637
14.4	Enumerating the Weight Distribution of the Convolutional Code . . . . .	642
14.5	Recursive Properties of the MSK, GMSK and DPSK Modulator . . . . .	646
14.6	Analytical Model of Coded DPSK Systems . . . . .	649
14.7	Theoretical and Simulation Performance of Coded DPSK Systems . . . . .	651
14.8	Summary and Conclusions . . . . .	654
<b>15</b>	<b>Comparative Study of Turbo Equalisers</b>	<b>657</b>
15.1	Motivation <sup>1</sup> . . . . .	657
15.2	System overview . . . . .	658
15.3	Simulation Parameters . . . . .	659
15.4	Results and Discussion . . . . .	663
15.4.1	Five-path Gaussian Channel . . . . .	663
15.4.2	Equally-weighted Five-path Rayleigh Fading Channel . . . . .	666
15.5	Summary and Conclusions . . . . .	674
<b>16</b>	<b>Reduced Complexity Turbo Equaliser</b>	<b>675</b>
16.1	Motivation . . . . .	675
16.2	Complexity of the Multi-level Full Response Turbo Equaliser . . . . .	676
16.3	System Model . . . . .	678
16.4	In-phase/Quadrature-phase Equaliser Principle . . . . .	680
16.5	Overview of the Reduced Complexity Turbo Equalizer . . . . .	682
16.5.1	Conversion of the DFE Symbol Estimates to LLR . . . . .	683
16.5.2	Conversion of the Decoder <i>A Posteriori</i> LLRs into Symbols . . . . .	685
16.5.3	Decoupling Operation . . . . .	689
16.6	Complexity of the In-phase/Quadrature-phase Turbo Equaliser . . . . .	689
16.7	System Parameters . . . . .	691
16.8	System Performance . . . . .	693
16.8.1	4-QAM System . . . . .	693
16.8.2	16-QAM System . . . . .	696
16.8.3	64-QAM System . . . . .	696
16.9	Summary and Conclusions . . . . .	699

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<b>17 Turbo Equalization for Space-time Trellis Coded Systems</b>	<b>703</b>
17.1 Introduction . . . . .	703
17.2 System Overview . . . . .	704
17.3 Principle of In-phase/Quadrature-phase Turbo Equalization . . . . .	705
17.4 Complexity Analysis . . . . .	708
17.5 Results and Discussion . . . . .	709
17.5.1 Performance versus Complexity Trade-off . . . . .	717
17.5.2 Performance of STTC Systems over Channels with Long Delays . . . . .	721
17.6 Summary and Conclusions . . . . .	723
<b>18 Summary and Conclusions</b>	<b>725</b>
18.1 Summary of the Book . . . . .	725
18.2 Concluding Remarks . . . . .	736
<b>Bibliography</b>	<b>741</b>
<b>Subject Index</b>	<b>759</b>
<b>Author Index</b>	<b>767</b>
<b>About the Authors</b>	<b>775</b>

This book is dedicated to the numerous contributors of this field, many of whom are listed in the Author Index

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## **Part II**

# **Turbo Convolutional and Turbo Block Coding**

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# Subject Index

## Symbols

3G ..... 411, 427, 450, 453

## A

A priori ..... 569  
 a-posteriori information ... **206**, 217, 218, 220, 221, 225, 230, 233, 237–238, 244, 421  
 a-posteriori probabilities ..... 107  
 a-priori information ..... **206**, 212, 217, 422  
 Acknowledgments ..... xxv  
 adaptive modulation ..... 499  
 adaptive OFDM ..... *see* AOFDM  
 addition ..... 259, 260, 264, 322, 417  
 adjacent subcarrier ..... 480, 493, 499  
 algorithm  
   Berlekamp-Massey ... *see* Berlekamp-Massey  
   Chase ..... 89  
   comparison ..... 310–313  
   Log-MAP ..... *see* Log-MAP  
   MAP ..... *see* MAP  
   Max-Log-MAP ..... *see* Max-Log-MAP  
   maximum likelihood *see* maximum likelihood algorithm  
   SOVA ..... *see* SOVA  
   Viterbi ..... *see* Viterbi algorithm  
 analogue weight ..... 294  
 Analytical model of coded DPSK systems ..... 649  
 AOFDM ..... 499  
 ARQ ..... 306

## B

backward recursion ... 212, 214–215, 218, 235–238, 429  
 Backward Recursive Computation of  $\beta_k(i)$  345–346  
 band-limited ..... 411  
 bandwidth efficiency ..... 421  
 base extension ..... *see* BEX  
 base station ..... 411  
 baseband representation ..... 413, 416, 468  
 Bayes' rule ..... 109, **209**, 211–214, 221, 294, 421  
 BCH ..... **67**, 586, 658  
   code ..... 68, 253–254, 276, 311, 442

  codeword ..... 221, 235  
   encoder ..... 69, 245, 448  
   extended ..... 233, 241  
   generator ..... 68  
   systematic ..... 69

BER ..... 3  
 Berlekamp-Massey ..... 79–82, 88  
 Berlekamp-Massey algorithm ..... 48–53  
 Berlekamp-Massey decoding example ..... 54–57  
 Berrou ..... 105, 114, 118, 154  
 BEX ..... 271–273, 285, 289, 322  
 BICM Coding Example ..... 359–361  
 BICM Principle ..... 356–359  
 BICM-ID Coding Example ..... 365–368  
 binary number system ..... 259, 261–262, 322  
 binary trellis ..... 213, 222, 235  
 bit interleaver ..... 317  
 Bit-Interleaved Coded Modulation ..... 356–361  
 Bit-Interleaved Coded Modulation with Iterative Decoding ..... 361–368  
 bits per symbol ..... *see* BPS  
 bitwise complement ..... 290  
 block code ..... 73, **276**, 293, **415**  
 block interleaver . 204, 226, 241, 243, 245, 247, 248, 252, 311  
   symbol ..... *see* symbol block interleaver  
 Block-based channel coding ..... 17–66  
 BM decoding example ..... 54  
 Bose-Chaudhuri-Hocquenghem ..... 658  
 Bose-Chaudhuri-Hocquenghem ..... 586  
 Bose-Chaudhuri-Hocquenghem (BCH) codes ... 24  
 BPS ..... 304, **427**, 429  
   effect ..... 319  
 BPSK turbo equaliser ..... 658  
 Branch metric ..... 10  
 branch metric ..... **74**, 76, 469, 509  
 branch transition probability ..... 221  
 Breiling ..... 114  
 Brief channel coding history ..... 3–4  
 broadcasting ..... 398

## C

capacity ..... 411  
 carry digit ..... 259, 262, 265  
 channel  
   capacity ..... 486  
   code ..... 425, 432, 442, 449  
     comparison ..... 453  
     high rate comparison ..... 456  
   coding ..... 411, 424  
   decoder ..... 422, 423, 429  
   dispersive wideband Rayleigh fading 472, 478  
   encoder ..... 425, 427  
   error ..... 76, 437, 507  
   estimation  
     perfect ..... 416, 500, 501  
   estimator ..... 416, 489  
     perfect ..... 414  
   frequency selective Rayleigh fading ..... 466  
   independent fading ..... 413  
   information  
     perfect ..... 414  
   non-dispersive Rayleigh fading 412, 422, 425, 431, 465  
   quality ..... 500, 501  
   Rayleigh fading ..... 413, 465, 501  
   WATM ..... *see* WATM  
   wideband fading ..... 466  
 channel code  
   comparison ..... 455  
   high rate comparison ..... 457  
 channel codec parameters ..... 425–429  
 Channel Impulse Response ..... *see* CIR  
 channel reliability measure  $L_c$  ..... 108  
 channel reliability value ..... 205, 208, 228, 239, 244–245, 315–316  
 Chase Algorithm .. 89–96, 292, 297, 298, 309, 310, 322  
   SISO ..... 256, 292–299, 310, 316, 323  
 Chien search ..... 40  
 Chinese Remainder Theorem ..... *see* CRT  
 CIR ..... 418, 478, 479, 501  
 Circuits for cyclic encoders ..... 32–35  
 CISI ..... 552  
 code constraint ..... 206  
 code rate .. 82, 84, 97, 204, 227, 241, 246, 251, 274, 276, 288, **289**, 290, 291, 305–307, 313, 314, 322, 415, 426, 427, 443, 500, 507  
 Coded Modulation in Narrowband Channels .. 368–382  
 Coded Modulation in Wideband Channels . 382–407  
 Coded Modulation Performance ..... 368–407  
 Coded Modulation Performance over AWGN Channels ..... 371–375  
 Coded Modulation Theory and Performance .. 327–408  
 codeword length . 235, 300, 301, 303, 306, 307, 322, 442  
 coding gain ..... 465, **482**, **486**

Coding Gain Versus Complexity and Interleaver Block Length ..... 377–381  
 Coding memory ..... 4  
 Coding rate ..... 4  
 Coherence bandwidth ..... 539  
 combiner ..... 416, 419  
 common divisor ..... 262  
 Comparative study of turbo equalisers ..... 657  
 competing codeword ..... 297  
 complex orthogonal sporadic code ..... 421  
 complexity 92, 95, 97, 203, 209, 218, 242, 247, 253, 254, 257, 293, 298, 300, 307, 320, 322, 411, 412, 423, 427, 457–461, 472  
 Complexity of the in-phase/quadrature-phase turbo equaliser ..... 689  
 Complexity of the multi-level full response turbo equaliser ..... 676  
 Complexity of turbo decoding and convolutional decoding ..... 575  
 Conclusion ..... 381–382  
 Conclusions ..... 397–398, 407  
 conditional linearity ..... 277  
 confidence value ..... 293, 301, 309  
 conjugate ..... 414–416, 418  
 constellation point ... 415, 437, 440, 451, 456, 503  
 Constraint length ..... 4  
 constraint length ..... 426, 427, 450, 458, 507  
 Construction of Trellis-based Equaliser States .. 558  
 Controlled Inter Symbol Interference ..... 552  
 Conversion of the decoder *a posteriori* LLRs into symbols ..... 685  
 Conversion of the DFE symbol estimates to LLR683  
 Convolutional channel coding ..... 3–15  
 Convolutional code ..... 423  
   interleaver effect ..... 448–449  
   non-systematic ..... 449  
   performance ..... 453  
   systematic ..... 449  
 convolutional code ..... 424  
 convolutional codes ..... 329  
 Convolutional encoding ..... 4–6  
 Correlative State Vector ..... 544  
 CRT ..... 259, 266–267, 283, 322  
 cyclic code ..... 67, 69  
 Cyclic codes ..... 24  
 Cyclic encoding ..... 26

