


APPLICATION		REVISION			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVAL
-	-	-	RELEASED/EC7817-001		
-	-	A	SEE EC8540-001 LRC/RH	02/27/06	D. MILLIGAN
-	-	B	SEE EC8598-001 MC/RH	03/14/06	D. MILLIGAN
-	-	C	SEE EC8802-001 DB/DB	02/16/07	S. REIDEL
-	-	D	SEE EC9084-001 DB/DB	07/24/07	S. REIDEL
-	-	E	SEE EC9179-001 DB/DB	10/30/07	S. REIDEL
-	-	F	SEE EC9417-001 DB/DB	05/13/08	M. CHOINIÈRE
-	-	G	SEE ECN400039 GT/GT	03/11/09	K. GOYAL

1. This specification prepared in accordance with USPS-STD-11.

UNITED STATES POSTAL SERVICE SPECIFICATION

SIGNATURE		DATE	 UNITED STATES POSTAL SERVICE®		
REVIEWED BY	L. R. Craun	06/29/05	INTELLIGENT MAIL® BARCODE (4-STATE CUSTOMER BARCODE)		
CHECKED BY	M. Choiniere	07/05/05			
APPROVED BY	R. Harvey	07/08/05			
PROJECT ENGINEER	D. Milligan	07/08/05			
NOT TO BE USED FOR MANUFACTURE UNLESS APPROVED FOR THE U.S. POSTAL SERVICE					
FOR THE UNITED STATES POSTAL SERVICE R. Root		07/08/05	Cage No. 27085	USPS-B-3200	SHEET 1 OF 57

1 SCOPE

1.1 Scope of the Intelligent Mail® Barcode – This specification covers the Intelligent Mail® barcode used in the USPS mailstream. It is also known as the USPS OneCode Solution or USPS 4-State Customer Barcode (abbreviated 4CB, 4-CB, or USPS4CB). This document specifies:

- a. Data content to be encoded
- b. Encoding rules to produce bars from data fields
- c. Physical dimensions of printed barcodes
- d. Physical limitations on printing

1.2 Classification – The Intelligent Mail barcode combines routing ZIP Code information and tracking information into a single 4-state code. It effectively encodes data from POSTNET and PLANET barcodes into a single barcode while providing a greater range of tracking data.

2 APPLICABLE DOCUMENTS

This section is not applicable to this specification.

3 REQUIREMENTS

3.1 Description

3.1.1 4-State Barcodes – A 4-state barcode is based on a tracker with ascenders and descenders. The four possible states are tracker (neither ascender nor descender), full (both ascender and descender), ascender only, and descender only as shown in Figure 1.

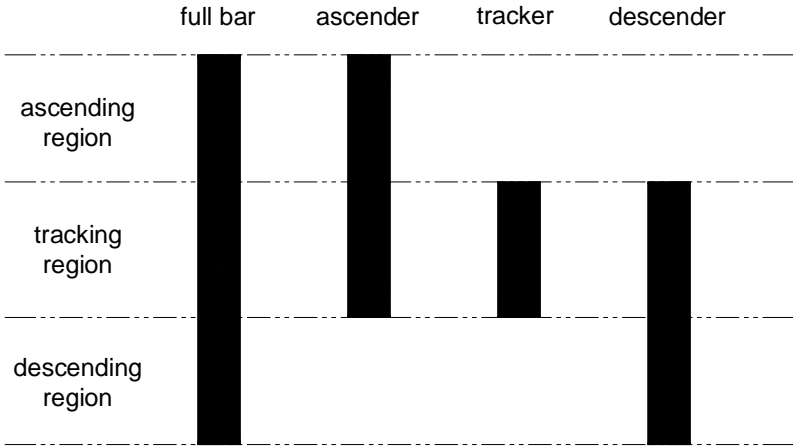


Figure 1. Sample 4-State Bars

3.1.2 Intelligent Mail Barcodes – The Intelligent Mail barcode is a 4-state barcode that consist of 65 bars. A sample envelope with an Intelligent Mail barcode is shown in Figure 2.



