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| --- | --- |
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| --- | --- | --- | --- |
| *Title:* | **HVS Model based Default Quantization Matrices** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This document presents a set of default Quantization Matrices designed by using a Human Visual System (HVS) Model for HEVC. A list of the these matrices are provided in the appendix.

QMatrix design for HEVC with a HVS Model

This proposal introduces a set of default Quantization Matrices (QMatrices) for HEVC.

For AVC [6] default QMatrices, 1 QMatrix type is considered for all 3 luma/chroma (Y, Cr, Cb) components.

In HEVC, we may follow the similar path for the default QMatrices. In that case, the maximum number of default QMatrices needed is 10 in HM4.0, and it is determined as follows:

1. Block structure-type (4x4, 8x8, 16x16, 32x32 - 4 cases ), Intra/Inter mode (2 cases) => 4x2 = 8.
2. Block structure-type (16x4, 32x8 - 2 cases ), Inter mode (1 case) => 2x1 = 2.

If the new technology proposal of SDIP (Short Distance Intra Prediction) is accepted in HM, the additional number of default QMatrices will be 8, as follows:

Block structure-type (16x4/4x16, 32x8/8x32, 8x2/2x8, 32x2/2x32 - 8), Intra mode (1 case) = 8x1 = 8.

The 10 default QMatrices in HM4.0 can be derived as follows:

1. First derive 4 square-sized (4x4, 8x8, 16x16, 32x32), symmetric Intra-only QMatrices as Core matrices by using a Human Visual System (HVS) Model based algorithm [1, 2] for a NxN block, as follows:



where, u= 0 to N-1, v=0 to N-1, f(u,v) = a scaled and normalized radial frequency derived [2] from f(u) and f(v), the horizontal and vertical frequencies respectively, and fpeak = the exponential radial peak frequency (=8 cycles/degree).



where Q(u, v) = Target QMatrix, and qp = average quantization parameter value (=12)

1. The remaining 6 default QMatrices are derived according to the flow-chart shown below in Steps-2 and 3:

In Step-2, a simple linear model is used for Intra-to-Inter QMatrix conversion. This model exploits the apparent relationship between the AVC Reference Intra and Inter QMatrices, as shown below for the 8x8 QMatrices:

The slopes of the above two near-linear graphs are used to convert the first and last rows/columns of the target Inter QMatrices from the corresponding sized Core Intra QMatrices available in Step-1. Then the symmetry property is used to complete the Inter QMatrices design.

A set of 10 default QMatrices (Zig-zag scanned) are available in the Appendex section as a reference for HM4.0. However, only 4 Core Intra only square-sized (4x4, 8x8, 16x16, 32x32) QMatrices in Step-1, are needed and the remaining 6 QMatrices can be designed from these Core QMatrices as mentioned above in Steps 2 and 3.

Also in another proposal [5], we have shown how to design the default QMatrices by using parametric models. In this case, only 2 Core QMatrices (Intra, 4x4 and 8x8) with 2x4= 8 Quadratic parameters are sufficient to design all 10 HEVC default QMatrices in HM4.0. The parameter model for 8x8 Intra QMatrices can be used to interpolate the 16x6 and 32x32 Intra QMatrices and then we can follow the same procedure as mentioned above in this proposal.

## Test Results

An informal subjective test is conducted at Sony with HEVC test sequences and the results for these HVS model based QMatrices are compared against the AVC type symmetric QMatrices [4]. The tests show that overall the HVS model based QMatrices provide better pictures subjectively than the AVC type QMatrices.

# Conclusion

This proposal presents the HVS model based QMatrix design method with 4 Core Intra QMatrices to start with for the design of all 10 HEVC default QMatrices in HM4.0. The subjective results show better quality when compared with AVC type QMatrices. We propose consideration of this type of QMatrix for further visual QMatrix evaluation.

# Patent rights declaration(s)

Sony Electronics Inc. / Sony Corp. may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).