## D

data bit ..... 440, 443, 467, 473, 475, 477, 500  
 decimal number system ..... 259, 261–262, 322  
 Decision Feedback Equaliser ..... 565  
 Decision Feedback Equalizer ..... 383–386  
 Decision Feedback Equalizer Aided Adaptive Coded Modulation ..... 386–398  
 Decision Feedback Equalizer Principle ..... 383–385  
 decoding algorithm ..... 242–243  
 decoding index ..... 299, 313  
 Decoupling operation ..... 688

- Definitions ..... 18–21, 24–26  
 delay spread ..... 489–493  
 delay-sensitive ..... 476  
 delay-spread ..... 538  
 demodulator . 76, 77, 88, 89, 92, 292, 309, 429, 444,  
     477, 500  
 digital audio ..... 398  
 Digital Video Broadcasting ..... *see* DVB  
 discarded codeword ..... 297–299  
 Discarded path ..... 10  
 discarded path ..... 222–224, 232  
 distance profile ..... 246  
 Distance properties of FEC codes ..... 24  
 diversity gain ..... 465, 503  
 divisible ..... 268, 270  
 division ..... 259, 261, 262, 265, 268  
 Doppler frequency-domain spreading ..... 538  
 dummy symbol ..... 306  
 DVB ..... 426, 453, 457  
 dynamic range ..... 276, 291, 304  
     extension ..... 273
- E**
- EFR ..... 538  
 Enumerating the weight distribution of the convolu-  
     tional code ..... 642  
 Equalizer Signal To Noise Ratio Loss ..... 385–386  
 Erroneous hard-decision Viterbi decoding ..... 11  
 error  
     correction ..... 260, 273, 291, 322  
     detection ..... 260, 273, 291, 322  
     floor ..... 492  
     pattern ..... 90, 92, 294  
 error correction capability ..... 279–281, 300–303,  
     306–307, 322, 436, 437  
 Error detection capability ..... 42  
 Error evaluator polynomial ..... 57  
 Error evaluator polynomial computation ..... 63–66  
 Error locator polynomial ..... 38  
 Error polynomial ..... 37  
 Error positions and magnitudes in RS and BCH cod-  
     ing ..... 37  
 Error-free hard-decision Viterbi decoding ..... 7–11  
 Error-free soft-decision Viterbi decoding ..... 13–15  
 Euclidean distance ..... 73, 296–299, 414, 424, 440  
 European digital audio broadcasting ..... 398  
 exponential operation ..... 219  
 extended BCH code ..... *see* BCH extended  
 extended Log-MAP ..... 238–240, 255  
 extended MAP ..... 233–240, 255  
 extended Max-Log-MAP ..... 238–240  
 Extension field ..... 18  
 extrinsic information . 105, **206**, 217, 222, 226, 230,  
     232, 233, 297  
 extrinsic LLR ..... 119
- F**
- fading  
     amplitude . 208, 295, 414, 420, 431, 489, 493  
     envelope ..... 416, 425, 431, 481, 489, 501  
 Fast Fourier Transform ..... *see* FFT  
 fault tolerance ..... 260  
 FFT ..... 260  
 Finite field ..... 18  
 Finite fields ..... 18–24  
 fixed radix number system ..... **261**, 263, 322  
 Fixed-Mode Based Performance ..... 391  
 flattening effect ..... 486, 492, 503  
 floating point ..... 219  
 Formulation of the key equations ..... 35–40  
 Forney ..... 129  
 Forney algorithm ..... 57–61  
 Forney algorithm example ..... 61–63  
 forward recursion ..... 212–215, 218, 235–238, 429  
 Forward Recursive Computation of  $\alpha_k(i)$  . 347–348  
 Fourier Transform ..... 556  
 Fractional out-of-band power ..... 558  
 free distance ..... 331, 442  
 frequency  
     non-selective ..... 412, 465  
     selective ..... 466, 502  
 Frequency dispersion ..... 538  
 Frequency shaping filter ..... 541  
 Frequency Shaping Function ..... 543  
 Frequency-selective fading ..... 538
- G**
- Galois field arithmetic ..... 23–24  
 Galois field construction ..... 21–22  
 Gauss-Jordan elimination ..... 45  
 Gaussian Minimum Shift Keying ..... 552  
 Generator polynomial ..... 4, 24  
 GMSK ..... 648  
 GPRS ..... 538  
 Gray-mapping ..... 425, 447, 475  
 GSM ..... 424, 426, 453
- H**
- Hagenauer ..... 131  
 Hamming code ..... 250, 252  
 Hamming distance . 67, 73, 74, 76, 88, 90, 93, 273,  
     277, 279, 290, 291  
 Hamming weight ..... 76, 260, 273, 274, 278  
 Hard-decision decoding ..... 8  
 high code rates ..... 658  
 high reliability ..... 420  
 High-Speed Circuit Switched Data ..... 538  
 HSCSD ..... 538
- I**
- I/Q EQ ..... 734  
 illegitimate projection ..... 281  
 illegitimate range ..... 271, 274, 284  
 In-Phase/Quadrature-phase equaliser ..... 680  
 In-Phase/Quadrature-phase Turbo Equaliser ..... 676  
 independent fading channel ..... *see* channel

independent source . . . . . 422  
 Input Output Weight Enumerating Function . . . . 637  
 interference signal . . . . . 489  
 integrated circuit . . . . . 426  
 inter symbol interference . . . . . *see* ISI  
 Inter-burst interleaving . . . . . 578  
 interleaver . . . . . 204, 240  
   block . . . . . *see* block interleaver  
   depth . . . . . 317–319  
   design . . . . . 248–250  
   effect . . . . . 246–248  
   length . . . . . 246–250, 254, 318  
   random . . . . . *see* random interleaver  
   random separation . . . . . *see* random separation  
   interleaver  
   random symbol . . . . . *see* random symbol  
   interleaver  
   random-in-column block . . . . . *see*  
     random-in-column block interleaver  
   size . . . . . 252, 318  
 Interleaver Design . . . . . 365  
 internal delay . . . . . 259  
 Intersymbol Interference . . . . . 382–383  
 intrinsic information . . . . . 105, 205, 212, 213, 216, 217,  
   221, 223, 226, 228, 233, 239, 244, 297,  
   298, 315  
 Introduction . . . . . 327–328, 368, 387, 401  
 IOWEF . . . . . 637  
 Irreducible polynomial . . . . . 18  
 IRWEF . . . . . 631  
 ISI . . . . . 466, 472, 675  
 iteration number . 241–242, 302–304, 313–314, 320,  
   323, 427, 458, 487  
 iterative decoding . . . . . 206, 302, 315, 322, 429

## J

Jacobian logarithm . . . . . 220, 238  
 Jakes' model . . . . . 478, 501  
 joint probability . . . . . 209

## L

Labelling Method . . . . . 361–364  
 latency . . . . . 476  
 legitimate projection . . . . . 281  
 legitimate range . . . . . 271, 273, 274, 284  
 line of sight . . . . . *see* LOS  
 linear block code . . . . . 73, 204, 276  
 linear combination . . . . . 414  
 Linear shift-register circuits for cyclic encoders . . 32  
 Linear shift-register division circuit . . . . . 35  
 LLR . . . . . 564  
 Log Likelihood Ratio . . . . . 564  
 log likelihood ratio . . . . . 206–208, 233, 294  
 Log-MAP . . . . . 220, 241, 242, 244, 250, 311, 425, 427,  
   429, 431, 475, 476, 500, 507, 565, 570  
 Log-MAP algorithm . . . . . 128  
 logarithmic domain . . . . . 427  
 lookup table . . . . . 302

LOS . . . . . 478

## M

M-level Quadrature Amplitude Modulation . . . . 675  
 M-QAM . . . . . 675, 734  
 magnitude comparison . . . . . 259, 261, 265, 273  
 magnitude fluctuation . . . . . 413  
 MAP . . . . . 206, 209–217, 220, 233, 242, 421–425, 427,  
   475, 565  
   summary . . . . . 215–217  
 MAP algorithm . . . . . 3  
 MAP Algorithm Summary . . . . . 349–351  
 mapping . . . . . 290, 305, 322, 425, 475, 477, 495  
 Max-Log-MAP . . . . . 218–220, 243, 244, 311, 316, 565  
 Max-Log-MAP algorithm . . . . . 124  
 Maximum A Posteriori . . . . . 565  
 maximum distance separable RRNS . 273, 276, 281,  
   303, 306, 322  
 maximum Doppler frequency . . . . . 488  
 Maximum Likelihood . . . . . 641  
 maximum likelihood  
   decoder . . . . . 90, 292, 470  
   decoding . . . . . 423, 424, 498, 509  
   detector . . . . . 414, 418, 420  
   path . . . . . 219, 221, 222, 225, 228, 232, 233, 470  
   sequence . . . . . 209  
   transmitted symbol . . . . . 414, 420  
 Maximum Likelihood Sequence Estimation . . . . 547  
 maximum ratio combining . . . . . *see* MRC  
 Maximum-minimum distance code . . . . . 24  
 Minimum distance of FEC codes . . . . . 24  
 minimum free distance . . . . . 94, 96, 97, 204, 235, 248,  
   250, 255, 260, 273–275, 277, 280, 281,  
   322, 460, 727  
 Minimum Shift Keying . . . . . 549  
 mixed radix  
   coefficient . . . . . 268–270, 299  
   conversion . . . . . *see* MRC  
   digit . . . . . 263, 268, 283–285  
   representation . . . . . 264, 272, 284  
 mixed radix number system . . . . . 263–264, 268, 322  
 ML . . . . . 641, 733  
 MLSE . . . . . 547  
 mobile station . . . . . 411  
 modified Log-MAP . . . . . 238–240, 255  
 modified MAP . . . . . 233–240, 255  
 modified Max-Log-MAP . . . . . 238–240  
 modulation . . . . . 411, 424  
   mode . . . . . 427, 499, 501, 503  
 Modulation Index . . . . . 541  
 modulator . . . . . 429, 477, 500  
 moduli 262, 268, 270, 271, 279, 286, 299, 300, 304,  
   306, 322  
   projection . . . . . 282, 283  
 modulo . . . . . 262, 265, 267, 268, 270, 271, 299  
 Modulo polynomial operations . . . . . 20  
 Motivation . . . . . 537  
 Motivation of the book . . . . . xxv