Figure 2. Sample Envelope with Intelligent Mail Barcode

3.1.3 Intelligent Mail Barcode Data Fields – Table I shows payload data fields to be encoded. The 20-digit tracking code shall consist of the Barcode Identifier, Service Type Identifier, Mailer Identifier, and Serial Number fields in the order specified in Table I. The routing code shall consist of the delivery point ZIP Code. The Intelligent Mail barcode shall be capable of encoding up to 31 digits of data as shown in Table I.

Table I – Intelligent Mail Barcode Data Fields

Type	Field	Digits
Tracking Code	Barcode Identifier	2 (2nd digit must be 0–4)
	Service Type Identifier	3
	Mailer Identifier	6 or 9
	Serial Number	9 (when used with 6 digit Mailer ID) 6 (when used with 9 digit Mailer ID)
Routing Code	Delivery Point ZIP Code	0, 5, 9, or 11
Total		31 maximum

For each of the fields in Table I, except the Routing Code, leading or trailing zeros shall be provided to achieve the correct size. Spaces and nulls are not acceptable characters

for padding. For ZIP Codes, which have one of four lengths, encoding shall provide padding beyond the digits to be encoded. No error detection and correction, such as a checksum with POSTNET or PLANET, shall be included as part of the data fields. Error detection and correction shall be added as part of the encoding process. The fields are described as follows:

- a. The Barcode Identifier shall be assigned by USPS to encode the presort identification that is currently printed in human readable form on the optional endorsement line (OEL) as well as for future USPS use. This shall be two digits, with the second digit in the range of 0–4. The allowable encoding ranges shall be 00–04, 10–14, 20–24, 30–34, 40–44, 50–54, 60–64, 70–74, 80–84, and 90–94. The list of valid field values is provided in Appendix A.
- b. The Service Type Identifier shall be assigned by USPS for any combination of services requested on the mailpiece. The allowable encoding range shall be 000–999. Each 3-digit value shall correspond to a particular mail class with a particular combination of service(s). Each service program, such as OneCode Confirm and OneCode ACS, shall provide the list of Service Type Identifier values. The list of valid field values when no services are requested is provided in Appendix A.
- c. The Mailer or Customer Identifier shall be assigned by USPS as a unique, 6 or 9 digit number that identifies a business entity. The allowable encoding range for the 6 digit Mailer ID shall be 000000-899999, while the allowable encoding range for the 9 digit Mailer ID shall be 900000000-999999999.
- d. The Serial or Sequence Number shall be assigned by the mailer for uniquely identifying and tracking mailpieces. The allowable encoding range shall be 000000000–999999999 when used with a 6 digit Mailer ID and 000000-999999 when used with a 9 digit Mailer ID.
- e. The Delivery Point ZIP Code shall be assigned by the mailer for routing the mailpiece. This shall replace POSTNET for routing the mailpiece to its final delivery point. The length may be 0, 5, 9, or 11 digits. The allowable encoding ranges shall be no ZIP Code, 00000–99999, 000000000–999999999, and 00000000000–99999999999.

3.2 Encoding Performance – The encoding process takes place in six steps as described in the following six sections. The process shall begin with the five data fields to be encoded and end with a string of 65 bars for printing. Specific examples are provided in Appendix B.

3.2.1 Step 1 — Conversion of Data Fields into Binary Data

3.2.1.1 Conversion of Routing Code – The routing code shall be converted from a 0-, 5-, 9-, or 11-digit string to an integer value in the range of 0 to 101,000,100,000 by applying the following algorithm:

If the routing code is 0 digits long, Value = 0

If the routing code is 5 digits long, Value = (5-digit string converted to integer) + 1

If the routing code is 9 digits long, Value = (9-digit string converted to integer) + 100000 + 1

If the routing code is 11 digits long, Value = (11-digit string converted to integer) + 1000000000 + 100000 + 1

The routing code shall then be converted into binary data. The binary data shall hold 104 bits maximum (or 13 bytes). The routing code binary data, which shall fit within 37 bits, shall be put into the rightmost 37 bits of the binary data.

