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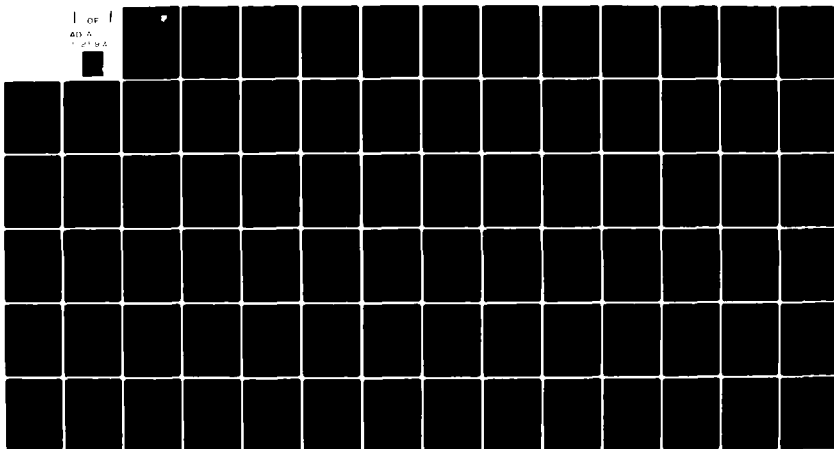
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GRAY CODES WITH EQUAL BIT-ERROR PROBABILITIES.(U)
AUG 81 J E LUDMAN, J L SAMPSON
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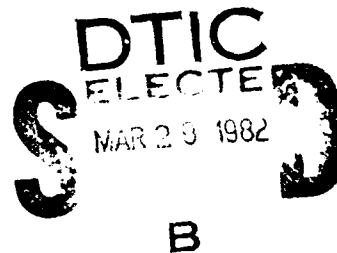


GRAY CODES WITH EQUAL BIT-ERROR PROBABILITIES

Jacques E. Ludman

John L. Sampson

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**ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441**

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APPROVED:



JACQUES E. LUDMAN
Project Engineer

APPROVED:



FREEMAN D. SHEPHERD JR.
Acting Director, Solid State Sciences Division

FOR THE COMMANDER:



JOHN P. HUSS
Acting Chief, Plans Office

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) It is often desirable to use Gray codes with properties different from those of the standard binary reflected code. Previously, only short codes (3 to 256-element) could be systematically generated or found with a given set of properties. This report describes a technique where long codes (65,000-element or longer) as well as short codes can be systematically generated with desired properties. The technique is described and demonstrated by generating codes of various lengths with the desired property of equal column change counts. Several examples of the use of the technique for generating codes with		

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other desired properties are outlined.

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Preface

The original idea that Gray code sequences can be moved to alter the nature of a Gray code comes from Jerry Silverman, RADC/ESE, who noted that in a Gray code path(not cycle), the last pair could usually (not always) be inserted elsewhere in the code. If a place for the pair could not be found, the last group of 4 or 6 could be checked and an insertion point found for it.

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Gray Codes With Equal Bit-Error Probabilities

1. INTRODUCTION

Gray codes¹ are used extensively in a variety of applications, such as shaft encoding or analog-to-digital conversions to minimize the effects of ambiguous analog signals near boundaries.² The codes are used also in the design of experiments^{3,4} to minimize parameter changes. Perhaps the most important application is the use of Gray codes in phase-shift-keyed (PSK) communications. For these applications, it is important to be able to generate Gray codes with particular characteristics. One extremely important set of Gray codes is the one with equal numbers of changes in each column of bits. This set has equal bit-error probabilities in PSK communications. Examples of members of this set for 3 bits to 16 bits are given in Tables 1 through 14.

The technique developed here to generate these codes is based on the symmetry properties of the binary reflected code (BRC)⁵⁻⁷ and the transformation of the BRC in accordance with simple rules. Codes up to 12-bit (4096-element) are readily transformed with pencil and paper, whereas larger codes, up to 20-bit (1,048 576-element), can be transformed with the aid of a computer.

(Received for publication 24 August 1981)

(Cited references are listed on page 80.)

2. THEORY

The fundamental property of a Gray code is that when expressed in binary form every element differs from each of its neighbors in one bit only. Since each element has N bits, it has N potential neighbors. Two of those neighbors will be the actual neighbors; the others will be located elsewhere in the code. The fundamental feature of the code transformation is that the sequence of elements between a given element and one of its potential neighbors can be removed, leaving the remaining sequence still a Gray code. If new neighbors for the removed sequence can be found adjacent to each other, the sequence may be inserted between them, resulting in a new Gray code containing all the elements of the original code but in a different order and thus with different properties.

The symmetry of the BRC is such that removable sequences and their insertion points are easily located and the effects of moving such sequences are predictable. Figure 1 may be used to show how this is done in the simple case of a 4-bit BRC. A boundary, called the half-boundary, has been marked halfway down the code, between elements 8 and 9. The entire portion of the code above this boundary is "reflected" below it, the elements, in reverse order, differing from their counterparts above only in the leftmost bit, which will be referred to as bit number 1. Thus the reflection of element 2 (0001) is element 15 (1001). Similarly, the quarter-boundaries and eighth-boundaries are indicated, reflecting the element with changes in bit number 2 and bit number 3, respectively. Binary reflected codes are always circuits; element 1 may be considered adjacent to element 16.

In Figure 1, it may be seen that element 4, in addition to its neighbors 3 and 5, has two potential neighbors 1 and 13, which are its reflections across the adjacent eighth-boundary and the half-boundary, respectively. Since elements 1 and 4 are potential neighbors, it is clear that elements 2 and 3 could be removed and that the remainder would still be a Gray code. Now it may be seen that elements 2 and 3 have as potential neighbors their reflection across the half-boundary, elements 15 and 14. The removed sequence, 2, 3 could therefore be inserted (in reverse order) between elements 14 and 15, resulting in a new Gray code containing all the elements of the original BRC. If the changes in each column of bits in Figure 1 are counted, the difference between the two codes becomes apparent: the BRC has 2 changes in column 1 (leftmost), 2 in column 2, 4 in column 3, and 6 in column 4. After transformation the column change count pattern has changed from 2, 2, 4, 8 to 4, 2, 4, 6. (The change between the last element and the first is included in the count.)

Initial Code					Transformed Code					
Element Number	Bit				Boundaries	Element Number	Bits			
	#1	#2	#3	#4			#1	#2	#3	#4
1	0	0	0	0	1/8	1	0	0	0	0
2	0	0	0	1		4	0	0	1	0
3	0	0	1	1		5	0	1	1	0
4	0	0	1	0	1/4	6	0	1	1	1
5	0	1	1	0		7	0	1	0	1
6	0	1	1	1	1/8	8	0	1	0	0
7	0	1	0	1		9	1	1	0	0
8	0	1	0	0	1/2	10	1	1	0	1
9	1	1	0	0		11	1	1	1	1
10	1	1	0	1	1/8	12	1	1	1	0
11	1	1	1	1		13	1	0	1	0
12	1	1	1	0	1/4	14	1	0	1	1
13	1	0	1	0		3	0	0	1	1
14	1	0	1	1	1/8	2	0	0	0	1
15	1	0	0	1		15	1	0	0	1
16	1	0	0	0		16	1	0	0	0
No. of Changes	2	2	4	8		No. of Changes	4	2	4	6

Figure 1. Four-bit Binary Reflected Gray Code With Reflection Boundaries Indicated. Elements 2 and 3 can be inserted between elements 14 and 15 without destroying the Gray code property.

A. VARIANTS OF THE PAIR

The simplest form of removal and insertion of neighbors that can be made is that of moving a pair of neighbors, such as the two just described, which is this move, labeled "A" and "B" in the sequence diagram, labeled "R," are illustrated in figure 2. (Note that only pairs, since no pair can move, can move.) It has already been seen that the movement of a pair will alter the contribution of changes in the columns, and that move A, of any size across any boundary, results in adding two changes to column i and subtracting two from column $i+1$. Examination of move B shows that it results in adding two changes to column i and subtracting two from column $i+1$. The effect of moving a pair in an N -bit code across a $(1/2)^N$ boundary (for $N=1$, half boundary; for $N=2$, quarter boundary; for $N=3$, eighth boundary) will cause the movement increase of the change count in column K if $i < K$ and decrease by 2 for count in column K . Later it will be seen that this is a special case of a set of more general rules.

In order to facilitate the explanation of more complicated movements of pairs of neighbors, hereafter, the process will be described in a pair (or sequence) moving between the neighbors of another pair as being "eaten" by that pair. The fact that a pair has eaten another pair (or a sequence) does not prevent the eating pair from moving, and does not change the effect of such a move. Any sequence that has been

eaten is simply carried along in the move of the pair that has eaten it. The change count is not affected by the presence of the sequence that is carried along. In the example (Figure 2), if move A alone is made, the new order of element numbers is

1, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 3, 2, 15, 16.

Move B alone results in

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 14, 11, 12, 13, 16.

Move A followed by move B results in

1, 4, 5, 6, 7, 8, 9, 10, 15, 2, 3, 14, 11, 12, 13, 16.

The column change count after both moves is 4, 4, 4, 4. There may be more than one way to reach a particular distribution of column changes; for example, 4, 4, 4, 4 may equally well be achieved if 4, 5 eat 12, 13 and 2, 3 eat 6, 7. The resulting Gray codes, of course, are not the same.

Element Number	Initial Code				Element Number	Transformed Code			
	#1	#2	#3	#4		#1	#2	#3	#4
1	0	0	0	0	1	0	0	0	0
2	0	0	0	1	4	0	0	1	0
3	0	0	1	1	5	0	1	1	0
4	0	0	1	0	6	0	1	1	1
5	0	1	1	0	7	0	1	0	1
6	0	1	1	1	8	0	1	0	0
7	0	1	0	1	9	1	1	0	0
8	0	1	0	0	10	1	1	0	1
9	1	1	0	0	15	1	0	0	1
10	1	1	0	1	2	0	0	0	1
11	1	1	1	1	3	0	0	1	1
12	1	1	1	0	14	1	0	1	1
13	1	0	1	0	11	1	1	1	1
14	1	0	1	1	12	1	1	1	0
15	1	0	0	1	13	1	0	1	0
16	1	0	0	0	16	1	0	0	0
No. of Changes	2	2	4	8	No. of Changes	4	4	4	4

Figure 2. Four-bit BRC Transformed With Two Moves, A and B, That Preserve the Gray Code Property

4. MOVEMENT OF LONGER SEQUENCES

Moving pairs can reduce the column change count only in the Nth column of an N-bit code. In order to reduce the count in other columns, longer sequences must be moved. They turn out to be of length 4, 8, 16, and so on. A sequence of four may be moved if all the bits in the next-to-last (N-1) column are alike. A sequence of eight must have like bits in column N-2, and so on. Figure 3 shows a 5-bit (32-element) BRC with a column change count of 2, 2, 4, 8, 16. Move A carries a sequence of eight across the half-boundary. In order to remain a Gray code, elements 8 and 9 must be matched with 25 and 24 respectively; this requires that the sequence of eight be inverted by halves, placing its last four elements before its first four. The order that results is

1, 2, 3, 4, 5, 6, 7, 8, 25, 26, 27, 28, 21, 22, 23, 24, 9, 10 . . .

Two changes have been subtracted from column 3 and added to column 1. Examination of the effects of moves such as this one leads to the formulation of two rules:

- Rule 1. If a sequence of $2^{(P+1)}$ elements is moved, where P is any integer between zero and N-3, the number of changes in column N-P is reduced by 2.
- Rule 2. If a sequence (of any size) is moved across a $(1/2)^K$ boundary, the number of changes in column K is increased by 2.

There are some restrictions on the movement of sequences:

- Rule 3. A sequence of $2^{(P+1)}$ elements must have like bits in all elements in its N-P column.
- Rule 4. A sequence may be moved and eaten only once (see Rule 6).
- Rule 5. A pair may eat only once.
- Rule 6. A pair may eat a sequence that includes other eaten sequences; no chain of moves, however, may result in a pair ultimately eating itself.
- Rule 7. After a sequence has moved, adjacent elements usually cannot move. (For example, after move A in Figure 3, elements 20 and 29 are fixed.) An exception to this rule will be seen shortly.

