

MODULATION CODING WITH RLL (1, K) AND MTR (2) CONSTRAINTS

Introduction

This invention relates to a method of converting a user bitstream into a coded bitstream by means of a channel code where the channel code has a constraint of $d=1$, to a coder for converting a user bitstream into a coded bitstream by means of a channel code
5 where the coder comprises processing device for applying a channel code with the constraint of $d=1$, to a recording device comprising such a coder, to a record carrier comprising a track comprising a signal comprising a user bitstream coded in a coded bitstream by means of a channel code where the channel code has the constraint of $d=1$, to a bit detector for performing bit detection on a code bitstream comprising a user bitstream coded in a coded
10 bitstream by means of a channel code where the channel code has the constraint of $d=1$, and to a playback device comprising such a bit detector.

At very high densities for a $d=1$ constrained storage system (e.g. capacities on a 12cm disc of 33-37 GB, well beyond the 25GB of Blu-ray Disc), consecutive 2T runs
15 are the Achilles' heel for the bit-detection. Such sequences of 2T runs bounded by larger runlengths at both sides, are called 2T-trains. Therefore, it turns out to be advantageous to limit the length of such 2T-trains. This is a general observation, and is not new as such. Currently, the 17PP code of BD as disclosed by T. Narahara, S. Kobayashi, M. Hattori, Y. Shimpuku, G. van den Enden, J.A.H.M. Kahlman, M. van Dijk and R. van Woudenberg, in
20 "Optical Disc System for Digital Video Recording", Jpn. J. Appl. Phys., Vol. 39 (2000) Part 1, No. 2B, pp. 912-919. has a so-called RMTR constraint (Repeated Minimum Transition Runlength) of $r=6$, which means that the number of consecutive minimum runlengths is limited to 6 or, stated differently, the maximum length of the 2T-train is 12 channel bits. The 17PP code is based on the parity-preserve principle as disclosed in US 5,477,222.

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In the literature, the RMTR constraint is often referred to as the MTR constraint. Originally, the *maximum transition-run* (MTR) constraint as introduced by J. Moon and B. Brickner, in "Maximum transition run codes for data storage systems", IEEE Transactions on Magnetism, Vol. 32, No. 5, pp. 3992-3994, 1996, for a $d=0$ case, specifies

the maximum number of consecutive "1"-bits in the NRZ bitstream where a "1" indicates a transition in the bi-polar channel bitstream. Equivalently, in the NRZI bitstream, the MTR constraint limits the number of successive 1T runs. As argued above, the MTR constraint can also be combined with a d -constraint, in which case the MTR constraint limits the number of consecutive *minimum runlengths* as is the case for the 17PP code. The basic idea behind the use of MTR codes is to eliminate the so-called *dominant* error patterns, that is, those patterns that would cause most of the errors in the *partial response maximum likelihood* (PRML) sequence detectors used for high density recording. A highly efficient rate $16 \rightarrow 17$ MTR code limiting the number of consecutive transitions to at most two for $d = 0$ has been described in T. Nishiya, K. Tsukano, T. Hirai, T. Nara, S. Mita, "Turbo-EEPRML: An EEPRML channel with an error correcting post-processor designed for 16/17 rate quasi MTR code", Proceedings Globecom '98, Sydney, pp. 2706-2711, 1998.

It is an objective of the present invention to provide a method of converting a user bitstream into a coded bitstream by means of a channel code that improves the performance of the bit-detector.

To achieve this object the method of converting a user bitstream into a coded bitstream by means of a channel code is characterized in that the channel code has an additional constraint of $r=2$.

Within the scope of a code-rate of $R = 2/3$ for $d=1$ the minimum RMTR constraint that is still possible is $r = 2$. It turned out that $r = 2$ results in a improved bit-detection performance. Thus, for exactly the same rate as the 17PP code, a maximally improved RMTR constraint and correspondingly improved bit-detection performance is obtained.

In addition another advantage is achieved by applying the RMTR constraint, which is a limitation of the back-tracking depth (or trace-back depth) of a Viterbi (PRML) bit-detector when such a detector is used on the receiving / retrieving side.

Performance gain due to the RMTR constraint has been studied experimentally for high-density optical recording channels derived from the Blu-ray Disc (BD) system. Experiments have been performed using the increased-density BD rewritable system with the disc capacity increased from the standard 23.3-25-27 GB to 37 GB. This

particular experimental platform has been chosen because of the plans for standardization of an increased-density system derived from the current Blu-ray Disc standard. PRML (Viterbi) bit detection has been employed. Moreover, next-generation high-numerical-aperture near-field optical recording systems will likewise profit from the improved bit-detection

5 performance that is offered by channel codes that have the $r=2$ constraint.

Performance of the Viterbi bit detector has been measured based on the sequenced amplitude margin (SAM) analysis. SAM analysis allows computing the error probability (SAMEP) at the output of the Viterbi detector as well as calculation of the SAM-based pre-detection signal-to-noise ratio (SAMSNR) defined as

$$10 \quad \text{SAMSNR} = 20 * \log_{10}(\sqrt{2} * \text{erfinv}(1 - 2 * \text{SAMEP})) \quad [\text{dB}].$$

SAMSNR proved to be a useful performance measure since it can be related to the potential capacity gain. Namely, in the relevant range of capacities around 35 GB, 1 dB gain in SAMSNR means almost 6 % disc capacity increase.

Channel codes with different RMTR constraints ($r=1$, $r=2$, $r=3$ and
15 $r=6$) have been compared to each other. (Note that the $r=1$ constraint is the only one that cannot be realized with a rate $R=2/3$ code; a rate $R=16/25$ is assumed instead.) In order to separate read-channel performance gain due to the imposed RMTR constraint from the corresponding write-channel gain, two different Viterbi bit detectors have been used: one which is aware of the RMTR constraint, and the other which is not. In the second case the
20 performance gain can be attributed solely to the improved spectral content of the data written on the disc (such that it is better matched to the characteristics of the write channel used).

When the 17PP channel code with the RMTR constraint $r=6$ (as used in the BD system) is employed, SAMSNR of 11.66 dB is achieved for both RMTR-aware and RMTR-unaware bit detectors, i.e. no RMTR-related performance gain is observed in the read
25 channel. When the channel code with $r=3$ is used, SAMSNR of 11.87 dB and 11.72 dB are achieved for the RMTR-aware and RMTR-unaware bit detectors correspondingly. As one can see, in both write and read channels, RMTR-related SAMSNR increase of about 0.15 dB is gained with respect to the case of $r=6$, leading to a total SAMSNR gain of about 0.3 dB. The channel code with $r=2$ leads to an even greater SAMSNR improvement with respect to
30 $r=6$: SAMSNR of 12.07 dB and 12.55 dB are achieved for the RMTR-aware and RMTR-unaware bit detectors correspondingly, which means a total SAMSNR gain of about 0.9 dB. Decreasing the RMTR further from $r=2$ to $r=1$ does not lead to any significant SAMSNR

gain. To the contrary, the overall system performance is deteriorated because of the increased code rate loss for the case of $r=1$ as is discussed in the following discussion.

For $d=1$ and RMTR $r=2$, the theoretical capacity amounts to:

$$C(d=1, k=\infty, r=2)=0.679289. \quad (1)$$

So, a code with rate $2/3$ is still feasible. For an even more aggressive RMTR constraint $r=1$, the theoretical capacity amounts to:

$$C(d=1, k=\infty, r=1)=0.650902. \quad (2)$$

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Clearly, a practical code with rate $2/3$ for $r=1$ is thus not possible. As shown by the experimental results, no performance gain is observed by going from $r=2$ to $r=1$, since 2T trains of length 1 and 2 are clearly distinguishable by the Viterbi bit-detector (intuitively by looking at the polarity at the longer runlengths at both sides of the short 2T-train). Therefore, the following derivation focuses on the case $r=2$, for which we can achieve the same code rate as the 17PP code of BD, with RMTR $r=6$.

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It is thus shown that a code with constraints $d=1$ and $r=2$ provides improved performance which can be used to obtain an increase in disc capacity or an increase in the reliability of the bit detection by allowing a gain of almost 1 dB (in fact 0.9 dB), i.e. about 5 % disc capacity increase.

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Detailed description of a code with $d=1$ and an RMTR Constraint $r=2$.

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A new $d=1$ parity-preserving RLL code with identical code-rate as 17PP ($R=2/3$) and with the minimum RMTR constraint possible ($r=2$) is proposed so that the bit-detection performance can be improved: the improvement can be quantified as 0.9 dB of (SAM) SNR, or, equivalently, about 5% of capacity in the capacity range of 35GB for a BD system.

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The following additional properties of the channel code can also to be realized, based on the ACH algorithm as disclosed by R.L. Adler, D. Coppersmith, and M. Hassner, in "Algorithms for Sliding Block Codes. An Application of Symbolic Dynamics to Information

Theory”, IEEE Transaction on Information Theory, Vol. IT-29, 1983, pp. 5-22. , a well-known technique for the construction of a sliding block code with look-ahead decoding:

- a byte-based mapping (of 8 user bits onto 12 channel bits), identical to that of the ETM code as disclosed by K. Kayanuma, C. Noda and T. Iwanaga, in “Eight to Twelve

5 Modulation Code for High Density Optical Disk”, Technical Digest ISOM-2003, Nov. 3-7 2003, Nara, Japan, paper We-F-45, pp. 160-161;

- DC-control via the parity-preserve principle as used in the 17PP code. This means that the parity of user words and channel words is identical as disclosed by US 5,477,222 or, equivalently, always opposite. Therefore, 128 even-parity and 128 odd-parity channel words

10 are needed for each of the encoding states of the Finite-State Machine (FSM) of the RLL code;

- state-independent decoding must preferably apply for the FSM to limit error-propagation: it is not needed for the decoder to know the FSM state for which a given channel word was encoded.

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First, the mathematical procedure for the ACH-based code-construction will be outlined for the specific case of codes with the parity-preserve property. Subsequently, two particular codes will be discussed, that have been designed according to this construction method: one code has runlength constraints $d=1$, $k=12$ and $r=2$, the other has runlength

20 constraints $d=1$, $k=10$ and $r=2$. Both codes have an 8-to-12 mapping, meaning that bytes of user information are encoded onto 12-bit channel words. Because of the larger k -constraint of the first code, the required amount of so-called state-splitting in the ACH algorithm will be less than for the second code with the more tight $k=10$ constraint: this is reflected by the fact that the maximum component of the approximate eigenvector equals 5 and 8 for the first and

25 the second code, respectively. It should be noted that, for the same 8-to-12 mapping, an even lower value for the k -constraint, $k=9$, is possible within the assumed boundary conditions (8-to-12 mapping, PP-property), but would require a 28-fold state-splitting in the ACH-algorithm, which leads to increased error propagation for such a code.

30 In order to explain the ACH-based code-construction of parity-preserving codes, the construction of a code using a combi-code construction is outlined.

In US-patent US6469645-B2, the concept of combi-codes has been disclosed. Additional information can be found in "Combi-Codes for DC-Free Runlength-Limited

Coding", Wim M.J. Coene, IEEE Transactions on Consumer Electronics, Vol. 46, No. 4, pp. 1082-1087, Nov. 2000.

A combi-code for a given constraint consists of a set of at least two codes for that constraint, possibly with different rates, where the encoders of the various codes share a
 5 *common* set of encoder states. As a consequence, after each encoding step the encoder of the current code may be replaced by the encoder of any other code in the set, where the new encoder has to start in the ending state of the current encoder. Typically, one of the codes, called the *standard* code or *main* code, is an efficient code for standard use; the other codes serve to realise certain additional properties of the channel bitstream. Sets of sliding-block
 10 decodable codes for a combi-code can be constructed via the ACH-algorithm; here the codes are jointly constructed starting with suitable presentations derived from the basic presentation for the constraint and using the *same* approximate eigenvector. The construction of a Combi-Code satisfying the (dk) constraints is guided by an *approximate eigenvector*, see K.A.S. Immink, "*Codes for Mass Data Storage Systems*", 1999, Shannon Foundation Publishers,
 15 The Netherlands and A. Lempel and M. Cohn, "*Look-Ahead Coding for Input-Constrained Channels*", IEEE Trans. Inform. Theory, Vol. 28, 1982, pp. 933-937, and H.D.L. Hollmann, "*On the Construction of Bounded-Delay Encodable Codes for Constrained Systems*", IEEE Trans. Inform. Theory, Vol. 41, 1995, pp. 1354-1378. The components of this vector indicate the amount of state-splitting needed in the ACH-algorithm as disclosed by R.L.
 20 Adler, D. Coppersmith, M. Hassner, in "*Algorithms for Sliding Block Codes. An Application of Symbolic Dynamics to Information Theory*", IEEE Trans. Inform. Theory, Vol. 29, 1983, pp. 5-22. This algorithm has to be applied to the construction of the main code and the substitution code simultaneously.

The *main code* is denoted C_1 ; it maps n -bit data words into m_1 -bit channel
 25 words, and can be constructed on the basis of an approximate eigenvector $v_i, i = 1, \dots, k+1$ that satisfies the inequality:

$$\sum_{j=1}^{k+1} D_{ij}^{m_1} v_j \geq 2^n v_i, \quad i = 1, \dots, k+1, \quad (3)$$

where the matrix D is a $(k+1) \times (k+1)$ matrix, known as the adjacency matrix or connection matrix for the state-transition diagram (STD) that describes (dk) -sequences.

30 For the substitution code, denoted C_2 , we derive a similar approximate eigenvector inequality, that takes the two properties of the substitution code into account: for each branch (or transition between coding states), there are two channel words with opposite parity and the same next-state. We enumerate separately the number of channel words of

length m_2 (leaving from state σ_i and arriving at state σ_j of the STD) that have even parity and the number of those words that have odd parity. We represent these numbers by $D_E[m_2]_{ij}$ and $D_O[m_2]_{ij}$, respectively. For the substitution code, the enumeration does not involve single channel words, but word-pairs, where the two channel words of each word-pair have opposite parity and arrive at the same next-state σ_j of the STD. For this purpose, we define a new connection matrix for sequences of length m denoted by $D_{EO}[m]$ with the matrix elements:

$$D_{EO}[m]_{ij} = \text{Min}[D_E[m]_{ij}, D_O[m]_{ij}]. \quad (4)$$

A substitution code that maps n -bit data words into a set of two m_2 -bit channel words with the same next-state and with opposite parity, can be constructed on the basis of an approximate eigenvector $v_i, i = 1, \dots, k+1$ that satisfies the inequality:

$$\sum_{j=1}^{k+1} D_{EO}[m_2]_{ij} v_j \geq 2^n v_i, \quad i = 1, \dots, k+1. \quad (5)$$

For the construction of a Combi-Code, an approximate eigenvector must satisfy the inequalities (3) and (5) simultaneously. The requirement of a single approximate eigenvector for the main code and the substitution code enables a seamless transition from the main code to the substitution code and vice versa. Moreover, the same operation of merging-of-states (as needed in the ACH-algorithm) can be carried out for both codes.

Design Rules for a Parity-Preserving RLL Code by means of Relaxation of Design Rules for a Substitution Code for the case that the latter is only to be used as Parity-Preserve Code

The substitution code used alone, that is without standard code, is a parity-preserve code (which by definition maintains the parity between user words and channel words). This can be seen as follows. For each n -bit input word, the substitution code has two channel words with opposite parity, and the same next-state. The possible choice between the two channel words with opposite parity represents in fact one bit of information: hence, we could consider this as a $n+1$ -to- m_2 mapping (with m_2 the length of the channel words).

Precisely 2^n input words and the corresponding channel words have *even* parity, and precisely 2^n input words and the corresponding channel words have *odd* parity: thus the code as such is parity-preserving. Now, in the special case that we only use the substitution code

(and thus no concatenation with a main code is required), the "same-next-state" property is not required at all, and can therefore be omitted. Therefore the *joint* design rule of Eq. (5) as required for a substitution code, can be relaxed for a parity-preserving code into the two independent design rules that have to be satisfied simultaneously by the aimed approximate
 5 eigenvector:

$$\sum_{j=1}^{k+1} D_E[m_2]_{ij} v_j \geq 2^n v_i, \quad i = 1, \dots, k+1, \quad (6)$$

and

$$\sum_{j=1}^{k+1} D_O[m_2]_{ij} v_j \geq 2^n v_i, \quad i = 1, \dots, k+1. \quad (7)$$

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The above formulas Eq. (6) and Eq. (7) are crucial since they describe the recipe for the code-construction of parity-preserving codes on the basis of the ACH-algorithm. This is a quite unique code-construction method, since the latest review on d,k constrained channel codes by K.A.S. Immink ("Codes for Mass Data Storage Systems",
 15 Second Edition, 2004, Shannon Foundation Publishers, Eindhoven) claims on page 290 that "... it is not yet clear how we can efficiently design parity preserving codes with the ACH algorithm." Obviously, the above code-construction has clarified the pending issue.