3.2.1.2 Conversion of Tracking Code – The tracking code shall be converted into binary data using the following steps:

Multiply the Binary Data field by 10 decimal, and then add the first Tracking Code digit (left digit of Barcode Identifier).

Multiply the Binary Data field by 5 decimal, and then add the second Tracking Code digit (right digit of Barcode Identifier, which is limited to value of 0 to 4).

For each of the remaining 18 Tracking Code digits (from left to right, each of which can range from 0 to 9), multiply the Binary Data Field by 10 decimal, then add the Tracking Code digit.

At the completion of this step, the binary data (13 bytes long) shall have the rightmost 102 bits filled with data from the routing code and tracking code.

3.2.1.3 Examples of Binary Encoding – Four examples of binary encoding are shown in Table II. The fourth (last) example is used in the remaining five steps of this section.

Table II – Examples of Binary Encoding

Bar-code ID	Service Type ID	Mailer ID	Serial Number	Routing ZIP Code	Base 16
01	234	567094	987654321	None	00 00 00 00 00 11 22 10 3B 5C 20 04 B1
01	234	567094	987654321	01234	00 00 00 0D 13 8A 87 BA B5 CF 38 04 B1
01	234	567094	987654321	012345678	00 02 02 BD C0 97 71 12 04 D2 18 04 B1
01	234	567094	987654321	01234567891	01 69 07 B2 A2 4A BC 16 A2 E5 C0 04 B1

3.2.2 Step 2 — Generation of 11-Bit CRC on Binary Data – An 11-bit CRC Frame Check Sequence (FCS) value shall be generated by applying the Generator Polynomial

(0xF35) to the rightmost 102 bits of the Binary Data. The leftmost 2 bits of the leftmost byte shall be excluded from the CRC calculation. This 11-bit FCS value shall be set aside for later use. The code in Appendix C shall be used to generate the CRC. An example is shown in Figure 3.

The provided routine for generating CRC is called. It returns the correct CRC value.

`USPS_MSB_Math_CRC11FrameCheckSequence(016907B2A24ABC16A2E5C004B116) = 75116`

Figure 3. Example of CRC

3.2.3 Step 3 — Conversion from Binary Data to Codewords – The Binary Data shall then be converted to several bases. The rightmost Codeword (J) shall be base 636. The leftmost Codeword (A) shall use 659 values (0–658). Codewords B through I shall be base 1365. Ten Codewords shall be generated, with the first (or leftmost) considered the most significant. The leftmost 2 bits of the 104-bit binary data shall be excluded from this conversion. The Codewords shall be labeled (from leftmost to rightmost) A through J. The conversion process consists of the following steps:

- 1 – Divide Binary Data by 636, quotient replaces Binary Data, remainder is Codeword J
- 2 – Divide Binary Data by 1365, quotient replaces Binary Data, remainder is Codeword I
- 3 – Divide Binary Data by 1365, quotient replaces Binary Data, remainder is Codeword H
- 4 – Divide Binary Data by 1365, quotient replaces Binary Data, remainder is Codeword G
- 5 – Divide Binary Data by 1365, quotient replaces Binary Data, remainder is Codeword F
- 6 – Divide Binary Data by 1365, quotient replaces Binary Data, remainder is Codeword E
- 7 – Divide Binary Data by 1365, quotient replaces Binary Data, remainder is Codeword D
- 8 – Divide Binary Data by 1365, quotient replaces Binary Data, remainder is Codeword C
- 9 – Divide Binary Data by 1365, quotient replaces Binary Data, remainder is Codeword B
- 10 – Binary Data (should be value between 0 and 658) is Codeword A

An example of converting binary data to Codewords is shown in Figure 4.

`016907B2A24ABC16A2E5C004B116 = 14 787 607 1022 861 19 816 1294 35 301`
 Codewords A B C D E F G H I J

Figure 4. Example of Codewords

If the Codeword has a value from 1287 to 1364, the Character shall be determined by indexing into Table II, in Appendix E, using the Codeword reduced by 1287 (result from 0 to 77).