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5. E. Maani, M. Haque, A. Tabatabai, "Parameterization of Default Quantization Matrices", JCTVC-G352, November 2011, Geneva, CH.
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# Appendix - Default HVS based Quantization Matrices

Table 1 – Specification of default 4x4 Intra QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| HVS Model | 12 | 12 | 12 | 13 | 13 | 13 | 16 | 15 | 15 | 16 | 19 | 22 | 19 | 31 | 31 | 53 |

Table 2 – Specification of default 4x4 Inter QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| HVS Model | 12 | 12 | 12 | 13 | 13 | 13 | 16 | 16 | 16 | 16 | 18 | 18 | 18 | 27 | 27 | 43 |

Table 3 – Specification of default 8x8 Intra QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| HVS Model | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 12 | 13 | 12 | 13 | 14 |
| **idx** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| HVS Model | 13 | 13 | 13 | 13 | 14 | 16 | 14 | 15 | 16 | 15 | 14 | 16 | 18 | 16 | 16 | 18 |
| **idx** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| HVS Model | 18 | 16 | 16 | 18 | 19 | 19 | 20 | 22 | 20 | 19 | 19 | 22 | 23 | 26 | 26 | 23 |
| **idx** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| HVS Model | 22 | 27 | 31 | 33 | 31 | 27 | 35 | 41 | 41 | 35 | 48 | 53 | 48 | 66 | 66 | 86 |

Table 4 – Specification of default 8x8 Inter QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| HVS Model | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 14 |
| **idx** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| HVS Model | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 18 | 18 | 18 | 18 |
| **idx** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| HVS Model | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 21 | 21 | 21 | 21 | 21 |
| **idx** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| HVS Model | 21 | 25 | 25 | 25 | 25 | 25 | 31 | 31 | 31 | 31 | 41 | 41 | 41 | 54 | 54 | 69 |