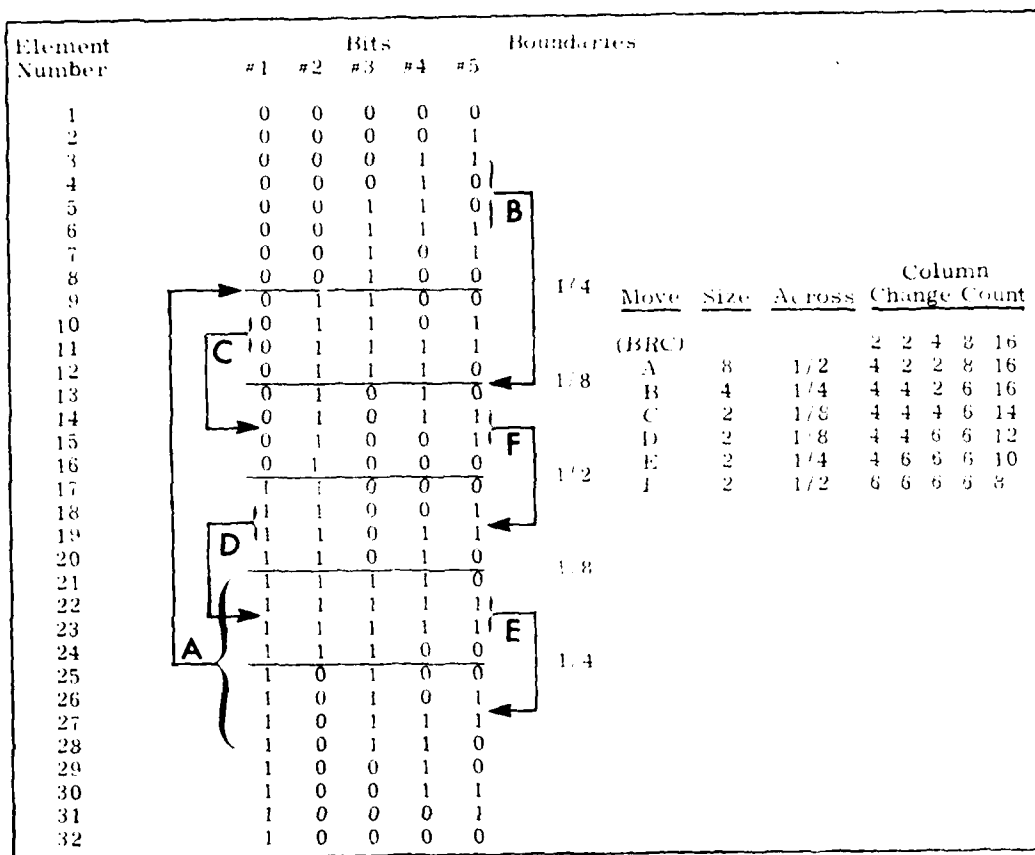


Figure 3. A 5-bit BRC. Letters A through F indicate a set of 6 moves leading to a column change count of 6, 6, 6, 6, 8

In Figure 3, move A separates elements 24 and 25 making them ineligible for further moves as a pair, but leaves pairs 22, 23 and 26, 27 still movable. Move B takes a sequence of four across a quarter-boundary. An inversion by halves is again necessary, leading to the order:

... 10, 11, 12, 5, 6, 3, 4, 13, 14 ...

By rules 1 and 2, the count in column 4 goes down 2 and that in column 2 goes up 2.

After moves A and B, other moves may be made to complete the transformation of the BRC into a Gray code with, for example, an equal distribution of column changes. The length of the sequence determines the column whose count is decreased (Rule 1); the boundary across which the sequence moves determines the column whose count is increased (Rule 2). This type of move is all that is necessary for

most of the desired distributions. There are several other allowed moves which are useful in the remaining cases.

A pair through which a higher-symmetry (lower K) boundary passes may move after both of its lower-symmetry neighboring pairs (through which a lower-symmetry boundary passes) have moved. This is an exception to Rule 7. The move labeled "F" in Figure 4 is an example of such a higher-symmetry move. The requirements for such a move are that both neighboring pairs have previously moved (moves D and E in Figure 4) and that the next-nearest neighbors be in place (elements 1 and 8 in Figure 4). The effect of such a move increases the column count as before, but the column decreased by two is column N-1 rather than column N. A still higher-symmetry move can be made if exactly three pairs of elements have been moved from each side of a given element. The count decrease here is in column N-2 and for higher-symmetry moves in correspondingly lower columns.

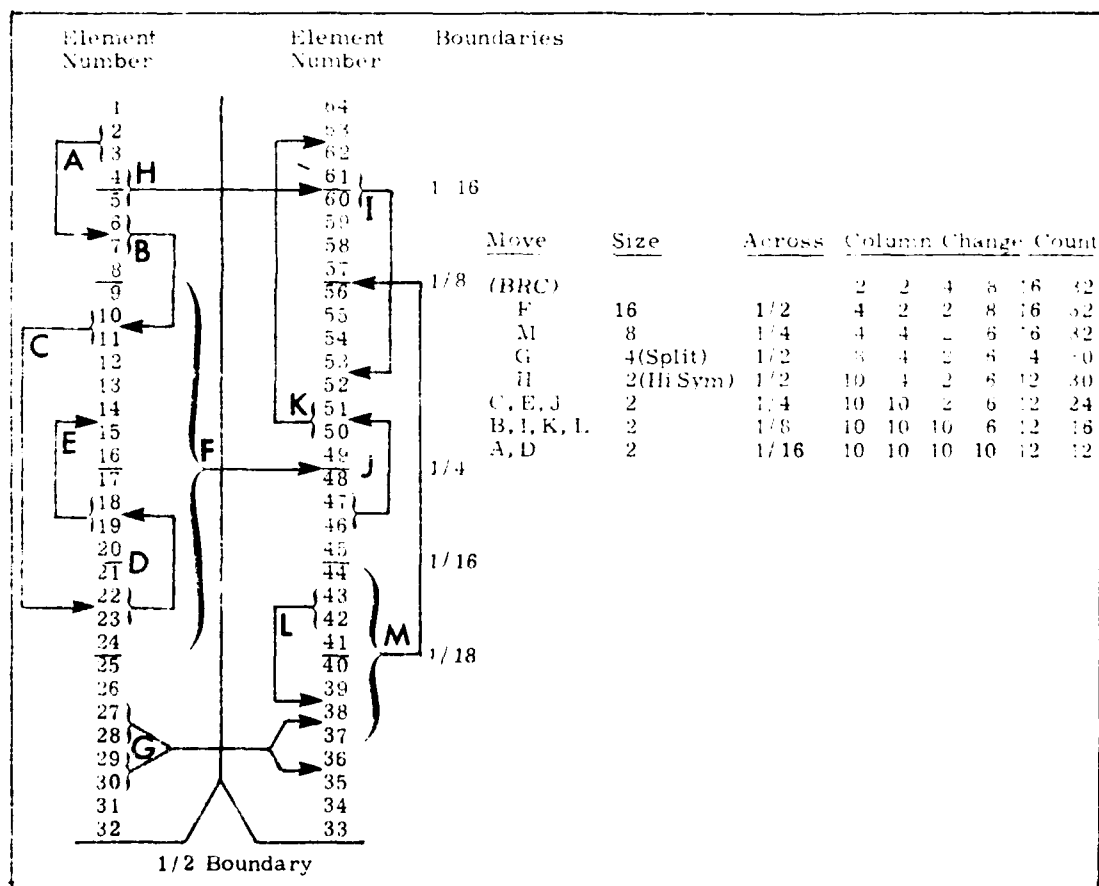


Figure 4. A Variety of Moves Leading to a 6-bit Gray Code With a Column Change Count of 10, 10, 10, 10, 12, 12. The lower half of the code has been folded upward for convenience, and the listing of bits omitted

Sequences of four or more need not be placed between the same elements but may be split up in a variety of ways; for example, the 3, 4, 5, 6 sequence of four may split into 3, 4 entering 13, 14 and 5, 6 entering 11, 12. This decreases column N-1 by two and N by two, and increases column 1 by four.

Tables 1 through 14 list the transition sequences for 3-bit through 16-bit Gray codes with equal bit-error probabilities. Each number in a table identifies the bit that changes between elements.² These codes were generated from the BRC using the moves thus far described. Figure 4 shows all of the foregoing moves used to generate a 10, 10, 10, 10, 12, 12 distributed code (N = 6), with the final sequence of BRC numbers

1, 8, 25, 26, 31, 32, 33, 34, 35, 30, 29, 36, 45, 48, 17, 20, 21, 24, 9, 12, 13, 14,
19, 22, 11, 6, 3, 2, 7, 10, 23, 18, 15, 16, 49, 52, 61, 4, 5, 60, 53, 54, 55, 56,
41, 44, 37, 28, 27, 38, 43, 42, 39, 40, 57, 58, 59, 62, 51, 46, 47, 50, 63, 64.

5. GENERAL MOVES

The moves noted in the previous sections are sufficient to change the BRC to another Gray code with any desired column change count. They are well-suited to the task because each move reduces the change count in one column and increases it in another in a thoroughly predictable way. For other purposes, there is a still more general class of moves which is useful and which includes these moves as a subset.

Symmetrically centered about every reflection boundary are a number of sequences that can be moved. In the 5-bit case already examined (Figure 3), for example, the quarter-boundary between 8 and 9 is a reflection boundary for sequences 8-9, 7-10, and 5-12 (of lengths 2, 4, and 8), as already noted. In addition, there are sequences 6-11, 4-13, 3-14, and 2-15 which are of length 6, 10, 12, and 14, respectively, and thus do not satisfy Rule 1. Nevertheless, they may be moved across the boundary and inserted in the proper place. Furthermore, there are other points where, with the right kind of inversion, these sequences can also be inserted.

The procedure is to locate a desired insertion point and invert the sequence by sections, breaking it at a point to match the insertion point. For example, the 1-2 sequence can be inserted between elements 24 and 25 by inverting at the symmetry point to get

... 24, 9, 10, 11, 6, 7, 8, 25 ...

or can be inserted between 22 and 23 by inverting at 10, 11 to get

. . . 22, 11, 6, 7, 8, 9, 10, 23 . . .

In addition, long sequences may be split up into parts, which are then inserted where needed.

Moves of this type are useful in solving such problems as Gray codes with time linearity.⁶ If the group of six in Figure 5 is inverted and put between 10 and 11 the order becomes

1, 8, 9, 10, 7, 2, 3, 4, 5, 6, 11, 12, 13, 14, 15, 16.

If the pair 2, 3 then eats pair 14, 15, the result is the $N = 4$ minimum time linearity found by Dickinson.³ With the use of such moves, and with an interactive computer to calculate the linearity (or some other desired property), the BRC can be readily converted.

Element Number	Bits				Boundaries
	#1	#2	#3	#4	
1	0	0	0	0	1/2
2	0	0	0	1	
3	0	0	1	1	
4	0	0	1	0	
5	0	1	1	0	
6	0	1	1	1	
7	0	1	0	1	
8	0	1	0	0	
9	1	1	0	0	
10	1	1	0	1	
11	1	1	1	1	
12	1	1	1	0	
13	1	0	1	0	
14	1	0	1	1	
15	1	0	0	1	
16	1	0	0	0	

Figure 5. A Variety of Possible Moves for a 6-element Sequence. The final column change count depends upon where the sequence goes

6. CONCLUSIONS

The task of creating Gray codes with a given set of characteristics has been shown to be solvable by locating and removing sequences from the binary reflected Gray code and reinserting these sequences in other parts of the code. These removable sequences abound and can be readily located by symmetry. The locations

for reinsertion of a sequence are numerous and also readily located by symmetry. The simple inversion of the moving sequence is obvious on comparing the sequence and the insertion point. With a little familiarity with moving sequences, it becomes easy to see how to split them up and put the pieces into various locations.

A particular subset of the allowed moves has the property of changing the column change counts in an exact way; the procedure has been given here for using that subset of moves in a straightforward way to convert the BRC to a Gray code with any desired change count distribution.