- MRC . . . 266, 268–270, 272, 279, 283, 286, 299, 300, 322, 411, 413–415, 433–434, 461
- multilevel modulation . . . . . 423
- multiple antenna . . . . . 411
- multiple paths . . . . . 466
- multiplexer . . . . . 204, 240
- multiplication . . . . . 219, 259–261, 264, 265, 270, 272, 273, 299, 322, 417
- multiplicative inverse . . . . . 265–268, 270, 273, 322
- N**
- narrow-band . . . . . 425, 431
- non-binary . . . . . 429
- non-binary code . . . . . 286, 305
- non-dispersive . . . . . 412, 418, 422, 425, 431, 465
- non-redundant moduli . . . . . 271
- non-redundant number system . . . . . 261
- Nonsystematic encoding . . . . . 26
- O**
- OFDM . . . . . 466, 472, 475
- subcarrier . . . . . 477
- Offset Quadrature Phase Shift Keying . . . . . 547
- Optimum TCM Codes . . . . . 334–335
- OQPSK . . . . . 547
- orthogonal design . . . . . 415, 420
- Orthogonal Frequency Division Multiplexing . 398–401, *see* OFDM
- Orthogonal Frequency Division Multiplexing Aided Coded Modulation . . . . . 401–407
- Orthogonal Frequency Division Multiplexing Principle . . . . . 398–401
- orthogonality . . . . . 417
- Overall Performance . . . . . 396–397
- overflow . . . . . 261, 265
- detection . . . . . 260, 273
- Overview of the Reduced Complexity Turbo Equalizer . . . . . 682
- P**
- parallel concatenated code . . . . . 204
- Parallel concatenated convolutional code analysis 630
- parallel transitions . . . . . 332
- parity bit . . . . . 440, 443, 475, 477
- Path metric . . . . . 10
- path metric . . . . . 74, 76, 220, 222, 223, 227, 228, 232, 244, 298, 310
- PCCC . . . . . 629, 733
- perfect signalling . . . . . 500, 501
- performance . . . . . 298, 299, 412, 475, 476
- Performance over Uncorrelated Narrowband Rayleigh Fading Channels . . . . . 375–377
- Periodogram . . . . . 555
- Peterson-Gorenstein-Zierler decoder . . . . . 40–42
- PGZ decoder for RS and BCH codes . . . . . 38
- PGZ decoding example . . . . . 42–47
- PGZ decoding of RS and BCH codes . . . . . 41
- PGZ RS and BCH decoder . . . . . 40
- phase rotation . . . . . 413
- Phase Shaping Function . . . . . 542
- Phase State . . . . . 544
- Phase States . . . . . 545
- picocellular . . . . . 411
- pilot symbol . . . . . 425
- Polynomial multiplication . . . . . 32
- Polynomial multiplication circuit . . . . . 32
- Power spectral density . . . . . 555
- Preface . . . . . xxv
- prime integer . . . . . 262
- Primitive element . . . . . 18
- Principle of Turbo Equalisation Using Single/Multiple Decoder(s) . . . . . 586
- probability density function . . . . . 208, 295, 503
- Problem Description . . . . . 339–341
- product code . . . . . 204, 241, 256
- protection class . . . . . 423, 440, 444, 475, 477
- puncturer . . . . . 204
- puncturing
- effect . . . . . 245–246
- pattern . . . . . 240, 246, 248, 428, 507
- Q**
- QPSK . . . . . 547, 675
- Quadrature Phase Shift Keying . . . . . 547
- quotient . . . . . 269
- R**
- Radial Basis Function . . . . . 675
- radix . . . . . 261, 261, 263, 268
- random interleaver . . . . . 204, 247, 248, 317, 444
- random separation interleaver . . . . . 444, 475, 477, 507
- random symbol interleaver . . . . . 317, 319
- random-in-column block interleaver . . . . . 248
- Rayleigh fading channel . . . . . *see* channel
- RBF . . . . . 675
- real-time . . . . . 476
- receiver antenna . . . . . 475
- receiver diversity . . . . . 411, 465
- recursive . . . . . 647
- Recursive Metric Update Formulae . . . . . 344–348
- Recursive properties of the MSK, GMSK and DPSK modulator . . . . . 646
- Recursive Systematic Convolutional . . . . . 563
- recursive systematic convolutional code . . . . . 203
- Reduced complexity turbo equaliser . . . . . 675
- redundant moduli . . . . . 271, 272, 275, 276, 306
- redundant phasors . . . . . 329
- redundant residue . . . . . 260
- redundant residue number system . . . . . *see* RRNS
- Reed-Solomon
- code . . . . . 276, 306, 322, 466, 472, 477, 497, 510
- systematic . . . . . 306
- Reed-Solomon (RS) codes . . . . . 24
- reflected path . . . . . 478
- reliability factor . . . . . 298, 304, 311

reliability value ..... 444  
 replica ..... 413, 414  
 residue ..... 273, 286, 288, 300, 304, 305  
   arithmetic operations ..... 264–265, 322  
   digit ..... 265, 268, 271, 277, 278, 280, 322  
   error ..... 300  
   representation ..... 283  
 residue number system ..... *see* RNS  
 residue to decimal conversion ..... 266–270  
 RNS ..... 259, 262–263, 266, 268, 322  
 Robertson ..... 105, 114, 144, 150  
 RRNS ..... xiv, 260, 270–271, 273, 274, 281, 283, 288, 322  
   code ..... 274, 286, 288, 290–292, 294, 295, 300, 303, 305, 306, 319, 322  
     modified systematic ..... 290–291, 303, 305, 306  
     non-systematic ..... 286–288, 303, 305, 322  
   soft input ..... 292–294  
   soft output ..... 294–297  
   systematic ..... 289–290, 303, 305, 322  
 coding theory ..... 273–292  
 complexity ..... 299–302, 307  
 decoder ..... 291–292, 301, 306  
 dynamic range ..... 288, 291  
 encoder ..... 286–291, 305–306  
 error correction ..... 277–279  
 error correction capability ..... **280**  
 error correction procedure ..... 279–286, 299  
 error detection ..... 277–279  
   linearity ..... 276–277  
   minimum free distance ..... 273–276  
   reduced ..... 284  
   SISO decoder ..... 292–299  
 RS and BCH codes ..... 24–66  
 RS and BCH decoding ..... 35  
 RS and BCH syndrome equations ..... 35  
 RS decoding ..... 35–66  
 RS encoding ..... 26–28  
 RS encoding example ..... 28–30  
 RS(12,8,2) PGZ decoding example ..... 42  
 RSC ..... 426, 449, 563, 578

## S

scaling ..... 260, 273  
 SCCC ..... 637, 733  
 semi-linear block code ..... 277, 322  
 Serial Concatenated Convolutional Code ..... 637  
 Serial concatenated convolutional code analysis ..... 637  
 set-partition ..... 425  
 Set-Partitioning ..... 337–339  
 Shannon limit ..... 203, 250  
 shift register ..... 69, 70, 467  
 Shift-register encoding example ..... 33–35  
 sign detection ..... 259, 265, 273  
 signal constellation ..... 415, 436  
 Simulation Parameters ..... 404  
 Simulation Results And Discussions ..... 404–407

Simulation Results and Discussions ..... 371–381  
 single transmitter ..... 413  
 Singleton bound in FEC coding ..... 24  
 sink ..... 425, 475, 500  
 SIR ..... 491, 510  
 SISO ..... 565, 676  
 soft channel output ..... **205**, 208, 217, 244, 297  
 soft input ..... 84, 241, 244, 256, 292, 322  
 soft output ..... 77, 88, 213, 215, 217, 221, 223, 232, 241, 244, 256, 258, 292, 297, 298, 310, 315, 322, 421, 423, 425, 429, 475, 500  
 Soft output GMSK equaliser ..... 562, 565  
 Soft-In Soft-Out ..... 676  
 Soft-In/Soft-Out ..... 565  
 Soft-In/Soft-Out Decoder For Turbo Equalisation ..... 591  
 Soft-In/Soft-Out Equaliser For Turbo Equalisation ..... 591  
 SOVA ..... 76, 206, 220–226, 243, 244, 298, 310, 311, 316, 565  
   example ..... 223–226  
 space-time  
   AOFDM ..... 499–510  
   block  
     1 BPS performance ..... 434  
     2 BPS performance ..... 434–436  
     3 BPS performance ..... 436–437  
     channel coded ..... 423–431  
     code ..... 412, 414–421, 423, 425, 432, 461, 465  
     decoder ..... 421, 425, 429, 475, 477  
     encoder ..... 415, 425, 429, 473, 477  
     MAP ..... 421–423  
   coding ..... 415  
   comparison ..... 480–488, 497–498  
   trellis  
     code ..... 411, 412, 420, 465  
     complexity ..... 477–478  
     decoder ..... 468–470, 475  
     encoder ..... 466–468, 473, 477  
     state diagram ..... 466  
   turbo equalisation ..... 466  
 space-time trellis  
   codes ..... 466–472  
 State and trellis transitions ..... 6–7  
 state diagram ..... 473, 478, 509  
   BCH(7,4,3) ..... 72  
 Suan-Ching ..... 259  
 sub-band ..... 499  
 subcarrier ..... 499  
 subtraction ..... 259, 264, 268, 299, 302, 322  
 Summary and conclusions ..... 725  
 Summary of the Log-MAP algorithm ..... 575  
 Summary of the MAP algorithm ..... 570  
 Sun Tzu ..... 259  
 surviving codeword ..... 297–299, 311  
 Survivor path ..... 10

survivor path . . . 75, 76, 219, 222, 224, 225, 228, 298, 310, 430  
 switching threshold . . . . . 502  
 symbol block interleaver . . . . . 313, 314  
 symbol interleaver . . . . . 317  
 symmetric system . . . . . 263  
 Syndrome polynomial . . . . . 58  
 Syndromes in RS and BCH coding . . . . . 36  
 System I and System II Performance . . . . . 392–395  
 System model . . . . . 678  
 System Overview . . . . . 368–370, 387–390, 401–404  
 System parameters . . . . . 691  
 System performance . . . . . 692  
 Systematic RS and BCH encoding . . . . . 27