Table 5 – Specification of default 16x16 Intra QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| HVS Model | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| **idx** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| HVS Model | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| **idx** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| HVS Model | 12 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 13 | 13 | 12 |
| **idx** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| HVS Model | 13 | 13 | 13 | 13 | 12 | 13 | 13 | 14 | 13 | 13 | 13 | 13 | 14 | 13 | 13 | 13 |
| **idx** | **64** | **65** | **66** | **67** | **68** | **69** | **70** | **71** | **72** | **73** | **74** | **75** | **76** | **77** | **78** | **79** |
| HVS Model | 13 | 14 | 15 | 14 | 14 | 14 | 14 | 15 | 15 | 14 | 14 | 14 | 14 | 15 | 16 | 15 |
| **idx** | **80** | **81** | **82** | **83** | **84** | **85** | **86** | **87** | **88** | **89** | **90** | **91** | **92** | **93** | **94** | **95** |
| HVS Model | 14 | 14 | 15 | 15 | 16 | 15 | 15 | 14 | 14 | 15 | 16 | 17 | 16 | 15 | 15 | 15 |
| **idx** | **96** | **97** | **98** | **99** | **100** | **101** | **102** | **103** | **104** | **105** | **106** | **107** | **108** | **109** | **110** | **111** |
| HVS Model | 16 | 17 | 17 | 16 | 15 | 15 | 15 | 16 | 17 | 18 | 17 | 16 | 16 | 16 | 17 | 18 |
| **idx** | **112** | **113** | **114** | **115** | **116** | **117** | **118** | **119** | **120** | **121** | **122** | **123** | **124** | **125** | **126** | **127** |
| HVS Model | 18 | 18 | 17 | 16 | 16 | 16 | 17 | 18 | 20 | 18 | 18 | 17 | 17 | 18 | 19 | 20 |
| **idx** | **128** | **129** | **130** | **131** | **132** | **133** | **134** | **135** | **136** | **137** | **138** | **139** | **140** | **141** | **142** | **143** |
| HVS Model | 20 | 19 | 18 | 17 | 17 | 18 | 18 | 20 | 20 | 19 | 19 | 19 | 19 | 20 | 22 | 22 |
| **idx** | **144** | **145** | **146** | **147** | **148** | **149** | **150** | **151** | **152** | **153** | **154** | **155** | **156** | **157** | **158** | **159** |
| HVS Model | 22 | 20 | 19 | 19 | 19 | 19 | 20 | 21 | 20 | 20 | 20 | 22 | 23 | 24 | 24 | 23 |
| **idx** | **160** | **161** | **162** | **163** | **164** | **165** | **166** | **167** | **168** | **169** | **170** | **171** | **172** | **173** | **174** | **175** |
| HVS Model | 22 | 20 | 20 | 20 | 21 | 22 | 22 | 22 | 23 | 25 | 26 | 27 | 26 | 25 | 23 | 22 |
| **idx** | **176** | **177** | **178** | **179** | **180** | **181** | **182** | **183** | **184** | **185** | **186** | **187** | **188** | **189** | **190** | **191** |
| HVS Model | 22 | 22 | 23 | 24 | 25 | 26 | 28 | 30 | 30 | 28 | 26 | 25 | 24 | 23 | 26 | 27 |
| **idx** | **192** | **193** | **194** | **195** | **196** | **197** | **198** | **199** | **200** | **201** | **202** | **203** | **204** | **205** | **206** | **207** |
| HVS Model | 28 | 31 | 33 | 33 | 33 | 31 | 28 | 27 | 26 | 29 | 31 | 33 | 35 | 37 | 37 | 35 |
| **idx** | **208** | **209** | **210** | **211** | **212** | **213** | **214** | **215** | **216** | **217** | **218** | **219** | **220** | **221** | **222** | **223** |
| HVS Model | 33 | 31 | 29 | 33 | 35 | 38 | 41 | 42 | 41 | 38 | 35 | 33 | 38 | 41 | 44 | 47 |
| **idx** | **224** | **225** | **226** | **227** | **228** | **229** | **230** | **231** | **232** | **233** | **234** | **235** | **236** | **237** | **238** | **239** |
| HVS Model | 47 | 44 | 41 | 38 | 45 | 48 | 51 | 53 | 51 | 48 | 45 | 53 | 57 | 59 | 59 | 57 |
| **idx** | **240** | **241** | **242** | **243** | **244** | **245** | **246** | **247** | **248** | **249** | **250** | **251** | **252** | **253** | **254** | **255** |
| HVS Model | 53 | 62 | 66 | 67 | 66 | 62 | 72 | 76 | 76 | 72 | 84 | 86 | 84 | 97 | 97 | 112 |