An example of looking up Codewords to Characters using Tables I and II in Appendix E is shown in figure 7.

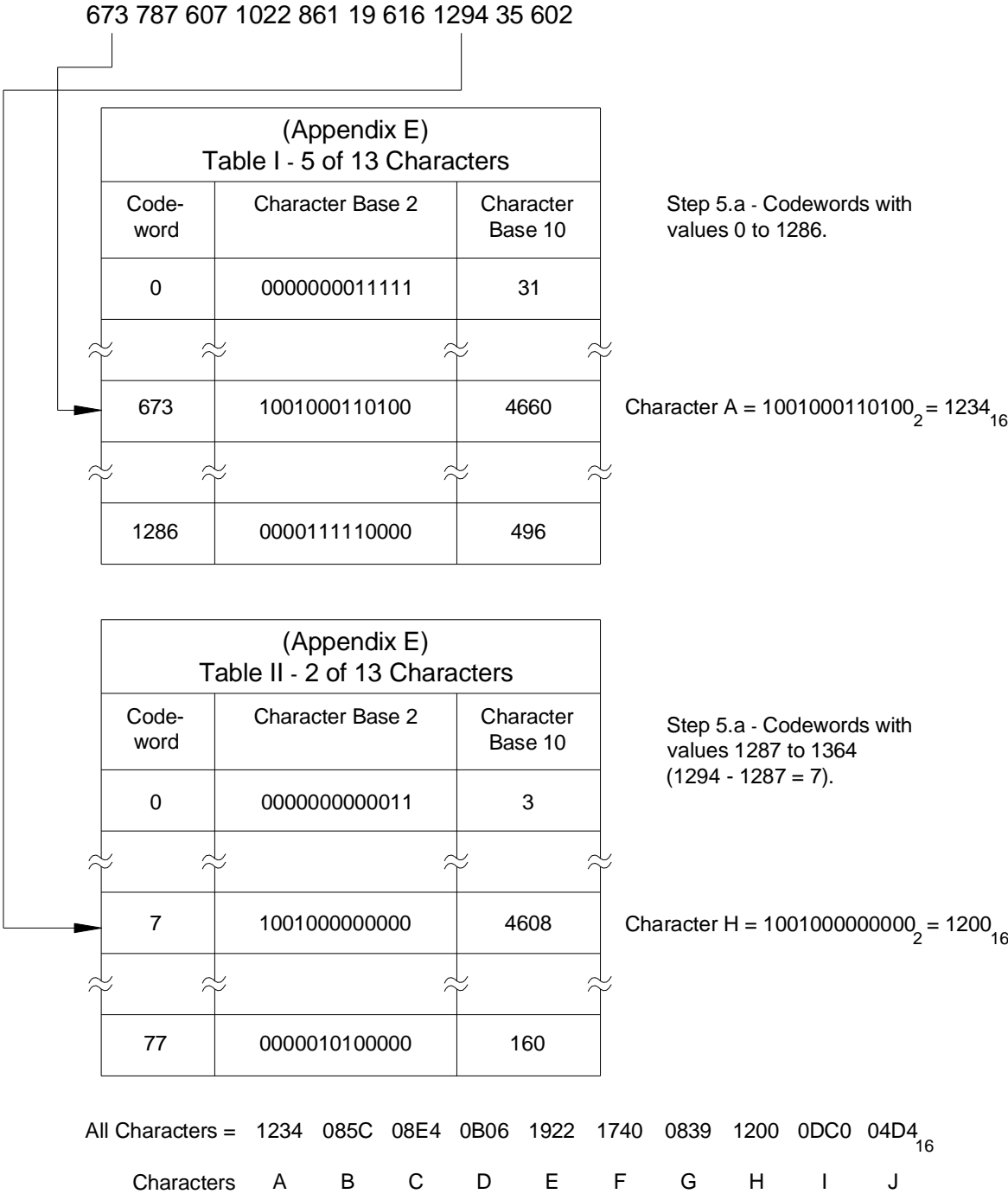


Figure 7. Example of Character Lookup

- b. Each Character shall be paired to one of the unused remaining 10 bits of the 11-bit FCS value. If the bit's value is 1, the Character shall be bitwise negated; if the bit's value is 0, the Character shall be left as is. Mapping of FCS bits to Characters is listed in Table III, in Appendix E. An example of this is shown in Figure 8.