## T

tailing symbols . . . . . 470  
 TBCH . . . . . 423, 424  
 TC . . . . . 423, 424, 431, 472, 476  
   comparison . . . . . 450  
   different rates . . . . . 451–452  
 TCM . . . . . 328, 423, 424, 431  
   encoder . . . . . 429  
 TCM Code Design for Fading Channels . . . . . 336–337  
 TCM Principle . . . . . 329–334  
 TDD . . . . . 691, 720  
 TDMA . . . . . 691, 720  
 test pattern . . . . . 89, 293, 298, 301, 309, 311  
 test position . . . . . 298, 320  
   effect . . . . . 309  
 The calculation of the Log Likelihood Ratio . . . . . 567  
 The Log-MAP algorithm . . . . . 570  
 The MAP Algorithm . . . . . 341–344  
 The MAP Algorithm in the Logarithmic-Domain . . . . . 348–349  
 The mobile radio channel . . . . . 538  
 The Symbol-based MAP Algorithm . . . . . 339–351  
 Theoretical and simulation performance of coded  
   DPSK systems . . . . . 651  
 theoretical result . . . . . 307  
 Time dispersion . . . . . 538  
 Time Division Duplex . . . . . 691, 720  
 Time Division Multiple Access . . . . . 691, 720  
 Time-selective fading . . . . . 538  
 transition metric . . . . . 228, 230  
 transition probability . . . . . 212–213, 218, 236–238  
 transmission matrix . . . . . 414, 415, 425, 431, 473, 476  
 transmission power . . . . . 489  
 transmit  
   antenna . . . . . 412, 415, 420, 433, 466, 475  
   diversity . . . . . 411, 415, 465  
 transmit antenna . . . . . 466, 503  
 Trellis Coded Modulation . . . . . 328–339  
 trellis coded modulation . . . . . *see* TCM  
 trellis diagram . . . . . 236, 469  
   BCH(7,4,3) . . . . . 74  
 trellis diagrams . . . . . 329  
 Trellis State . . . . . 545

trellis transition . . . . . 429, 468, 469, 478, 509  
   probability . . . . . 211  
 triangular inequality . . . . . 277  
 TTCM . . . . . 423, 424, 431  
 TTCM Decoder . . . . . 353–356  
 TTCM Encoder . . . . . 351–353  
 TU . . . . . 577  
 turbo BCH code . . . . . *see* TBCH  
 turbo code . . . . . 203, 255, 256, 292, 318, 421, 424, 439, 443  
   block . . . . . 204, 311–313  
   complexity . . . . . 299–302, 429–431  
   decoder . . . . . 205–206, 425, 444  
   encoder . . . . . 204, 245  
   example . . . . . 226–233  
   interleaver . . . . . 303, 314, 323  
   interleaver design . . . . . 248–250  
   interleaver effect 246–248, 317–319, 443–448  
   interleaver length . . . . . 246–248, 252  
   interleaver size . . . . . 476, 484, 507  
   memory . . . . . 429–431  
 turbo coding . . . . . 563  
 Turbo coding in GSM . . . . . 562  
 Turbo coding performance results . . . . . 579  
 turbo convolutional code . . . . . *see* TC  
 Turbo equalisation . . . . . 583  
 turbo equalisation . . . . . 466, 472  
 Turbo equalisation for Partial Response Systems 583  
 Turbo equalisation performance bound . . . . . 629  
 Turbo Trellis Coded Modulation . . . . . 351–356  
 turbo trellis coded modulation . . . . . *see* TTCM  
 Turbo-coded GSM . . . . . 565  
 Typical Urban . . . . . 577

## U

UMTS . . . . . 426, 427, 448  
 uncorrelated . . . . . 425, 431  
 uniform interleaver . . . . . 629, 633  
 unique representation . . . . . 261  
 Universal Mobile Telecommunication System . . . . . *see*  
   UMTS  
 unlimited range . . . . . 261  
 update sequence . . . . . 132  
 UTRA . . . . . 450, 453

## V

VA . . . . . 3  
 valid codeword . . . . . 273, 276–280, 282, 283, 293, 294, 311  
 Vandemonde matrix . . . . . 39  
 vehicular . . . . . 411  
 Viterbi algorithm . . . . . 7–15, 73–79, 88, 108, 209, 220, 221, 247, 309, 323, 334, 424, 425, 429, 431, 470, 475, 478  
   decoder . . . . . 74, 75, 247, 311  
 voice . . . . . 411

**W**

WATM ..... 478, 496, 500  
weight distribution ..... 235, 260  
weighted number system ..... **261**, 265  
weighting factor ..... **299**, 304, 311  
Welch ..... 555  
Winning path ..... 11  
wireless channel ..... 411



# Author Index

## Symbols

, A. [145] .....	198
, J. [142] .....	190
, K. [145] .....	198
, R. [137] .....	172

## A

Abend, K. [227] .....	353
Adachi, F. [269] .....	415
Adachi, F. [277] .....	415
Adachi, F. [355] .....	639
Adde, P. [146] .....	203, 257
Adde, P. [122] .....	573, 585, 587, 596, 633
Adde, P. [202] .....	300
Adoul, J-P. [323] .....	546
Agrawal, D. [83] .....	0, 472, 480, 504, 520
Ahlén, A. [312] .....	521–524, 531, 716
Aitsab, O. [201] .....	294
Aitsab, O. [200] .....	294
Akihisa Ushirokawa, [354] .....	639
Al-Dhahir, N. [82] .....	0, 472, 480, 517
Al-Semari, S.A. [290] .....	459
Alamouti, S.M. [255] .....	393
Alamouti, S.M. [78]0, 415–417, 419, 424, 425, 429, 436, 439, 468, 471, 480, 517, 520, 713, 739	
Alard, M. [261] .....	403
Alia, G. [167] .....	262
Alia, G. [162] .....	261
Alia, G. [166] .....	262
Altman, E. [198] .....	281
Ambroze, A. [141] .....	175
Anderson, J.B. [102] .....	0
Anderson, J.B. [318] ..	545, 548, 552, 553, 564, 587
Andreas Knickenberg, [362] .....	685
Andrews, K. [140] .....	172
Angui, E. [122] .....	573, 585, 587, 596, 633
Ariyavisitakul, S. [84] .....	0, 472, 520
Aulin, T. [318] .....	545, 548, 552, 553, 564, 587

## B

Bahl, L.R. [20] .. 0, 3, 172, 189–191, 203, 206, 208,	
---	--

241, 341, 344, 353, 373, 394, 427, 430, 481, 573, 575, 587, 596, 669, 737	
Baier, A. [57] .. 0, 203, 217, 218, 238, 298, 573, 585, 587, 737	
Baraniecka, A. [153] .....	261
Baraniecka, A. [184] .....	262
Barbarossa, S. [293] .....	472
Barbulescu, A.S [75] .....	0, 204, 588, 590, 669
Barsi, F. [172] .....	262
Barsi, F. [168] .....	262, 275, 277, 281, 285
Battail, G. [138] .....	172, 198
Bauch, G. [324] .....	546, 595, 598, 604
Bauch, G. [342] .....	595, 633, 680
Bauch, G. [283] .....	425–427, 469, 481, 508
Bauch, G. [81] .....	0, 472, 480, 517, 520, 714
Bauch, G. [82] .....	0, 472, 480, 517
Bee Leong Yeap, [362] .....	685
Benedetto, S. [66] .. 0, 172, 175, 187, 198, 603, 639, 641, 643, 646, 650, 661, 664, 743	
Benedetto, S. [65] .....	0, 639
Benedetto, S. [106] 0, 639, 647, 649, 651, 656, 659, 743	
Benedetto, S. [235] .....	367, 369
Berlekamp, E.R. [40] .....	0, 3, 4, 66, 67, 82, 735
Berlekamp, E.R. [1] .. 0, 4, 17, 18, 35, 47, 48, 57, 66, 67, 82, 336, 735	
Bernard Sklar, [76] .....	0, 247, 320
Berrou, C. [122] .....	573, 585, 587, 596, 633
Berrou, C. [21] .. 0, 3, 171, 191, 203, 247, 301, 320, 329, 355, 427, 428, 430, 431, 448, 456, 545, 571, 593, 603, 639, 668, 735	
Berrou, C. [128] .....	190, 572
Berrou, C. [107] .. 0, 407, 545, 546, 578, 593–596, 623, 668, 680, 685, 686, 714, 742	
Berrou, C. [22]0, 245, 247, 301, 320, 427–431, 448, 456, 524, 571, 572, 593, 603, 639, 735	
Berrou, C. [62] .....	0, 428, 448
Besette, B. [323] .....	546
Biglieri, E. [232] .....	358, 400
Blahut, R. [121] .....	67, 336
Blahut, R.E. [111] .....	40
Blahut, R.E. [3] 0, 17, 18, 35, 38, 40, 48, 51, 57, 66,	

276, 278, 735  
 Blake, I.F. [93] . . . . . 0, 17, 38, 47  
 Bose, R.C. [24] . . . . . 0, 3, 67, 596, 668  
 Bose, R.C. [25] . . . . . 0, 3  
 Bossert, M [97] . . . . . 0  
 Branka Vucetic, [356] . . . . . 639  
 Breiling, M. [127] . . . . . 577  
 Breiling, M. [359] . . . . . 639  
 Breiling, M. [358] . . . . . 639  
 Brennan, D. [282] . . . . . 416, 417  
 Burgess, D. [44] . . . . . 0  
 Burkert, F. [325] . . . . . 546  
 Burkett, F. [70] . . . . . 0, 203, 252, 428, 431, 668, 735

## C

Cain, J.B. [7] . . . . . 0, 17, 35, 48, 57, 63, 66, 735  
 Caire, G. [325] . . . . . 546  
 Caire, G. [232] . . . . . 358, 400  
 Calderbank, A. [86] 0, 393, 471, 472, 480, 504, 520  
 Calderbank, A. [278] . . . . . 415, 424, 471, 517, 739  
 Calderbank, A. [280] . . . . . 415, 424, 471, 517, 739  
 Calderbank, A. [279] . . . . . 415, 424, 471, 517, 739  
 Calderbank, A.R. [80] . . . . . 0, 416, 419, 424, 425, 427, 429, 436, 439, 471, 517, 520, 739  
 Calderbank, A.R. [281] 415, 424, 471, 517, 520, 739  
 Calderbank, A.R. [87] . . . . . 0, 415, 424, 471, 517, 520, 739  
 Calderbank, A.R. [77] . . . . . 0, 415, 424, 471–473, 475, 476, 480–482, 517, 520, 524, 531, 713, 739  
 Calderbank, A.R. [79] . . . . . 0, 416, 419, 421, 424, 425, 429, 436, 439, 471, 517, 713, 739  
 Carlson, A.B. [330] . . . . . 548  
 Cavers, J.K. [223] . . . . . 338, 354, 358, 393  
 Chang, R.W. [257] . . . . . 402  
 Chase, D. [37] . . . . . 0, 67, 85, 91, 295  
 Chaudhury, P. [266] . . . . . 415, 431, 457, 520  
 Chen, J-H. [220] . . . . . 330  
 Chen, J-H. [19] . . . . . 0  
 Cheney, P. [152] . . . . . 261  
 Cheung, J.C. [239] . . . . . 387–389, 392  
 Cheung, J.C.S. [314] . . . . . 522, 573  
 Chien, R.T. [113] . . . . . 40  
 Choi, B.J. [253] . . . . . 392  
 Choi, B.J. [317] . . . . . 535  
 Choi, W. [292] . . . . . 472, 520  
 Chris Heegard, [96] . . . . . 0, 572  
 Chua, S-G. [303] . . . . . 506, 519  
 Chua, S. [310] . . . . . 520  
 Chua, S. [244] . . . . . 390  
 Chua, S. [248] . . . . . 390  
 Chuang, J. [85] . . . . . 0, 472, 480, 504, 520  
 Cimini, L.J. [259] . . . . . 402  
 Cioffi, J. [292] . . . . . 472, 520  
 Cioffi, J. [272] . . . . . 415  
 Clark, G.C. Jr [7] . . . . . 0, 17, 35, 48, 57, 63, 66, 735  
 Claudio, E. [175] . . . . . 262