Table 6 – Specification of default 16x16 Inter QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| HVS Model | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| **idx** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| HVS Model | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| **idx** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| HVS Model | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| **idx** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| HVS Model | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| **idx** | **64** | **65** | **66** | **67** | **68** | **69** | **70** | **71** | **72** | **73** | **74** | **75** | **76** | **77** | **78** | **79** |
| HVS Model | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 |
| **idx** | **80** | **81** | **82** | **83** | **84** | **85** | **86** | **87** | **88** | **89** | **90** | **91** | **92** | **93** | **94** | **95** |
| HVS Model | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 17 |
| **idx** | **96** | **97** | **98** | **99** | **100** | **101** | **102** | **103** | **104** | **105** | **106** | **107** | **108** | **109** | **110** | **111** |
| HVS Model | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| **idx** | **112** | **113** | **114** | **115** | **116** | **117** | **118** | **119** | **120** | **121** | **122** | **123** | **124** | **125** | **126** | **127** |
| HVS Model | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| **idx** | **128** | **129** | **130** | **131** | **132** | **133** | **134** | **135** | **136** | **137** | **138** | **139** | **140** | **141** | **142** | **143** |
| HVS Model | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| **idx** | **144** | **145** | **146** | **147** | **148** | **149** | **150** | **151** | **152** | **153** | **154** | **155** | **156** | **157** | **158** | **159** |
| HVS Model | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| **idx** | **160** | **161** | **162** | **163** | **164** | **165** | **166** | **167** | **168** | **169** | **170** | **171** | **172** | **173** | **174** | **175** |
| HVS Model | 21 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| **idx** | **176** | **177** | **178** | **179** | **180** | **181** | **182** | **183** | **184** | **185** | **186** | **187** | **188** | **189** | **190** | **191** |
| HVS Model | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 25 | 25 |
| **idx** | **192** | **193** | **194** | **195** | **196** | **197** | **198** | **199** | **200** | **201** | **202** | **203** | **204** | **205** | **206** | **207** |
| HVS Model | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| **idx** | **208** | **209** | **210** | **211** | **212** | **213** | **214** | **215** | **216** | **217** | **218** | **219** | **220** | **221** | **222** | **223** |
| HVS Model | 27 | 27 | 27 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 34 | 34 | 34 | 34 |
| **idx** | **224** | **225** | **226** | **227** | **228** | **229** | **230** | **231** | **232** | **233** | **234** | **235** | **236** | **237** | **238** | **239** |
| HVS Model | 34 | 34 | 34 | 34 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 45 | 45 | 45 | 45 | 45 |
| **idx** | **240** | **241** | **242** | **243** | **244** | **245** | **246** | **247** | **248** | **249** | **250** | **251** | **252** | **253** | **254** | **255** |
| HVS Model | 45 | 52 | 52 | 52 | 52 | 52 | 59 | 59 | 59 | 59 | 68 | 68 | 68 | 78 | 78 | 89 |