For the practical case considered here with the 8-to-12 parity-preserving RLL code, the parameters (with the definitions of above as used for the substitution code) are:
 20 $d=1, r=2, k=12, n+1=8$ and $m_2=12$. Note that these parameters should not lead to any confusion here: the actual mapping of the code as a parity-preserve code is 8-to-12; the corresponding substitution code (if it would exist), would have a 7-to-12 mapping (with two channel words along the branches).

25 The invention will now be discussed based on figures.

Figure 1 shows a state transition diagram for the RLL constraints $d=1, k=12$ and $r=2$.

30 As a first example, an RLL code is disclosed with constraints: $d=1, k=12$ and $r=2$. The state-transition diagram (STD) for these RLL constraints is shown in Fig. 1. The RMTR constraint becomes obvious from STD-states 1, 2, 14, 15, 16, 17 and 3 at the upper-left corner of the figure. An even lower k -constraint is possible as will be outlined in

the second example, but this requires an 8-fold state-splitting and more states in the FSM of the code, leading to a larger complexity.

The approximate eigenvector for ACH-based construction of a sliding-block code with the parity-preserving property, and mapping 8-bit symbols onto 12-bit channel words, satisfying Eqs. (6-7) of the above code-construction, has been chosen as :

$$\{3, 5, 5, 5, 5, 5, 5, 4, 4, 4, 3, 3, 0, 2, 4, 2, 3\}. \quad (8)$$

State-splitting according to the above approximate eigenvector, and subsequent state-merging leads to a final Finite-State Machine comprising 10 states. The code-tables are shown in the table III. The states are numbered from S0 to S9. The code-words are listed by their decimal representation, with the MSB first (at left side of code-word). Channel words entering a given state are characterized by their specific word endings as indicated in Table I.

Table I.

Characteristics of Word-Ending and States

Word Ending	States
-001	S0, S1, S2
-00101	S0, S1
-0010101	S0, S1
-0010	S0, S1, S2, S3, S4
-001010	S0, S1, S2, S3
-00101010	S0, S1, S2
$-10^m $	S5, S6, S7, S8, S9
$(2 \leq m \leq 6)$	
$-10^m $	S5, S6, S7, S8
$(7 \leq m \leq 9)$	
$-10^m $	S5, S6, S7
$(10 \leq m \leq 11)$	

Note that the state-merging resulting into S0, S1 and S2 for all of the six first lines in the above table has made it possible to arrive at a 10-state FSM.

A sliding block code needs to decode the next-state of a given channel word in order to be able to uniquely decode said channel word. The next-state depends on the characteristics of the considered channel word (in particular the bits at the end of the word, as indicated in Table I), and a number of leading bits of the next channel word. The combination of a given channel word and its next state is sufficient to uniquely decode the corresponding source symbol. The "next-state" function for the latter discrimination has been realized in the coding tables according to a specific grouping (see Table II) with respect to the decimal representation.

Note that for a given channel word, at maximum 5 states (the maximum amount of state-splitting applied) can be possible "next-states" for that word. There are two sets, each of 5 states, that represent the maximum number of next-states (the 1st set comprising S0, S1, ..., S4, the 2nd set comprising S5, S6, ..., S9). Note that the fan-out of all states in each of both sets is clearly separated into contiguous subsets of output words. Each subset is based on a range of decimal representations. Such a grouping of words in the fan-out of the states of the FSM limits error propagation. A similar ordering could of course be obtained based on a lexicographic ordering instead of the decimal ordering (which has some 'gaps' or missing words because of the RLL constraints).

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Table II.
Characteristics of Fan-Out of States
(decimal representation)

State	Even Words	Odd Words
S0	1-66	1-63
S1	70-133	64-123
S2	134-198	126-192
S3	199-261	194-259
S4	262-319	263-334
S5	219-281	218-284
S6	137-199	136-202
S7	200-215	206-217
	282-321	288-343
S8	54-118	53-111

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S9	14-52	13-51
	122-134	114-135
	≥ 325	≥ 345

DC control aspects.

Note that other measures for reducing the error-propagation that is caused by the insertion of DC-control bits into the source bitstream, prior to encoding, can also be combined with the currently proposed channel code. Such a measure is described by US 6,265,994.

As a second example, an RLL code is disclosed with constraints $d=1$, $k=10$ and $r=2$. Compared relative to the state-transition diagram (STD) of Fig. 1 for $k=12$, it is obvious that states 12 and 13 are not valid states for the $k=10$ constraint that is considered in this second code. The approximate eigenvector for ACH-based construction of a sliding-block code with the parity-preserving property, and mapping 8-bit symbols onto 12-bit channel words, satisfying Eqs. (6-7) of the above code-construction, has been chosen as:

$$\{5, 8, 8, 8, 8, 8, 7, 7, 6, 5, 3, 4, 7, 3, 5\}. \quad (9)$$

State-splitting according to the above approximate eigenvector, and subsequent state-merging leads to a final Finite-State Machine comprising 16 states. The code-tables are shown in the table IV. The states are numbered from S0 to S15. A sliding block code needs to decode the next-state of a given channel word in order to be able to uniquely decode said channel word. The next-state depends on the characteristics of the considered channel word, and a number of leading bits of the next channel word. The combination of a given channel word and its next state is sufficient to uniquely decode the corresponding user (or source) symbol.

TABLE III

	S0		S1		S2		S3		S4	
	Even	Odd	Even	Odd	Even	Odd	Even	Odd	Even	Odd
0	5 0	1 0	293 0	276 5	676 5	656 5	1298 0	1288 5	2196 5	2197 0
1	5 1	1 1	293 1	276 6	676 6	656 6	1298 1	1288 6	2196 6	2197 1
2	9 0	1 2	297 0	276 7	676 7	656 7	1298 2	1288 7	2196 7	2208 5
3	9 1	2 0	297 1	276 8	676 8	656 8	1298 3	1288 8	2196 8	2208 6
4	9 2	2 1	297 2	276 9	676 9	656 9	1298 4	1288 9	2196 9	2208 7
5	10 0	2 2	298 0	289 0	1025 0	661 0	1300 5	1296 5	2209 0	2208 8
6	10 1	2 3	298 1	289 1	1025 1	661 1	1300 6	1296 6	2209 1	2208 9
7	10 2	2 4	298 2	289 2	1025 2	672 5	1300 7	1296 7	2209 2	2213 0

12

5	8	10 3	4 5	320 5	290 0	1026 0	672 6	1300 8	1296 8	2210 0	2213 1
	9	17 0	4 6	320 6	290 1	1026 1	672 7	1300 9	1296 9	2210 1	2217 0
	10	17 1	4 7	320 7	290 2	1026 2	672 8	1313 0	1301 0	2210 2	2217 1
	11	17 2	4 8	320 8	290 3	1026 3	672 9	1313 1	1301 1	2210 3	2217 2
	12	18 0	4 9	320 9	290 4	1026 4	677 0	1313 2	1312 5	2210 4	2305 0
10	13	18 1	8 5	325 0	292 5	1028 5	677 1	1314 0	1312 6	2212 5	2305 1
	14	18 2	8 6	325 1	292 6	1028 6	1024 5	1314 1	1312 7	2212 6	2305 2
	15	18 3	8 7	329 0	292 7	1028 7	1024 6	1314 2	1312 8	2212 7	2306 0
	16	18 4	8 8	329 1	292 8	1028 8	1024 7	1314 3	1312 9	2212 8	2306 1
	17	20 5	8 9	329 2	292 9	1028 9	1029 0	1314 4	1317 0	2212 9	2306 2
15	18	20 6	16 5	330 0	296 5	1032 5	1029 1	1316 5	1317 1	2216 5	2306 3
	19	20 7	16 6	330 1	296 6	1032 6	1033 0	1316 6	1321 0	2216 6	2306 4
	20	20 8	16 7	330 2	296 7	1032 7	1033 1	1316 7	1321 1	2216 7	2308 5
	21	20 9	16 8	330 3	296 8	1032 8	1033 2	1316 8	1321 2	2216 8	2308 6
	22	33 0	16 9	337 0	296 9	1032 9	1034 0	1316 9	1322 0	2216 9	2308 7
20	23	33 1	21 0	337 1	321 0	1040 5	1034 1	1320 5	1322 1	2304 5	2308 8
	24	33 2	21 1	337 2	321 1	1040 6	1034 2	1320 6	1322 2	2304 6	2308 9
	25	34 0	32 5	338 0	321 2	1040 7	1034 3	1320 7	1344 5	2304 7	2312 5
	26	34 1	32 6	338 1	322 0	1040 8	1041 0	1320 8	1344 6	2304 8	2312 6
	27	34 2	32 7	338 2	322 1	1040 9	1041 1	1320 9	1344 7	2309 0	2312 7
25	28	34 3	32 8	338 3	322 2	1045 0	1041 2	1345 0	1344 8	2309 1	2312 8
	29	34 4	32 9	338 4	322 3	1045 1	1042 0	1345 1	1344 9	2313 0	2312 9
	30	36 5	37 0	513 0	322 4	1056 5	1042 1	1345 2	1349 0	2313 1	2320 5
	31	36 6	37 1	513 1	324 5	1056 6	1042 2	1346 0	1349 1	2313 2	2320 6

	S0		S1		S2		S3		S4		
	Even	Odd	Even	Odd	Even	Odd	Even	Odd	Even	Odd	
30	32	36 7	41 0	513 2	324 6	1056 7	1042 3	1346 1	1353 0	2314 0	2320 7
	33	36 8	41 1	514 0	324 7	1056 8	1042 4	1346 2	1353 1	2314 1	2320 8
	34	36 9	41 2	514 1	324 8	1056 9	1044 5	1346 3	1353 2	2314 2	2320 9
	35	40 5	42 0	514 2	324 9	1061 0	1044 6	1346 4	1354 0	2314 3	2325 0
	36	40 6	42 1	514 3	328 5	1061 1	1044 7	1348 5	1354 1	2321 0	2325 1
35	37	40 7	42 2	514 4	328 6	1065 0	1044 8	1348 6	1354 2	2321 1	2336 5
	38	40 8	64 5	516 5	328 7	1065 1	1044 9	1348 7	1354 3	2321 2	2336 6
	39	40 9	64 6	516 6	328 8	1065 2	1057 0	1348 8	2048 5	2322 0	2336 7
	40	65 0	64 7	516 7	328 9	1066 0	1057 1	1348 9	2048 6	2322 1	2336 8
40	41	65 1	64 8	516 8	336 5	1066 1	1057 2	1352 5	2048 7	2322 2	2336 9
	42	65 2	64 9	516 9	336 6	1066 2	1058 0	1352 6	2053 0	2322 3	2341 0
	43	66 0	69 0	520 5	336 7	1088 5	1058 1	1352 7	2053 1	2322 4	2341 1
	44	66 1	69 1	520 6	336 8	1088 6	1058 2	1352 8	2057 0	2324 5	2345 0
	45	66 2	73 0	520 7	336 9	1088 7	1058 3	1352 9	2057 1	2324 6	2345 1
45	46	66 3	73 1	520 8	512 5	1088 8	1058 4	2049 0	2057 2	2324 7	2345 2
	47	66 4	73 2	520 9	512 6	1088 9	1060 5	2049 1	2058 0	2324 8	2346 0
	48	68 5	74 0	528 5	512 7	1093 0	1060 6	2049 2	2058 1	2324 9	2346 1
	49	68 6	74 1	528 6	512 8	1093 1	1060 7	2050 0	2058 2	2337 0	2346 2
	50	68 7	74 2	528 7	517 0	1097 0	1060 8	2050 1	2058 3	2337 1	2368 5
50	51	68 8	74 3	528 8	517 1	1097 1	1060 9	2050 2	2065 0	2337 2	2368 6
	52	68 9	81 0	528 9	521 0	1097 2	1064 5	2050 3	2065 1	2338 0	2368 7
	53	72 5	81 1	533 0	521 1	1098 0	1064 6	2050 4	2065 2	2338 1	2368 8
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	55	72 7	82 0	544 5	522 0	1098 2	1064 8	2052 6	2066 1	2338 3	2373 0
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	58	80 5	82 3	544 8	522 3	1105 1	1089 1	2052 9	2066 4	2340 6	2377 1
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	60	80 7	84 5	549 0	529 1	1106 0	1090 0	2056 6	2068 6	2340 8	2378 0
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	62	80 9	84 7	553 0	530 0	1106 2	1090 2	2056 8	2068 8	2344 5	2378 2
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65	S0				S1				S2				S3				S4				
	Even		Odd		Even		Odd		Even		Odd		Even		Odd		Even		Odd		
70	64	129	1	84	9	553	2	530	2	1106	4	1090	4	2064	5	2081	0	2344	7	2385	0
	65	129	2	128	5	554	0	530	3	1108	5	1092	5	2064	6	2081	1	2344	8	2385	1
	66	130	0	128	6	554	1	530	4	1108	6	1092	6	2064	7	2081	2	2344	9	2385	2
	67	130	1	128	7	554	2	532	5	1108	7	1092	7	2064	8	2082	0	2369	0	2386	0
	68	130	2	128	8	576	5	532	6	1108	8	1092	8	2064	9	2082	1	2369	1	2386	1
75	69	130	3	133	0	576	6	532	7	1108	9	1092	9	2069	0	2082	2	2369	2	2386	2
	70	130	4	133	1	576	7	532	8	1152	5	1096	5	2069	1	2082	3	2370	0	2386	3
	71	132	5	137	0	576	8	532	9	1152	6	1096	6	2080	5	2082	4	2370	1	2386	4
	72	132	6	137	1	576	9	545	0	1152	7	1096	7	2080	6	2084	5	2370	2	2561	0
	73	132	7	137	2	581	0	545	1	1152	8	1096	8	2080	7	2084	6	2370	3	2561	1
	74	132	8	138	0	581	1	545	2	1157	0	1096	9	2080	8	2084	7	2370	4	2561	2

13

5	75	132	9	138	1	585	0	546	0	1157	1	1104	5	2080	9	2084	8	2372	5	2562	0
	76	136	5	138	2	585	1	546	1	1161	0	1104	6	2085	0	2084	9	2372	6	2562	1
	77	136	6	138	3	585	2	546	2	1161	1	1104	7	2085	1	2088	5	2372	7	2562	2
	78	136	7	145	0	586	0	546	3	1161	2	1104	8	2089	0	2088	6	2372	8	2562	3
	79	136	8	145	1	586	1	546	4	1162	0	1104	9	2089	1	2088	7	2372	9	2562	4
10	80	136	9	145	2	586	2	548	5	1162	1	1153	0	2089	2	2088	8	2376	5	2564	5
	81	144	5	146	0	586	3	548	6	1162	2	1153	1	2090	0	2088	9	2376	6	2564	6
	82	144	6	146	1	593	0	548	7	1162	3	1153	2	2090	1	2113	0	2376	7	2564	7
	83	144	7	146	2	593	1	548	8	1169	0	1154	0	2090	2	2113	1	2376	8	2564	8
	84	144	8	146	3	593	2	548	9	1169	1	1154	1	2112	5	2113	2	2376	9	2564	9
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	86	149	0	148	5	594	1	552	6	1170	0	1154	3	2112	7	2114	1	2384	6	2568	6
	87	149	1	148	6	594	2	552	7	1170	1	1154	4	2112	8	2114	2	2384	7	2568	7
	88	160	5	148	7	594	3	552	8	1170	2	1156	5	2112	9	2114	3	2384	8	2568	8
	89	160	6	148	8	594	4	552	9	1170	3	1156	6	2117	0	2114	4	2384	9	2568	9
20	90	160	7	148	9	596	5	577	0	1170	4	1156	7	2117	1	2116	5	2560	5	2576	5
	91	160	8	161	0	596	6	577	1	1172	5	1156	8	2121	0	2116	6	2560	6	2576	6
	92	160	9	161	1	596	7	577	2	1172	6	1156	9	2121	1	2116	7	2560	7	2576	7
	93	165	0	161	2	596	8	578	0	1172	7	1160	5	2121	2	2116	8	2560	8	2576	8
	94	165	1	162	0	596	9	578	1	1172	8	1160	6	2122	0	2116	9	2565	0	2576	9
	95	169	0	162	1	640	5	578	2	1172	9	1160	7	2122	1	2120	5	2565	1	2581	0