Cocke, J. [20] . . . . . 0, 3, 172, 189–191, 203, 206, 208, 241, 341, 344, 353, 373, 394, 427, 430, 481, 573, 575, 587, 596, 669, 737  
 Combelles, P. [202] . . . . . 300  
 Constello, D.J. Jr [203] . . . . . 308  
 Constello, D.J. Jr [5] . . . . . 0, 17, 35, 38, 48, 57, 66, 85, 234, 279, 281, 359–361, 363, 373, 735  
 Cosentino, R. [171] . . . . . 262  
 Costello, D.J. [67] . . . . . 0, 172, 198

## D

Dai, Q. [345] . . . . . 595  
 Darnell, M. [34] . . . . . 0  
 Debuda, R. [331] . . . . . 555, 558  
 Deng, R. [270] . . . . . 415  
 Deng, R.H. [229] . . . . . 353  
 Didier, P. [107] 0, 407, 545, 546, 578, 593–596, 623, 668, 680, 685, 686, 714, 742  
 Divsalar, D. [106] . . . . . 0, 639, 647, 649, 651, 656, 659, 743  
 Divsalar, D. [208] . . . . . 329, 338, 354, 393  
 Divsalar, D. [209] . . . . . 329  
 Divsalar, D. [235] . . . . . 367, 369  
 Douillard, C. [107] . . . . . 0, 407, 545, 546, 578, 593–596, 623, 668, 680, 685, 686, 714, 742  
 Duel-Hallen, A. [254] . . . . . 392

## E

Elias, P. [12] . . . . . 0, 3, 427  
 Erfanian, J.A. [58] . . . . . 0, 203, 217, 218, 238, 298, 573, 585, 587, 737  
 ETS, I [321] . . . . . 546  
 ETS, I [320] . . . . . 546  
 Etzel, M. [177] . . . . . 262, 275, 281, 285

## F

Fano, R.M. [15] . . . . . 0, 3  
 Farrell, P. [32] . . . . . 0  
 Faudeil, S. [122] . . . . . 573, 585, 587, 596, 633  
 Fields, E.L. [185] . . . . . 262  
 Forney, G. [284] . . . . . 427  
 Forney, G. [30] . . . . . 0  
 Forney, G.D. [285] . . . . . 427  
 Forney, G.D. [224] . . . . . 341  
 Forney, G.D. [18] 0, 3, 427, 429, 481, 552, 555, 601, 652, 668  
 Forney, G.D. Jr [115] . . . . . 47, 57, 59, 82  
 Foschini, G. Jr [267] . . . . . 415  
 Fossorier, M. [29] . . . . . 0  
 Frank Jordan, [346] . . . . . 595  
 Franz, V. [324] . . . . . 546, 595, 598, 604  
 Fraser, D. [178] . . . . . 262  
 Fritchman, B.D. [227] . . . . . 353  
 Fuja, T.E. [290] . . . . . 459  
 Fujiwara, T. [35] . . . . . 0  
 Fujiwara, T. [36] . . . . . 0  
 Fujiwara, T. [29] . . . . . 0

**G**

Gallager, [137] ..... 172  
 Gans, M. [267] ..... 415  
 Gersho, A. [220] ..... 330  
 Gerson, I.A. [322] ..... 546  
 Gertsman, M.J. [343] ..... 595–597, 685  
 Giannakis, G. [293] ..... 472  
 Giannakis, G. [294] ..... 472  
 Giles, T. [353] ..... 639  
 Glance, B. [268] ..... 415  
 Glavieux, A. [21] 0, 3, 171, 191, 203, 247, 301, 320, 329, 355, 427, 428, 430, 431, 448, 456, 545, 571, 593, 603, 639, 668, 735  
 Glavieux, A. [364] ..... 685, 686, 694, 716  
 Glavieux, A. [107] 0, 407, 545, 546, 578, 593–596, 623, 668, 680, 685, 686, 714, 742  
 Glavieux, A. [22] 0, 245, 247, 301, 320, 427–431, 448, 456, 524, 571, 572, 593, 603, 639, 735  
 Glavieux, A. [62] ..... 0, 428, 448  
 Glavieux, A. [88] ..... 0, 240, 257, 294  
 Goalic, A. [147] ..... 203, 240, 257  
 Goeckel, D. [250] ..... 390  
 Goeckel, D. [311] ..... 520  
 Goldsmith, A. [310] ..... 520  
 Goldsmith, A.J. [244] ..... 390  
 Goldsmith, A.J. [248] ..... 390  
 Goldsmith, A.J. [303] ..... 506, 519  
 Golomb, S.W. [117] ..... 48  
 Gorenstein, D. [38] ..... 0, 4, 35, 38–40, 82  
 Greestein, L. [268] ..... 415  
 Guan-Feng Qin, [347] ..... 596  
 Guido Montorsi, [352] ..... 639  
 Gulak, G. [58] 0, 203, 217, 218, 238, 298, 573, 585, 587, 737

**H**

Haavisto, P. [323] ..... 546  
 Hagenauer, J. [342] ..... 595, 633, 680  
 Hagenauer, J. [325] ..... 546  
 Hagenauer, J. [60] 0, 206, 220, 300, 573, 585, 587, 596, 737  
 Hagenauer, J. [61] 0, 206, 220, 222, 224, 300, 573, 585, 587, 596, 737  
 Hagenauer, J. [68] 0, 172, 203, 205, 251, 427–429, 431, 524, 572, 667  
 Hagenauer, J. [233] ..... 361, 429  
 Hagenauer, J. [70] 0, 203, 252, 428, 431, 668, 735  
 Hallen, H. [254] ..... 392  
 Hamming, R.W. [40] ..... 0, 3, 4, 66, 67, 82, 735  
 Hankanen, T. [323] ..... 546  
 Hanzo, L. [372] ..... 737  
 Hanzo, L. [300] ..... 506–508  
 Hanzo, L. [249] ..... 390  
 Hanzo, L. [306] ..... 519  
 Hanzo, L. [56] 0, 66, 338, 368, 385, 408, 427, 428, 430, 431, 454, 456–458, 481, 509,

546–548, 552, 555, 559, 562, 572, 573, 587, 589, 590, 594, 625, 658, 735  
 Hanzo, L. [9] ..... 17, 21, 25, 35, 48, 57, 66  
 Hanzo, L. [206] ..... 325, 386, 387, 389, 392, 402, 404–406, 408, 419, 427–429, 444, 445, 472, 481, 484, 504, 506–510, 520, 522, 525, 545, 546, 557, 685, 686, 738  
 Hanzo, L. [245] ..... 390, 392, 519, 522, 533  
 Hanzo, L. [253] ..... 392  
 Hanzo, L. [187] ..... 262  
 Hanzo, L. [371] ..... 714, 733, 745  
 Hanzo, L. [298] ..... 506, 509  
 Hanzo, L. [243] ..... 390  
 Hanzo, L. [242] ..... 390, 506  
 Hanzo, L. [196] ..... 262, 520  
 Hanzo, L. [301] ..... 506–508, 527  
 Hanzo, L. [204] ..... 308, 325, 738  
 Hanzo, L. [197] ..... 262, 308, 325, 738  
 Hanzo, L. [304] ..... 509  
 Hanzo, L. [183] ..... 262, 275  
 Hanzo, L. [188] ..... 262  
 Hanzo, L. [189] ..... 262  
 Hanzo, L. [295] ..... 480, 481, 514, 525  
 Hanzo, L. [296] ..... 480, 481  
 Hanzo, L. [313] ..... 521  
 Hanzo, L. [315] ..... 525  
 Hanzo, L. [195] ..... 262, 294  
 Hanzo, L. [256] ..... 394  
 Hanzo, L. [216] ..... 330  
 Hanzo, L. [215] ..... 330  
 Hanzo, L. [217] ..... 330  
 Hanzo, L. [149] ..... 246  
 Hanzo, L. [305] ..... 509, 519, 535  
 Hanzo, L. [316] ..... 527  
 Hanzo, L. [299] ..... 506  
 Hanzo, L. [359] ..... 639  
 Hanzo, L. [358] ..... 639  
 Hanzo, L. [363] ..... 685  
 Hanzo, L. [317] ..... 535  
 Hanzo, L. [263] ..... 407  
 Hanzo, L. [365] ..... 686  
 Hanzo, L. [52] ..... 0, 262  
 Hanzo, L. [120] ..... 67, 204, 225  
 Hanzo, L. [194] ..... 262  
 Hanzo, L. [176] ..... 262  
 Hanzo, L. [307] ..... 520  
 Hanzo, L. [190] ..... 262  
 Hartmann, C.R.P. [24] ..... 0, 3, 67, 596, 668  
 Hastings, C. [150] ..... 261  
 Hastings, C. [151] ..... 261  
 Hastings, C.W. [49] ..... 0, 261, 262, 275  
 Hattori, T. [276] ..... 415  
 He, B. [357] ..... 639  
 Heegard, C. [140] ..... 172  
 Heller, J.A. [109] ..... 3  
 Hidelang, T. [325] ..... 546  
 Hirade, K. [276] ..... 415  
 Hirade, K. [319] ..... 545, 555, 559

Hirasawa, S. [116] ..... 48  
 Hiroike, A. [277] ..... 415  
 Ho, M.S.C. [353] ..... 639  
 Ho, P. [223] ..... 338, 354, 358, 393  
 Hocquenghem, A. [23] ..... 0, 3, 67, 668  
 Hoeher, P. [60] 0, 206, 220, 300, 573, 585, 587, 596,  
 737  
 Hoffman, D. [100] ..... 0  
 Höher, [143] ..... 190  
 Höher, P. [59] 0, 203, 206, 217, 220, 241, 242, 350,  
 351, 355, 373, 394, 430, 481, 508, 514,  
 573, 579, 580, 587, 596, 610, 737  
 Honary, B. [32] ..... 0  
 Honary, B. [33] ..... 0  
 Honary, B. [34] ..... 0  
 Honary, B. [28] ..... 0, 234  
 Honary, B. [31] ..... 0  
 Horn, R. [291] ..... 471  
 Hu, S. [254] ..... 392  
 Huang, C. [178] ..... 262  
 Huang, C. [159] ..... 261  
 Huang, H. [155] ..... 261  
 Huber, J. [101] ..... 0  
 Huber, J. [63] ..... 0