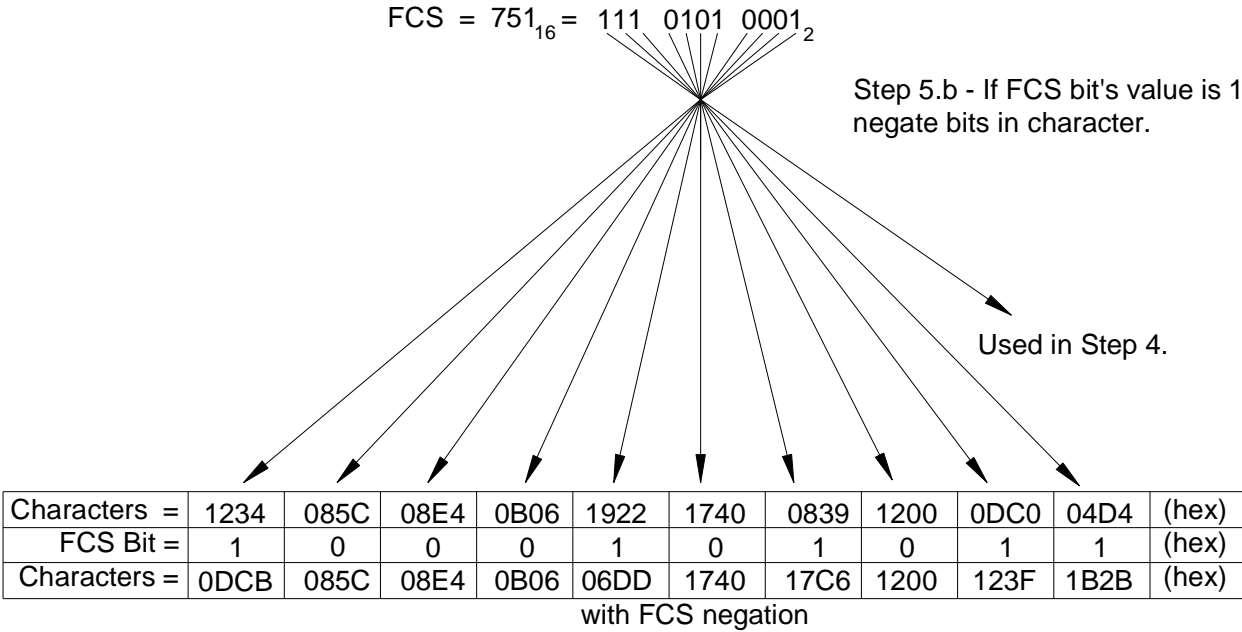