Table 7 – Specification of default 32x32 Intra QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx = 0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 13 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 12 |
| 13 | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 12 |
| 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 13 | 13 | 13 | 13 | 13 | 13 |
| 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| 13 | 13 | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 13 | 13 |
| 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 14 |
| 14 | 14 | 14 | 14 | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 15 | 14 | 14 |
| 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 14 | 14 | 14 | 14 | 14 | 14 |
| 14 | 14 | 14 | 15 | 15 | 15 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 |
| 15 | 15 | 15 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 16 | 15 | 15 | 14 |
| 14 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 16 | 15 | 15 | 15 | 14 | 14 | 14 |
| 14 | 14 | 15 | 15 | 16 | 16 | 16 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 16 |
| 16 | 16 | 16 | 16 | 16 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 17 |
| 16 | 16 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 16 |
| 16 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 17 | 18 | 17 | 16 | 16 | 16 | 16 |
| 16 | 16 | 16 | 16 | 17 | 17 | 17 | 18 | 18 | 17 | 17 | 17 | 16 | 16 | 16 | 16 |
| 16 | 16 | 16 | 16 | 17 | 18 | 18 | 18 | 17 | 17 | 16 | 16 | 16 | 16 | 16 | 17 |
| 17 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 17 | 17 | 16 | 16 | 16 | 16 | 16 | 17 |
| 17 | 18 | 18 | 19 | 18 | 18 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 18 | 19 |
| 19 | 19 | 19 | 19 | 19 | 18 | 18 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 18 |
| 19 | 20 | 19 | 18 | 18 | 18 | 17 | 17 | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 20 |
| 20 | 20 | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 19 | 20 |
| 21 | 20 | 19 | 19 | 18 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 |
| 21 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 20 | 21 |
| 21 | 20 | 19 | 19 | 19 | 19 | 18 | 19 | 19 | 19 | 20 | 20 | 21 | 22 | 22 | 22 |
| 22 | 22 | 21 | 20 | 20 | 19 | 19 | 19 | 18 | 19 | 19 | 19 | 19 | 20 | 21 | 21 |
| 20 | 20 | 19 | 19 | 19 | 19 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 23 | 23 | 23 |
| 22 | 22 | 21 | 20 | 20 | 19 | 19 | 19 | 19 | 19 | 20 | 20 | 21 | 21 | 21 | 20 |
| 20 | 20 | 20 | 20 | 20 | 21 | 22 | 22 | 23 | 24 | 24 | 24 | 24 | 24 | 23 | 22 |
| 22 | 21 | 20 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 22 | 21 | 21 | 21 | 21 | 21 |
| 21 | 22 | 22 | 23 | 24 | 25 | 25 | 26 | 26 | 25 | 25 | 24 | 23 | 22 | 22 | 21 |
| 21 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 23 | 24 | 25 |
| 26 | 26 | 27 | 27 | 27 | 26 | 26 | 25 | 24 | 23 | 22 | 22 | 22 | 22 | 22 | 22 |
| 22 | 23 | 23 | 22 | 23 | 23 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 28 | 28 | 28 |
| 27 | 26 | 26 | 25 | 24 | 23 | 23 | 23 | 22 | 23 | 23 | 24 | 23 | 24 | 24 | 24 |
| 25 | 26 | 26 | 27 | 28 | 29 | 30 | 30 | 30 | 29 | 28 | 27 | 26 | 26 | 25 | 24 |
| 24 | 24 | 23 | 24 | 25 | 25 | 25 | 25 | 26 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| 32 | 31 | 30 | 29 | 28 | 27 | 26 | 26 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 27 |
| 27 | 28 | 29 | 31 | 32 | 33 | 33 | 33 | 33 | 33 | 32 | 31 | 29 | 28 | 27 | 27 |
| 26 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 30 | 32 | 33 | 34 | 35 | 35 | 35 | 35 |
| 34 | 33 | 32 | 30 | 29 | 28 | 28 | 27 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
| 35 | 36 | 37 | 37 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 30 | 31 |
| 32 | 33 | 34 | 35 | 37 | 38 | 39 | 39 | 39 | 39 | 38 | 37 | 35 | 34 | 33 | 32 |
| 31 | 30 | 32 | 33 | 34 | 35 | 37 | 38 | 40 | 41 | 41 | 42 | 41 | 41 | 40 | 38 |
| 37 | 35 | 34 | 33 | 32 | 34 | 35 | 37 | 38 | 40 | 41 | 43 | 44 | 44 | 44 | 44 |
| 43 | 41 | 40 | 38 | 37 | 35 | 34 | 37 | 38 | 40 | 41 | 43 | 44 | 46 | 47 | 47 |
| 47 | 46 | 44 | 43 | 41 | 40 | 38 | 37 | 40 | 41 | 43 | 45 | 46 | 48 | 49 | 50 |
| 50 | 49 | 48 | 46 | 45 | 43 | 41 | 40 | 43 | 45 | 47 | 48 | 50 | 51 | 52 | 53 |
| 52 | 51 | 50 | 48 | 47 | 45 | 43 | 46 | 48 | 50 | 52 | 54 | 55 | 56 | 56 | 55 |
| 54 | 52 | 50 | 48 | 46 | 50 | 53 | 55 | 57 | 58 | 59 | 59 | 59 | 58 | 57 | 55 |
| 53 | 50 | 55 | 57 | 59 | 61 | 62 | 63 | 63 | 62 | 61 | 59 | 57 | 55 | 59 | 62 |
| 64 | 66 | 67 | 67 | 67 | 66 | 64 | 62 | 59 | 65 | 67 | 69 | 71 | 71 | 71 | 71 |
| 69 | 67 | 65 | 70 | 72 | 74 | 76 | 76 | 76 | 74 | 72 | 70 | 76 | 78 | 80 | 81 |
| 81 | 80 | 78 | 76 | 82 | 84 | 86 | 86 | 86 | 84 | 82 | 89 | 91 | 92 | 92 | 91 |
| 89 | 96 | 97 | 98 | 97 | 96 | 103 | 104 | 104 | 103 | 111 | 112 | 111 | 119 | 119 | 127 |