7. TRANSITION SEQUENCES FOR GRAY CODES

TABLE 1. TRANSITION SEQUENCE FOR 3-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

12131213

TABLE 2. TRANSITION SEQUENCE FOR 4-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

23241432 34131214

TABLE 3. TRANSITION SEQUENCE FOR 5-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

34243425 15251315 43234514 12131215

TABLE 4. TRANSITION SEQUENCE FOR 6-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

34352543 45242326 16261316 45436263 45461412 13251565 25651312 14121326

TABLE 5. TRANSITION SEQUENCE FOR 7-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

34353436 26454345 46243534 37172717 37175645 43727345 46571417 52571753
57252324 23261676 45254676 13162614 16261316 26151675 25761312 14121327

TABLE 6. TRANSITION SEQUENCE FOR 8-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

34385834	36343534	37343534	36343534	30182818	67564543	45465768	18281418
28183825	28657535	75682428	63682623	24232523	24232717	27131727	14172713
17271517	68657546	45482845	46457568	67131768	65754645	48284546	45756867
14176865	72756867	13176865	72756867	16121312	14121312	57828713	12142328

TABLE 7. TRANSITION SEQUENCE FOR 9-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

45464535	65456537	34353436	34353438	34353436	34353437	34353436	34353439
19291939	19291419	29193925	29392429	39262976	36792435	34372797	68565745
46454345	46454756	58679724	27976856	53565867	97252797	63679724	23262324
23252324	23281828	13182814	18281318	28151828	13182814	18281318	28161872
78131872	78141879	76267978	13187976	26797815	18797685	65256586	79781318
79768565	25658679	78141879	76856574	59496454	92945469	49547565	86797813
18797685	65745949	64549294	54694954	75658679	78171213	12141213	12152324
23261896	76267698	13189676	26769814	18929813	18929815	18929813	12142329

TABLE 8. TRANSITION SEQUENCE FOR 10-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

45464547	4546454A	8A454645	47375658	56575654	56575658	56573546	36463534
39343534	36343534	37343534	36343534	38343534	36343534	37343534	36343534
3A1A7828	7A1A7838	7A1A7828	7A1A1A78	287A1A78	387A1A78	287A151A	78676965
75658542	A5856575	47A7687A	1A786769	65756585	35856575	6967687A	1A786769
65756585	A4A6A4A5	A1A7A4A5A	4A6A4A5A	4A2A4A5A	4A6A4A5A	47A4A5A4	A6A4A585
65756967	687A141A	78676962	6967687A	1A786769	63696768	7A1A7867	69626967
687A161A	727A1A73	7A1A727A	141A727A	1A737A1A	727A151A	78769296	787A1A78
76939678	7A1A7876	9296787A	142A7876	96756585	64547454	64543454	64547454
65856576	96787A27	34353436	34353438	28382428	38252838	24283826	28382428
38252838	24283827	23242325	23242326	34353439	19291939	19291419	29193919
29151929	19391929	14192919	39192916	19291319	29141929	13192915	19291319
29141929	13192917	19828913	19828914	19828913	19828915	19828913	19828914
19828913	19828916	19828913	19828914	19828913	19828915	19828913	19828914
19828913	19828982	13121412	13121523	24231216	23242325	23242327	19A78769
67565856	A4A5A4A7	4A5A4A6A	4A5A4A2A	4A5A4A6A	4A5A47A4	A5A4A658	56576967
87A91319	A7876967	56582856	57696787	A9142325	23242326	23242325	2324232A

TABLE 2. TRANSITION SEQUENCE FOR 11-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
454636A6	76864686	76A63547	376A6768	67565956	57565856	57565456	57565856
57565956	5768676A	67353436	34353438	34353436	34353437	34353436	34353439
34353436	34353437	34353436	34353438	34353436	34353437	34353436	34353438
18897878	79881889	78387988	18897828	79881418	89782879	88188976	38798818
89782879	88151889	78287988	18897838	79881828	14182818	38182818	18281838
18281428	38252838	24373435	34363435	34383435	34363435	34373435	34263435
34392939	24293925	29392429	39262939	24293925	29392429	39272939	24293925
29392429	88879787	6A676865	75659565	75636575	65956575	68676A67	87978889
26298887	97887977	88892429	88838889	25298883	88892429	88838889	28232427
25232423	26232429	88797876	A6768657	56595657	56548454	64547454	64547454
64547454	64548456	57565956	57568676	A6787978	89253437	34353436	34353437
1A2A1A3A	1A2A141A	2A1A3A1A	2A151A2A	1A3A1A2A	141A2A1A	3A1A2A1A	1A3A1A3A
1A2A141A	2A1A3A1A	2A151A2A	1A3A1A2A	141A2A1A	3A1A2A1A	1A3A1A3A	1A3A1A3A
8797876A	67682867	6A676877	8889A1A9	8797876A	67682867	6A676877	8889A1A9
8797876A	67682867	6A676877	8889A1A9	8797876A	67682867	6A676877	8889A1A9
98879787	6A676838	676A6787	97889A1A	98879787	6A676838	676A6787	97889A1A
1A988797	676A6768	65756595	65758285	75659565	7568676A	67687978	9A131A98
8797876A	67686575	65756575	82857565	95657568	676A6787	97889A1A	1A2A171A
2A161A2A	131A2A14	1A2A131A	2A151A2A	131A2A14	1A2A131A	2A181A98	5888889A
131A9888	28889A14	1A988828	889A131A	98882888	9A151A96	8888889A	131A9888
79782879	78889A14	1A988879	78287978	889A131A	98887978	28797888	9A161A98
88797876	A6768657	56595658	78586848	58488848	58486848	58487845	48684851
48284858	48684548	78485848	68485848	88485848	68587856	59565756	8676A678
7978889A	131A9888	797876A6	76865756	59565878	58684858	48884858	48684851
48784548	68485848	28485848	68454878	48584868	48584888	48584868	58785659
56575686	76A67879	78889A14	1A929A13	1A929A15	1A929A13	1A929A14	1A929A13
1A929A17	1A929A13	1A929A14	1A929A13	1A929A15	1A929A13	1A929A14	1A929A13
1A929A16	1A929A13	1A929A14	1A929A13	1A929A15	1A929A13	1A929A14	1A929A13
1A929A19	12131214	12131215	12131214	12131216	12131214	12131215	12131214
23272324	12131215	23242326	23242325	23242328	23242325	23242326	23242325
23242327	23241A82	8A131A82	8A151A82	8A131A82	8A142326	23242325	23242328

TABLE 10. TRANSITION SEQUENCE FOR 12-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454B
45464547	45464548	45464547	45464549	39787B4E	78793546	45473797	87B76867
69676867	565A5657	56585657	56595657	56585657	56545657	56585657	56595657
66585657	565A5657	68676867	6867B7B7	97353797	87B76867	69676864	68676967
6867B7B7	973A4548	38483538	79787B4E	78797836	34353437	34353436	3435343A
34353436	34353437	34353436	34353438	34353436	34353437	34353436	34353439
34353436	34353437	34353436	34353438	34353436	34353437	34353436	3435343C
10201030	10201410	20103010	20151020	10302436	34353437	34353436	34353438
34353436	34353437	34353436	34353439	34353436	34353437	34353436	34353438
34353436	34353437	34353436	3435343A	1A2A1A3A	1A2A141A	2A1A3A1A	2A151A2A
1A3A1A2A	142A3A26	2A3A242A	3A252A3A	242A3A27	2A3A242A	9C898A87	9787B768
67696768	67565A56	57565856	57565953	59565756	58565756	5A565768	67696768
67B78797	8A898C9A	252A9C89	8A879787	B7686769	67686368	67696768	67B78797
8A898C9A	242A9C89	8A879787	3787978A	898C9A26	2A9C898A	879787B6	76867696
76863686	76967686	76B78797	8A898C9A	242A9C89	8A879787	B3B78797	8A898C9A
252A9C89	8A879787	B3B78797	8A898C9A	242A9C89	8A879787	B3B78797	8A898C9A
262A939A	242A939A	252A939A	242A939A	262A939A	242A939A	252A939A	242A9C98
A879787B	76867696	76867565	A5657565	85657565	95645474	54645484	54645474
54645434	54645474	54645484	54645474	54659565	75658565	7565A565	76867696
76867B78	7978A89C	9A272A9C	98A3A89C	9A242A9C	98A3A89C	9A252A9C	98A3A89C
9A242A9C	98A3A89C	9A262A9C	98A3A89C	9A242A9C	98A3A89C	9A252A9C	98A3A89C
9A242A9C	98A3A89C	9A292324	23252324	23262324	23252324	23273435	34363435
34383435	34363435	34373435	34363435	343B1B2B	1B3B1B2B	141B2B1B	3B1B2B15
1B2B1B3B	1BAC2CAB	141BAC2C	AB1BAC3C	AB1BAC2C	AB161BAC	2CAB1BAC	3CAB1BAC
1BAB141B	AC2C4B1B	AC3TAB1B	AC2CAB15	1BAC2CAB	1BAC3CAB	1BAC2CAB	141BAC2C
AB1BAC3C	AB1BAC2C	AB171BAC	2CAB1BAC	3CAB1B2B	141B2B1B	3B1B2B15	1B2B1B3B
1B2B141B	2B1B3B1B	2B161B2B	1B3B1B2B	141B2B1B	3B1B2B15	1B2B1B3B	1B2B141B
2B1B3B1B	2B181B2B	1B3B1B2B	141B2B1B	3B1B2B15	1B2B1B3B	1B2B141B	2B1B3B1B
2B161B2B	1B3B1B2B	141B2B1B	3B1B2B15	1B2B1B3B	1B2B141B	2B1B3B1B	2B171B2B
171B2B14	1B2B131B	2B151B2B	131B2B14	1B2B131B	2B161B2B	131B2B14	1B2B131B
2B151B2B	131B2B14	1B2B131B	2B191BA9	C98A2A89	C9AB131B	A9C98A2A	89C9AB14

1BA9C98A	2A89C9AB	131BA9C9	8A2A89C9	AB151BA9	C98A2A89	C9AB131B	A9C98A2A
89C9AB14	1BA9C98A	2A89C9AB	131BA9C9	8A2A89C9	AB161BA9	C98A2A89	C9AB131B
A9C98A2A	89C9AB14	1BA9C98A	2A89C9AB	131BA9C9	8A2A89C9	AB151BA9	C98A2A89
C9AB131B	A9C98A2A	89C9AB14	1BA9C98A	2A89C9AB	131BA9C9	8A2A89C9	AB171BA9
C98A8797	87B76867	69676867	565A5657	565C8C5C	6C5C7C5C	6C5C9C5C	6C4C5C4C
7C4C5C4C	6C4C5C4C	8C4C5C4C	6C4C5C4C	7C4C5C4C	6C4C5C4C	2C4C5C4C	6C4C5C4C
7C4C5C4C	6C4C5C4C	8C4C5C4C	6C4C5C4C	7C4C5C4C	6C5C9C5C	6C5C7C5C	6C5C8C5C
57565A56	57686769	676867B7	87978A89	C9AB131B	A929AB14	1BA929AB	131BA929
AB151BA9	29AB131B	A929AB14	1BA929AB	131BA929	AB161BA9	29AB131B	A929AB14
1BA929AB	131BA929	AB151BA9	29AB131B	A929AB14	1BA929AB	131BA929	AB181BA9
C898A879	787B2B78	7978A898	C9AB131B	A9C898AB	79787B2B	787978AB	98C9AB14
1BA9C898	A879787B	2B787978	A898C9AB	131BA9C8	98AB7978	7E2B7879	78A898C9
AB151BA9	C898A879	787B2B78	7978A898	C9AB131B	A9C898AB	79787B2B	68676867
68626867	69676867	68787978	A898C9AB	141BA9C8	98AB7978	7B676867	68676867
68676967	68676878	7978A898	C9AB131B	A9C898AB	79787B2B	68676967	68626867
69676867	68787978	A898C9AB	161BA9C8	58A87978	72787978	A898C9AB	131BA9C9
98A87978	72787978	A898C9AB	141BA9C8	98A87978	72787978	A898C9AB	131BA9C9
98A87978	7B768676	96768657	565A5657	56585C6C	5C7C5C4C	5C9C5C2C	565C5C7C
5C7C5C6C	58565756	56565756	66769676	867B7879	78A898C9	AB151BA9	C898A879
787B7686	76967682	86769676	867B7879	78A898C9	AB131BA9	C898A879	787B7686
76967686	7565A565	75658C6C	C5C7C5C6	C5C9C5C2	C5C9C5C6	78C7C5C6	C5856575
65A56576	86769676	867B7879	78A898C9	AB141BA9	C898A879	787B7686	76967686
7565A565	7565C8C5	C6C5C7C5	C6C5C9C5	C6C4C5C4	C7C4C5C4	C6C4C5C4	C8C4C5C4
C6C4C5C4	C7C4C5C4	C6C4C5C4	C2C4C5C4	C6C4C5C4	C7C4C5C4	C6C4C5C4	C8C4C5C4
C6C4C5C4	C7C4C5C4	C6C5C9C5	C6C5C7C5	C6C5C8C5	657565A5	65768676	9676867B
787978AB	98C9AB13	1BA2AB17	1BA2AB13	1BA2AB14	1BA2AB14	1BA2AB15	1BA2AB13
1BA2AB14	1BA2AB13	1BA2AB16	1BA2AB13	1BA2AB14	12131215	12131214	1213121A
12131214	12131215	12131214	12131216	12131214	12131215	12131214	12131217
12131214	12131215	12131214	12131216	12131214	12131215	12131214	2328C324
12131215	23242326	23242325	23242327	23242325	23242326	23242325	23242329
23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328
23242325	23242326	23242325	23242327	23242325	23242326	23242325	2324232C