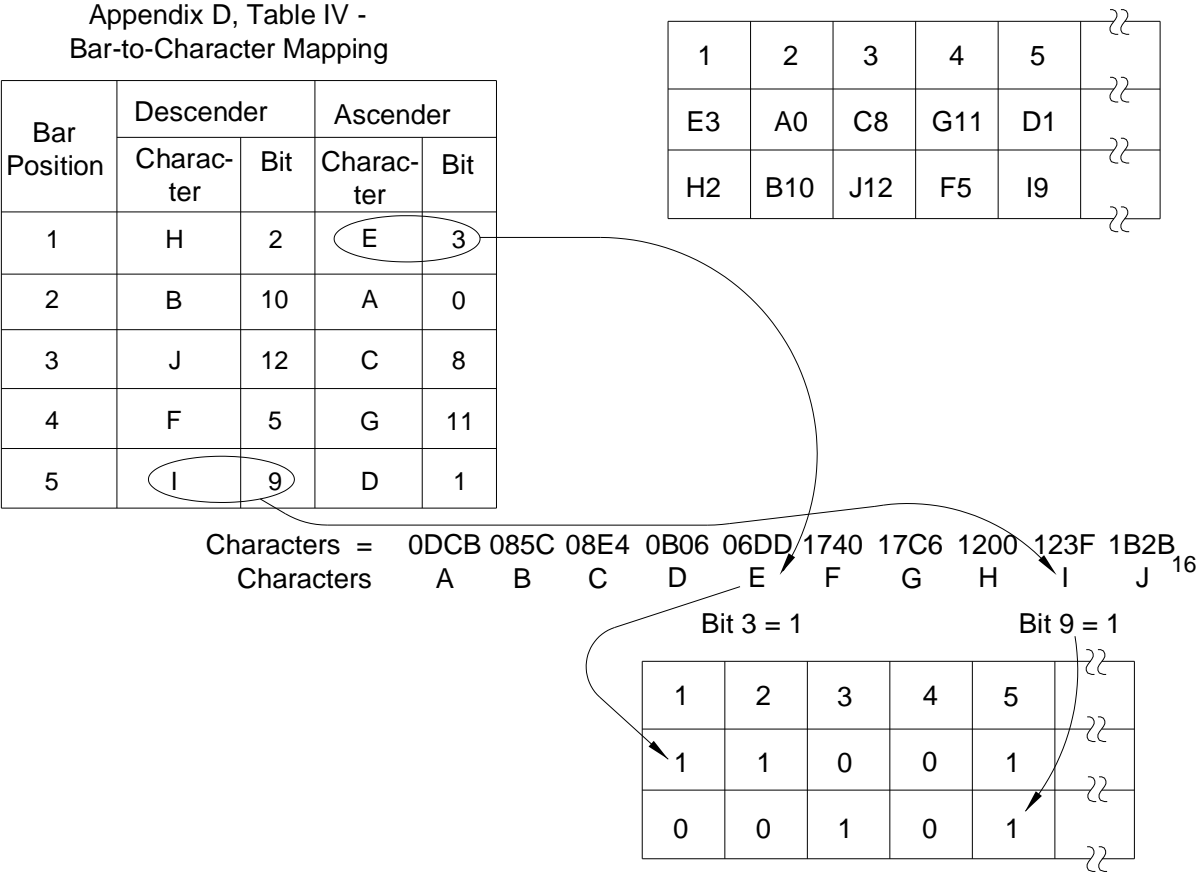