25	S0				S1				S2				S3				S4				
	Even		Odd		Even		Odd		Even		Odd		Even		Odd		Even		Odd		
30	96	169	1	162	2	640	6	578	3	1185	0	1160	8	2122	2	2120	6	2569	0	2581	1
	97	169	2	162	3	640	7	578	4	1185	1	1160	9	2122	3	2120	7	2569	1	2592	5
	98	257	0	162	4	640	8	580	5	1185	2	1168	5	2129	0	2120	8	2569	2	2592	6
	99	257	1	164	5	645	0	580	6	1186	0	1168	6	2129	1	2120	9	2570	0	2592	7
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	102	258	1	164	8	649	1	580	9	1186	3	1168	9	2130	1	2128	7	2570	3	2597	0
	103	258	2	164	9	649	2	584	5	1186	4	1173	0	2130	2	2128	8	2577	0	2597	1
	104	258	3	168	5	650	0	584	6	1188	5	1173	1	2130	3	2128	9	2577	1	2601	0
	105	258	4	168	6	650	1	584	7	1188	6	1184	5	2130	4	2177	0	2577	2	2601	1
40	106	260	5	168	7	650	2	584	8	1188	7	1184	6	2132	5	2177	1	2578	0	2601	2
	107	260	6	168	8	650	3	584	9	1188	8	1184	7	2132	6	2177	2	2578	1	2602	0
	108	260	7	168	9	657	0	592	5	1188	9	1184	8	2132	7	2178	0	2578	2	2602	1
	109	260	8	256	5	657	1	592	6	1192	5	1184	9	2132	8	2178	1	2578	3	2602	2
	110	260	9	256	6	657	2	592	7	1192	6	1189	0	2132	9	2178	2	2578	4	2624	5
45	111	264	5	256	7	658	0	592	8	1192	7	1189	1	2176	5	2178	3	2580	5	2624	6
	112	264	6	256	8	658	1	592	9	1192	8	1193	0	2176	6	2178	4	2580	6	2624	7
	113	264	7	261	0	658	2	641	0	1192	9	1193	1	2176	7	2180	5	2580	7	2624	8
	114	264	8	261	1	658	3	641	1	1280	5	1193	2	2176	8	2180	6	2580	8	2624	9
	115	264	9	265	0	658	4	641	2	1280	6	1281	0	2181	0	2180	7	2580	9	2629	0
50	116	272	5	265	1	660	5	642	0	1280	7	1281	1	2181	1	2180	8	2593	0	2629	1
	117	272	6	265	2	660	6	642	1	1280	8	1281	2	2185	0	2180	9	2593	1	2633	0
	118	272	7	266	0	660	7	642	2	1285	0	1282	0	2185	1	2184	5	2593	2	2633	1
	119	272	8	266	1	660	8	642	3	1285	1	1282	1	2185	2	2184	6	2594	0	2633	2
	120	272	9	266	2	660	9	642	4	1289	0	1282	2	2186	0	2184	7	2594	1	2634	0
55	121	277	0	266	3	673	0	644	5	1289	1	1282	3	2186	1	2184	8	2594	2	2634	1
	122	277	1	273	0	673	1	644	6	1289	2	1282	4	2186	2	2184	9	2594	3	2634	2
	123	288	5	273	1	673	2	644	7	1290	0	1284	5	2186	3	2192	5	2594	4	2634	3
	124	288	6	273	2	674	0	644	8	1290	1	1284	6	2193	0	2192	6	2596	5	2641	0
	125	288	7	274	0	674	1	644	9	1290	2	1284	7	2193	1	2192	7	2596	6	2641	1
60	126	288	8	274	1	674	2	648	5	1290	3	1284	8	2193	2	2192	8	2596	7	2641	2
	127	288	9	274	2	674	3	648	6	1297	0	1284	9	2194	0	2192	9	2596	8	2642	0

60																					
	S5				S6				S7				S8				S9				
	Even		Odd		Even		Odd		Even		Odd		Even		Odd		Even		Odd		
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	1	2196	6	2197	1	1298	1	1288	6	2596	9	2644	8	293	1	276	6	676	6	656	6
	2	2196	7	2208	5	1298	2	1288	7	2600	5	2644	9	297	0	276	7	676	7	656	7
	3	2196	8	2208	6	1297	1	1288	8	2600	6	2688	5	297	1	276	8	676	8	656	8
	4	2196	9	2208	7	1297	2	1288	9	2600	8	2688	6	297	2	276	9	676	9	656	9
70	5	2209	0	2208	8	1025	0	1296	5	1300	5	2693	1	298	0	289	0	2626	2	661	0
	6	2209	1	2208	9	1025	1	1296	6	1300	6	2697	0	298	1	289	1	2626	3	661	1
	7	2209	2	2213	0	1025	2	1296	7	1300	7	2697	1	298	2	289	2	2626	4	672	5
	8	2210	0	2213	1	1026	0	1296	8	1300	8	2697	2	320	5	290	0	2628	5	672	6
75	9	2210	1	2217	0	1026	1	1296	9	1300	9	2698	0	320	6	290	1	2628	6	672	7
	10	2210	2	2217	1	1026	2	1301	0	1313	0	2698	1	320	7	290	2	2628	7	672	8
	11	2210	3	2217	2	1026	3	1301	1	1313	1	2642	1	320	8	290	3	2628	8	672	9
	12	2210	4	2305	0	1026	4	1312	5	1313	2	2642	2	320	9	290	4	2632	5	677	0
	13	2212	5	2305	1	1028	5	1312	6	1314	0	2642	3	325	0	292	5	2632	6	677	1

5	14	2212	6	2305	2	1028	6	1024	5	1314	1	2642	4	325	1	292	6	2632	7	648	9
	15	2212	7	2306	0	1028	7	1024	6	1314	2	2644	5	329	0	292	7	2632	8	2706	0
	16	2212	8	2306	1	1028	8	1024	7	1314	3	2644	6	329	1	292	8	674	4	2706	4
	17	2212	9	2306	2	1028	9	1029	0	1314	4	1317	0	329	2	292	9	2625	0	2706	1
	18	2216	5	2306	3	1032	5	1029	1	1316	5	1317	1	330	0	296	5	2625	1	2706	2
10	19	2216	6	2306	4	1032	6	1033	0	1316	6	1321	0	330	1	296	6	2625	2	2706	3
	20	2216	7	2308	5	1032	7	1033	1	1316	7	1321	1	330	2	296	7	2626	0	648	7
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	22	2216	9	2308	7	1032	9	1034	0	1316	9	1322	0	337	0	296	9	33	0	2705	0
	23	2304	5	2308	8	1040	5	1034	1	1320	5	1322	1	337	1	321	0	33	1	2705	1
15	24	2304	6	2308	9	1040	6	1034	2	1320	6	1322	2	337	2	321	1	33	2	2705	2
	25	2304	7	2312	5	1040	7	1034	3	1320	7	1344	5	338	0	321	2	34	0	32	5
	26	2304	8	2312	6	1040	8	1041	0	1320	8	1344	6	338	1	322	0	34	1	32	6
	27	2309	0	2312	7	1040	9	1041	1	1320	9	1344	7	338	2	322	1	34	2	32	7
	28	2309	1	2312	8	1045	0	1041	2	1345	0	1344	8	338	3	322	2	34	3	32	8
20	29	2313	0	2312	9	1045	1	1042	0	1345	1	1344	9	338	4	322	3	34	4	32	9
	30	2313	1	2320	5	1056	5	1042	1	1345	2	1349	0	513	0	322	4	36	5	37	0
	31	2313	2	2320	6	1056	6	1042	2	1346	0	1349	1	513	1	324	5	36	6	37	1
			S5				S6				S7				S8				S9		
		Even		Odd		Even		Odd		Even		Odd		Even		Odd		Even		Odd	
25	32	2314	0	2320	7	1056	7	1042	3	1346	1	1353	0	513	2	324	6	36	7	41	0
	33	2314	1	2320	8	1056	8	1042	4	1346	2	1353	1	514	0	324	7	36	8	41	1
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	35	2314	3	2325	0	1061	0	1044	6	1346	4	1354	0	514	2	324	9	40	5	42	0
	36	2321	0	2325	1	1061	1	1044	7	1348	5	1354	1	514	3	328	5	40	6	42	1
30	37	2321	1	2336	5	1065	0	1044	8	1348	6	1354	2	514	4	328	6	40	7	42	2
	38	2321	2	2336	6	1065	1	104													

15

5	81	2090	0	2088	9	1162	2	1153	1	2376	6	2564	6	586	3	548	6	144	5	146	0
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	83	2090	2	2113	1	1169	0	1154	0	2376	8	2564	8	593	1	548	8	144	7	146	2
	84	2112	5	2113	2	1169	1	1154	1	2376	9	2564	9	593	2	548	9	144	8	146	3
	85	2112	6	2114	0	1169	2	1154	2	2384	5	2568	5	594	0	552	5	144	9	146	4
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	87	2112	8	2114	2	1170	1	1154	4	2384	7	2568	7	594	2	552	7	149	1	148	6
	88	2112	9	2114	3	1170	2	1156	5	2384	8	2568	8	594	3	552	8	160	5	148	7
	89	2117	0	2114	4	1170	3	1156	6	2384	9	2568	9	594	4	552	9	160	6	148	8
	90	2117	1	2116	5	1170	4	1156	7	2560	5	2576	5	596	5	577	0	160	7	148	9
15	91	2121	0	2116	6	1172	5	1156	8	2560	6	2576	6	596	6	577	1	160	8	161	0
	92	2121	1	2116	7	1172	6	1156	9	2560	7	2576	7	596	7	577	2	160	9	161	1
	93	2121	2	2116	8	1172	7	1160	5	2560	8	2576	8	596	8	578	0	165	0	161	2
	94	2122	0	2116	9	1172	8	1160	6	2565	0	2576	9	596	9	578	1	165	1	162	0
	95	2122	1	2120	5	1172	9	1160	7	2565	1	2581	0	640	5	578	2	169	0	162	1

		S5				S6				S7				S8				S9			
		Even		Odd		Even		Odd		Even		Odd		Even		Odd		Even		Odd	
20																					
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	97	2122	3	2120	7	1185	1	1160	9	2569	1	2592	5	640	7	578	4	169	2	162	3
	98	2129	0	2120	8	1185	2	1168	5	2569	2	2592	6	257	0	580	5	2628	7	162	4
25	99	2129	1	2120	9	1186	0	1168	6	2570	0	2592	7	257	1	580	6	645	0	164	5
	100	2129	2	2128	5	1186	1	1168	7	2570	1	2592	8	257	2	580	7	645	1	164	6
	101	2130	0	2128	6	1186	2	1168	8	2570	2	2592	9	258	0	580	8	649	0	164	7
	102	2130	1	2128	7	1186	3	1168	9	2570	3	2597	0	258	1	580	9	649	1	164	8
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	104	2130	3	2128	9	1188	5	1173	1	2577	1	2601	0	258	3	584	6	650	0	168	5
	105	2130	4	2177	0	1188	6	1184	5	2577	2	2601	1	258	4	584	7	650	1	168	6
	106	2132	5	2177	1	1188	7	1184	6	2578	0	2601	2	260	5	584	8	650	2	168	7
35	107	2132	6	2177	2	1188	8	1184	7	2578	1	2602	0	260	6	274	4	650	3	168	8
	108	2132	7	2178	0	1188	9	1184	8	2578	2	2602	1	260	7	274	3	657	0	592	5
	109	2132	8	2178	1	1192	5	1184	9	2578	3	2602	2	260	8	256	5	657	1	592	6
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	113	2176	7	2180	5	1192	9	1193	1	2580	7	2624	8	264	7	261	0	658	2	641	0
	114	2176	8	2180	6	1280	5	1193	2	2580	8	2624	9	264	8	261	1	658	3	641	1
45	115	2181	0	2180	7	1280	6	1281	0	2580	9	2629	0	264	9	265	0	658	4	641	2
	116	2181	1	2180	8	1280	7	1281	1	2593	0	2629	1	272	5	265	1	660	5	642	0
	117	2185	0	2180	9	1280	8	1281	2	2593	1	2633	0	272	6	265	2	660	6	642	1
	118	2185	1	2184	5	1285	0	1282	0	2593	2	2633	1	272	7	266	0	660	7	642	2
50	119	2185	2	2184	6	1285	1	1282	1	2594	0	2633	2	272	8	266	1	660	8	642	3
	120	2186	0	2184	7	1289	0	1282	2	2594	1	2634	0	272	9	266	2	660	9	642	4
	121	2186	1	2184	8	1289	1	1282	3	2594	2	2634	1	277	0	266	3	673	0	644	5
	122	2186	2	2184	9	1289	2	1282	4	2594	3	2634	2	277	1	273	0	673	1	644	6
50	123	2186	3	2192	5	1290	0	1284	5	2594	4	2634	3	288	5	273	1	673	2	644	7
	124	2193	0	2192	6	1290	1	1284	6	2596	5	2641	0	288	6	273	2	674	0	644	8
	125	2193	1	2192	7	1290	2	1284	7	2596	6	2641	1	288	7	274	0	674	1	644	9
	126	2193	2	2192	8	1290	3	1284	8	2596	7	2641	2	288	8	274	1	674	2	648	5
	127	2194	0	2192	9	1297	0	1284	9	2596	8	2642	0	288	9	274	2	674	3	648	6

55

TABLE IV

State S00 Part-1: Entries 0- 31				State S00 Part-3: Entries 64- 95					
=====				=====					
Even		Odd		Even		Odd			
=====				=====					
0	000000000101	0	000000000100	8	64	000000101000	14	000001001001	4
1	000000000101	1	000000000100	9	65	000000101000	15	000001001010	0
2	000000000101	2	000000000100	10	66	000001000001	0	000001001010	1
3	000000000101	3	000000000100	11	67	000001000001	1	000001001010	2
4	0000000001001	0	000000000100	12	68	000001000001	2	000001001010	3
5	0000000001001	1	000000000100	13	69	000001000001	3	000001001010	4
6	0000000001001	2	000000000100	14	70	000001000001	4	000001001010	5
7	0000000001001	3	000000000100	15	71	000001000010	0	000001001010	6
8	0000000001001	4	0000000001000	8	72	000001000010	1	000001000001	0
9	0000000001010	0	0000000001000	9	73	000001000010	2	000001000001	1
10	0000000001010	1	0000000001000	10	74	000001000010	3	000001000001	2
11	0000000001010	2	0000000001000	11	75	000001000010	4	000001000001	3
12	0000000001010	3	0000000001000	12	76	000001000010	5	000001000001	4
13	0000000001010	4	0000000001000	13	77	000001000010	6	000001000010	0
14	0000000001010	5	0000000001000	14	78	000001000010	7	000001000010	1
15	0000000001010	6	0000000001000	15	79	000001000010	8	000001000010	2
16	00000000010001	0	00000000010000	8	80	000001000010	9	000001000010	3
17	00000000010001	1	00000000010000	9	81	000001000010	10	000001000010	4
18	00000000010001	2	00000000010000	10	82	000001000010	11	000001000010	5
19	00000000010001	3	00000000010000	11	83	000001000010	12	000001000010	6
20	00000000010001	4	00000000010000	12	84	000001000010	13	000001000010	7
21	00000000010010	0	00000000010000	13	85	000001000010	14	000001000010	8
22	00000000010010	1	00000000010000	14	86	000001000010	15	000001000010	9
23	00000000010010	2	00000000010000	15	87	000001000001	8	000001000010	10
24	00000000010010	3	00000000010101	0	88	000001000001	9	000001000010	11
25	00000000010010	4	00000000010101	1	89	000001000001	10	000001000010	12
26	00000000010010	5	00000000010101	2	90	000001000001	11	000001000010	13
27	00000000010010	6	00000000010000	8	91	000001000001	12	000001000010	14
28	00000000010010	7	00000000010000	9	92	000001000001	13	000001000010	15
29	00000000010100	8	00000000010000	10	93	000001000001	14	000001000000	8
30	00000000010100	9	00000000010000	11	94	000001000001	15	000001000000	9
31	00000000010100	10	00000000010000	12	95	000001000001	8	000001000000	10
State S00 Part-2: Entries 32- 63				State S00 Part-4: Entries 96-127					
=====				=====					
Even		Odd		Even		Odd			
=====				=====					
32	00000000010100	11	00000000010000	13	96	000001000000	9	000001000000	11
33	00000000010100	12	00000000010000	14	97	000001000000	10	000001000000	12
34	00000000010100	13	00000000010000	15	98	000001000000	11	000001000000	13
35	00000000010100	14	000000000100101	0	99	000001000000	12	000001000000	14
36	00000000010100	15	000000000100101	1	100	000001000000	13	000001000001	0
37	000000000100001	0	000000000100101	2	101	000001000000	14	000001000001	1
38	000000000100001	1	000000000100101	3	102	000001000000	15	000001000001	2
39	000000000100001	2	000000000100101	0	103	0000010000001	0	000001000001	3
40	000000000100001	3	000000000100101	1	104	0000010000001	1	000001000001	0
41	000000000100001	4	000000000100101	2	105	0000010000001	2	000001000001	1
42	000000000100010	0	000000000100101	3	106	0000010000001	3	000001000001	2
43	000000000100010	1	000000000100101	4	107	0000010000001	4	000001000001	3
44	000000000100010	2	000000000100101	0	108	0000010000010	0	000001000001	4
45	000000000100010	3	000000000100101	1	109	0000010000010	1	000001000010	0
46	000000000100010	4	000000000100101	2	110	0000010000010	2	000001000010	1
47	000000000100010	5	000000000100101	3	111	0000010000010	3	000001000010	2
48	000000000100010	6	000000000100101	4	112	0000010000010	4	000001000010	3
49	000000000100010	7	000000000100000	8	113	0000010000010	5	000001000010	4
50	000000000100100	8	000000000100000	9	114	0000010000010	6	000001000010	5
51	000000000100100	9	000000000100000	10	115	0000010000010	7	000001000010	6
52	000000000100100	10	000000000100000	11	116	0000010000010	8	000001000001	0
53	000000000100100	11	000000000100000	12	117	0000010000010	9	000001000001	1
54	000000000100100	12	000000000100000	13	118	0000010000010	10	000001000001	2
55	000000000100100	13	000000000100000	14	119	0000010000010	11	000001000001	3
56	000000000100100	14	0000000001000101	0	120	0000010000010	12	000001000001	4
57	000000000100100	15	0000000001000101	1	121	0000010000010	13	0000010000010	0
58	000000000100000	8	0000000001000101	2	122	0000010000010	14	0000010000010	1
59	000000000100000	9	0000000001000101	3	123	0000010000010	15	0000010000010	2
60	000000000100000	10	0000000001000101	0	124	000001000001000	8	0000010000010	3
61	000000000100000	11	0000000001000101	1	125	000001000001000	9	0000010000010	4
62	000000000100000	12	0000000001000101	2	126	000001000001000	10	0000010000010	5
63	000000000100000	13	0000000001000101	3	127	000001000001000	11	0000010000010	6