Table 8 – Specification of default 32x32 Inter QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx = 0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 |
| 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 |
| 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 17 |
| 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 18 |
| 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| 18 | 18 | 18 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| 19 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 22 | 22 |
| 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| 22 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 24 |
| 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| 24 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 26 |
| 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 |
| 26 | 26 | 26 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 29 | 29 |
| 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |
| 29 | 29 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 30 | 30 | 30 | 30 | 30 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| 31 | 31 | 31 | 31 | 31 | 31 | 31 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| 37 | 37 | 37 | 37 | 37 | 37 | 37 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 |
| 39 | 39 | 39 | 39 | 39 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 |
| 42 | 42 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 49 | 49 |
| 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 53 | 53 | 53 | 53 | 53 | 53 | 53 |
| 53 | 53 | 53 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 61 | 61 | 61 | 61 |
| 61 | 61 | 61 | 61 | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 70 | 70 | 70 | 70 | 70 |
| 70 | 75 | 75 | 75 | 75 | 75 | 80 | 80 | 80 | 80 | 86 | 86 | 86 | 92 | 92 | 98 |

– Specification of default 16x4 Inter QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| HVS Model | 12 | 12 | 12 | 12 | 12 | 13 | 16 | 13 | 12 | 12 | 12 | 12 | 14 | 17 | 18 | 15 |
| **idx** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| HVS Model | 13 | 12 | 12 | 13 | 16 | 20 | 20 | 17 | 14 | 12 | 13 | 15 | 18 | 21 | 22 | 20 |
| **idx** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| HVS Model | 16 | 13 | 14 | 17 | 20 | 23 | 25 | 21 | 18 | 15 | 16 | 20 | 22 | 27 | 30 | 23 |
| **idx** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| HVS Model | 20 | 17 | 18 | 21 | 25 | 34 | 39 | 27 | 22 | 20 | 23 | 30 | 45 | 52 | 34 | 59 |

Table 10 – Specification of default 32x8 Inter QMatrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **idx = 0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 14 |
| 13 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 14 | 16 | 18 | 16 | 15 | 13 |
| 13 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 14 | 15 | 17 | 19 | 20 | 18 | 16 | 14 |
| 13 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 15 | 16 | 18 | 21 | 21 | 19 | 17 | 15 |
| 14 | 13 | 12 | 12 | 12 | 12 | 13 | 14 | 16 | 18 | 20 | 21 | 21 | 21 | 18 | 16 |
| 15 | 13 | 13 | 12 | 12 | 13 | 14 | 15 | 17 | 19 | 21 | 22 | 22 | 21 | 20 | 18 |
| 16 | 14 | 13 | 12 | 13 | 13 | 15 | 16 | 18 | 21 | 21 | 23 | 24 | 22 | 21 | 19 |
| 17 | 15 | 14 | 13 | 13 | 14 | 16 | 18 | 20 | 21 | 22 | 25 | 26 | 23 | 21 | 21 |
| 18 | 16 | 15 | 13 | 14 | 15 | 17 | 19 | 21 | 22 | 24 | 27 | 28 | 25 | 22 | 21 |
| 20 | 18 | 16 | 14 | 15 | 16 | 18 | 21 | 21 | 23 | 26 | 29 | 30 | 27 | 24 | 22 |
| 21 | 19 | 17 | 15 | 16 | 18 | 20 | 21 | 22 | 25 | 28 | 31 | 33 | 29 | 26 | 23 |
| 21 | 21 | 18 | 16 | 17 | 19 | 21 | 22 | 24 | 27 | 30 | 35 | 37 | 31 | 28 | 25 |
| 22 | 21 | 20 | 18 | 18 | 21 | 21 | 23 | 26 | 29 | 33 | 39 | 42 | 35 | 30 | 27 |
| 24 | 22 | 21 | 19 | 20 | 21 | 22 | 25 | 28 | 31 | 37 | 46 | 49 | 39 | 33 | 29 |
| 26 | 23 | 21 | 21 | 22 | 24 | 27 | 30 | 35 | 42 | 53 | 57 | 46 | 37 | 31 | 28 |
| 25 | 29 | 33 | 39 | 49 | 61 | 65 | 53 | 42 | 35 | 46 | 57 | 70 | 75 | 61 | 80 |