TABLE 11. TRANSITION SEQUENCE FOR 13-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454B
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454C
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454B
3B898A4A	898B353B	898A4A89	8B363B89	8A4A898B	35474546	454838B8	98A87978
7C787949	787C7879	78A898B8	3538B898	A879787C	78794978	7C787978	A898B836
38B898AB	79787C78	79768676	A6768676	96768676	B6575658	56575659	56575658
5657565A	56575658	56575659	56575658	5657565A	56575658	56575659	56575658
5657565A	56575658	56575659	56575658	565756B6	76867696	768676A6	76867978
7C787978	A898B835	38B89848	98B83738	B898A787	9787C787	9768676A	67686769
6768676B	4B676867	69676867	6A676867	9787C787	9787A898	B8353436	34353439
34353436	34353437	34353436	34353438	34353436	34353437	34353436	3435343A
34353436	34353437	34353436	34353438	34353436	34353437	34353436	34353439
34353436	34353437	34353436	34353438	34353436	34353437	34353436	3435343D
34353436	34353437	34353436	34353438	34353436	34353437	34353436	34353439
34353436	34353437	34353436	34353438	34353436	34353437	34353436	3435343A
34353436	34353437	34353436	34353438	34353436	34353437	34353436	3435343B
1B2B1B3B	1B2B141B	2B1B3B1B	2B151B2B	1B3B1B2B	141B2B1B	3B1B2B16	1B2B1B3B
1B2B141B	2B1B3B1B	2B151B2B	1B3B1B2B	141B2B1B	3B1B2B17	1B2B1B3B	1B2B141B
2B1B3B1B	2B151B2B	1B3B1B2B	141B0A9A	2A9DAB1B	3B1B0A9A	2A9DAB16	1B0A9A2A
9DAB1BAD	9A3A9DAB	1BAD9A2A	9DAB141B	AD9A2A9D	AB1BAD9A	3A9DAB1B	AD9A2A9D
AB151BAD	9A2A9DAB	1BAD9A3A	9DAB1BAD	9A2A9DAB	141BAD9A	2A9DAB1B	AD9A3A9D
AB1BAD9A	2A9DAB1B	1BAD9A9B	B898A879	787C7879	29787C78	7978A898	B89A9DAB
1BAD9A9B	B898A879	787C7879	39787C78	7978A898	B89A9DAB	1BAD9A9B	B898A879
787C7879	29787C78	7978A898	B89A9DAB	141BAD9A	98B898AB	79787C78	7929787C
787978AB	98B89A9D	AB1BAD9A	98B898AB	79787C78	7939787C	787978AB	98B89A9D
AB1BAD9A	98B898AB	79787C78	7929787C	787978AB	98B89A9D	AB151BAD	9A98B898
A879787C	78792978	7C787978	A898B89A	9DAB1BAD	9A98B898	A879787C	78793978
7C787978	A898B89A	9DAB1BAD	9A98B898	A879787C	78792978	7C787978	A898B89A

9DAB141B	AD9A98B8	98A87978	7C787929	787C7879	78A898B8	9A9DAB1B	AD9A98B8
98A87978	7C787939	787C7879	78A898B8	9A9DAB26	2BAD9A98	B898A879	787C7879
768676A6	76867696	768676B6	57565856	57565956	57565856	57565A56	57565856
57375658	5657565A	56575658	56575659	56575658	565756B6	76867696	768676A6
76867978	7C787978	A898B89A	9DAB242B	AD9A98B8	983898B8	9A9DAB25	2BAD9A9E
B8983898	B89A9DAB	242BAD9A	98B89838	98B89A9D	AB272BAD	9A98B898	A7879787
C7879768	676A6768	67696768	676B3B67	68676967	68676A67	68679787	C7879787
A898B89A	9DAB242B	AD9A98B8	98A78797	87C78797	68676A67	68676967	68676B3B
67686769	6768676A	67686797	87C78797	87A898B8	9A9DAB25	2BAD9A93	9A9DAB24
2BAD9A93	9A9DAB26	2BAD9A93	9A9DAB24	2B3B252B	3B242B3B	292BA9D9	A939A9D9
AB242BA9	D9A939A9	D9AB252B	A9D9A939	A9D9AB24	2BA3AB26	2BA3AB24	2BA3AB25
2BA3AB24	2BA3AB27	2BA3AB24	2BA3AB25	2BA3AB24	2BA3AB26	2BA3AB24	2BA3AB25
2BA3AB24	2BA3AB28	2BA3AB24	2BA3AB25	2BA3AB24	2BA3AB26	2BA3AB24	2BA3AB25
2BA3AB24	2BA3AB27	2BA3AB24	2BA3AB25	2BA3AB24	36343534	3A343534	36343534
37343534	36343534	38343534	36343534	37343534	36343534	39343534	36343534
37343534	36343534	38343534	36343534	37343534	36343534	3C1CRD9A	9B898A2A
898B9A9D	BC1CRD9A	9B898A3A	898B9A9D	BC1CRD9A	9B898A2A	898B9A9D	BC141CRD
9A9B898A	2A898B9A	9D8C1CRD	9A9B898A	3A898B9A	9D8C1CRD	9A9B898A	2A898B9A
9D8C151C	BD9A9B89	8A2A898B	9A9D8C1C	BD9A9B89	8A3A898B	9A9D8C1C	BD9A9B89
8A2A898B	9A9D8C14	1CRD9A9B	898A2A89	8B9A9D8C	1CRD9A9B	898A3A89	8B9A9D8C
1CRD9A9B	898A2A89	8B9A9D8C	161CRD9A	9B898A2A	898B9A9D	BC1CRD9A	9B898A3A
898B9A9D	BC1CRD9A	9B898A78	79787C7E	79768676	A6768676	96768676	B6575658
5D6D5D7D	5D6D5D9D	5D6D5D7D	5D6D5D8D	5D6D5D7D	5D6D5DAD	5D6D5D7D	5D6D5D8D
5D6D5D7D	4D5D4D6D	4D5D4D9D	4D5D4D6D	4D5D4D7D	4D5D4D6D	4D5D4D8D	4D5D4D6D
4D5D4D7D	4D5D4D6D	4D5D4D2D	4D5D4D6D	4D5D4D7D	4D5D4D6D	4D5D4D8D	4D5D4D6D
4D5D4D7D	4D5D4D6D	4D5D4D9D	4D5D4D6D	4D5D4D7D	5D6D5D8D	5D6D5D7D	5D6D5DAD
5D6D5D7D	5D6D5D8D	5D6D5D7D	5D6D5D9D	5D6D5D7D	5D6D585A	5756B676	86769676
8676A676	8679787C	7879787A	898B9A9D	BC141CRD	9A9B898A	7879787C	78797686
76A67686	76967686	76B65756	585D6D5D	7D5D6D5D	9D5D6D5D	7D5D6D5D	8D5D6D5D
7D5D6D5D	AD5D6D5D	7D5D6D5D	8D5D6D5D	2D5D6D5D	8D5D6D5D	7D5D6D5D	AD5D6D5D
7D5D6D5D	8D5D6D5D	7D5D6D5D	9D5D6D5D	7D5D6D58	565756B6	76867696	768676A6
76867978	7C787978	7A898B9A	9D8C1CRD	9A9B898A	7879787C	78797686	76A67686

76967686	76865756	58565756	59565756	58565756	5A565756	58565754	64549454
64547454	64548454	64547454	64543454	64547454	64548454	64547454	64549454
64575658	5657565A	56575658	56575659	56575658	565756B6	76867696	768676A6
76867978	7C787978	7A898B9A	9DBC1CRD	9A2A9DBC	151CRD9A	2A9DBC1C	BD9A3A9D
BC1CRD9A	2A9DBC14	1CRD9A2A	9DBC1CRD	9A3A9DBC	1CRD9A2A	9DBC171C	BD9A2A9D
BC1CRD9A	3A9DBC1C	BD9A2A9D	BC141CRD	9A2A9DBC	1CRD9A3A	9DBC1CRD	9A2A9DBC
151CRD9A	2A9DBC1C	BD9A3A9D	BC1CRD9A	2A9DBC14	1C2C1CRD	9A3A9DBC	1C2C161C
2C1C3C1C	2C141C2C	1C3C1C2C	151C2C1C	3C1C2C14	1C2C1C3C	1C2C181C	2C1C3C1C
2C141C2C	1C3C1C2C	151C2C1C	3C1C2C14	1C2C1C3C	1C2C161C	2C1C3C1C	2C141C2C
1C3C1C2C	151C2C1C	3C1C2C14	1C2C1C3C	1C2C171C	2C1C3C1C	2C141C2C	1C3C1C2C
151C2C1C	3C1C2C14	1C2C1C3C	1C2C161C	2C1C3C1C	2C141C2C	1C3C1C2C	151C2C1C
3C1C2C14	1C2C1C3C	1C2C191C	2C1C3C1C	2C141C2C	1C3C1C2C	151C2C1C	3C1C2C14
1C2C1C3C	1C2C161C	2C1C3C1C	2C141C2C	1C3C1C2C	151C2C1C	3C1C2C14	1C2C1C3C
1C2C171C	2C1C3C1C	2C141C2C	1C3C1C2C	151C2C1C	3C1C2C14	1C2C1C3C	1C2C161C
2C1C3C1C	2C141C2C	1C3C1C2C	151C2C1C	3C1C2C14	1C2C1C3C	1C2C181C	2C1C3C1C
2C141C2C	1C3C1C2C	151C2C1C	3C1C2C14	1C2C1C3C	1C2C161C	2C1C3C1C	2C141C2C
1C3C1C2C	151C2C1C	3C1C2C14	1C2C1C3C	1C2C171C	2C1C3C1C	2C141C2C	1C3C1C2C
151C2C1C	3C1C2C14	1C2C1C3C	1C2C161C	2C1C3C1C	2C141C2C	1C3C1C2C	151C2C1C
3C1C2C14	1C2C1C3C	1C2C1A1C	BA2ABC1C	BA3ABC1C	BA2ABC14	1CBA2ABC	1CBA3ABC
1CBA2ABC	151CBA2A	BC1CBA3A	BC1CBA2A	BC141CBA	2ABC1CBA	3ABC1CBA	2ABC161C
BA2ABC1C	BA3ABC1C	BA2ABC14	1CBA2ABC	131CBA2A	BC151CBA	2ABC131C	BA2ABC14
1CBA2ABC	131CBA2A	BC171CBA	2ABC131C	BA2ABC14	1CBA2ABC	131CBA2A	BC151CBA
2ABC131C	BA2ABC14	1CBA2ABC	131CBA2A	BC161CBA	2ABC131C	BA2ABC14	1CBA2ABC
131CBA2A	BC151CBA	2ABC131C	BA2ABC14	1CBA2ABC	131CBA2A	BC181CBA	2ABC131C
BA2ABC14	1CBA2ABC	131CBA2A	BC151CBA	2ABC131C	BA2ABC14	1CBA2ABC	131CBA2A
BC161CBA	2ABC131C	BA2ABC14	1CBA2ABC	131CBA2A	BC151CBA	2ABC131C	BA2ABC14
1CBA2ABC	131CBA2A	BC171CBA	2ABC131C	BA2ABC14	1CBA2ABC	131CBA2A	BC151CBA
2ABC131C	BA2ABC14	1CBA2ABC	131CBA2A	BC161CBA	2ABC131C	BA2ABC14	1CBA9D9A
929A9D9A	BC131CBA	9D9A929A	9D9ABC15	1CBA9D9A	929A9D9A	BC131CBA	9D9A929A
9D9ABC14	1CBA9D9A	929A9D9A	BC131CBA	9D9A929A	9D9ABC19	1CB2BC13	1CB2BC14
1CB2BC13	1CB2BC15	1CB2BC13	1CB2BC14	1CBAD9A9	29A9DABC	131CBAD9	A929A9DA
BC161CBA	D9A929A9	DABC131C	BAD9A929	A9DABC14	1CBAD9A9	29A9DABC	131CBAD9