17

State S01 Part-1: Entries 0- 31				State S01 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0 000010010000	8 000010010100	8	64 000100010000	15 000100010010	2	
	1 000010010000	9 000010010100	9	65 000100010101	0 000100010010	3	
	2 000010010000	10 000010010100	10	66 000100010101	1 000100010010	4	
	3 000010010000	11 000010010100	11	67 000100010101	2 000100010010	5	
10	4 000010010000	12 000010010100	12	68 000100010000	8 000100010010	6	
	5 000010010000	13 000010010100	13	69 000100010000	9 000100010010	7	
	6 000010010000	14 000010010100	14	70 000100010000	10 000100010100	8	
	7 000010010000	15 000010010100	15	71 000100010000	11 000100010100	9	
	8 000010010101	0 000010100001	0	72 000100010000	12 000100010100	10	
15	9 000010010101	1 000010100001	1	73 000100010000	13 000100010100	11	
	10 000010010101	2 000010100001	2	74 000100010000	14 000100010100	12	
	11 000010100000	8 000010100001	3	75 000100010000	15 000100010100	13	
	12 000010100000	9 000010100001	4	76 000100010010	0 000100010100	14	
	13 000010100000	10 000010100010	0	77 000100010010	1 000100010100	15	
20	14 000010100000	11 000010100010	1	78 000100010010	2 000100010001	0	
	15 000010100000	12 000010100010	2	79 000100010010	3 000100010001	1	
	16 000010100000	13 000010100010	3	80 000100010100	0 000100010001	2	
	17 000010100000	14 000010100010	4	81 000100010100	1 000100010001	3	
	18 000010100000	15 000010100010	5	82 000100010100	2 000100010001	4	
25	19 000010100101	0 000010100010	6	83 000100010100	3 000100010001	0	
	20 000010100101	1 000010100010	7	84 000100010100	4 000100010001	1	
	21 000010100101	2 000010100100	8	85 000100010100	0 000100010001	2	
	22 000010100101	3 000010100100	9	86 000100010100	1 000100010001	3	
	23 000010100101	0 000010100100	10	87 000100010100	2 000100010001	4	
30	24 000010100101	1 000010100100	11	88 000100010100	3 000100010001	5	
	25 000010100101	2 000010100100	12	89 000100010100	4 000100010001	6	
	26 000010100101	3 000010100100	13	90 000101000000	8 000100010001	7	
	27 000010100101	4 000010100100	14	91 000101000000	9 000100010001	8	
	28 000100000001	0 000010100100	15	92 000101000000	10 000100010001	9	
35	29 000100000001	1 000010100100	8	93 000101000000	11 000100010001	10	
	30 000100000001	2 000010100100	9	94 000101000000	12 000100010001	11	
	31 000100000001	3 000010100100	10	95 000101000000	13 000100010001	12	
State S01 Part-2: Entries 32- 63				State S01 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32 000100000001	4 000010100100	11	96 000101000000	14 000100010010	13	
	33 000100000010	0 000010100100	12	97 000101000010	0 000100010010	14	
45	34 000100000010	1 000010100100	13	98 000101000010	1 000100010010	15	
	35 000100000010	2 000100000000	8	99 000101000010	2 000100010000	8	
	36 000100000010	3 000100000000	9	100 000101000010	3 000100010000	9	
	37 000100000010	4 000100000000	10	101 000101000100	0 000100010000	10	
	38 000100000010	5 000100000000	11	102 000101000100	1 000100010000	11	
50	39 000100000010	6 000100000000	12	103 000101000100	2 000100010000	12	
	40 000100000010	7 000100000000	13	104 000101000100	3 000100010000	13	
	41 000100000100	8 000100000101	0	105 000101000100	4 000100010000	14	
	42 000100000100	9 000100000101	1	106 000101000100	0 000100010000	15	
	43 000100000100	10 000100000101	2	107 000101000100	1 000101000001	0	
55	44 000100000100	11 000100000101	3	108 000101000100	2 000101000001	1	
	45 000100000100	12 000100000101	0	109 000101000100	3 000101000001	2	
	46 000100000100	13 000100000101	1	110 000101000100	4 000101000001	3	
	47 000100000100	14 000100000101	2	111 000101000100	5 000101000001	4	
	48 000100000100	15 000100000101	3	112 000101000100	6 000101000001	0	
60	49 000100000100	8 000100000101	4	113 000101010001	0 000101000001	1	
	50 000100000100	9 000100000101	0	114 000101010001	1 000101000001	2	
	51 000100000100	10 000100000101	1	115 000101010001	2 000101000001	3	
	52 000100000100	11 000100000101	2	116 000101010001	3 000101000001	4	
	53 000100000100	12 000100000101	3	117 000101010001	4 000101000001	5	
65	54 000100000100	13 000100000101	4	118 000101010010	0 000101000001	6	
	55 000100000100	14 000100000101	5	119 000101010010	1 000101000001	7	
	56 000100000100	15 000100000101	6	120 000101010010	2 000101000001	8	
	57 000100000100	8 000100000100	0	121 000101010010	3 000101000001	9	
	58 000100000100	9 000100000100	1	122 000101010010	4 000101000001	10	
70	59 000100000100	10 000100000100	2	123 000101010010	5 000101000001	11	
	60 000100000100	11 000100000100	3	124 001000000001	0 000101000001	12	
	61 000100000100	12 000100000100	4	125 001000000001	1 000101000001	13	
	62 000100000100	13 000100000100	0	126 001000000001	2 000101000001	14	
75	63 000100000100	14 000100000100	1	127 001000000001	3 000101000001	15	

18

State S02 Part-1: Entries 0- 31				State S02 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0	001000000010	0	000101001000	8	64	001001000101
	1	001000000010	1	000101001000	9	65	001001000101
	2	001000000010	2	000101001000	10	66	001001000101
	3	001000000010	3	000101001000	11	67	001001000101
	4	001000000010	4	000101001000	12	68	001001001001
10	5	001000000010	5	000101001000	13	69	001001001001
	6	001000000010	6	000101001000	14	70	001001001001
	7	001000000010	7	000101001000	15	71	001001001001
	8	001000000100	8	000101010000	8	90	001001001001
	9	001000000100	9	000101010000	9	73	001001001010
15	10	001000000100	10	000101010000	10	74	001001001010
	11	001000000100	11	000101010000	11	75	001001001010
	12	001000000100	12	000101010000	12	76	001001001010
	13	001000000100	13	000101010000	13	95	001001001010
	14	001000000100	14	000101010000	14	78	001001001010
20	15	001000000100	15	000101010000	15	79	001001001010
	16	001000000100	8	001000000000	8	80	001001010001
	17	001000000100	9	001000000000	9	81	001001010001
	18	001000000100	10	001000000000	10	100	001001010001
	19	001000000100	11	001000000000	11	83	001001010001
25	20	001000000100	12	001000000000	12	84	001001010001
	21	001000000100	13	001000000101	0	85	001001010010
	22	001000000100	14	001000000101	1	86	001001010010
	23	001000000100	15	001000000101	2	105	001001010010
	24	001000000100	8	001000000101	3	87	001001010010
30	25	001000000100	9	001000000101	0	88	001001010010
	26	001000000100	10	001000000101	1	89	001001010010
	27	001000000100	11	001000000101	2	90	001001010010
	28	001000000100	12	001000000101	3	110	001001010010
	29	001000000100	13	001000000101	4	93	001001010100
35	30	001000000100	14	001000000101	0	94	001001010100
	31	001000000100	15	001000000101	1	95	001001010100
State S02 Part-2: Entries 32- 63				State S02 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32	001000010101	0	001000001010	2	96	001001010100
	33	001000010101	1	001000001010	3	120	001001010100
	34	001000010101	2	001000001010	4	98	001001010100
45	35	001000010000	8	001000001010	5	99	001001010100
	36	001000010000	9	001000001010	6	100	001001010100
	37	001000010000	10	001000010001	0	101	001010000000
	38	001000010000	11	001000010001	1	125	001010000000
	39	001000010000	12	001000010001	2	103	001010000000
50	40	001000010000	13	001000010001	3	104	001010000000
	41	001000010000	14	001000010001	4	105	001010000000
	42	001000010000	15	001000010010	0	106	001010000000
	43	001000010010	0	001000010010	1	130	001010000000
	44	001000010010	1	001000010010	2	108	001010000101
55	45	001000010010	2	001000010010	3	109	001010000101
	46	001000010010	3	001000010010	4	110	001010000101
	47	001000010001	0	001000010010	5	111	001010000101
	48	001000010001	1	001000010010	6	135	001010000101
	49	001000010001	2	001000010010	7	113	001010000101
60	50	001000010001	3	001000010100	8	114	001010000101
	51	001000010001	4	001000010100	9	115	001010000101
	52	001000010101	0	001000010100	10	116	001010000101
	53	001000010101	1	001000010100	11	140	001010000101
	54	001000010101	2	001000010100	12	118	001010000101
65	55	001000010101	3	001000010100	13	119	001010000101
	56	001000010101	4	001000010100	14	120	001010000101
	57	001001000000	8	001000010100	15	121	001010000101
	58	001001000000	9	001000010001	0	145	001010000101
	59	001001000000	10	001000010001	1	123	001010000101
70	60	001001000000	11	001000010001	2	124	001010010001
	61	001001000000	12	001000010001	3	125	001010010001
	62	001001000000	13	001000010001	4	126	001010010001
	63	001001000000	14	001000010001	0	150	001010010001
75							

19

State S03 Part-1: Entries 0- 31				State S03 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0 001010010010	0 001010000010	0	64 010000001000	14 010000001010	5	
	1 001010010010	1 001010000010	1	65 010000001000	15 010000001010	6	
	2 001010010010	2 001010000010	2	66 010000001000	8 010000010001	0	
	3 001010010010	3 001010000010	3	67 010000001000	9 010000010001	1	
	4 001010010010	4 001010000010	4	68 010000001000	10 010000010001	2	
10	5 001010010010	5 001010000010	5	69 010000001000	11 010000010001	3	
	6 001010010010	6 001010000010	6	70 010000001000	12 010000010001	4	
	7 001010010010	7 001010000010	7	71 010000001000	13 010000010010	0	
	8 001010010100	8 001010000100	8	72 010000001000	14 010000010010	1	
	9 001010010100	9 001010000100	9	73 010000001000	15 010000010010	2	
15	10 001010010100	10 001010000100	10	74 010000010101	0 010000010010	3	
	11 001010010100	11 001010000100	11	75 010000010101	1 010000010010	4	
	12 001010010100	12 001010000100	12	76 010000010101	2 010000010010	5	
	13 001010010100	13 001010000100	13	77 010000010000	8 010000010010	6	
	14 001010010100	14 001010000100	14	78 010000010000	9 010000010010	7	
20	15 001010010100	15 001010000100	15	79 010000010000	10 010000010100	8	
	16 001010100001	0 001010001000	8	80 010000010000	11 010000010100	9	
	17 001010100001	1 001010001000	9	81 010000010000	12 010000010100	10	
	18 001010100001	2 001010001000	10	82 010000010000	13 010000010100	11	
	19 001010100001	3 001010001000	11	83 010000010000	14 010000010100	12	
25	20 001010100001	4 001010001000	12	84 010000010000	15 010000010100	13	
	21 001010100010	0 001010001000	13	85 010000010010	0 010000010100	14	
	22 001010100010	1 001010001000	14	86 010000010010	1 010000010100	15	
	23 001010100010	2 001010001000	15	87 010000010010	2 010000010001	0	
	24 001010100010	3 001010010000	8	88 010000010010	3 010000010001	1	
30	25 001010100010	4 001010010000	9	89 010000010001	0 010000010001	2	
	26 001010100010	5 001010010000	10	90 010000010100	1 010000010001	3	
	27 001010100010	6 001010010000	11	91 010000010101	2 010000010001	4	
	28 001010100010	7 001010010000	12	92 010000010101	3 010000010010	0	
	29 001010100100	8 001010010000	13	93 010000010101	4 010000010010	1	
35	30 001010100100	9 001010010000	14	94 010000010101	0 010000010010	2	
	31 001010100100	10 001010010000	15	95 010000010101	1 010000010010	3	
State S03 Part-2: Entries 32- 63				State S03 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32 001010100100	11 001010010101	0	96 010000010101	2 010000010001	4	
	33 001010100100	12 001010010101	1	97 010000010101	3 010000010001	5	
	34 001010100100	13 001010010101	2	98 010000010101	4 010000010001	6	
45	35 001010100100	14 001010100000	8	99 010000010000	8 010000010001	7	
	36 001010100100	15 001010100000	9	100 010000010000	9 010000010010	8	
	37 010000000001	0 001010100000	10	101 010000010000	10 010000010010	9	
	38 010000000001	1 001010100000	11	102 010000010000	11 010000010010	10	
	39 010000000001	2 001010100000	12	103 010000010000	12 010000010010	11	
50	40 010000000001	3 001010100000	13	104 010000010000	13 010000010010	12	
	41 010000000001	4 001010100000	14	105 010000010000	14 010000010010	13	
	42 010000000010	0 001010100000	15	106 010000010010	0 010000010010	14	
	43 010000000010	1 001010100101	0	107 010000010010	1 010000010010	15	
	44 010000000010	2 001010100101	1	108 010000010010	2 010000010000	8	
55	45 010000000010	3 001010100101	2	109 010000010010	3 010000010000	9	
	46 010000000010	4 001010100101	3	110 010000010010	0 010000010000	10	
	47 010000000010	5 010000000000	8	111 010000010001	1 010000010000	11	
	48 010000000010	6 010000000000	9	112 010000010001	2 010000010000	12	
	49 010000000010	7 010000000000	10	113 010000010001	3 010000010000	13	
60	50 010000000100	8 010000000101	0	114 010000010001	4 010000010000	14	
	51 010000000100	9 010000000101	1	115 010000010010	0 010000010000	15	
	52 010000000100	10 010000000101	2	116 010000010010	1 010000000001	0	
	53 010000000100	11 010000000101	3	117 010000010010	2 010000000001	1	
	54 010000000100	12 010000000101	0	118 010000010010	3 010000000001	2	
65	55 010000000100	13 010000000101	1	119 010000010010	4 010000000001	3	
	56 010000000100	14 010000000101	2	120 010000010010	5 010000000001	4	
	57 010000000100	15 010000000101	3	121 010000010010	6 010000000010	0	
	58 010000000100	8 010000000101	4	122 010000010001	0 010000000010	1	
	59 010000000100	9 010000000101	0	123 010000010001	1 010000000010	2	
70	60 010000000100	10 010000000101	1	124 010000010001	2 010000000010	3	
	61 010000000100	11 010000000101	2	125 010000010001	3 010000000010	4	
	62 010000000100	12 010000000101	3	126 010000010001	4 010000000010	5	
	63 010000000100	13 010000000101	4	127 010000010010	0 010000000010	6	