**I**

Inisan, J-R. [146] ..... 203, 257

**J**

Jacobs, I.M. [109] ..... 3  
 Jacq, S. [88] ..... 0, 240, 257, 294  
 Jafarkhani, H. [80] 0, 416, 419, 424, 425, 427, 429,  
 436, 439, 471, 517, 520, 739  
 Jafarkhani, H. [79] 0, 416, 419, 421, 424, 425, 429,  
 436, 439, 471, 517, 713, 739  
 Jakes, W.C. Jr [286] ..... 428, 448, 484, 508  
 James, T. [205] ..... 309  
 Jarvinen, K. [323] ..... 546  
 Jasiuk, M.A. [322] ..... 546  
 Jelinek, F. [20] 0, 3, 172, 189–191, 203, 206, 208,  
 241, 341, 344, 353, 373, 394, 427, 430,  
 481, 573, 575, 587, 596, 669, 737  
 Jenkins, W. [177] ..... 262, 275, 281, 285  
 Jenkins, W. [161] ..... 261  
 Jenkins, W. [154] ..... 261  
 Jenkins, W. [179] ..... 262  
 Jenkins, W. [198] ..... 281  
 Jenkins, W. [199] ..... 281  
 Jenkins, W.K. [156] ..... 261, 262  
 Jenkins, W.K. [181] ..... 262  
 Jennings, A. [114] ..... 45  
 Jézéquel, M. [107] 0, 407, 545, 546, 578, 593–596,  
 623, 668, 680, 685, 686, 714, 742  
 Jimenez, [145] ..... 198  
 Jinhong Yuan, [356] ..... 639  
 John Lodge, [360] ..... 640  
 John, [144] ..... 194, 197  
 Johnson, C. [291] ..... 471

Johnson, D.A. [337] ..... 573, 587  
 Jozef Hámorský, [362] ..... 685  
 Jullien, G. [153] ..... 261  
 Jullien, G. [184] ..... 262  
 Jullien, G. [160] ..... 261  
 Jullien, G. [182] ..... 262  
 Jullien, G. [186] ..... 262  
 Jullien, G.A. [181] ..... 262  
 Jung, P. [72] ..... 0  
 Jung, P. [132] ..... 193, 590  
 Jung, P. [73] ..... 0

**K**

Kalet, I. [262] ..... 403, 506  
 Kallel, S. [255] ..... 393  
 Kallel, S. [344] ..... 595  
 Kamio, Y. [302] ..... 506, 520  
 Kamio, Y. [246] ..... 390  
 Kapanen, P. [323] ..... 546  
 Karl-Dirk Kammeyer, [346] ..... 595  
 Kasahara, M. [116] ..... 48  
 Kasami, T. [89] ..... 0  
 Kasami, T. [35] ..... 0  
 Kasami, T. [36] ..... 0  
 Kasami, T. [29] ..... 0  
 Keir, Y. [152] ..... 261  
 Keller, T. [300] ..... 506–508  
 Keller, T. [206] ..... 325, 386, 387, 389, 392, 402,  
 404–406, 408, 419, 427–429, 444, 445,  
 472, 481, 484, 504, 506–510, 520, 522,  
 525, 545, 546, 557, 685, 686, 738  
 Keller, T. [196] ..... 262, 520  
 Keller, T. [301] ..... 506–508, 527  
 Keller, T. [204] ..... 308, 325, 738  
 Keller, T. [197] ..... 262, 308, 325, 738  
 Keller, T. [299] ..... 506  
 Khorram, H. [342] ..... 595, 633, 680  
 Kirsch, A.L. [258] ..... 402  
 Klein, A. [252] ..... 391, 392, 671, 701  
 Koch, W. [57] 0, 203, 217, 218, 238, 298, 573, 585,  
 587, 737  
 Komaki, S. [241] ..... 390, 519  
 Kozen, D. [140] ..... 172  
 Kreyszig, E. [334] ..... 560  
 Krishna, H. [170] ..... 262  
 Krishna, H. [50] 0, 262, 275–277, 279, 281, 286  
 Krishna, H. [51] ..... 0, 262, 275, 281, 285, 286  
 Krishnan, R. [182] ..... 262  
 Kumaresan, R. [174] ..... 262, 274  
 Kumaresan, R. [165] ..... 262

**L**

Labat, J. [364] ..... 685, 686, 694, 716  
 Lafanechére, A. [229] ..... 353  
 Laflamme, C. [323] ..... 546  
 Lajos Hanzo, [362] ..... 685  
 Lajos Hanzo, [191] ..... 262  
 Lajos Hanzo, [192] ..... 262

- Lang Lin, [349] ..... 633  
 Laot, C. [364] ..... 685, 686, 694, 716  
 Lassalle, R. [261] ..... 403  
 Lau, V. [308] ..... 520  
 Lau, V.K.N. [309] ..... 520  
 Lau, V.K.N. [247] ..... 390, 506, 520  
 Le Goff, S. [62] ..... 0, 428, 448  
 Lechner, G. [325] ..... 546  
 Lee, C.S. [217] ..... 330  
 Lee, L.H.C. [234] ..... 361, 373  
 Leon, B.J. [156] ..... 261, 262  
 Leonard, D. [100] ..... 0  
 Levesque, A.H. [4] ..... 0, 17, 35, 38, 40, 48, 57  
 Li, X. [212] ..... 330, 363, 368  
 Li, X. [214] ..... 330, 367  
 Li, X. [218] ..... 330, 369, 372  
 Li, X. [213] ..... 330, 372, 374  
 Li, Y. [84] ..... 0, 472, 520  
 Li, Y. [85] ..... 0, 472, 480, 504, 520  
 Lidl, R. [99] ..... 0, 17, 219, 237  
 Lie-Liang Yang, [191] ..... 262  
 Lie-Liang Yang, [192] ..... 262  
 Liew, T. [204] ..... 308, 325, 738  
 Liew, T. [197] ..... 262, 308, 325, 738  
 Liew, T. [295] ..... 480, 481, 514, 525  
 Liew, T. [296] ..... 480, 481  
 Liew, T. [313] ..... 521  
 Liew, T. [315] ..... 525  
 Liew, T. [195] ..... 262, 294  
 Liew, T. [149] ..... 246  
 Liew, T. [307] ..... 520  
 Liew, T.H. [372] ..... 737  
 Liew, T.H. [249] ..... 390  
 Liew, T.H. [196] ..... 262, 520  
 Liew, T.H. [215] ..... 330  
 Liew, T.H. [317] ..... 535  
 Liew, T.H. [263] ..... 407  
 Liew, T.H. [52] ..... 0, 262  
 Lin, K-Y. [50] ..... 0, 262, 275–277, 279, 281, 286  
 Lin, S. [203] ..... 308  
 Lin, S. [5] ..... 0, 17, 35, 38, 48, 57, 66, 85, 234, 279, 281, 359–361, 363, 373, 735  
 Lin, S. [35] ..... 0  
 Lin, S. [36] ..... 0  
 Lin, S. [29] ..... 0  
 Lindner, C. [100] ..... 0  
 Liu, X. [311] ..... 520  
 Liu, Y. [169] ..... 262, 275  
 Liu, Z. [293] ..... 472  
 Liu, Z. [294] ..... 472  
 Lo, H. [158] ..... 261  
 Lodge, J.L. [343] ..... 595–597, 685
- M**  
 Macleod, M. [308] ..... 520  
 Macleod, M.D. [247] ..... 390, 506, 520  
 MacWilliams, F. [148] ..... 204  
 MacWilliams, F.J. [91] ..... 0, 66, 735
- Maestrini, P. [172] ..... 262  
 Maestrini, P. [168] ..... 262, 275, 277, 281, 285  
 Makhoul, J. [110] ..... 40  
 Mandelbaum, D. [193] ..... 262, 275  
 Manolakis, D.G. [335] ..... 563, 564  
 Manoukian, H. [31] ..... 0  
 Marc Fossorier, [350] ..... 633  
 Marco Breiling, [362] ..... 685  
 Maric, S.V. [309] ..... 520  
 Markarian, G. [32] ..... 0  
 Markarian, G. [33] ..... 0  
 Markarian, G. [34] ..... 0  
 Markarian, G. [28] ..... 0, 234  
 Marsland, I.D. [344] ..... 595  
 Martinelli, E. [167] ..... 262  
 Martinelli, E. [162] ..... 261  
 Martinelli, E. [166] ..... 262  
 Massey, J.L. [2] ..... 0, 4, 35, 39, 47, 48, 51, 57, 67, 82  
 Massey, J.L. [16] ..... 0, 3  
 Massey, J.L. [41] ..... 0, 4, 67, 82  
 Mathiopoulos, P.T. [344] ..... 595  
 Matsuako, H. [302] ..... 506, 520  
 Matsuoka, H. [246] ..... 390  
 Michelson, A.M. [4] ..... 0, 17, 35, 38, 40, 48, 57  
 Michelson, A.M. [25] ..... 0, 3  
 Miller, M.J. [203] ..... 308  
 Miller, W. [182] ..... 262  
 Miller, W. [186] ..... 262  
 Mix, D.F. [238] ..... 387  
 Mohan, S. [102] ..... 0  
 Moher, M. [336] ..... 572, 633  
 Mohr, W. [266] ..... 415, 431, 457, 520  
 Montorsi, G. [66] ..... 0, 172, 175, 187, 198, 603, 639, 641, 643, 646, 650, 661, 664, 743  
 Montorsi, G. [65] ..... 0, 639  
 Montorsi, G. [106] ..... 0, 639, 647, 649, 651, 656, 659, 743  
 Montorsi, G. [235] ..... 367, 369  
 Morinaga, N. [241] ..... 390, 519  
 Morinaga, N. [302] ..... 506, 520  
 Morinaga, N. [246] ..... 390  
 Mouly, M. [341] ..... 587, 625, 658  
 Mueller-Roemer, F. [260] ..... 403  
 Muller, J-M. [322] ..... 546  
 Münster, M. [253] ..... 392  
 Murota, K. [319] ..... 545, 555, 559
- N**  
 Naguib, A. [83] ..... 0, 472, 480, 504, 520  
 Naguib, A. [81] ..... 0, 472, 480, 517, 520, 714  
 Naguib, A. [86] ..... 0, 393, 471, 472, 480, 504, 520  
 Naguib, A. [281] ..... 415, 424, 471, 517, 520, 739  
 Naguib, A. [280] ..... 415, 424, 471, 517, 739  
 Naguib, A.F. [87] ..... 0, 415, 424, 471, 517, 520, 739  
 Nakajima, N. [277] ..... 415  
 Nambi Seshadri, [77] ..... 0, 415, 424, 471–473, 475, 476, 480–482, 517, 520, 524, 531, 713, 739