A988898A	7877787C	78797686	76A67686	76967686	76R65756	58565D7D	5D615D9D
5D6D5D7D	5D6D5D8D	5D6D5D7D	5D6D5DAD	5D6D5D7D	5D6D5D8D	5D6D5D7D	5D6D5D8D
5D6D5D7D	5D6D5DAD	5D6D5D7D	5D6D5D8D	5D6D5D7D	5D6D5D9D	5D6D5D7D	56585657
56R67686	76967686	76A67686	79787C78	79787A89	8889A9DA	EC151CEA	D9A98889
8A787978	7C787976	8676A676	86769676	8676R2E6	76867696	768676A6	76867778
7C787978	7A898889	A9DAEC13	1CBA09A9	88898A78	79787C78	79768676	A6768676
96768676	R2E67686	76967686	76A67686	79787C78	79787A89	8889A9DA	EC141CEA
D9A98889	8A787978	7C787976	8676A676	86769676	8676P2E6	76867696	768676A6
76867978	7C787978	7A898889	A9DAEC13	1CBA09A9	88898A78	79787C78	79768676
A6768676	96768676	R2E67686	76967686	76A67686	79787C78	79787A89	8889A9DA
EC171CEA	D9A98889	82898889	A9DAEC13	1CBA09A9	88898289	8889A9DA	EC141CEA
D9A98889	82898889	A9DAEC13	1CBA09A9	88898289	8889A9DA	EC151CEA	D9A98889
82898889	A9DAEC13	1CBA09A9	88898289	8889A9DA	EC141CEA	D9A98889	82898889
A9DAEC13	1CBA09A9	88898A87	9787C787	9768676A	A7686769	A7686768	65766565
D6D5D7D5	D6D5D9D5	D6D5D7D5	D6D5D8D5	D6D5D7D5	D6D5DAD5	D6D5D7D5	D6D5D8D5
D6D5D7D4	D5D4D6D4	D5D4D9D4	D5D4D6D4	D5D4D7D4	D5D4D6D4	D5D4D8D4	D5D4D6D4
D5D4D7D4	D5D4D6D4	D5D4D2D4	D5D4D6D4	D5D4D7D4	D5D4D6D4	D5D4D8D4	D5D4D6D4
D5D4D7D4	D5D4D6D4	D5D4D9D4	D5D4D6D4	D5D4D7D5	D6D5D8D5	D6D5D7D5	D6D5DAD5
D6D5D7D5	D6D5D8D5	D6D5D7D5	D6D5D9D5	D6D5D7D5	D6D58565	756R6766	67696766
A76A6768	A79787C7	87978A89	8889A9DA	EC161CEA	D9A98889	8A879787	C7879297
87C78797	8A898889	A9DAEC13	12141213	12151213	12141213	12181213	12141213
12151213	12141213	12161213	12141213	12151213	12141213	27232423	25232423
26232423	25232423	281E2E13	182E141E	2E131E2E	151E2E13	182E141E	2E131E2E
161E2E13	1E2E141E	2E131E2E	151E2E13	1E2E141E	2E131E2E	171E2E13	12141213
12151213	12141213	12161213	12141213	12151213	12141213	12181213	12141213
12151213	24232623	24231215	23242327	23242325	23242326	23242325	23242329
23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328
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23242325	23242326	23242325	23242327	23242325	23242326	23242325	2324232F
23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242329
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23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242326

TABLE 12. TRANSITION SEQUENCE FOR 14-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

[illegible]

34353436	34353437	34353436	34353438	34353436	34353437	34353436	34353439
34353436	34353437	34353436	34353438	34353436	34353437	34353436	3435343A
34353436	34353437	34353436	34353438	34353436	34353437	34353436	34353439
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34353436	34353437	34353436	34353438	34353436	34353437	34353436	3435343A
34353436	34353437	34353436	34353438	34353436	34353437	34353436	34353439
34353436	34353437	34353436	34353438	34353436	34353437	34353436	3435343C

1CEAE9A	9C9A898B	898A8978	7D787978	7A787978	7B2E7879	787A7879	787D7879
8A898B89	8A9C9A9E	AERC1CE	AB9A9C9A	898E898A	89787D78	79787A78	79787B3E
7879787A	7879787D	78798A89	8B898A9C	9A9BAERC	1CEAE9A	9C9A898B	898A8978
7D787978	7A787978	7B2E7879	787A7879	787D7879	8A898B89	8A9C9A9E	AERC141C
BEAE9A9C	9A898B89	8A89787D	7879787A	7879787B	2B787978	7A787978	7D78798A
898E898A	9C9A9BAE	EC1CEAE	9A9C9A89	8B898A89	787D7879	787A7879	787B3E78
79787A78	79787D78	798A898B	898A9C9A	9BAERC1C	BEAE9A9C	9A898B89	8A89787D
7879787A	7879787B	2B787978	7A787978	7D78798A	898E898A	9C9A9BAE	EC151CE

AE9A9C9A	898E898A	89787D78	79787A78	79787B2E	7879787A	7879787D	78798A89
8B898A9C	9A9BAERC	1CEAE9A	9C9A898B	898A8978	7D787978	7A787978	7B3E7879
787A7879	787D7879	8A898B89	8A9C9A9E	AERC1C3E	AE9A9C9A	898E898A	89787D78
79787A78	79787B2E	7879787A	7879787D	78798A89	8B898A9C	9A9BAERC	141CEAE
9A9C9A89	8B898A89	787D7879	787A7879	787B2E78	79787A78	79787D78	798A898B
898A9C9A	9BAERC1C	BEAE9A9C	9A898B89	8A89787D	7879787A	7879787B	3B787978
7A787978	7D78798A	898E898A	9C9A9BAE	EC1CEAE	9A9C9A89	8B898A89	787D7879
787A7879	787B6768	67696768	676A6768	67696768	676C6768	67696762	67696768

676C6768	67696768	676A6768	67696768	676B7879	787A7879	787D7879	8A898B89
8A9C9A9E	AERC161C	BEAE9A9C	9A898B89	8A89787D	7879787A	78797872	7879787A
7879787D	78798A89	8B898A9C	9A9BAERC	1CEAE9A	9C9A898B	898A8978	7D787978
7A787978	7B768676	96768676	A6768676	96768676	C6768676	96763676	96768676
C6768676	96768676	A6768676	96768676	7879787A	7879787D	78798A89	8B898A9C
9A9BAERC	1CEAE9A	9C9A898B	898A8978	7D787978	7A787978	7B768676	96768676
A6768676	96768676	C6768676	96762676	96768676	C6768676	96768676	A6768676
9676867B	7879787A	7879787D	78798A89	8B898A9C	9A9BAERC	141CEAE	9A9C9A89

8B898A89	787D7879	787A7879	787B7686	76967686	76A67686	76967686	76C67686
76967658	565756E5	EAE5E6E5	E7E5E6E5	E8E5E6E5	C7E5E6E5	E9E5E6E5	E7E5E6E5
E8E5E6E5	E7E5E6E5	ERE5E6E5	E7E5E6E5	E8E5E6E5	E7E5E6E5	E9E5E6E5	E7E5E6E5
E8E5E6E5	E7E5E6E5	EAE5E6E5	E7E5E6E5	E4E8E4E5	E4E6E4E5	E4E7E4E5	E4E6E4E5
E4E9E4E5	E4E6E4E5	E4E7E4E5	E4E6E4E5	E4E8E4E5	E4E6E4E5	E4E7E4E5	E4E6E4E5
E4E2E4E5	E4E6E4E5	E4E7E4E5	E4E6E4E5	E4E8E4E5	E4E6E4E5	E4E7E4E5	E4E6E4E5
E4E9E4E5	E4E6E4E5	E4E7E4E5	E4E6E4E5	E4E8E4E5	E6E5E7E5	E6E5EAE5	E6E5E7E5
E6E5E8E5	E6E5E7E5	E6E5E9E5	E6E5E7E5	E6E5E8E5	E6E5E7E5	E6E5E8E5	E6E5E7E5
E6E5E8E5	E6E5E7E5	E6E5E9E5	E6E5E7E5	E6E5E8E5	E6E5E7E5	E6E5EAE5	E6575658
56769676	8676C676	86769676	8676A676	86769676	867B7879	787A7879	787D7879
8A898B89	8A9C9A9B	AERC1CRE	AB9A9C9A	898B898A	89787D78	79787A78	79787B76
86769676	8676A676	86769676	8676C676	86769676	36769676	8676C676	86769676
8676A676	86769676	867B7879	787A7879	787D7879	8A898B89	8A9C9A9B	AERC1CRE
AB9A9C9A	898B898A	89787D78	79787A78	79787B76	86769676	8676A676	86769676
8676C676	86769676	58565756	5EAE5E6E	5E7E5E6E	5E8E5E6E	5E7E5E6E	5E9E5E6E
5E7E5E6E	5E8E5E6E	5E7E5E6E	5E8E5E6E	5E7E5E6E	5E8E5E6E	5E7E5E6E	5E9E5E6E
5E7E5E6E	5E8E5E6E	5E7E5E6E	5EAE5E6E	5E7E5E6E	5E2E5E6E	5E7E5E6E	5EAE5E6E
5E7E5E6E	5E8E5E6E	5E7E5E6E	5E9E5E6E	5E7E5E6E	5E8E5E6E	5E7E5E6E	5E8E5E6E
5E7E5E6E	5E8E5E6E	5E7E5E6E	5E9E5E6E	5E7E5E6E	5E8E5E6E	5E7E5E6E	5EAE5657
56585676	96768676	C6768676	96768676	A6768676	96768676	7879787A	7879787D
78798A89	8B898A9C	9A9BAERC	151CREAB	9A9C9A89	8B898A2A	898B898A	9C9A9BAE
EC1CREAB	9A9C9A89	8B898A89	787D7879	787A7879	787B7686	76967686	76A67686
76967686	76C67686	76967685	657565A5	65756585	65756595	65756585	65756585
65756585	65756595	65756585	657565A5	65756535	657565A5	65756585	65756595
65756585	65756585	65756585	65756595	65756585	657565A5	65756586	76967686
76C67686	76967686	76A67686	76967686	7B787978	7A787978	7D78798A	898B898A
9C9A9BAE	EC1CREAB	9A9C9A89	8B898A2A	898B898A	9C9A9BAE	EC141CRE	AB9A9C9A
898B898A	2AB98B89	8A9C9A9B	AERC1CRE	AB9A9C9A	898B898A	3A898B89	8A9C9A9B
AERC1CRE	AB9A9C9A	898B898A	2AB98B89	8A9C9A9B	AERC171C	REAB9A9C	9A898B89
8AB79787	D7679787	A7879787	B7686769	6768676A	67686769	6768676C	67686769
67685657	5E6E5EAE	5E6E5E7E	5E6E5E8E	5E6E5E7E	5E6E5E9E	5E6E5E7E	5E6E5E8E
5E6E5E7E	5E6E5E8E	5E6E5E7E	5E6E5E8E	5E6E5E7E	5E6E5E9E	5E6E5E7E	5E6E5E8E

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5E6E76C7	6E6E769E	5E6E76A7	6E6E769E	6E6E7B7E	9E7E7A7E	9E7E7B7E	9E7E8E9E
8E8E9C9E	9EAEBC1C	8EAB9A9C	9E8E9E8E	8E8E9E8E	D7E7E7E7	A7E7E7E7	E7E8E6E9

BAEAAAEA EC253436 34353438 34353436 34353437 34353436 34353439 34353436
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 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D
 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D17 1D2D1D3D 1D2D141D 2D1D3D1D

 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D
 1D3D1D2D 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D
 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D
 3D1D2D17 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D16
 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D17 1D2D1D3D
 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D
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 1D3D1D2D 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D
 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D
 3D1D2D17 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D16
 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D17 1D2D1D3D
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 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D17 1D2D1D3D 1D2D141D 2D1D3D1D
 2D151D2D 1D3D1D2D 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D
 1D3D1D2D 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D