75

20

State S04 Part-1: Entries 0- 31					State S04 Part-3: Entries 64- 95						
Even		Odd		80	Even		Odd				
5	0	010001010100	8	010001000100	8	64	010010100010	7	010010100000	8	
	1	010001010100	9	010001000100	9	65	010010100100	8	010010100000	9	
	2	010001010100	10	010001000100	10	66	010010100100	9	010010100000	10	
	3	010001010100	11	010001000100	11	67	010010100100	10	010010100000	11	
10	4	010001010100	12	010001000100	12	68	010010100100	11	010010100000	12	
	5	010001010100	13	010001000100	13	69	010010100100	12	010010100000	13	
	6	010001010100	14	010001000100	14	70	010010100100	13	010010100000	14	
	7	010001010100	15	010001000100	15	71	010010100100	14	010010100000	15	
15	8	010010000000	8	010001001000	8	90	72	010010100100	15	010010100101	0
	9	010010000000	9	010001001000	9	73	010010101000	8	010010100101	1	
	10	010010000000	10	010001001000	10	74	010010101000	9	010010100101	2	
	11	010010000000	11	010001001000	11	75	010010101000	10	010010100101	3	
20	12	010010000000	12	010001001000	12	95	76	010010101000	11	010010101001	0
	13	010010000000	13	010001001000	13	77	010010101000	12	010010101001	1	
	14	010010000000	14	010001001000	14	78	010010101000	13	010010101001	2	
	15	010010000101	0	010001001000	15	79	010010101000	14	010010101001	3	
25	16	010010000101	1	010001010000	8	100	80	010010101000	15	010010101001	4
	17	010010000101	2	010001010000	9	81	010100000000	8	010100000001	0	
	18	010010000101	3	010001010000	10	82	010100000000	9	010100000001	1	
	19	010010000101	0	010001010000	11	83	010100000000	10	010100000001	2	
30	20	010010000101	1	010001010000	12	110	84	010100000000	11	010100000001	3
	21	010010000101	2	010001010000	13	85	010100000000	12	010100000001	4	
	22	010010000101	3	010001010000	14	105	86	010100000000	13	010100000010	0
	23	010010000101	4	010001010000	15	87	010100000101	0	010100000010	1	
35	24	010010000101	0	010010000001	0	88	010100000101	1	010100000010	2	
	25	010010000101	1	010010000001	1	89	010100000101	2	010100000010	3	
	26	010010000101	2	010010000001	2	90	010100000101	3	010100000010	4	
	27	010010000101	3	010010000001	3	91	010100000101	0	010100000010	5	
40	28	010010000101	4	010010000001	4	110	92	010100000101	1	010100000010	6
	29	010010000101	5	010010000010	0	93	010100000101	2	010100000010	7	
	30	010010000101	6	010010000010	1	94	010100000101	3	010100000100	8	
	31	010010010001	0	010010000010	2	95	010100000101	4	010100000100	9	
State S04 Part-2: Entries 32- 63					115	State S04 Part-4: Entries 96-127					
Even		Odd			Even		Odd				
40	32	010010010001	1	010010000010	3	96	010100000101	0	010100000100	10	
	33	010010010001	2	010010000010	4	120	97	010100000101	1	010100000100	11
	34	010010010001	3	010010000010	5	98	010100000101	2	010100000100	12	
	35	010010010001	4	010010000010	6	99	010100000101	3	010100000100	13	
45	36	010010010010	0	010010000010	7	100	010100000101	4	010100000100	14	
	37	010010010010	1	010010000010	8	101	010100000101	5	010100000100	15	
	38	010010010010	2	010010000010	9	125	102	010100000101	6	010100000100	8
	39	010010010010	3	010010000010	10	103	010100010001	0	010100000100	9	
50	40	010010010010	4	010010000010	11	104	010100010001	1	010100000100	10	
	41	010010010010	5	010010000010	12	105	010100010001	2	010100000100	11	
	42	010010010010	6	010010000010	13	106	010100010001	3	010100000100	12	
	43	010010010010	7	010010000010	14	130	107	010100010001	4	010100000100	13
55	44	010010010100	8	010010000010	15	108	010100010010	0	010100000100	14	
	45	010010010100	9	010010000100	8	109	010100010010	1	010100000100	15	
	46	010010010100	10	010010000100	9	110	010100010010	2	010100010000	8	
	47	010010010100	11	010010000100	10	111	010100010010	3	010100010000	9	
60	48	010010010100	12	010010000100	11	135	112	010100010010	4	010100010000	10
	49	010010010100	13	010010000100	12	113	010100010010	5	010100010000	11	
	50	010010010100	14	010010000100	13	114	010100010010	6	010100010000	12	
	51	010010010100	15	010010000100	14	115	010100010010	7	010100010000	13	
65	52	010010100001	0	010010000100	15	116	010100010100	8	010100010000	14	
	53	010010100001	1	010010010000	8	140	117	010100010100	9	010100010000	15
	54	010010100001	2	010010010000	9	118	010100010100	10	010100010101	0	
	55	010010100001	3	010010010000	10	119	010100010100	11	010100010101	1	
70	56	010010100001	4	010010010000	11	120	010100010100	12	010100010101	2	
	57	010010100010	0	010010010000	12	145	121	010100010100	13	010100100000	8
	58	010010100010	1	010010010000	13	122	010100010100	14	010100100000	9	
	59	010010100010	2	010010010000	14	123	010100010100	15	010100100000	10	
	60	010010100010	3	010010010000	15	124	010100100001	0	010100100000	11	
	61	010010100010	4	010010010101	0	125	010100100001	1	010100100000	12	
	62	010010100010	5	010010010101	1	126	010100100001	2	010100100000	13	
	63	010010100010	6	010010010101	2	150	127	010100100001	3	010100100000	14

75

21

State S05 Part-1: Entries 0- 31					State S05 Part-3: Entries 64- 95					
Even		Odd		80	Even		Odd			
5	0	010100100010	0	010100100101	0	64	100000000010	6	100000010010	6
	1	010100100010	1	010100100101	1	65	100000000010	7	100000010010	7
	2	010100100010	2	010100100101	2	66	1000000000100	8	100000010100	8
	3	010100100010	3	010100100101	3	67	1000000000100	9	100000010100	9
	4	010100100010	4	010100101001	0	68	1000000000100	10	100000010100	10
10	5	010100100010	5	010100101001	1	69	1000000000100	11	100000010100	11
	6	010100100010	6	010100101001	2	70	1000000000100	12	100000010100	12
	7	010100100010	7	010100101001	3	71	1000000000100	13	100000010100	13
	8	010100100100	8	010100101001	4	72	1000000000100	14	100000010100	14
	9	010100100100	9	010100101010	0	73	1000000000100	15	100000010100	15
15	10	010100100100	10	010100101010	1	74	1000000001000	8	100000100001	0
	11	010100100100	11	010100101010	2	75	1000000001000	9	100000100001	1
	12	010100100100	12	010100101010	3	76	1000000001000	10	100000100001	2
	13	010100100100	13	010100101010	4	77	1000000001000	11	100000100001	3
	14	010100100100	14	010101000000	8	78	1000000001000	12	100000100001	4
20	15	010100100100	15	010101000000	9	79	1000000001000	13	100000100010	0
	16	010100101000	8	010101000000	10	80	1000000001000	14	100000100010	1
	17	010100101000	9	010101000000	11	81	1000000001000	15	100000100010	2
	18	010100101000	10	010101000000	12	82	1000000010000	8	100000100010	3
	19	010100101000	11	010101000000	13	83	1000000010000	9	100000100010	4
25	20	010100101000	12	010101000000	14	84	1000000010000	10	100000100010	5
	21	010100101000	13	0101010000101	0	85	1000000010000	11	100000100010	6
	22	010100101000	14	0101010000101	1	86	1000000010000	12	100000100010	7
	23	010100101000	15	0101010000101	2	87	1000000010000	13	100000100010	8
	24	010101000001	0	0101010000101	3	88	1000000010000	14	100000100010	9
30	25	010101000001	1	0101010001001	0	89	1000000010000	15	100000100010	10
	26	010101000001	2	0101010001001	1	90	1000000010101	0	100000100010	11
	27	010101000001	3	0101010001001	2	91	1000000010101	1	100000100010	12
	28	010101000001	4	0101010001001	3	92	1000000010101	2	100000100010	13
	29	010101000010	0	0101010001001	4	93	1000000100000	8	100000100010	14
35	30	010101000010	1	0101010001010	0	94	1000000100000	9	100000100010	15
	31	010101000010	2	0101010001010	1	95	1000000100000	10	100000101000	8
State S05 Part-2: Entries 32- 63					115	State S05 Part-4: Entries 96-127				
Even		Odd			Even		Odd			
40	32	010101000010	3	0101010001010	2	96	1000000100000	11	1000000101000	9
	33	010101000010	4	0101010001010	3	97	1000000100000	12	1000000101000	10
	34	010101000010	5	0101010001010	4	98	1000000100000	13	1000000101000	11
	35	010101000010	6	0101010001010	5	99	1000000100000	14	1000000101000	12
	36	010101000010	7	0101010001010	6	100	1000000100000	15	1000000101000	13
45	37	0101010000100	8	1000000000101	0	101	10000001000101	0	1000000101000	14
	38	0101010000100	9	1000000000101	1	102	10000001000101	1	1000000101000	15
	39	0101010000100	10	1000000000101	2	103	10000001000101	2	1000001000001	0
	40	0101010000100	11	1000000000101	3	104	10000001000101	3	1000001000001	1
	41	0101010000100	12	10000000001001	0	105	1000000101001	0	1000001000001	2
50	42	0101010000100	13	10000000001001	1	106	1000000101001	1	1000001000001	3
	43	0101010000100	14	10000000001001	2	107	1000000101001	2	1000001000001	4
	44	0101010000100	15	10000000001001	3	108	1000000101001	3	1000001000001	0
	45	0101010001000	8	10000000001001	4	109	1000000101001	4	1000001000001	1
	46	0101010001000	9	10000000001010	0	110	1000000101010	0	1000001000001	2
55	47	0101010001000	10	10000000001010	1	111	1000000101010	1	1000001000001	3
	48	0101010001000	11	10000000001010	2	112	1000000101010	2	1000001000001	4
	49	0101010001000	12	10000000001010	3	113	1000000101010	3	1000001000001	5
	50	0101010001000	13	10000000001010	4	114	1000000101010	4	1000001000001	6
	51	0101010001000	14	10000000001010	5	115	1000001000000	8	1000001000001	7
60	52	0101010001000	15	10000000001010	6	116	1000001000000	9	1000001000001	8
	53	1000000000001	0	1000000010001	0	117	1000001000000	10	1000001000001	9
	54	1000000000001	1	1000000010001	1	118	1000001000000	11	1000001000001	10
	55	1000000000001	2	1000000010001	2	119	1000001000000	12	1000001000001	11
	56	1000000000001	3	1000000010001	3	120	1000001000000	13	1000001000001	12
65	57	1000000000001	4	1000000010001	4	121	1000001000000	14	1000001000001	13
	58	1000000000010	0	1000000010010	0	122	10000010000101	0	1000001000001	14
	59	1000000000010	1	1000000010010	1	123	10000010000101	1	1000001000001	15
	60	1000000000010	2	1000000010010	2	124	10000010000101	2	1000001000001	8
	61	1000000000010	3	1000000010010	3	125	10000010000101	3	1000001000001	9
70	62	1000000000010	4	1000000010010	4	126	100000100001001	0	1000001000001	10
	63	1000000000010	5	1000000010010	5	127	100000100001001	1	1000001000001	11

75

22

State S06 Part-1: Entries 0- 31				State S06 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0	100001001010	0	100001010000	8	64	100010010100
	1	100001001010	1	100001010000	9	65	100010010100
	2	100001001010	2	100001010000	10	66	100010010100
	3	100001001010	3	100001010000	11	67	100010010100
	4	100001001010	4	100001010000	12	68	100010010100
10	5	100001001010	5	100001010000	13	69	100010010100
	6	100001001010	6	100001010000	14	70	100010010100
	7	100001010001	0	100001010000	15	71	100010010100
	8	100001010001	1	100010000001	0	72	100010100001
	9	100001010001	2	100010000001	1	73	100010100001
15	10	100001010001	3	100010000001	2	74	100010100001
	11	100001010001	4	100010000001	3	75	100010100001
	12	100001010010	0	100010000001	4	76	100010100001
	13	100001010010	1	100010000010	0	77	100010100010
	14	100001010010	2	100010000010	1	78	100010100010
20	15	100001010010	3	100010000010	2	79	100010100010
	16	100001010010	4	100010000010	3	80	100010100010
	17	100001010010	5	100010000010	4	81	100010100010
	18	100001010010	6	100010000010	5	82	100010100010
	19	100001010010	7	100010000010	6	83	100010100010
25	20	100001010100	8	100010000010	7	84	100010100010
	21	100001010100	9	100010000010	8	85	100010100010
	22	100001010100	10	100010000010	9	86	100010100010
	23	100001010100	11	100010000010	10	87	100010100010
	24	100001010100	12	100010000010	11	88	100010100010
30	25	100001010100	13	100010000010	12	89	100010100010
	26	100001010100	14	100010000010	13	90	100010100010
	27	100001010100	15	100010000010	14	91	100010100010
	28	100010000000	8	100010000010	15	92	100010100010
	29	100010000000	9	100010000100	8	93	100010101000
35	30	100010000000	10	100010000100	9	94	100010101000
	31	100010000000	11	100010000100	10	95	100010101000
State S06 Part-2: Entries 32- 63				State S06 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32	100010000000	12	100010000100	11	100100010000	10
	33	100010000000	13	100010000100	12	100100010000	11
	34	100010000000	14	100010000100	13	100100010000	12
45	35	100010000101	0	100010000100	14	100100010000	13
	36	100010000101	1	100010000100	15	100100010000	14
	37	100010000101	2	100010000100	8	100100010000	15
	38	100010000101	3	100010000100	9	100100010101	0
	39	100010000101	0	100010000100	10	100100010101	1
50	40	100010000101	1	100010000100	11	100100010101	2
	41	100010000101	2	100010000100	12	100100100000	8
	42	100010000101	3	100010000100	13	100100100000	9
	43	100010000101	4	100010000100	14	100100100000	10
	44	100010000101	0	100010000100	15	100100100000	11
55	45	100010000101	1	100010000101	0	100100100000	12
	46	100010000101	2	100010000101	1	100100100000	13
	47	100010000101	3	100010000101	2	100100100000	14
	48	100010000101	4	100010100000	8	100100100000	15
	49	100010000101	5	100010100000	9	100100100101	0
60	50	100010000101	6	100010100000	10	100100100101	1
	51	100010010001	0	100010100000	11	100100100101	2
	52	100010010001	1	100010100000	12	100100100101	3
	53	100010010001	2	100010100000	13	100100101001	0
	54	100010010001	3	100010100000	14	100100101001	1
65	55	100010010001	4	100010100000	15	100100101001	2
	56	100010010010	0	100010100101	0	100100101001	3
	57	100010010010	1	100010100101	1	100100101001	4
	58	100010010010	2	100010100101	2	100100101010	0
	59	100010010010	3	100010100101	3	100100101010	1
70	60	100010010010	4	100010101001	0	100100101010	2
	61	100010010010	5	100010101001	1	100100101010	3
	62	100010010010	6	100010101001	2	100100101010	4
	63	100010010010	7	100010101001	3	100101000000	8