Figure 8. Example of Characters

3.2.6 Step 6 — Conversion from Characters to the Intelligent Mail Barcode – At this point there are 10 (A–J) Characters of 13 (12–0) bits each, for a total of 130 bits. Each bit shall correspond to an extender (either an ascender or a descender) in a 65-bar Intelligent Mail barcode. A bit value of 0 shall represent the absence of the extender, and a bit value of 1 shall represent the presence of the extender. The bars shall be numbered from 1 (leftmost) to 65 (rightmost). Table IV in Appendix E maps bars to characters. At this point the barcode shall consist of 65 bars, each of which is in one of four possible states (see Figure 9).

Bars are constructed left to right, selecting bits from characters. The least significant bit is bit 0. Using Table IV in Appendix D, the left 5 bars are constructed using the bit specified in the table.



1 represents the presence of the extender. 0 represents its absence. A represents an ascender is present. D indicates a descender is present. T indicates neither is present, and F indicates both are present. The leftmost 5 bars in this example are thus = AADTF.

The bars for this example are:
 AADTFFDFTDADTAADAATFDTDDAAADDTDTTDAFADADDFTFFDDTT
 TADFAAADFTDAADA

The final barcode is:

Figure 9. Example of the Final Barcode

3.3 Physical Characteristics

3.3.1 Dimensions – Physical dimensions for the four types of bars shall be as shown in Figure 10.

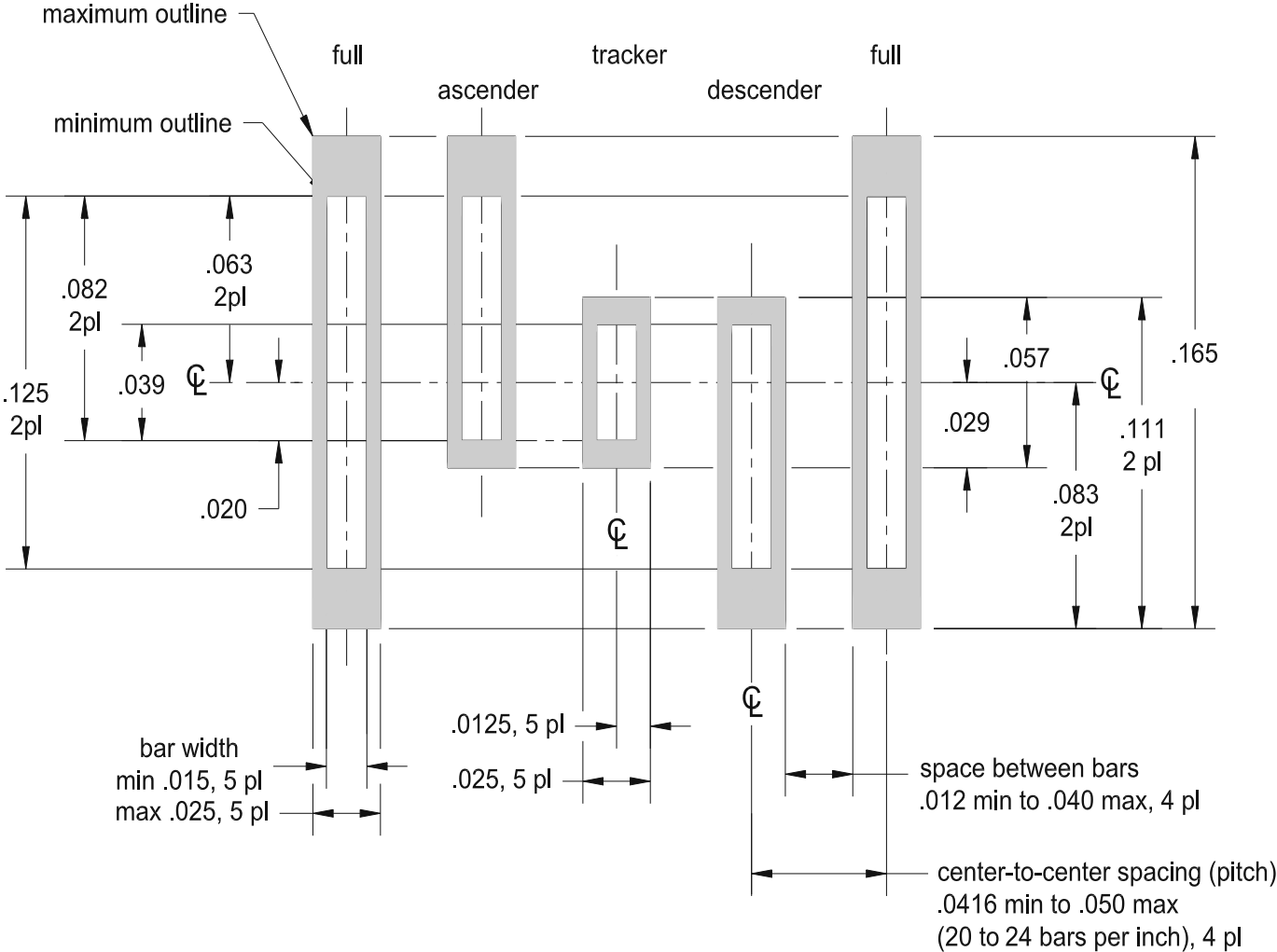


Figure 10. Physical Dimensions

Vertical dimensions shall be based on the centerline of the barcode, forming an overall barcode height of 0.125 inch to 0.165 inch. Any vertical jitter shall be contained within the vertical dimensions from the centerline.