Namekawa, T. [116] . . . . . 48  
 Narayanan, K.R. [348] . . . . . 596, 639, 640, 661  
 Nasshan, M. [72] . . . . . 0  
 Nasshan, M. [132] . . . . . 193, 590  
 Ng, S. [149] . . . . . 246  
 Ng, S.X. [216] . . . . . 330  
 Ng, S.X. [215] . . . . . 330  
 Ng, S.X. [217] . . . . . 330  
 Nickl, H. [70] . . . . . 0, 203, 252, 428, 431, 668, 735  
 Niederreiter, H. [99] . . . . . 0, 17, 219, 237  
 Norifumi Kamiya, [354] . . . . . 639  
 Nowack, J.M. [322] . . . . . 546

## O

Offer, E. [68] . . . . . 0, 172, 203, 205, 251, 427–429, 431, 524, 572, 667  
 Oh, M. [42] . . . . . 0  
 Oh, M. [43] . . . . . 0  
 Ohno, K. [269] . . . . . 415  
 Ojanperä, T. [289] . . . . . 431, 457, 519, 713  
 Oliphant, M. [287] . . . . . 430, 457  
 Ömer F. Açıkel, [71]0, 432, 456, 516, 525, 529, 669  
 Onoe, S. [266] . . . . . 415, 431, 457, 520  
 Orlandi, G. [175] . . . . . 262  
 Ormeci, P. [311] . . . . . 520

## P

Papke, L. [68].0, 172, 203, 205, 251, 427–429, 431, 524, 572, 667  
 Papoulis, A. [338] . . . . . 574  
 Parsons, D. [326] . . . . . 546  
 Pasupathy, S. [332] . . . . . 555, 558  
 Pasupathy, S. [58] . . . . . 0, 203, 217, 218, 238, 298, 573, 585, 587, 737  
 Pautet, M.B. [341] . . . . . 587, 625, 658  
 Perez, L.C. [67] . . . . . 0, 172, 198  
 Perez, L.C. [221] . . . . . 337  
 Peter Hoehner, [360] . . . . . 640  
 Peter Jung, [74] . . . . . 0  
 Peter, [143] . . . . . 190  
 Peterson, D. [178] . . . . . 262  
 Peterson, W.W. [6] . . . . . 0, 17, 35, 38, 39, 48, 57  
 Peterson, W.W. [26] . . . . . 0, 3, 35, 38, 40, 82  
 Peterson, W.W. [90] . . . . . 0, 17, 35  
 Phelps, K. [100] . . . . . 0  
 Piazza, F. [175] . . . . . 262  
 Piazza, L. [228] . . . . . 353  
 Piazza, L. [225] . . . . . 344  
 Piazza, L. [256] . . . . . 394  
 Piazza, L. [217] . . . . . 330  
 Picart, A. [107]0, 407, 545, 546, 578, 593–596, 623, 668, 680, 685, 686, 714, 742  
 Picart, A. [88] . . . . . 0, 240, 257, 294  
 Pietrobon, S.S. [75] . . . . . 0, 204, 588, 590, 669  
 Pietrobon, S.S. [353] . . . . . 639  
 Pietrobon, S.S. [229] . . . . . 353  
 Pietrobon, S.S. [221] . . . . . 337  
 Pirhonen, R. [252] . . . . . 391, 392, 671, 701

Pless, V. [94] . . . . . 0, 17, 39  
 Pliquett, J. [295] . . . . . 480, 481, 514, 525  
 Pliquett, J. [296] . . . . . 480, 481  
 Pollara, F. [106]0, 639, 647, 649, 651, 656, 659, 743  
 Pollara, F. [235] . . . . . 367, 369  
 Prasad, R. [289] . . . . . 431, 457, 519, 713  
 Proakis, [144] . . . . . 194, 197  
 Proakis, J.G. [104] . . . . . 0, 416, 417, 444, 454, 466, 696, 698  
 Proakis, J.G. [335] . . . . . 563, 564  
 Proakis, J.G. [236] . . . . . 386, 387  
 Proakis, J.G. [226] . . . . . 345, 369  
 Pyndiah, R. [146] . . . . . 203, 257  
 Pyndiah, R. [201] . . . . . 294  
 Pyndiah, R. [200] . . . . . 294  
 Pyndiah, R. [147] . . . . . 203, 240, 257  
 Pyndiah, R. [123] . . . . . 203, 205, 257, 668  
 Pyndiah, R. [202] . . . . . 300  
 Pyndiah, R. [88] . . . . . 0, 240, 257, 294

## R

Radhakrishnan, D. [163] . . . . . 261  
 Raleigh, G. [272] . . . . . 415  
 Ramachandran, V. [173] . . . . . 262  
 Ramesh Mahendra Pyndiah, [69] . . . . . 0, 294, 301, 314  
 Ramnarayanan, A. [164] . . . . . 262  
 Raoul, O. [146] . . . . . 203, 257  
 Raphaeli, D. [108] . . . . . 0, 595, 668  
 Rappaport, T.S. [328] . . . . . 546  
 Rauch, H. [178] . . . . . 262  
 Raviv, J. [20] . . . . . 0, 3, 172, 189–191, 203, 206, 208, 241, 341, 344, 353, 373, 394, 427, 430, 481, 573, 575, 587, 596, 669, 737  
 Ray-Chaudhuri, D.K. [24] . . . . . 0, 3, 67, 596, 668  
 Ray-Chaudhuri, D.K. [25] . . . . . 0, 3  
 Red, S. [287] . . . . . 430, 457  
 Reed, I.S. [39] . . . . . 0, 4  
 Reiffen, B. [14] . . . . . 0, 3  
 Ritcey, J.A. [212] . . . . . 330, 363, 368  
 Ritcey, J.A. [214] . . . . . 330, 367  
 Ritcey, J.A. [218] . . . . . 330, 369, 372  
 Ritcey, J.A. [213] . . . . . 330, 372, 374  
 Roberto Garelo, [352] . . . . . 639  
 Robertson, P. [210] . . . . . 329, 341, 353–356, 372, 375, 376, 394  
 Robertson, P. [126] . . . . . 171, 572, 573, 587, 597  
 Robertson, P. [59] . . . . . 0, 203, 206, 217, 220, 241, 242, 350, 351, 355, 373, 394, 430, 481, 508, 514, 573, 579, 580, 587, 596, 610, 737  
 Robertson, P. [339] . . . . . 581, 669  
 Robertson, P. [231] . . . . . 354  
 Robertson, P. [64] . . . . . 0, 427–429, 433, 459  
 Rodger, C. [100] . . . . . 0  
 Roger S. Cheng, [349] . . . . . 633  
 Rudolph, L.D. [24] . . . . . 0, 3, 67, 596, 668

## S

Sadowsky, [142] . . . . . 190

- Salami, R.A. [323] ..... 546  
 Sampei, S. [241] ..... 390, 519  
 Sampei, S. [302] ..... 506, 520  
 Sampei, S. [246] ..... 390  
 Saunders, S. [327] ..... 546  
 Scaglione, A. [293] ..... 472  
 Schlegel, C. [222] ..... 337  
 Schlegel, C. [55] ..... 0, 415, 428, 433  
 Schur, J. [112] ..... 40  
 Seghers, J. [67] ..... 0, 172, 198  
 Sergio Benedetto, [352] ..... 639  
 Seshadri, N. [83] ..... 0, 472, 480, 504, 520  
 Seshadri, N. [81] ..... 0, 472, 480, 517, 520, 714  
 Seshadri, N. [84] ..... 0, 472, 520  
 Seshadri, N. [278] ..... 415, 424, 471, 517, 739  
 Seshadri, N. [274] ..... 415  
 Seshadri, N. [281] ..... 415, 424, 471, 517, 520, 739  
 Seshadri, N. [87] ..... 0, 415, 424, 471, 517, 520, 739  
 Seshadri, N. [280] ..... 415, 424, 471, 517, 739  
 Seshadri, N. [279] ..... 415, 424, 471, 517, 739  
 Seshadri, N. [86] ..... 0, 393, 471, 472, 480, 504, 520  
 Shannon, C.E. [10] ..... 0, 189, 203, 251, 524, 735  
 Shannon, C.E. [95] ..... 0  
 Shenoy, A. [174] ..... 262, 274  
 Shenoy, A. [165] ..... 262  
 Shi-Dong Zhou, [347] ..... 596  
 Shibutani, A. [355] ..... 639  
 Shu Lin, [350] ..... 633  
 Shwedyk, E. [345] ..... 595  
 Simon, M.K. [208] ..... 329, 338, 354, 393  
 Simon, M.K. [209] ..... 329  
 Simon, M.K. [333] ..... 560  
 Sklar, B. [92] ..... 0, 278, 428, 444, 555, 558  
 Sklar, B. [119] ..... 67  
 Skoeld, J. [252] ..... 391, 392, 671, 701  
 Sloane, J.A. [91] ..... 0, 66, 735  
 Sloane, N. [148] ..... 204  
 Soderstrand, M.A. [180] ..... 262  
 Soderstrand, M.A. [185] ..... 262  
 Soderstrand, M.A. [181] ..... 262  
 Sollenberger, N. [85] ..... 0, 472, 480, 504, 520  
 Solomon, G. [39] ..... 0, 4  
 Steele, R. [12] ..... 0, 3, 427  
 Steele, R. [297] ..... 506, 519  
 Steele, R. [56] ..... 0, 66, 338, 368, 385, 408, 427,  
 428, 430, 431, 454, 456–458, 481, 509,  
 546–548, 552, 555, 559, 562, 572, 573,  
 587, 589, 590, 594, 625, 658, 735  
 Steele, R. [9] ..... 17, 21, 25, 35, 48, 57, 66  
 Steele, R. [240] ..... 390, 506  
 Steele, R. [314] ..... 522, 573  
 Steele, R. [120] ..... 67, 204, 225  
 Stenbit, J. [118] ..... 67, 68  
 Stephen B. Wicker, [96] ..... 0, 572  
 Sternad, M. [312] ..... 521–524, 531, 716  
 Stuber, G.L. [348] ..... 596, 639, 640, 661  
 Su, C. [158] ..... 261  
 Suda, H. [355] ..... 639  
 Sugiyama, Y. [116] ..... 48  
 Sun, J-D. [170] ..... 262  
 Sun, J-D. [50] ..... 0, 262, 275–277, 279, 281, 286  
 Sun, J-D. [51] ..... 0, 262, 275, 281, 285, 286  
 Sundberg, C.E. [318] ..... 545, 548, 552, 553, 564, 587  
 Suoranta, R. [252] ..... 391, 392, 671, 701  
 Sven Riedel, [351] ..... 633  
 Sweeney, P. [44] ..... 0  
 Sweeney, P. [42] ..... 0  
 Sweeney, P. [43] ..... 0  
 Sweeney, P. [105] ..... 0  
 Szabo, N.S. [48] ..... 0, 261, 262, 265, 268, 273–275,  
 286, 737
- ## T
- Takata, T. [35] ..... 0  
 Takata, T. [36] ..... 0  
 Tanaka, R.I. [48] ..... 0, 261, 262, 265, 268, 273–275,  
 286, 737  
 Tannenbaum, M. [152] ..... 261  
 Taricco, G. [232] ..... 358, 400  
 Tarokh, V. [83] ..... 0, 472, 480, 504, 520  
 Tarokh, V. [278] ..... 415, 424, 471, 517, 739  
 Tarokh, V. [80] 0, 416, 419, 424, 425, 427, 429, 436,  
 439, 471, 517, 520, 739  
 Tarokh, V. [281] ..... 415, 424, 471, 517, 520, 739  
 Tarokh, V. [87] ..... 0, 415, 424, 471, 517, 520, 739  
 Tarokh, V. [79] 0, 416, 419, 421, 424, 425, 429, 436,  
 439, 471, 517, 713, 739  
 Tarokh, V. [280] ..... 415, 424, 471, 517, 739  
 Tarokh, V. [279] ..... 415, 424, 471, 517, 739  
 Taylor, F. [155] ..... 261  
 Taylor, F. [159] ..... 261  
 Taylor, F. [164] ..... 262  
 Taylor, F.J. [47] ..... 0, 261, 268, 737  
 Teague, J. [178] ..... 262  
 Thitimajshima, P. [21] 0, 3, 171, 191, 203, 247, 301,  
 320, 329, 355, 427, 428, 430, 431, 448,  
 456, 545, 571, 593, 603, 639, 668, 735  
 Tidestav, C. [312] ..... 521–524, 531, 716  
 Tjhung, T. [270] ..... 415  
 Tomlinson, M. [141] ..... 175  
 Torrance, J. [305] ..... 509, 519, 535  
 Torrance, J.M. [298] ..... 506, 509  
 Torrance, J.M. [243] ..... 390  
 Torrance, J.M. [242] ..... 390, 506  
 Torrance, J.M. [304] ..... 509  
 Torrance, J.M. [316] ..... 527  
 Torrance, J.M. [299] ..... 506  
 Toshihiko Okamura, [354] ..... 639  
 Tseng, B. [186] ..... 262
- ## U
- Ungerböck, G. [219] ..... 330–334, 337  
 Ungerböck, G. [207] ..... 329, 331, 336–338, 372, 394  
 Ungerboeck, G. [54] ..... 0, 415, 427, 428  
 Ungerboeck, G. [53] ..... 0, 415, 427, 428