 141D2D1D 3D1D2D16 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D
 3D1D2D17 1D2D1D3D 1D2D141D 2D1D3D1D 2D151D2D 1D3D1D2D 141D2D1D EA2AEABC
 BD1DBCBA EA2AEABC BD1DBCBA EA2AEABC BD161DBC BAEAA2AEA BCB1DBC BAEAA3AEA
 BCB1DBC BAEAA2AEA BCB141D BCBAAEA2A EABCB1D BCBAAEA3A EABCB1D BCBAAEA2A
 EABCB15 1DBCBAEA 2AEABCB1D 1DBCBAEA 3AEABCB1D 1DBCBAEA 2AEABCB1D 141DBCBA
 EA9B9A9C 929C9A9B 9AEABCB1D 1DBCBAEA 3AEABCB1D 1DBCBAEA 9B9A9C92 9C9A9B9A
 EABCB19 1DBCBAEA2 EABCB1D BCBAAEB9 A9C939C9 A9BAEABC BD1DBCBA E2EABCB1D
 141DBCBA EAB9A9C9 29C9A9BA EABCB1D BCBAAEB9 A9C939C9 A9BAEABC BD1DBCBA

AEA3AEAB	CD1DCBAE	A2AEABCD	141DCBAE	A2AEABCD	1DCBAEA3	AEABCD1D	CBAEA2AE
ABCD151D	CBAEA2AE	ABCD131D	CBAEA2AE	ABCD141D	CBAEA2AE	ABCD131D	CBAEA2AE
ABCD171D	CBAEA2AE	ABCD131D	CBAEA2AE	ABCD141D	CBAEA2AE	ABCD131D	CBAEA2AE
ABCD151D	CBAEA2AE	ABCD131D	CBAEA2AE	ABCD141D	CBAEA2AE	ABCD131D	CBAEA2AE
ABCD161D	CBAEA2AE	ABCD131D	CBAEA2AE	ABCD141D	CBAEA2AE	ABCD131D	CBAEA2AE
ABCD151D	CBAEA2AE	ABCD131D	CBAEA2AE	ABCD141D	CBAEA2AE	ABCD131D	CBAEA2AE
ABCD1A1D	C2CD131D	C2CD141D	C2CD131D	C2CD151D	C2CD131D	C2CD141D	C2CD131D
C2CD161D	C2CD131D	C2CD141D	C2CD131D	C2CD151D	C2CD131D	C2CD141D	C2CD131D
C2CD171D	C2CD131D	C2CD141D	C2CD131D	C2CD151D	C2CD131D	C2CD141D	C2CD131D
C2CD161D	C2CD131D	C2CD141D	C2CD131D	C2CD151D	C2CD131D	C2CD141D	C2CD131D
C2CD181D	C2CD131D	C2CD141D	C2CD131D	C2CD151D	C2CD131D	C2CD141D	C2CD131D
C2CD161D	C2CD131D	C2CD141D	C2CD131D	C2CD151D	C2CD131D	C2CD141D	C2CD131D
C2CD171D	C2CD131D	C2CD141D	C2CD131D	C2CD151D	C2CD131D	C2CD141D	C2CD1326
23242325	23242329	23242325	23242326	23242325	23242327	23242325	23242326
23242325	23242328	23242325	23242326	23242325	23242327	23242325	23242326
23242325	23242320	10201310	20141020	13102015	10201310	20141020	13102016
10201310	20141020	13102015	10201310	20141020	13102017	10201310	20141020
13102015	10201310	20141020	13102016	10201310	20141020	1310DCRE	AB9A9C20
9A9BAERC	DC151CDC	BEAB9A9C	2C9A9BAE	BCDC131C	DCREAB9A	9C2C9A9B	AEBDC14
1CDCREAB	9A9C2C9A	9BAERCDC	131CDCRE	AB9A9C20	9A9BAERC	DC181CDC	BEAB9A9C
98A898B8	98A828A8	98B898A8	9C9A9BAE	BCDC131C	DCREAB9A	9C98A898	B898A828
A898B898	A89C9A9B	AERCDC14	1CDCREAB	9A9C98A8	98B898A8	28A898B8	98A89C9A
9BAERCDC	131CDCRE	AB9A9C98	A898B898	A828A898	B898A89C	9A9BAERC	DC151CDC
BEAB9A9C	98A898B8	98A828A8	98B898A8	9C9A9BAE	BCDC131C	DCREAB9A	9C98A898
B898A828	A898B898	A89C9A9B	AERCDC14	1CDCREAB	9A9C98A8	98B898A8	28A898B8
98A89C9A	9BAERCDC	131CDCRE	AB9A9C98	A898B898	A828A898	B898A89C	9A9BAERC
DC161CDC	BEAB9A9C	98A898B8	98A828A8	98B898A8	9C9A9BAE	BCDC131C	DCREAB9A
9C98A898	B898A828	A898B898	A89C9A9B	AERCDC14	1CDCREAB	9A9C98A8	98B898A8
28A898B8	98A89C9A	9BAERCDC	131CDCRE	AB9A9C98	A898B898	A828A898	B898A89C
9A9BAERC	DC151CDC	BEAB9A9C	98A898B8	98A87978	7D787978	7A787978	7B768676
96768676	A6768676	96768676	C6768676	96727696	768676C6	76867696	768676A6
76867696	76867B78	79787A78	79787D78	7978A898	B898A89C	9A9BAERC	DC131CDC

BEAB9A9C	98A898B8	98A87978	7D787978	7A787978	7E768676	96768676	A6768676
96768676	C6768676	96727696	768676C6	76867696	768676A6	76867696	768676F6
79787A78	79787D78	7978A898	B898A89C	9A98A8EC	DC141CDC	BEAB9A9C	98A898B8
98A87978	7D787978	7A787978	7E768676	96768676	A6768676	96768676	C6768676
96768565	756E5EAE	5E6E5E7E	5E6E5E8E	5E6E5E7E	5E6E5E9E	5E6E5E7E	5E6E5E9E
5E6E5E7E	5E6E5E8E	5E6E5E7E	5E6E5E8E	5E6E5E7E	5E6E5E9E	5E6E5E7E	5E6E5E8E
5E6E5E7E	5E6E5EAE	5E6E5E7E	5E6E2E6E	5E7E5E6E	5EAE5E6E	5E7E5E6E	5E8E5E6E
5E7E5E6E	5E9E5E6E	5E7E5E6E	5E8E5E6E	5E7E5E6E	5EAE5E6E	5E7E5E6E	5E8E5E6E

5E7E5E6E	5E9E5E6E	5E7E5E6E	5E8E5E6E	5E7E5E6E	5EAE5E6E	756E5E76	96768676
C6768676	96768676	A6768676	96768678	7879787A	7879787B	787978A8	98B898B8
9C9A9BAE	BCDC131C	DCBEAB9A	9C929C9A	9BAEBCDC	171CDCBE	AB9A9C92	9C9A9BAE
BCDC131C	DCBEAB9A	9C929C9A	9BAEBCDC	141CDCBE	AB9A9C92	9C9A9BAE	BCDC131C
DCBEAB9A	9C929C9A	9BAEBCDC	151CDCBE	AB9A9C92	9C9A9BAE	BCDC131C	DCBEAB9A
9C929C9A	9BAEBCDC	141CDCBE	AB9A9C92	9C9A9BAE	BCDC131C	DCBEAB9A	9C929C9A
9BAEBCDC	161CDC2C	DC131CDC	2CDC141C	DC2CDC13	1CDC2CDC	151CDC2C	DC131CDC
2CDC141C	DC2CDC13	1CDC2CDC	191CDC2C	DC131CDC	2CDC141C	DC2CDC13	1CDC2CDC

151CDC2C	DC131CDC	2CDC141C	DC2CDC13	1CDC2CDC	161CDC2C	DC131214	12131215
12131214	12131217	12131214	12131215	12131214	12131216	12131214	12131215
12131214	12131216	12131214	12131215	12131214	12131216	12131214	12131215
12131214	12131217	12131214	12131215	12131214	12132623	23242325	23242326
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23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328
23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242329

23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328
23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328
23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328
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23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328
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23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328
23242325	23242326	23242325	23242327	23242325	23242326	23242325	23242328

TABLE 13. TRANSITION SEQUENCE FOR 15-BIT GRAY CODE WITH UNIFORM DISTRIBUTION OF COLUMN CHANGES

[illegible]

[illegible]

[illegible]

301010010	301020014	102010030	10201510	201030010	201410020	103010020	101020010
701010014	102010030	10201510	201030010	201410020	103010020	171020010	301020014
102010030	10201510	201030010	201410020	103010020	101020010	301020014	102010030
10201510	201030010	201410020	103010020	101020010	301020014	102010030	10201510
201030010	201410020	103010020	101020010	301020014	102010030	252030024	20302720
302030024	252030024	10302620	30242030	252030024	20302920	30242030	252030024
20302620	30242030	252030024	20302720	30242030	252030024	20302620	30242030
252030024	20302920	30242030	252030024	20302620	30242030	252030024	20302720

2E1E3E1E	2E141E2E	1E3E1E2E	161E2E1E	3E1E2E14	1E2E1E3E	1E2E151E	2E1E3E1E
2E141E2E	1E3E1E2E	171E2E1E	3E1E2E14	1E2E1E3E	1E2E151E	2E1E3E1E	2E141E2E
1E3E1E2E	161E2E1E	3E1E2E14	1E2E1E3E	1E2E151E	0D8C8FBA	0AB2BACA	8FB8D0CE
1E3E1E0D	8C8FBACA	82BACABF	8C8DCE14	1E0D8C8F	BACAB2BA	CABF8C8D	CE1E0D8C
8FBACAB3	BACABF8C	8DCE1E0D	8C8FBACA	82BACABF	8C8DCE1B	1E02CE1E	03CE1E0C
CE141E02	CE1E03CE	1E02CE15	1E02CE1E	03CE1E02	CE141E02	CE1E03CE	1E02CE1E
1E02CE1E	03CE1E02	CE141E02	CE1E03CE	1E02CE15	1E02CE1E	03CE1E02	CE141E02
CE1E03CE	1E02CE17	1E02CE1E	03CE1E02	CE141E02	CE1E03CE	1E02CE15	1E02CE1E

03CE1E02	CE141E02	CE1E03CE	1E02CE1E	1E02CE1E	03CE1E02	CE141E02	CE1E03CE
1E02CE15	1E02CE1E	03CE1E02	CE141E02	CE1E03CE	FBACAB3E	ACABF8C8	CE1E02CE
181E00CE	FBACAB3E	ACABF8C8	CE1E03CE	FBACAB3E	ACABF8C8	CE1E03CE	FBACAB2E
ACABF8C8	CE141E02	CEFBACAB	2BACABFE	0DCE1E0D	CEFBACAB	3BACABFE	0DCE1E0D
CEFBACAB	2BACABFE	0DCE151E	0DCEFBAC	AB2BACAB	FB8DCE1E	0DCEFBAC	AB3BACAB
FB8DCE1E	0DCEFBAC	AB2BACAB	FB8DCE14	1E0DCEFE	ACAB2BAC	ABF8DCE	1E0DCEFE
ACAB3BAC	ABF8DCE	1E0DCEFE	ACAB2BAC	ABF8DCE	161E0DCE	FBACAB2E	ACABF8C8
CE1E0DCE	FBACAB3E	ACABF8C8	CE1E03CE	FBACAB2E	ACABF8C8	CE141E02	CEFBACAB

2BACABFE	0DCE1E0D	CEFBACAB	3BACABFE	0DCE1E0D	CEFBACAB	2BACABFE	0DCE151E
0DCEFBAC	AB2BACAB	FB8DCE1E	0DCEFBAC	AB3BACAB	FB8DCE1E	0DCEFBAC	AB2BACAB
FB8DCE14	1E0DCEFE	ACAB2BAC	ABF8DCE	1E0DCEFE	ACAB3BAC	ABF8DCE	1E0DCEFE
ACAB2BAC	ABF8DCE	171E0DCE	FBACAB2E	ACABF8C8	CE1E03CE	FBACAB3E	ACABF8C8
CE1E03CE	FBACAB2E	ACABF8C8	CE141E02	CEFBACAB	2BACABFE	0DCE1E0D	CEFBACAB
3BACABFE	0DCE1E0D	CEFBACAB	2BACABFE	0DCE151E	0DCEFBAC	AB9A9D9A	9B9A9D9A
9B9A9D9A	9BACABFE	0DCE1E0D	CEFBACAB	9A9D9A9E	9A9D9A9E	9A9D9A9E	ACABF8C8
CE1E0DCE	FBACAB9A	9D9A9B9A	9D9A9B9A	9D9A9BAC	ABF8DCE	141E0DCE	FBACAB9A