75

23

State S07 Part-1: Entries 0- 31				State S07 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0 100100010010	0 100101000101	0	64 100101000100	14 101000010000	14	
	1 100100010010	1 100101000101	1	65 100101000100	15 101000010000	15	
	2 100100010010	2 100101000101	2	66 100101000100	8 101000010101	0	
	3 100100010010	3 100101000101	3	67 100101000100	9 101000010101	1	
	4 100100010010	4 100101000101	0	68 100101000100	10 101000010101	2	
10	5 100100010010	5 100101000101	1	69 100101000100	11 101000010000	8	
	6 100100010010	6 100101000101	2	70 100101000100	12 101000010000	9	
	7 100100010010	7 100101000101	3	71 100101000100	13 101000010000	10	
	8 100100010100	8 100101000101	4	72 100101000100	14 101000010000	11	
	9 100100010100	9 100101000101	0	73 100101000100	15 101000010000	12	
15	10 100100010100	10 100101000101	1	74 100101010000	8 101000010000	13	
	11 100100010100	11 100101000101	2	75 100101010000	9 101000010000	14	
	12 100100010100	12 100101000101	3	76 100101010000	10 101000010000	15	
	13 100100010100	13 100101000101	4	77 100101010000	11 101000010010	0	
	14 100100010100	14 100101000101	5	78 100101010000	12 101000010010	1	
20	15 100100010100	15 100101000101	6	79 100101010000	13 101000010010	2	
	16 100100100001	0 100101010001	0	80 100101010000	14 101000010010	3	
	17 100100100001	1 100101010001	1	81 100101010000	15 101000010010	0	
	18 100100100001	2 100101010001	2	82 101000000000	8 101000010010	1	
	19 100100100001	3 100101010001	3	83 101000000000	9 101000010010	2	
25	20 100100100001	4 100101010001	4	84 101000000000	10 101000010010	3	
	21 100100100010	0 100101010010	0	85 101000000000	11 101000010010	4	
	22 100100100010	1 100101010010	1	86 101000000000	12 101000010101	0	
	23 100100100010	2 100101010010	2	87 101000000101	0 101000010101	1	
	24 100100100010	3 100101010010	3	88 101000000101	1 101000010101	2	
30	25 100100100010	4 100101010010	4	89 101000000101	2 101000010101	3	
	26 100100100010	5 100101010010	5	90 101000000101	3 101000010101	4	
	27 100100100010	6 100101010010	6	91 101000000101	0 101000010000	8	
	28 100100100010	7 100101010010	7	92 101000000101	1 101000010000	9	
	29 100100100100	8 101000000001	0	93 101000000101	2 101000010000	10	
35	30 100100100100	9 101000000001	1	94 101000000101	3 101000010000	11	
	31 100100100100	10 101000000001	2	95 101000000101	4 101000010000	12	
State S07 Part-2: Entries 32- 63				State S07 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32 100100100100	11 101000000001	3	96 101000000101	0 101001000000	13	
	33 100100100100	12 101000000001	4	97 101000000101	1 101001000000	14	
	34 100100100100	13 101000000001	0	98 101000000101	2 101001000101	0	
45	35 100100100100	14 101000000010	1	99 101000000101	3 101001000101	1	
	36 100100100100	15 101000000010	2	100 101000000101	4 101001000101	2	
	37 100100101000	8 101000000010	3	101 101000000101	5 101001000101	3	
	38 100100101000	9 101000000010	4	102 101000000101	6 101001000101	0	
	39 100100101000	10 101000000010	5	103 101000000101	0 101001000101	1	
50	40 100100101000	11 101000000010	6	104 101000000101	1 101001000101	2	
	41 100100101000	12 101000000010	7	105 101000000101	2 101001000101	3	
	42 100100101000	13 101000000100	8	106 101000000101	3 101001000101	4	
	43 100100101000	14 101000000100	9	107 101000000101	4 101001000101	0	
	44 100100101000	15 101000000100	10	108 101000000101	0 101001000101	1	
55	45 100101000001	0 101000000100	11	109 101000000101	1 101001000101	2	
	46 100101000001	1 101000000100	12	110 101000000101	2 101001000101	3	
	47 100101000001	2 101000000100	13	111 101000000101	3 101001000101	4	
	48 100101000001	3 101000000100	14	112 101000000101	4 101001000101	5	
	49 100101000001	4 101000000100	15	113 101000000101	5 101001000101	6	
60	50 100101000010	0 101000000100	8	114 101000000101	6 101001000001	0	
	51 100101000010	1 101000000100	9	115 101000000101	7 101001000001	1	
	52 100101000010	2 101000000100	10	116 101000000101	8 101001000001	2	
	53 100101000010	3 101000000100	11	117 101000000101	9 101001000001	3	
	54 100101000010	4 101000000100	12	118 101000000101	10 101001000001	4	
65	55 100101000010	5 101000000100	13	119 101000000101	11 101001000001	0	
	56 100101000010	6 101000000100	14	120 101000000101	12 101001000001	1	
	57 100101000010	7 101000000100	15	121 101000000101	13 101001000001	2	
	58 100101000010	8 101000000100	8	122 101000000101	14 101001000001	3	
	59 100101000010	9 101000000100	9	123 101000000101	15 101001000001	4	
70	60 100101000010	10 101000000100	10	124 101000000101	0 101001000001	5	
	61 100101000010	11 101000000100	11	125 101000000101	1 101001000001	6	
	62 100101000010	12 101000000100	12	126 101000000101	2 101001000001	7	
	63 100101000010	13 101000000100	13	127 101000000101	3 101001000001	8	

75

24

State S08 Part-1: Entries 0- 31				State S08 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0 100001001010	0 100001010000	8	64 1000000000010	6 100000010010	6	
	1 100001001010	1 100001010000	9	65 1000000000010	7 100000010010	7	
	2 100001001010	2 100001010000	10	66 1000000000100	8 100000010100	8	
	3 100001001010	3 100001010000	11	67 1000000000100	9 100000010100	9	
	4 100001001010	4 100001010000	12	68 1000000000100	10 100000010100	10	
10	5 100001001010	5 100001010000	13	69 1000000000100	11 100000010100	11	
	6 100001001010	6 100001010000	14	70 1000000000100	12 100000010100	12	
	7 100001010001	0 100001010000	15	71 1000000000100	13 100000010100	13	
	8 100001010001	1 100010000001	0	72 1000000000100	14 100000010100	14	
	9 100001010001	2 100010000001	1	73 1000000000100	15 100000010100	15	
15	10 100001010001	3 100010000001	2	74 1000000001000	8 100000100001	0	
	11 100001010001	4 100010000001	3	75 1000000001000	9 100000100001	1	
	12 100001010010	0 100010000001	4	76 1000000001000	10 100000100001	2	
	13 100001010010	1 100010000010	0	77 1000000001000	11 100000100001	3	
	14 100001010010	2 100010000010	1	78 1000000001000	12 100000100001	4	
20	15 100001010010	3 100010000010	2	79 1000000001000	13 100000100010	0	
	16 100001010010	4 100010000010	3	80 1000000001000	14 100000100010	1	
	17 100001010010	5 100010000010	4	81 1000000001000	15 100000100010	2	
	18 100001010010	6 100010000010	5	82 1000000001000	8 100000100010	3	
	19 100001010010	7 100010000010	6	83 1000000001000	9 100000100010	4	
25	20 100001010100	8 100010000010	7	84 1000000001000	10 100000100010	5	
	21 100001010100	9 100010000100	8	85 1000000001000	11 100000100010	6	
	22 100001010100	10 100010000100	9	86 1000000001000	12 100000100010	7	
	23 100001010100	11 100010000100	10	87 1000000001000	13 100000100100	8	
	24 100001010100	12 100010000100	11	88 1000000001000	14 100000100100	9	
30	25 100001010100	13 100010000100	12	89 1000000001000	15 100000100100	10	
	26 100001010100	14 100010000100	13	90 1000000010101	0 100000100100	11	
	27 100001010100	15 100010000100	14	91 1000000010101	1 100000100100	12	
	28 100010000000	8 100010000100	15	92 1000000010101	2 100000100100	13	
	29 100010000000	9 100010001000	8	93 100000100000	8 100000100100	14	
35	30 100010000000	10 100010001000	9	94 100000100000	9 100000100100	15	
	31 100010000000	11 100010001000	10	95 100000100000	10 100000100100	8	
State S08 Part-2: Entries 32- 63				State S08 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32 100010000000	12 100010001000	11	96 100000100000	11 100000101000	9	
	33 100010000000	13 100001001000	13	97 100000100000	12 100000101000	10	
	34 100010000000	14 100001001000	14	98 100000100000	13 100000101000	11	
45	35 1000100000101	0 100001001000	15	99 100000100000	14 100000101000	12	
	36 1000100000101	1 100001001000	12	100 100000100000	15 100000101000	13	
	37 1000100000101	2 1000000000101	0	101 100000100101	0 100000101000	14	
	38 1000100000101	3 1000000000101	1	102 100000100101	1 100000101000	15	
	39 100010001001	0 1000000000101	2	103 100000100101	2 100001000001	0	
50	40 100010001001	1 1000000000101	3	104 100000100101	3 100001000001	1	
	41 100010001001	2 1000000001001	0	105 100000101001	0 100001000001	2	
	42 100010001001	3 1000000001001	1	106 100000101001	1 100001000001	3	
	43 100010001001	4 1000000001001	2	107 100000101001	2 100001000001	4	
	44 100010001010	0 1000000001001	3	108 100000101001	3 100001000010	0	
55	45 100010001010	1 1000000001001	4	109 100000101001	4 100001000010	1	
	46 100010001010	2 1000000001010	0	110 100000101010	0 100001000010	2	
	47 100010001010	3 1000000001010	1	111 100000101010	1 100001000010	3	
	48 100010001010	4 1000000001010	2	112 100000101010	2 100001000010	4	
	49 100010001010	5 1000000001010	3	113 100000101010	3 100001000010	5	
60	50 100001001001	4 1000000001010	4	114 100000101010	4 100001000010	6	
	51 100001001001	2 1000000001010	5	115 100001000000	8 100001000010	7	
	52 100001001001	3 1000000001010	6	116 100001000000	9 100001000100	8	
	53 1000000000001	0 100000010001	0	117 100001000000	10 100001000100	9	
	54 1000000000001	1 100000010001	1	118 100001000000	11 100001000100	10	
65	55 1000000000001	2 100000010001	2	119 100001000000	12 100001000100	11	
	56 1000000000001	3 100000010001	3	120 100001000000	13 100001000100	12	
	57 1000000000001	4 100000010001	4	121 100001000000	14 100001000100	13	
	58 1000000000010	0 100000010010	0	122 100001000101	0 100001000100	14	
	59 1000000000010	1 100000010010	1	123 100001000101	1 100001000100	15	
70	60 1000000000010	2 100000010010	2	124 100001000101	2 100001001000	8	
	61 1000000000010	3 100000010010	3	125 100001000101	3 100001001000	9	
	62 1000000000010	4 100000010010	4	126 100001001001	0 100001001000	10	
	63 1000000000010	5 100000010010	5	127 100001001001	1 100001001000	11	

75

25

State S09 Part-1: Entries 0- 31				State S09 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0 100100010010	0 100101000101	0	64 100010010100	8 100010101001	4	
	1 100100010010	1 100101000101	1	65 100010010100	9 100100000001	0	
	2 100100010010	2 100101000101	2	66 100010010100	10 100100000001	1	
	3 100100010010	3 100101000101	3	67 100010010100	11 100100000001	2	
	4 100100010010	4 100101000101	0	68 100010010100	12 100100000001	3	
10	5 100100010010	5 100101000101	1	69 100010010100	13 100100000001	4	
	6 100100010010	6 100101000101	2	70 100010010100	14 100100000010	0	
	7 100100010010	7 100101000101	3	71 100010010100	15 100100000010	1	
	8 100100010100	8 100101000101	4	72 100010100001	0 100100000010	2	
	9 100100010100	9 100101000101	0	73 100010100001	1 100100000010	3	
15	10 100100010100	10 100101000101	1	74 100010100001	2 100100000010	4	
	11 100100010100	11 100101000101	2	75 100010100001	3 100100000010	5	
	12 100100010100	12 100101000101	3	76 100010100001	4 100100000010	6	
	13 100100010100	13 100101000101	4	77 100010100010	0 100100000010	7	
	14 100100010100	14 100101000101	5	78 100010100010	1 100100000100	8	
20	15 100100010100	15 100101000101	6	79 100010100010	2 100100000100	9	
	16 100100100001	0 100101010001	0	80 100010100010	3 100100000100	10	
	17 100100100001	1 100101010001	1	81 100010100010	4 100100000100	11	
	18 100100100001	2 100101010001	2	82 100010100010	5 100100000100	12	
	19 100100100001	3 100101010001	3	83 100010100010	6 100100000100	13	
25	20 100100100001	4 100101010001	4	84 100010100010	7 100100000100	14	
	21 100100100010	0 100101010010	0	85 100010100100	8 100100000100	15	
	22 100100100010	1 100101010010	1	86 100010100100	9 100100001000	8	
	23 100100100010	2 100101010010	2	87 100010100100	10 100100001000	9	
	24 100100100010	3 100101010010	3	88 100010100100	11 100100001000	10	
30	25 100100100010	4 100101010010	4	89 100010100100	12 100100001000	11	
	26 100100100010	5 100101010010	5	90 100010100100	13 100100001000	12	
	27 100100100010	6 100101010010	6	91 100010100100	14 100100001000	13	
	28 100100100010	7 100101010010	7	92 100010100100	15 100100001000	14	
	29 100100100100	8 101000000001	0	93 100010101000	8 100100001000	15	
35	30 100100100100	9 101000000001	1	94 100010101000	9 100100010000	8	
	31 100100100100	10 100101000000	14	95 100010101000	10 100100010000	9	
State S09 Part-2: Entries 32- 63				State S09 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32 100100100100	11 100101000000	11	96 100010101000	11 100100010000	10	
	33 100100100100	12 100101000000	12	97 100010101000	12 100100010000	11	
	34 100100100100	13 100101000000	13	98 100010101000	13 100100010000	12	
45	35 100100100100	14 100101000000	9	99 100010101000	14 100100010000	13	
	36 100100100100	15 100101000000	10	100 100010101000	15 100100010000	14	
	37 100100101000	8 100010010000	8	101 100100000000	8 100100010000	15	
	38 100100101000	9 100010010000	9	102 100100000000	9 100100010101	0	
	39 100100101000	10 100010010000	10	103 100100000000	10 100100010101	1	
50	40 100100101000	11 100010010000	11	104 100100000000	11 100100010101	2	
	41 100100101000	12 100010010000	12	105 100100000000	12 100100100000	8	
	42 100100101000	13 100010010000	13	106 100100000000	13 100100100000	9	
	43 100100101000	14 100010010000	14	107 100100000101	0 100100100000	10	
	44 100100101000	15 100010010000	15	108 100100000101	1 100100100000	11	
55	45 100101000001	0 100010010101	0	109 100100000101	2 100100100000	12	
	46 100101000001	1 100010010101	1	110 100100000101	3 100100100000	13	
	47 100101000001	2 100010010101	2	111 100100000101	0 100100100000	14	
	48 100101000001	3 100010100000	8	112 100100000101	1 100100100000	15	
	49 100101000001	4 100010100000	9	113 100100000101	2 100100100101	0	
60	50 100101000010	0 100010100000	10	114 100100000101	3 100100100101	1	
	51 100010010001	0 100010100000	11	115 100100000101	4 100100100101	2	
	52 100010010001	1 100010100000	12	116 100100000101	0 100100100101	3	
	53 100010010001	2 100010100000	13	117 100100000101	1 100100101001	0	
	54 100010010001	3 100010100000	14	118 100100000101	2 100100101001	1	
65	55 100010010001	4 100010100000	15	119 100100000101	3 100100101001	2	
	56 100010010010	0 100010100101	0	120 100100000101	4 100100101001	3	
	57 100010010010	1 100010100101	1	121 100100000101	5 100100101001	4	
	58 100010010010	2 100010100101	2	122 100100000101	6 100100101010	0	
	59 100010010010	3 100010100101	3	123 100100010001	0 100100101010	1	
70	60 100010010010	4 100010101001	0	124 100100010001	1 100100101010	2	
	61 100010010010	5 100010101001	1	125 100100010001	2 100100101010	3	
	62 100010010010	6 100010101001	2	126 100100010001	3 100100101010	4	
	63 100010010010	7 100010101001	3	127 100100010001	4 100101000000	8	