**V**

- Vahid Tarokh, [77] . 0, 415, 424, 471–473, 475, 476, 480–482, 517, 520, 524, 531, 713, 739  
 Vainio, J. [323] . . . . . 546  
 Villebrun, E. [59] . . 0, 203, 206, 217, 220, 241, 242, 350, 351, 355, 373, 394, 430, 481, 508, 514, 573, 579, 580, 587, 596, 610, 737  
 Viterbi, A.J. [17] . . . 0, 3, 67, 73, 427, 429, 601, 652, 668, 735  
 Vu, T. [157] . . . . . 261  
 Vucetic, B. [98] . . . . . 0

**W**

- Wachsmann, U. [63] . . . . . 0  
 Wade, G. [141] . . . . . 175  
 Wales, S.W. [337] . . . . . 573, 587  
 Wall, J. [100] . . . . . 0  
 Wang, C.C. [333] . . . . . 560  
 Wang, M.Z. [357] . . . . . 639  
 Waters, P.H. [337] . . . . . 573, 587  
 Watson, R. [151] . . . . . 261  
 Watson, R.W. [49] . . . . . 0, 261, 262, 275  
 Webb, W.T. [297] . . . . . 506, 519  
 Webb, W.T. [206] . . . 325, 386, 387, 389, 392, 402, 404–406, 408, 419, 427–429, 444, 445, 472, 481, 484, 504, 506–510, 520, 522, 525, 545, 546, 557, 685, 686, 738  
 Webb, W.T. [240] . . . . . 390, 506  
 Weber, M. [287] . . . . . 430, 457  
 Wei, L-F. [230] . . . . . 353  
 Weldon, E.J. Jr [6] . . . . . 0, 17, 35, 38, 39, 48, 57  
 Wen Feng, [356] . . . . . 639  
 Wesel, R. [311] . . . . . 520  
 Wesemeyer, S. [44] . . . . . 0  
 Whalen, A.D. [370] . . . . . 695  
 Wicker, S.B. [103] . . . . . 0  
 William E. Ryan, [71] . . 0, 432, 456, 516, 525, 529, 669  
 Winter, E.H. [322] . . . . . 546  
 Winters, J [274] . . . . . 415  
 Winters, J. [275] . . . . . 415  
 Winters, J. [271] . . . . . 415  
 Wittneben, A. [273] . . . . . 415  
 Wolf, J.K. [27] . . . . . 0, 73, 434  
 Wong, C.H. [249] . . . . . 390  
 Wong, C.H. [237] . . . . . 386, 388, 389  
 Wong, C.H. [306] . . . . . 519  
 Wong, C.H. [245] . . . . . 390, 392, 519, 522, 533  
 Wong, C.H. [371] . . . . . 714, 733, 745  
 Wong, C.H. [216] . . . . . 330  
 Wong, C.H. [365] . . . . . 686  
 Wong, K.H.H. [12] . . . . . 0, 3, 427  
 Wong, K.H.H. [8] . . . . . 17, 25, 35, 48, 57  
 Woodard, J.P. [372] . . . . . 737  
 Wórz, T. [339] . . . . . 581, 669  
 Worz, T. [64] . . . . . 0, 427–429, 433, 459  
 Wórz, T. [210] . . 329, 341, 353–356, 372, 375, 376, 394

- Wozencraft, J.M. [13] . . . . . 0, 3  
 Wozencraft, J.M. [14] . . . . . 0, 3

**Y**

- Yan Yao, [347] . . . . . 596  
 Yang, L-L. [187] . . . . . 262  
 Yang, L-L. [183] . . . . . 262, 275  
 Yang, L-L. [188] . . . . . 262  
 Yang, L-L. [189] . . . . . 262  
 Yang, L-L. [295] . . . . . 480, 481, 514, 525  
 Yang, L-L. [296] . . . . . 480, 481  
 Yang, L-L. [215] . . . . . 330  
 Yang, L-L. [190] . . . . . 262  
 Yang, L. [195] . . . . . 262, 294  
 Yang, L. [149] . . . . . 246  
 Yang, L. [194] . . . . . 262  
 Yang, L. [176] . . . . . 262  
 Yang, L.L. [253] . . . . . 392  
 Yang, L.L. [52] . . . . . 0, 262  
 Yau, S. [169] . . . . . 262, 275  
 Ye Liu, [350] . . . . . 633  
 Yeap, B. [295] . . . . . 480, 481, 514, 525  
 Yeap, B. [296] . . . . . 480, 481  
 Yeap, B.L. [372] . . . . . 737  
 Yeap, B.L. [371] . . . . . 714, 733, 745  
 Yeap, B.L. [363] . . . . . 685  
 Yeap, B.L. [263] . . . . . 407  
 Yeap, B.L. [365] . . . . . 686  
 Yee, M. [307] . . . . . 520  
 Yee, M.S. [306] . . . . . 519  
 Yee, M.S. [363] . . . . . 685  
 Yen, K. [190] . . . . . 262  
 Yuan, J. [98] . . . . . 0  
 Yuan, Y. [163] . . . . . 261  
 Yuri V. Svirid, [351] . . . . . 633

**Z**

- Zarai, Y. [108] . . . . . 0, 595, 668  
 Zehavi, E. [211] . . . . . 329, 330, 358–360, 372, 400  
 Zhou, H. [270] . . . . . 415  
 Zierler, N. [38] . . . . . 0, 4, 35, 38–40, 82  
 Zigangirov, [145] . . . . . 198  
 Zimmermann, M.S. [258] . . . . . 402



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## Blurb

For the sake of completeness and wide reader appeal, virtually no prior knowledge is assumed in the field of channel coding. In **Chapter 1** we commence our discourse by introducing the family of convolutional codes and the hard- as well as soft-decision Viterbi algorithm in simple conceptual terms with the aid of worked examples.

**Chapter 2** provides a rudimentary introduction to the most prominent classes of block codes, namely to Reed-Solomon (RS) and Bose-Chaudhuri-Hocquenghem (BCH) codes. A range of algebraic decoding techniques are reviewed and worked examples are provided.

**Chapter 3** elaborates on the trellis-decoding of BCH codes using worked examples and characterises their performance. Furthermore, the classic Chase algorithm is introduced and its performance is investigated.

**Chapter 4** introduces the concept of turbo convolutional codes and gives a detailed discourse on the Maximum A Posteriori (MAP) algorithm and its computationally less demanding counterparts, namely the Log-MAP and Max-Log-MAP algorithms. The Soft Output Viterbi Algorithm (SOVA) is also highlighted and its concept is augmented with the aid of a detailed worked example. Then the effects of the various turbo codec parameters are investigated.

**Chapter 5** comparatively studies the trellis structure of convolutional and turbo codes, while **Chapter 6** characterises turbo BCH codes. **Chapter 7** is a unique portrayal of the novel family of Redundant Residue Number System (RNS) based codes and their turbo decoding. **Chapter 8** considers the family of joint coding and modulation based arrangements, which are often referred to as coded modulation schemes. Specifically, Trellis Coded Modulation (TCM), Turbo Trellis Coded Modulation (TTCM), Bit-Interleaved Coded Modulation (BICM) as well as iterative joint decoding and demodulation assisted BICM (BICM-ID) are studied and compared under various narrow-band and wide-band propagation conditions.

In **Chapter 9 and 10** space-time block codes and space-time trellis codes are introduced. Their performance is studied comparative in conjunction with a whole host of channel codecs, providing guide-lines for system designers. As a lower-complexity design alternative to multiple-transmitter, multiple-receiver (MIMO) based schemes the concept of near-instantaneously Adaptive Quadrature Amplitude Modulation (AQAM), combined with near-instantaneously adaptive turbo channel coding is introduced in **Chapter 11**.

Based on the introductory concepts of **Chapter 12**, **Chapter 13** is dedicated to the detailed principles of iterative joint channel equalisation and channel decoding techniques known as turbo equalisation. **Chapter 14** provides theoretical performance bounds for turbo equalisers, while **Chapter 15** offers a wide-ranging comparative study of various turbo equaliser arrangements. The problem of reduced implementation complexity is addressed in **Chapter 16**. Finally, turbo equalised space-time trellis codes are the subject of **Chapter 17**.