9D9A9B9A	9D9A9B9A	9D9A9BAC	ABF8DCE	1E0DCEFE	ACAB9A9D	9A9B9A93	9A9B9A9D
9A9BACAB	FB8DCE1E	0DCEFBAC	AB9A9D9A	9B9A9D9A	9B9A9D9A	9BACABFE	0DCE161E
0DCEFBAC	AB9A9D9A	9B9A9D9A	9B9A9D9A	9BACABFE	0DCE1E0D	CEFBACAB	9A9D9A9B
9A9D9A9B	9A9D9A9B	ACABF8C8	CE1E0DCE	FBACAB9A	9D9A9B9A	9D9A9B9A	9D9A9BAC
ABF8DCE	141E0DCE	FBACAB9A	9D9A9B9A	9D9A9BAC	ABF8DCE	1E0DCEFE	1E0DCEFE
ACAB9A9D	9A9B9A93	9A9B9A9D	9A9BACAB	FB8DCE1E	0DCEFBAC	AB9A9D9A	9B9A9D9A
9B9A9D9A	9BACABFE	0DCE151E	0DCEFBAC	AB9A9D9A	9B9A9D9A	9BACABFE	9BACABFE
0DCE1E0D	CEFBACAB	9A9D9A9B	9A9D9A9B	9A9D9A9B	ACABF8C8	CE1E0DCE	FBACAB9A

9D9A9B9A 929A9B9A 9D9A9BAC ABFBCECE 141ECDCE FBACAB9A 9D9A9B9A 929A9B9A
9D9A9BAC ABFBCECE 1ECDCEFB ACAB9A9D 9A9B9A93 9A9B9A9D 9A9BACAB FBCECE1E
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141ECDCE FBACA2AC ABFBCECE 1ECDCEFB ACA3ACAB FBCECE1E CDCEFBAC A2ACABFB
CDCE151E CDCEFBAC AB9A9D9A 9A929A9 9A9D9AB ACABFBCE CE1ECDCE FBACAB9A
D9A9B9A9 39A9B9A9 D9ABACAB FBCECE1E CDCEFBAC AB9A9D9A 9A929A9 9A9D9AB
ACABFBCE CE141ECD CBFBACA3 A9D9A9B9 A98C89BA 898B89BA 898E8978 7A787978
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8676D676 86769676 8676A676 86769676 8676B676 86769676 8676A676 86769676
78797878 78797878 78798E89 8A898B89 8A898C89 A99A9A9D ABACABFB CDCE191E
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5F6F5F7F	5F6F5F9F	5F6F5F7F	5F6F5F8F	5F6F5F7F	5F6F5F8F	5F6F5F7F	5F6F5F8F
2F8F5F6F	5F7F5F6F	5FAF5F6F	5F7F5F6F	5F8F5F6F	5F7F5F6F	5F9F5F6F	5F7F5F6F
5F8F5F6F	5F7F5F6F	5FBF5F6F	5F7F5F6F	5F8F5F6F	5F7F5F6F	5F9F5F6F	5F7F5F6F
5F8F5F6F	5F7F5F6F	5FAF5F6F	5F7F5F6F	5F8F5F6F	5F7F5F6F	5F9F5F6F	5F7F5F6F
5F8F5F6F	5F7F5F6F	5FCF5F6F	5F7F5F6F	5F8F5F6F	5F7F5F6F	5F9F5F6F	5F7F5F6F
5F8F5F6F	5F7F5F6F	5FAF5F6F	5F7F5F6F	5F8F5F6F	5F7F5F6F	5F9F5F6F	5F7F5F6F
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 13121712 13121412 13121512 13121412 13121612 13121412 13121512 13121412
 13121912 13121412 13121512 13121412 13121612 13121412 13121512 13121412

13121712 13121412 13121512 13121412 13121612 13121412 13121512 13121412
 13121812 13121412 13121512 13121412 13121612 13121412 13121512 13121412
 13121712 13121412 13121512 13121412 13121612 13121412 13121512 13121412
 13121812 13121412 1EDBCBFB ACAB3BAC ABFCBDE 12151EDB CBFRACAB 2BACABFB
 CBDE1EDB CBFRACAB 3BACABFB CBDE1EDB CBFRACAB 2BACABFB CBDE141E DBCBFBAC
 AB2BACAB FBCEDE1E DBCBFBAC AB3BACAB FBCEDE1E DBCBFBAC AB2BACAB FBCEDE16
 1EDBCBFB ACAB2BAC ABFCBDE 1EDBCBFB ACAB3BAC ABFCBDE 1EDBCBFB ACA12BAC
 ABFCBDE 141EDBCB FBACAB2B ACABFBFB DE1EDBCB FBACAB3B ACABFBFB DE1EDBCB

FBACAB2B ACABFBFB DE151EDB CBFRACAB 2BACABFB CBDE1EDB CBFRACAB 3BACABFB
 CBDE242E DBCBFBAC AB3BACAB FBCEDE27 2EDBCBFB ACAB3BAC ABFCBDE 242EDBCB
 FBACAB3B ACABFBFB DE252EDB CBFRACAB 3BACABFB CBDE242E DBCBFBAC AB3BACAB
 FBCEDE26 2EDBCBFB ACAB3BAC ABFCBDE 242EDBCB FBACAB3B ACABFBFB DE252EDB
 CBFRACAB 3BACABFB CBDE242E D3DE282E D3DE242E D3DE252E D3DE242E D3DE262E
 D3DE242E D3DE252E D3DE242E D3DE272E D3DE242E D3DE252E D3DE242E D3DE262E
 D3DE242E D3DE252E D3DE242E D3DE292E D3DE242E D3DE252E D3DE242E D3DE262E
 D3DE242E D3DE252E D3DE242E D3DE272E D3DE242E D3DE252E D3DE242E D3DE262E

D3DE242E D3DE252E D3DE242E D3DE282E D3DE242E D3DE252E D3DE242E D3DE262E
 D3DE242E D3DE252E D3DE242E D3DE272E D3DE242E D3DE252E D3DE242E D3DE262E
 25232423 2A232423 25232423 26232423 25232423 27232423 25232423 26232423
 25232423 28232423 25232423 26232423 25232423 27232423 25232423 26232423
 25232423 29232423 25232423 26232423 25232423 27232423 25232423 26232423
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 25232423 2D1D2D13 1D2D141D 2D131D2D 151D2D13 1D2D141D 2D131D2D 161D2D13
 1D2D141D 2D131D2D 151D2D13 1D2D141D 2D131D2D 171D2D13 1D2D141D 2D131D2D

151D2D13	1D2D141D	2D131D2D	161D2D13	1D2D141D	2D131D2D	151D2D13	1D2D141D
2D131D2D	181D2D13	1D2D141D	2D131D2D	151D2D13	1D2D141D	2D131D2D	161D2D13
1D2D141D	2D131DED	2DED151D	ED2DED13	1DED2DED	141DED2D	ED131DED	2DED141D
ED2DED13	1DED2DED	141DED2D	ED131DED	2DED151D	ED2DED13	1DED2DED	141DED2D
ED131DED	2DED161D	ED2DED13	1DED2DED	141DED2D	ED131DED	2DED151D	ED2DED13
1DED2DED	141DED2D	ED131DED	2DED191D	ED2DED13	1DED2DED	141DED2D	ED131DED
2DED151D	ED2DED13	1DED2DED	141DED2D	ED131DED	2DED161D	ED2DED13	1DED2DED
141DED2D	ED131DED	2DED151D	ED2DED13	1DED2DED	141DED2D	ED131DED	2DED141D

TABLE 14. TRANSITION SEQUENCE FOR 16-BIT GRAY CODE WITH
UNIFORM DISTRIBUTION OF COLUMN CHANGES

45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454B
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454C
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454B
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454D
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
45464547	45464548	45464547	45464549	45464547	45464548	45464547	4546454A
46546445	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4C454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4B454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4E454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4B454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4C454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4B454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4I454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4B454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4C454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4B454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645

4F454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4B454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4C454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4B454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645
4A454645	47454645	48454645	47454645	49454645	47454645	48454645	47454645

4G3GRCD	4DFCRG35	3GRCD4D	RCRG363G	RCRD4DRC	RG353GRC	RD4DRCRG	373GRCD
4DRCRG35	3GRCD4D	RCRG363G	RCRD4DRC	RG353GRC	RD4DRCRG	383GRCD	4DFCRG35
3GRCD4D	RCRG363G	RCRD4DRC	RG353GRC	RD4DRCRG	373GRCD	4DFCRG35	3GRCD4D
RCRG363G	RCRD4DRC	RG353GRC	RDABACAB	AEAB9A9C	9A9E9A9D	9A9E9A9B	CB9AB89B
B99AB89B	F99AB89E	B99AB89B	CB9498CB	98A998EB	98AB98FB	98AB98EB	98AB89CB
9A9B9A9D	9A9B9A9C	9A9BAEAB	ACABADBC	RG393GRC	RDABACAB	AEA4AEAB	ACABADBC
RG353GRC	RDABACAB	AEA4AEAB	ACABADBC	RG363GRC	RDABACAB	AEA4AEAB	ACABADBC
RG353GRC	RDABACAB	AEA4AEAB	ACABADBC	RG373GRC	RDABACAB	AEA4AEAB	ACABADBC

[illegible]

79787B78	79787A78	79787C78	79787A78	79747978	7A787978	7C787978	7A787978
7E787978	7A787978	7D787978	7A787978	7E787978	7A78798C	898A898B	898A898F
898A898B	898A898C	89A9B9A9	D9A9B9A9	C9A9BAEA	BACABIBC	BG373GBC	BDBACABA
EAB9A9C9	A9B9A9D9	A9B9A98C	898A898B	898A898F	898A898B	898A898C	848C898A
898B898A	898F898A	898B898A	898C89A9	B9A9D9A9	B9A9C9A9	BAEABACA	BDBCBG35
3GBCBDBA	CABAEAB9	A9C9A9B9	A9D9A9B9	A98C898A	898B898A	898F898A	898B898A
898C848C	898A898B	898A898F	898A898B	898A898C	89A9B9A9	D9A9B9A9	C9A9BAEA
BACABIBC	BG363GBC	BDBACABA	EAB9A9C9	A9B9A9D9	A9B9A9B9	A9D9A9B9	A9C9A9BA
EABACABD	BCBG353G	BCBDBACA	BAEAB9A9	C9A9B9A9	D9A9B9A9	B9A9D9A9	B9A9C9A9
BAEABACA	BDBCBG3B	3GBCBDBA	CABAEAB9	A9C9A9B9	A9D9A9B9	A898C89B	A898B89B
A898F89B	A898B89B	A898C89B	7A787978	7E787978	7A787979	7D787978	7A787978
7E787978	7A787978	7C787978	7A787978	676B676B	6769676B	676A676B	6769676B
676E676B	6769676B	676A676B	6769676B	676B676B	6769676B	676A676B	6769676B
676C676B	6769676B	676A676B	6769676B	676B676B	6769676B	6765A56	6765B56
57565956	57565856	57565D56	57565856	57565956	57565856	57565A56	57565856
57565956	57565856	57565B56	57565856	57565956	57565856	57565A56	57565856
57565956	57565856	57565C56	57565856	57565956	57565856	57565A56	57565856
57565956	57565856	57565B56	57565856	57565956	57565856	57565A56	57565856
57565956	57565856	57565C56	57565856	57565956	57565856	57565A56	57565856
57565956	57565856	57565B56	57565856	57565956	57565856	57565A56	57565856
57565956	57565856	57565D56	57565856	57565956	57565856	57565A56	57565856
6768676B	67686769	6768676A	67686769	6768676C	67686769	6768676A	67686769
6768676B	67687978	7A787978	7C787978	7A787978	7E787978	7A787978	7D787978
7A787978	7E787978	7A7898C8	98A898B6	98A898F8	98A898B8	98A898C8	98A9B9A9
D9A9B9A9	C9A9BAEA	BACABIBC	BG353GBC	BDBACABA	EAB9A9C9	A9B9A9D9	A9B9A89B
C898A89B	B898A89B	F898A89B	B898A89B	C848C89B	A898B89B	A898F89B	A898B89B
A898C89B	A9B9A9D9	A9B9A9C9	A9BAEABA	CABIBCBG	363GBCBD	BACABAEA	B9A9C9A9
B9A9D9A9	B9A4A9B9	A9D9A9B9	A9C9A9BA	EABACABD	BCBG353G	BCBDBACA	BAEAB9A9
C9A9B9A9	D9A9B9A4	A9B9A9D9	A9B9A9C9	A9BAEABA	CABIBCBG	373GBCBG	BACABAEA