75

State S10

Part-1: Entries 0- 31

=====

Even

Odd

=====

5

0 101001001000

8 101010000000

9

1 101001001000

9 101010000000

10

2 101001001000

10 101010000000

11

3 101001001000

11 101010000000

12

4 101001001000

12 101010000000

13

5 101001001000

13 101010000000

14

6 101001001000

14 1010100000101

0

7 101001001000

15 1010100000101

1

8 101001010000

8 1010100000101

2

9 101001010000

9 1010100000101

3

10 101001010000

10 1010100001001

0

11 101001010000

11 1010100001001

1

12 101000100001

4 1010100001001

2

13 101000100010

0 1010100001001

3

14 101000100010

1 1010100001001

4

15 101000100010

2 1010010001010

0

16 101000100010

3 1010100001010

1

17 101000100010

4 1010100001010

2

18 101000100010

5 1010100001010

3

19 101000100010

6 1010100001010

4

20 101000100010

7 1010100001010

5

21 101000100100

8 1010100001010

6

22 101000100100

9 1010100100001

0

23 101000100100

10 1010100100001

1

24 101000100100

11 1010100100001

2

25 101000100100

12 1010100100001

3

26 101000100100

13 1010001010100

9

27 101000100100

14 1010001010100

10

28 101000100100

15 1010001010100

11

29 101000101000

8 1010001010100

12

30 101000101000

9 1010001010100

13

31 101000101000

10 1010001010100

14

State S10

Part-2: Entries 32- 63

=====

Even

Odd

=====

40

32 101000101000

11 1010001010100

15

33 101000101000

12 1010100000000

8

34 101000101000

13 1010000000010

0

35 101000101000

14 1010000000010

1

36 101000101000

15 1010000000010

2

37 1010010000001

0 1010000000010

3

38 1010010000001

1 1010000000010

4

39 1010010000001

2 1010000000010

5

40 1010010000001

3 1010000000010

6

41 1010010000001

4 1010000000010

7

42 1010010000010

0 1010000000100

8

43 1010010000010

1 1010000000100

9

44 1010010000010

2 1010000000100

10

45 1010010000010

3 1010000000100

11

46 1010010000010

4 1010000000100

12

47 1010010000010

5 1010000000100

13

48 1010010000010

6 1010000000100

14

49 1010010000010

7 1010000000100

15

50 1010010000100

8 1010000001000

8

51 1010010000100

9 1010000001000

9

52 1010010000100

10 1010000001000

10

53 1010010000100

11 1010000001000

11

54 1010010000100

12 1010000001000

12

55 10100010000100

13 1010000001000

13

56 1010010000100

14 1010000001000

14

57 1010010000100

15 1010000001000

15

58 1001010000100

8 101000010000

8

59 1001010000100

9 101000010000

9

60 1001010000100

10 101000010000

10

61 1001010000100

11 101000010000

11

62 1001010000100

12 101000010000

12

63 1001010000100

13 101000010000

13

State S10

Part-3: Entries 64- 95

=====

Even

Odd

=====

64 1001010000100

14 101000010000

14

65 1001010000100

15 101000010000

15

66 100101001000

8 101000010101

0

67 100101001000

9 101000010101

1

68 100101001000

10 101000010101

2

69 100101001000

11 101000100000

8

70 100101001000

12 101000100000

9

71 100101001000

13 101000100000

10

72 100101001000

14 101000100000

11

73 100101001000

15 101000100000

12

74 100101010000

8 101000100000

13

75 100101010000

9 101000100000

14

76 100101010000

10 101000100000

15

77 100101010000

11 101000100101

0

78 100101010000

12 101000100101

1

79 100101010000

13 101000100101

2

80 100101010000

14 101000100101

3

81 100101010000

15 101000010101

0

82 101000000000

8 101000101001

1

83 101000000000

9 101000101001

2

84 101000000000

10 101000101001

3

85 101000000000

11 101000101001

4

86 101000000000

12 101000101010

0

87 1010000000101

0 101000101010

1

88 1010000000101

1 101000101010

2

89 1010000000101

2 101000101010

3

90 1010000000101

3 101000101010

4

91 1010000001001

0 101001000000

8

92 1010000001001

1 101001000000

9

93 1010000001001

2 101001000000

10

94 1010000001001

3 101001000000

11

95 1010000001001

4 101001000000

12

State S10

Part-4: Entries 96-127

=====

Even

Odd

=====

96 1010000001010

0 101001000000

13

97 1010000001010

1 101001000000

14

98 1010000001010

2 1010010000101

0

99 1010000001010

3 1010010000101

1

100 1010000001010

4 1010010000101

2

101 1010000001010

5 1010010000101

3

102 1010000001010

6 1010010001001

0

103 1010000001001

0 1010010001001

1

104 1010000100001

1 1010010001001

2

105 10100000010001

2 1010010001001

3

106 10100000010001

3 1010010001001

4

107 10100000010001

4 1010010001010

0

108 10100000010010

0 1010010001010

1

109 10100000010010

1 1010010001010

2

110 10100000010010

2 1010010001010

3

111 10100000010010

3 1010010001010

4

112 10100000010010

4 1010010001010

5

113 10100000010010

5 1010001001010

6

114 10100000010010

6 1010010100001

0

115 10100000010010

7 1010010100001

1

116 10100000010010

8 1010010100001

2

117 10100000010010

9 1010010100001

3

118 10100000010010

10 1010010100001

4

119 10100000010010

11 1010010100010

0

120 10100000010010

12 1010010100010

1

121 10100000010010

13 1010010100010

2

122 10100000010010

14 1010010100010

3

123 10100000010010

15 1010010100010

4

124 10100001000001

0 1010010100010

5

125 10100001000001

1 1010010100010

6

126 10100001000001

2 1010010100010

7

127 10100001000001

3 1010010100010

8

State S10

Part-5: Entries 128- 159

=====

Even

Odd

=====

128 10100001000001

4 1010010100010

9

129 10100001000001

5 1010010100010

10

130 10100001000001

6 1010010100010

11

131 10100001000001

7 1010010100010

12

132 10100001000001

8 1010010100010

13

133 10100001000001

9 1010010100010

14

134 10100001000001

10 1010010100010

15

135 10100001000001

11 1010010100010

16

136 10100001000001

12 1010010100010

17

137 10100001000001

13 1010010100010

18

138 10100001000001

14 1010010100010

19

139 10100001000001

15 1010010100010

20

140 10100001000001

16 1010010100010

21

141 10100001000001

17 1010010100010

22

142 10100001000001

18 1010010100010

23

143 10100001000001

19 1010010100010

24

144 10100001000001

20 1010010100010

25

145 10100001000001

21 1010010100010

26

146 10100001000001

22 1010010100010

27

147 10100001000001

23 1010010100010

28

148 10100001000001

24 1010010100010

29

149 10100001000001

25 1010010100010

30

150 10100001000001

26 1010010100010

31

27

State S11 Part-1: Entries 0- 31				State S11 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0	010001010100	8	010001000100	8	64	010000001000
	1	010001010100	9	010001000100	9	65	010000001000
	2	010001010100	10	010001000100	10	66	010000001000
	3	010001010100	11	010001000100	11	67	010000001000
	4	010001010100	12	010001000100	12	68	010000001000
10	5	010001010100	13	010001000100	13	69	010000001000
	6	010001010100	14	010001000100	14	70	010000001000
	7	010001010100	15	010001000100	15	71	010000001000
	8	010010000000	8	010001001000	8	72	010000001000
	9	010010000000	9	010001001000	9	73	010000001000
15	10	010010000000	10	010001001000	10	74	010000001010
	11	010010000000	11	010001001000	11	75	010000001010
	12	010010000000	12	010001001000	12	76	010000001010
	13	010010000000	13	010001001000	13	77	010000001000
	14	010010000000	14	010001001000	14	78	010000001000
20	15	010010000101	0	010001001000	15	79	010000001000
	16	010010000101	1	010001010000	8	80	010000001000
	17	010010000101	2	010001010000	9	81	010000001000
	18	010010000101	3	010001010000	10	82	010000001000
	19	010010000101	0	010001010000	11	83	010000001000
25	20	010010000101	1	010001010000	12	84	010000001000
	21	010010000101	2	010001010000	13	85	010000001010
	22	010010000101	3	010001010000	14	86	010000001010
	23	010010000101	4	010001010000	15	87	010000001010
	24	010010000101	0	010010000001	0	88	010000001010
30	25	010010000101	1	010010000001	1	89	010000001010
	26	010010000101	2	010010000001	2	90	010000001010
	27	010010000101	3	010010000001	3	91	010000001010
	28	010010000101	4	010010000001	4	92	010000001010
	29	010010000101	5	010010000010	0	93	010000001010
35	30	010001010010	3	010010000010	1	94	010000001010
	31	010001010010	4	010010000010	2	95	010000001010
State S11 Part-2: Entries 32- 63				State S11 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32	010001010010	5	010010000010	3	96	010000001010
	33	010001010010	6	010010000010	4	97	010000001010
	34	010001010010	7	010010000010	5	98	010000001010
45	35	010001010010	1	010010000010	6	99	010001000000
	36	010001010010	2	010010000010	7	100	010001000000
	37	010000000001	0	010010000010	8	101	010001000000
	38	010000000001	1	010010000010	9	102	010001000000
	39	010000000001	2	010010000010	10	103	010001000000
50	40	010000000001	3	010010000010	11	104	010001000000
	41	010000000001	4	010010000010	12	105	010001000000
	42	010000000010	0	010010000010	13	106	010001000010
	43	010000000010	1	010010000010	14	107	010001000010
	44	010000000010	2	010010000010	15	108	010001000010
55	45	010000000010	3	010010000010	8	109	010001000010
	46	010000000010	4	010001000010	7	110	010001000010
	47	010000000010	5	010000000000	8	111	010001000010
	48	010000000010	6	010000000000	9	112	010001000010
	49	010000000010	7	010000000000	10	113	010001000010
60	50	010000000010	8	010000000010	0	114	010001000010
	51	010000000010	9	010000000010	1	115	010001000010
	52	010000000010	10	010000000010	2	116	010001000010
	53	010000000010	11	010000000010	3	117	010001000010
	54	010000000010	12	010000000010	0	118	010001000010
65	55	010000000010	13	010000000010	1	119	010001000010
	56	010000000010	14	010000000010	2	120	010001000010
	57	010000000010	15	010000000010	3	121	010001000010
	58	010000000000	8	010000000010	4	122	010001000001
	59	010000000000	9	010000000010	0	123	010001000001
70	60	010000000000	10	010000000010	1	124	010001000001
	61	010000000000	11	010000000010	2	125	010001000001
	62	010000000000	12	010000000010	3	126	010001000001
	63	010000000000	13	010000000010	4	127	010001000010
75							

		Even		Odd	
5	0	010100100010	0	010100100101	0
	1	010100100010	1	010100100101	1
	2	010100100010	2	010100100101	2
	3	010100100010	3	010100100101	3
	4	010100100010	4	010100101001	0
10	5	010100100010	5	010100101001	1
	6	010100100010	6	010100101001	2
	7	010100100010	7	010100101001	3
	8	010100100100	8	010100101001	4
	9	010100100100	9	010100101010	0
15	10	010100100100	10	010100101010	1
	11	010100100100	11	010100101010	2
	12	010100100100	12	010100101010	3
	13	010100100100	13	010100101010	4
	14	010100100100	14	010101000000	8
20	15	010100100100	15	010101000000	9
	16	010100101000	8	010101000000	10
	17	010100101000	9	010101000000	11
	18	010100101000	10	010101000000	12
	19	010100101000	11	010101000000	13
25	20	010100101000	12	010101000000	14
	21	010100101000	13	010101000101	0
	22	010100101000	14	010101000101	1
	23	010100101000	15	010101000101	2
	24	010101000001	0	010101000101	3
30	25	010101000001	1	010101000101	0
	26	010101000001	2	010101000101	1
	27	010101000001	3	010101000101	2
	28	010101000001	4	010101000101	3
	29	010101000010	0	010101000101	4
35	30	010100100001	4	010101000101	0
	31	010010010001	0	010101001010	1

State S12 Part-3: Entries 64- 95

80	Even	Odd
64	010010100010	7 010010100000
65	010010100100	8 010010100000
66	010010100100	9 010010100000
67	010010100100	10 010010100000
68	010010100100	11 010010100000
69	010010100100	12 010010100000
70	010010100100	13 010010100000
71	010010100100	14 010010100000
72	010010100100	15 010010100101
73	010010101000	8 010010100101
74	010010101000	9 010010100101
75	010010101000	10 010010100101
76	010010101000	11 010010101001
77	010010101000	12 010010101001
78	010010101000	13 010010101001
79	010010101000	14 010010101001
80	010010101000	15 010010101001
81	010100000000	8 010100000001
82	010100000000	9 010100000001
83	010100000000	10 010100000001
84	010100000000	11 010100000001
85	010100000000	12 010100000001
86	010100000000	13 010100000010
87	010100000101	0 010100000010
88	010100000101	1 010100000010
89	010100000101	2 010100000010
90	010100000101	3 010100000010
91	010100001001	0 010100000010
92	010100001001	1 010100000010
93	010100001001	2 010100000010
94	010100001001	3 010100000010
95	010100001001	4 010100000010

State S12 Part-2: Entries 32- 63

40	Even		Odd		
	32	010010010001	1	010101001010	2
	33	010010010001	2	010101001010	3
45	34	010010010001	3	010101001010	4
	35	010010010001	4	010101001010	5
	36	010010010010	0	0101001001010	6
	37	010010010010	1	101010010010	7
	38	010010010010	2	101010010100	8
50	39	010010010010	3	101010010100	9
	40	010010010010	4	101010010100	10
	41	010010010010	5	101010010100	11
	42	010010010010	6	101010010100	12
	43	010010010010	7	101010010100	13
55	44	010010010100	8	101010010100	14
	45	010010010100	9	010100100000	15
	46	010010010100	10	101010010010	0
	47	010010010100	11	101010010010	1
	48	010010010100	12	101010010010	2
60	49	010010010100	13	101010010010	3
	50	010010010100	14	101010010010	4
	51	010010010100	15	101010010010	5
	52	010010100001	0	101010010010	6
	53	010010100001	1	010010010000	8
65	54	010010100001	2	010010010000	9
	55	010010100001	3	010010010000	10
	56	010010100001	4	010010010000	11
	57	010010100010	0	010010010000	12
	58	010010100010	1	010010010000	13
70	59	010010100010	2	010010010000	14
	60	010010100010	3	010010010000	15
	61	010010100010	4	010010010101	0
	62	010010100010	5	010010010101	1
	63	010010100010	6	010010010101	2

115 State S12 Part-4: Entries 96-127

		Even		Odd	
120	96	010100001010	0	010100000100	10
	97	010100001010	1	010100000100	11
	98	010100001010	2	010100000100	12
	99	010100001010	3	010100000100	13
	100	010100001010	4	010100000100	14
	101	010100001010	5	010100000100	15
125	102	010100001010	6	010100001000	8
	103	010100010001	0	010100001000	9
	104	010100010001	1	010100001000	10
	105	010100010001	2	010100001000	11
	106	010100010001	3	010100001000	12
130	107	010100010001	4	010100001000	13
	108	010100010010	0	010100001000	14
	109	010100010010	1	010100001000	15
	110	010100010010	2	010100010000	8
	111	010100010010	3	010100010000	9
135	112	010100010010	4	010100010000	10
	113	010100010010	5	010100010000	11
	114	010100010010	6	010100010000	12
	115	010100010010	7	010100010000	13
	116	010100010100	8	010100010000	14
140	117	010100010100	9	010100010000	15
	118	010100010100	10	010100010101	0
	119	010100010100	11	010100010101	1
	120	010100010100	12	010100010101	2
	121	010100010100	13	010100100000	8
145	122	010100010100	14	010100100000	9
	123	010100010100	15	010100100000	10
	124	010100100001	0	010100100000	11
	125	010100100001	1	010100100000	12
	126	010100100001	2	010100100000	13
150	127	010100100001	3	010100100000	14

29

State S13 Part-1: Entries 0- 31				State S13 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0 001000000010	0 001010000010	0	64 001001000101	0 001000100010	1	
	1 001000000010	1 001010000010	1	65 001001000101	1 001000100010	2	
	2 001000000010	2 001010000010	2	66 001001000101	2 001000100010	3	
	3 001000000010	3 001010000010	3	67 001001000101	3 001000100010	4	
	4 001000000010	4 001010000010	4	68 001001000101	0 001000100010	5	
10	5 001000000010	5 001010000010	5	69 001001000101	1 001000100010	6	
	6 001000000010	6 001010000010	6	70 001001000101	2 001000100010	7	
	7 001000000010	7 001010000010	7	71 001001000101	3 001000100100	8	
	8 001000000100	8 001010000100	8	72 001001000101	4 001000100100	9	
	9 001000000100	9 001010000100	9	73 001001000101	0 001000100100	10	
15	10 001000000100	10 001010000100	10	74 001001000101	1 001000100100	11	
	11 001000000100	11 001010000100	11	75 001001000101	2 001000100100	12	
	12 001000000100	12 001010000100	12	76 001001000101	3 001000100100	13	
	13 001000000100	13 001010000100	13	77 001001000101	4 001000100100	14	
	14 001000000100	14 001010000100	14	78 001001000101	5 001000100100	15	
20	15 001000000100	15 001010000001	4	79 001001000101	6 001000101000	8	
	16 001000001000	8 001000000000	8	80 001001010001	0 001000101000	9	
	17 001000001000	9 001000000000	9	81 001001010001	1 001000101000	10	
	18 001000001000	10 001000000000	10	82 001001010001	2 001000101000	11	
	19 001000001000	11 001000000000	11	83 001001010001	3 001000101000	12	
25	20 001000001000	12 001000000000	12	84 001001010001	4 001000101000	13	
	21 001000001000	13 001000000101	0	85 001001010010	0 001000101000	14	
	22 001000001000	14 001000000101	1	86 001001010010	1 001000101000	15	
	23 001000001000	15 001000000101	2	87 001001010010	2 001001000001	0	
	24 001000010000	8 001000000101	3	88 001001010010	3 001001000001	1	
30	25 001000010000	9 001000001001	0	89 001001010010	4 001001000001	2	
	26 001000010000	10 001000001001	1	90 001001010010	5 001001000001	3	
	27 001000010000	11 001000001001	2	91 001001010010	6 001001000001	4	
	28 001000010000	12 001000001001	3	92 001001010010	7 001001000001	0	
	29 001000010000	13 001000001001	4	93 001001010100	8 001001000001	1	
35	30 001000010000	14 001000001010	0	94 001001010100	9 001001000001	2	
	31 001000010000	15 001000001010	1	95 001001010100	10 001001000001	3	
State S13 Part-2: Entries 32- 63				State S13 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32 001000010101	0 001000001010	2	96 001001010100	11 001001000010	4	
	33 001000010101	1 001000001010	3	97 001001010100	12 001001000010	5	
	34 001000010101	2 001000001010	4	98 001001010100	13 001001000010	6	
45	35 001000100000	8 001000001010	5	99 001001010100	14 001001000010	7	
	36 001000100000	9 001000001010	6	100 001001010100	15 001001000010	8	
	37 001000100000	10 001000010001	0	101 001010000000	8 001001000010	9	
	38 001000100000	11 001000010001	1	102 001010000000	9 001001000010	10	
	39 001000100000	12 001000010001	2	103 001010000000	10 001001000010	11	
50	40 001000100000	13 001000010001	3	104 001010000000	11 001001000010	12	
	41 001000100000	14 001000010001	4	105 001010000000	12 001001000010	13	
	42 001000100000	15 001000010010	0	106 001010000000	13 001001000010	14	
	43 001000100101	0 001000010010	1	107 001010000000	14 001001000010	15	
	44 001000100101	1 001000010010	2	108 001010000101	0 001001001000	8	
55	45 001000100101	2 001000010010	3	109 001010000101	1 001001001000	9	
	46 001000100101	3 001000010010	4	110 001010000101	2 001001001000	10	
	47 001000101001	0 001000010010	5	111 001010000101	3 001001001000	11	
	48 001000101001	1 001000010010	6	112 001010000101	0 001001001000	12	
	49 001000101001	2 001000010010	7	113 001010000101	1 001001001000	13	
60	50 001000101001	3 001000010100	8	114 001010000101	2 001001001000	14	
	51 001000101001	4 001000010100	9	115 001010000101	3 001001001000	15	
	52 001000101010	0 001000010100	10	116 001010000101	4 001001010000	8	
	53 001000101010	1 001000010100	11	117 001010000101	0 001001010000	9	
	54 001000101010	2 001000010100	12	118 001010000101	1 001001010000	10	
65	55 001000101010	3 001000010100	13	119 001010000101	2 001001010000	11	
	56 001000101010	4 001000010100	14	120 001010000101	3 001001010000	12	
	57 001001000000	8 001000010100	15	121 001010000101	4 001001010000	13	
	58 001001000000	9 001000100001	0	122 001010000101	5 001001010000	14	
	59 001001000000	10 001000100001	1	123 001000000001	4 001001010000	15	
70	60 001001000000	11 001000100001	2	124 001000000001	0 001010000001	0	
	61 001001000000	12 001000100001	3	125 001000000001	1 001010000001	1	
	62 001001000000	13 001000100001	4	126 001000000001	2 001010000001	2	
	63 001001000000	14 001000100010	0	127 001000000001	3 001010000001	3	

75

State S14 Part-1: Entries 0- 31

State S14 Part-3: Entries 64- 95

[illegible]

State S14 Part-2: Entries 32- 63

115

State S14 Part-4: Entries 96-127

40	Even				Odd				Even				Odd			
45	32	0001000000001	4	001010010101	0	96	000101000000	14	000100100100	13						
	33	0001000000010	0	001010010101	1	97	0001010000101	0	000100100100	14						
	34	0001000000010	1	001010010101	2	98	0001010000101	1	000100100100	15						
	35	0001000000010	2	0001000000000	8	99	0001010000101	2	000100101000	9						
	36	0001000000010	3	0001000000000	9	100	0001010000101	3	000100101000	9						
50	37	0001000000010	4	0001000000000	10	101	000101001001	0	000100101000	10						
	38	0001000000010	5	0001000000000	11	102	000101001001	1	000100101000	11						
	39	0001000000010	6	0001000000000	12	103	000101001001	2	000100101000	12						
	40	0001000000010	7	0001000000000	13	104	000101001001	3	000100101000	13						
	41	0001000000100	8	0001000000101	0	105	000101001001	4	000100101000	14						
55	42	0001000000100	9	0001000000101	1	106	000101001010	0	000100101000	15						
	43	0001000000100	10	0001000000101	2	107	000101001010	1	000101000001	0						
	44	0001000000100	11	0001000000101	3	108	000101001010	2	000101000001	1						
	45	0001000000100	12	0001000001001	0	109	000101001010	3	000101000001	2						
	46	0001000000100	13	0001000001001	1	110	000101001010	4	000101000001	3						
60	47	0001000000100	14	0001000001001	2	111	000101001010	5	000101000001	4						
	48	0001000000100	15	0001000001001	3	112	000101001010	6	000101000001	0						
	49	000100001000	8	000100001001	4	113	000101010001	0	000101000010	1						
	50	000100001000	9	000100001010	0	114	000101010001	1	000101000010	2						
	51	000100001000	10	000100001010	1	115	000101010001	2	000101000010	3						
65	52	000100001000	11	000100001010	2	116	000101010001	3	000101000010	4						
	53	000100001000	12	000100001010	3	117	000101010001	4	000101000010	5						
	54	000100001000	13	000100001010	4	118	000101010010	0	000101000010	6						
	55	000100001000	14	000100001010	5	119	000101010010	1	000101000010	7						
	56	000100001000	15	000100001010	6	120	000101010010	2	000101000010	8						
70	57	000100001000	8	0001000010001	0	121	000101010010	3	000101000010	9						
	58	000100001000	9	0001000010001	1	122	000101010010	4	000101000010	10						
	59	000100001000	10	0001000010001	2	123	000101010010	5	000101000010	11						
	60	000100001000	11	0001000010001	3	124	001010010001	0	000101000010	12						
	61	000100001000	12	0001000010001	4	125	001010010001	1	000101000010	13						
	62	000100001000	13	0001000010010	0	126	001010010001	2	000101000010	14						
	63	000100001000	14	0001000010010	1	127	001010010001	3	000101000010	15						

75

31

State S15 Part-1: Entries 0- 31				State S15 Part-3: Entries 64- 95			
Even		Odd		Even		Odd	
5	0 000010010000	8 000010010100	8	64 000010001000	14 000001001001	4	
	1 000010010000	9 000010010100	9	65 000010001000	15 000001001010	0	
	2 000010010000	10 000010010100	10	66 000001000001	0 000001001010	1	
	3 000010010000	11 000010010100	11	67 000001000001	1 000001001010	2	
	4 000010010000	12 000010010100	12	68 000001000001	2 000001001010	3	
10	5 000010010000	13 000010010100	13	69 000001000001	3 000001001010	4	
	6 000010010000	14 000010010100	14	70 000001000001	4 000001001010	5	
	7 000010010000	15 000010010100	15	71 000001000010	0 000001001010	6	
	8 000010010101	0 000010100001	0	72 000001000010	1 000001010001	0	
	9 000010010101	1 000010100001	1	73 000001000010	2 000001010001	1	
15	10 000010010101	2 000010100001	2	74 000001000010	3 000001010001	2	
	11 000010100000	8 000010100001	3	75 000001000010	4 000001010001	3	
	12 000010100000	9 000010100001	4	76 000001000010	5 000001010001	4	
	13 000010100000	10 000010100010	0	77 000001000010	6 000001010001	0	
	14 000010100000	11 000010100010	1	78 000001000010	7 000001010010	1	
20	15 000010100000	12 000010100010	2	79 000001000100	8 000001010010	2	
	16 000010100000	13 000010100010	3	80 000001000100	9 000001010010	3	
	17 000010100000	14 000010100010	4	81 000001000100	10 000001010010	4	
	18 000010100000	15 000010100010	5	82 000001000100	11 000001010010	5	
25	19 000010100101	0 000010100010	6	83 000001000100	12 000001010010	6	
	20 000010100101	1 000010100010	7	84 000001000100	13 000001010010	7	
	21 000010100101	2 000010100100	8	85 000001000100	14 000001010100	8	
	22 000010100101	3 000010100100	9	86 000001000100	15 000001010100	9	
	23 000010101001	0 000010100100	10	87 000001001000	8 000001010100	10	
	24 000010101001	1 000010100100	11	88 000001001000	9 000001010100	11	
30	25 000010101001	2 000010100100	12	89 000001001000	10 000001010100	12	
	26 000010101001	3 000010100100	13	90 000001001000	11 000001010100	13	
	27 000010101001	4 000010100100	14	91 000001001000	12 000001010100	14	
	28 101010000001	0 000010100100	15	92 000001001000	13 000001010100	15	
35	29 001010100100	8 000010101000	8	93 000001001000	14 000010000000	8	
	30 001010100100	9 000010101000	9	94 000001001000	15 000010000000	9	
	31 001010100100	10 000010101000	10	95 000001010000	8 000010100000	10	
State S15 Part-2: Entries 32- 63				State S15 Part-4: Entries 96-127			
Even		Odd		Even		Odd	
40	32 001010100100	11 000010101000	11	96 000001010000	9 000010000000	11	
	33 001010100100	12 000010101000	12	97 000001010000	10 000010000000	12	
	34 001010100100	13 000010101000	13	98 000001010000	11 000010000000	13	
45	35 001010100100	14 001010100000	8	99 000001010000	12 000010000000	14	
	36 001010100100	15 001010100000	9	100 000001010000	13 000010000101	0	
	37 010101000100	8 001010100000	10	101 000001010000	14 000010000101	1	
	38 010101000100	9 001010100000	11	102 000001010000	15 000010000101	2	
	39 010101000100	10 001010100000	12	103 000010000001	0 000010000101	3	
50	40 010101000100	11 001010100000	13	104 000010000001	1 000010001001	0	
	41 010101000100	12 001010100000	14	105 000010000001	2 000010001001	1	
	42 010101000100	13 001010100000	15	106 000010000001	3 000010001001	2	
	43 010101000100	14 001010100101	0	107 000010000001	4 000010001001	3	
	44 010101000100	15 001010100101	1	108 000010000010	0 000010001001	4	
55	45 010101001000	8 001010100101	2	109 000010000010	1 000010001010	0	
	46 010101001000	9 000010101000	15	110 000010000010	2 000010001010	1	
	47 010101001000	10 000010010010	7	111 000010000010	3 000010001010	2	
	48 010101001000	11 000010101000	14	112 000010000010	4 000010001010	3	
	49 010101001000	12 000001000000	8	113 000010000010	5 000010001010	4	
60	50 010101001000	13 000001000000	9	114 000010000010	6 000010001010	5	
	51 010101001000	14 000001000000	10	115 000010000010	7 000010001010	6	
	52 010101001000	15 000001000000	11	116 000010000100	8 000010010001	0	
	53 101010000001	1 000001000000	12	117 000010000100	9 000010010001	1	
	54 101010000001	2 000001000000	13	118 000010000100	10 000010010001	2	
65	55 101010000001	3 000001000000	14	119 000010000100	11 000010010001	3	
	56 101010000001	4 000001000101	0	120 000010000100	12 000010010001	4	
	57 101010000010	0 000001000101	1	121 000010000100	13 000010010010	0	
	58 101010000010	1 000001000101	2	122 000010000100	14 000010010010	1	
	59 101010000010	2 000001000101	3	123 000010000100	15 000010010010	2	
70	60 101010000010	3 000001001001	0	124 000010001000	8 000010010010	3	
	61 101010000010	4 000001001001	1	125 000010001000	9 000010010010	4	
	62 000010001000	12 000001001001	2	126 000010001000	10 000010010010	5	
	63 000010001000	13 000001001001	3	127 000010001000	11 000010010010	6	

75

CLAIMS:

1. A method of converting a user bitstream into a coded bitstream by means of a channel code where the channel code has a constraint of $d=1$, characterized in that the channel code has an additional constraint of $r=2$.
- 5 2. A method as claimed in claim 1, characterized in that said channel code is parity-preserving channel code, thus preserving a parity between user words and corresponding channel words of the channel code.
3. A method as claimed in claim 2, characterized in that the channel code is a
10 sliding-block decodable channel code obtainable via an approximate eigenvector that satisfies two inequalities at the same time, a first inequality for even-parity channel words, and a second inequality for odd-parity channel words.
4. A method as claimed in claim 3, characterized in that the code has an
15 additional k -constraint of $k=12$.
5. A method as claimed in claim 3, characterized in that the code has an additional k -constraint of $k=10$.
- 20 6. A method as claimed in claim 4 and 5, characterized in that the code has an 8-to-12 mapping.
7. A coder for converting a user bitstream into a coded bitstream by means of a channel code where the coder comprises processing device for applying a channel code with
25 the constraint of $d=1$, characterized in that the coder is arranged to apply an additional constraint of $r=2$ when converting the user bitstream into the coded bitstream.

8. A coder as claimed in claim 7, characterized in that said channel code is a parity-preserving channel code, thus preserving a parity between user words and corresponding channel words of the channel code.

5 9. A coder as claimed in claim 8, characterized in that the channel code is a sliding-block decodable channel code obtainable via an approximate eigenvector that satisfies two inequalities at the same time, a first inequality for even-parity channel words, and a second inequality for the odd-parity channel words.

10 10. A coder as claimed in claim 9, characterized in that the code has an additional k-constraint of $k=12$.

11. A coder as claimed in claim 9, characterized in that the code has an additional k-constraint of $k=10$.

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12. A coder as claimed in claim 10 and 11, characterized in that the code has an 8-to-12 mapping.

13. A recording device comprising a coder as claimed in any one of the claims 7 to 12, an input device for receiving the user bitstream and providing the user bit stream to the coder and recording means for recording the coded bitstream on a record carrier as provided by the coder to the recording means.

14. A bit detector for performing bit detection on a code bitstream comprising a user bitstream coded in a coded bitstream by means of a channel code where the channel code has the constraint of $d=1$, characterized in that the channel code has an additional constraint of $r=2$.

15. A bit detector as claimed in claim 14, characterized in that said channel code is a parity-preserving channel code, thus preserving a parity between user words and corresponding channel words of the channel code.

16. A bit detector as claimed in claim 15, characterized in that the channel code is a sliding-block decodable channel code obtainable via an approximate eigenvector that

satisfies two inequalities at the same time, a first inequality for the even-parity channel words, and a second inequality for the odd-parity channel words.

17. A bit detector as claimed in claim 16, characterized in that the code has an additional k-constraint of $k=12$.

18. A bit detector as claimed in claim 16, characterized in that the code has an additional k-constraint of $k=10$.

19. A bit detector as claimed in claim 17 or 18, characterized in that the code has an 8-to-12 mapping.

20. A playback device comprising a bit detector as claimed in any one of the claims 14 to 19.

21. A signal comprising a user bitstream coded in a coded bitstream by means of a channel code where the channel code has the constraints of $d=1$ characterized in that the channel code has an additional constraint of $r=2$.

22. A record carrier comprising a track comprising a signal comprising a user bitstream coded in a coded bitstream by means of a channel code where the channel code has the constraint of $d=1$, characterized in that the channel code has an additional constraint of $r=2$.

23. A record carrier comprising a signal as claimed in claim 22, characterized in that said channel code is a parity-preserving channel code, thus preserving a parity between user words and corresponding channel words of the channel code.

24. A record carrier as claimed in claim 23, characterized in that the channel code is a sliding-block decodable channel code obtainable via an approximate eigenvector that satisfies two inequalities at the same time, a first inequality for the even-parity channel words, and a second inequality for the odd-parity channel words.

25. A record carrier as claimed in claim 24, characterized in that the code has an additional k-constraint of $k=12$.

26. A record carrier as claimed in claim 24, characterized in that the code has an
5 additional k-constraint of $k=10$.

27. A record carrier as claimed in claim 25 or 26, characterized in that the code has an 8-to-12 mapping.