3E1E2E1E	3E1E2E14	1E2E1E3E	1E2E151E	2E1E3E1E	2E141E2E	1E3E1E2E	161E2E1E
3E1E2E14	1E2E1E3E	1E2E151E	2E1E3E1E	2E141E2E	1E3E1E2E	171E2E1E	3E1E2E14
1E2E1E3E	1E2E151E	2E1E3E1E	2E141E2E	1E3E1E2E	161E2E1E	3E1E2E14	1E2E1E3E
1E2E151E	2E1E3E1E	2E141E2E	1E3E1E2E	181E2E1E	3E1E2E14	1E2E1E3E	1E2E151E
2E1E3E1E	2E141E2E	1E3E1E2E	161E2E1E	3E1E2E14	1E2E1E3E	1E2E151E	2E1E3E1E
2E141E2E	1E3E1E2E	171E2E1E	3E1E2E14	1E2E1E3E	1E2E151E	2E1E3E1E	2E141E2E
1E3E1E2E	161E2E1E	3E1E2E14	1E2E1E3E	1E2E151E	2E1E3E1E	2E141E2E	1E3E1E2E
191E2E1E	3E1E2E14	1E2E1E3E	1E2E151E	2E1E3E1E	2E141E2E	1E3E1E2E	161E2E1E

1FDECDC2	CDCEDF1F	DECDC3C0	CEDF1FDE	CDC2C0CE	DF141FDE	CDC2C0CE	DF1FDEC0
C3C0CEDF	1FDECDC2	CDCEDF1F	1FDECDC2	CDCEDF1F	DECDC3C0	CEDF1FDE	CDC2C0CE
DF141FDE	CDC2C0CE	DF1FDEC0	C3C0CEDF	1FDECDC2	CDCEDF1F	1FDECDC2	CDCEDF1F
DECDC3C0	CEDF1FDE	CDC2C0CE	DF141FDE	CDC2C0CE	DF1FDEC0	C3C0CEDF	1FDECDC2
CDCEDF1F	1FDECDC2	CDCEDF1F	DECDC3C0	CEDF1FDE	CDC2C0CE	DF141FDE	CDC2C0CE
DF1FDEC0	C3C0CEDF	1FDECDC2	CDCEDF1F	1FDECDC2	CDCEDF1F	DECDC3C0	CEDF1FDE
CDC2C0CE	DF141FDE	CDC2C0CE	DF1FDEC0	C3C0CEDF	1FDECDC2	CDCEDF1F	1FDECDC2
D3DF1FD2	DF141FD2	DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF1FD2	DF141FD2	DF1FD3DF

DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF1FD2	DF141FD2	DF1FD3DF	1FD2DF19	1FD2DF1F
D3DF1FD2	DF141FD2	DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF1FD2	DF141FD2	DF1FD3DF
1FD2DF15	1FD2DF1F	D3DF1FD2	DF141FD2	DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF1FD2
DF141FD2	DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF1FD2	DF141FD2	DF1FD3DF	1FD2DF15
1FD2DF1F	D3DF1FD2	DF141FD2	DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF1FD2	DF141FD2
DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF1FD2	DF141FD2	DF1FD3DF	1FD2DF15	1FD2DF1F
D3DF15DF	DF141FD2	DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF15DF	DF141FD2	DF1FD3DF
1FD2DF15	1FD2DF1F	D3DF1FD2	DF141FD2	DF1FD3DF	1FD2DF15	1FD2DF1F	D3DF1FD2

D2DED1F DED3DEF 1FDED2DE DF161FDE D2DED1F DED3DEF 1FDED2DE DF141FDE
 D2DED1F DED3DEF 1FDED2DE DF151FDE D2DED1F DED3DEF 1FDED2DE DF141FDE
 D2DED1F DED3DEF 1FDED2DE DF191FDE D2DED1F DED3DEF 1FDED2DE DF141FDE
 D2DED1F DED3DEF 1FDED2DE DF151FDE D2DED1F DED3DEF 1FDED2DE DF141FDE
 D2DED1F DED3DEF 1FDED2DE DF161FDE D2DED1F DED3DEF 1FDED2DE DF141FDE
 D2DED1F DED3DEF 1FDED2DE DF151FDE D2DED1F DED3DEF 1FDED2DE DF141FDE
 D2DED1F DED3DEF 1FDED2DE DF171FDE D2DED1F DED3DEF 1FDED2DE DF141FDE
 D2DED1F DED3DEF 1FDED2DE DF151FDE D2DED1F DED3DEF 1FDED2DE DF141FDE

DEDF141F DEDCGRCB 2BCRGCE DF1FDEDC GRCB3RCB GCDEF1F DEDCGRCB 2BCRGCE
 DF161FDE DCGRCR2B CRGCEDF 1FDEDCGB CR3BCRG CDEF1FDE DCGRCR2B CRGCEDF
 141FDEDC GRCB2RCB GCDEF1F DEDCGRCB 3BCRGCE DF1FDEDC GRCB2RCB GCDEF15
 1FDEDCGB CR2BCRG CDEF1FDE DCGRCR3B CRGCEDF 1FDEDCGB CR2BCRG CDEF141F
 DEDCGRCB 2BCRGCE DF1FDEDC GRCB3RCB GCDEF1F DEDCGRCB 2BCRGCE DF181FDE
 DCGRCR2B CRGCEDF 1FDEDCGB CR3BCRG CDEF1FDE DCGRCR2B CRGCEDF 141FDEDC
 GRCB2RCB GCDEF1F DEDCGRCB 3BCRGCE DF1FDEDC GRCB2RCB GCDEF15 1FDEDCGB
 CR2BCRG CDEF1FDE DCGRCR3B CRGCEDF 1FDEDCGB CR2BCRG CDEF141F DEDCGRCB

2BCRGCE DF1FDEDC GRCB3RCB GCDEF1F DEDCGRCB 2BCRGCE DF161FDE DCGRCR2B
 CRGCEDF 1FDEDCGB CR3BCRG CDEF1FDE DCGRCR2B CRGCEDF 141FDEDC GRCB2RCB
 GCDEF1F DEDCGRCB 3BCRGCE DF1FDEDC GRCB2RCB GCDEF15 1FDEDCGB CR2BCRG
 CDEF1FDE DCGRCR3B CRGCEDF 1FDEDCGB CR2BCRG CDEF141F DEDCGRCB 2BCRGCE
 DF1FDEDC GRCB3RCB GCDEF1F DEDCGRCB 2BCRGCE DF171FDE DCGRCR2B CRGCEDF
 1FDEDCGB CR3BCRG CDEF1FDE DCGRCR2B CRGCEDF 141FDEDC GRCB2RCB GCDEF1F
 DEDCGRCB 3BCRGCE DF1FDEDC GRCB2RCB GCDEF15 1FDEDCGB CR2BCRG CDEF1FDE
 DCGRCR3B CRGCEDF 1FDEDCGB CR2BCRG CDEF141F DEDCGRCB 2BCRGCE DF1FDEDC

GRCB3RCB GCDEF1F DEDCGRCB 2BCRGCE DF161FDE DCGRCR2B CRGCEDF 1FDEDCGB
 CR3BCRG CDEF1FDE DCGRCR2B CRGCEDF 141FDEDC GRCB2RCB GCDEF1F DEDCGRCB
 3BCRGCE DF1FDEDC GRCB2RCB GCDEF15 1FDEDCGB CR2BCRG CDEF1FDE DCGRCR3B
 CRGCEDF 1FDEDCGB CR2BCRG CDEF141F DEDCGRCB 2BCRGCE DF1FDEDC GRCB3RCB
 GCDEF1F DEDCGRCB 2BCRGCE DF1A1FDE DCGRCRDA BACABAE 2AEABACA BADBCRG
 CDEF1FDE DCGRCRDA BACABAE 3AEABACA BADBCRG CDEF1FDE DCGRCRDA BACABAE
 2AEABACA BADBCRG CDEF141F DEDCGRCB DABACABA EA2AEABA CABADRCB GCDEF1F
 DEDCGRCB DABACABA EA3AEABA CABADRCB GCDEF1F DEDCGRCB DABACABA EA2AEABA

CABADRCB GCDEDF15 1FDEDCGB CRDABACA BAE2AEAE BACABADB CBGCEIDF 1FDEDCGB
 CRDABACA BAE3AEAE BACABADB CBGCEIDF 1FDEDCGB CRDABACA BAE2AEAE BACABADB
 CBGCEIDF 141FDEIC GBCBDABA CABAE2A EABACABA DBCRGCE DF1FDEIC GBCBDABA
 CABAE3A EABACABA DBCRGCE DF1FDEIC GBCBDABA CABAE2A EABACABA DBCRGCE
 DF161FDE DCGBCBDA BACABAE 2AEABACA BADRCBGC DEDF1FDE DCGBCBDA BACABAE
 3AEABACA BADRCBGC DEDF1FDE DCGBCBDA BACABAE 2AEABACA BADRCBGC DEDF141F
 DEDCGRCB DABACABA EA2AEABA CABADRCB GCDEDF1F DEDCGRCB DABACABA EA3AEABA
 CABADRCB GCDEDF1F DEDCGRCB DABACABA EA2AEABA CABADRCB GCDEDF15 1FDEDCGB

CRDABACA BAE2AEAE BACABADB CBGCEIDF 1FDEDCGB CRDABACA BAE3AEAE BACABADB
 CBGCEIDF 1FDEDCGB CRDABACA BAE2AEAE BACABADB CBGCEIDF 141FDEIC GBCBDABA
 CABAE2A EABACABA DBCRGCE DF1FDEIC GBCBDABA CABAE3A EABACABA DBCRGCE
 DF1FDEIC GBCBDABA CABAE2A EABACABA DBCRGCE DF171FDE DCGBCBDA BACABAE
 2AEABACA BADRCBGC DEDF1FDE DCGBCBDA BACABAE 3AEABACA BADRCBGC DEDF1FDE
 DCGBCBDA BACABAE 2AEABACA BADRCBGC DEDF141F DEDCGRCB DABACABA EA2AEABA
 CABADRCB GCDEDF1F DEDCGRCB DABACABA EA3AEABA CABADRCB GCDEDF1F DEDCGRCB
 DABACABA EA2AEABA CABADRCB GCDEDF15 1FDEDCGB CRDABACA BAE2AEAE BACABADB

CBGCEIDF 1FDEDCGB CRDABACA BAE3AEAE BACABADB CBGCEIDF 1FDEDCGB CRDABACA
 BAE2AEAE BACABADB CBGCEIDF 141FDEIC GBCBDABA CABAE2A EABACABA DBCRGCE
 DF1FDEIC GBCBDABA CABAE3A EABACABA DBCRGCE DF1FDEIC GBCBDABA CABAE2A
 EABACABA DBCRGCE DF161FDE DCGBCBDA BACABAE 2AEABACA BADRCBGC DEDF1FDE
 DCGBCBDA BACABAE 3AEABACA BADRCBGC DEDF1FDE DCGBCBDA BACABAE 2AEABACA
 BADRCBGC DEDF141F DEDCGRCB DABACABA EA2AEABA CABADRCB GCDEDF1F DEDCGRCB
 DABACABA EA3AEABA CABADRCB GCDEDF1F DEDCGRCB DABACABA EA2AEABA CABADRCB
 GCDEDF15 1FDEDCGB CRDABACA BAE2AEAE BACABADB CBGCEIDF 1FDEDCGB CRDABACA

BAE3AEAE BACABADB CBGCEIDF 1FDEDCGB CRDABACA BAE2AEAE BACABADB CBGCEIDF
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