Horizontal dimensions shall be based on the centerline of the individual bars, forming an overall barcode pitch of 22 ± 2 bars per inch. Individual bars shall be printed with a width of 0.020 ± 0.005 inch. The pitch and widths shall result in spacing between bars of 0.012 inch to 0.040 inch.

The distance from the lead (left) edge of the 1st (left most) bar to the lead (left) edge of the 65th (right most) bar shall never be less than 2.667 inches. The distance from the

lead (left) edge of the 1st bar (left most) to the trail (right) edge of the 65th (right most) bar shall never be greater than 3.225 inches.

3.3.2 Clear Zone – A clear zone shall be placed around the barcode to ensure that readers can locate and read the barcode. A minimum clear zone shall be 0.028 inch above and below the barcode and 0.125 inch on each end of the barcode. Clear zones are shown in Figure 11.

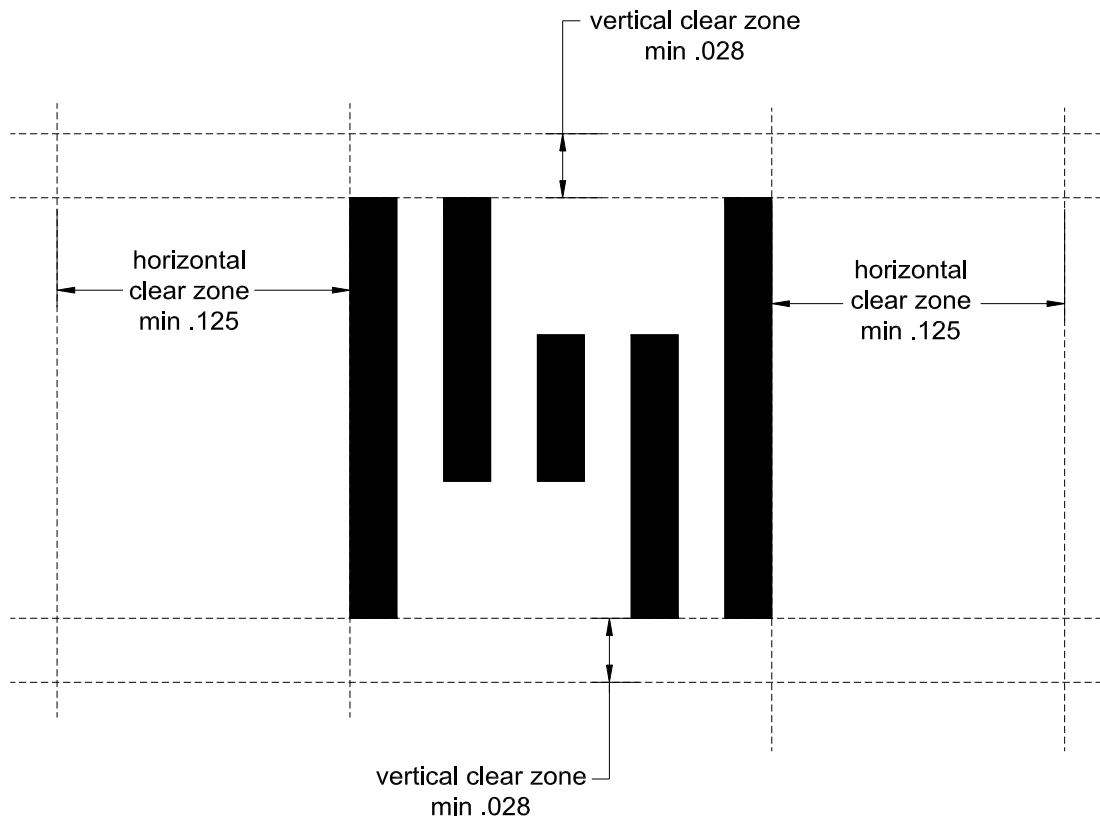


Figure 11. Clear Zones

3.3.3 Barcode Tilt – When printing height-modulated barcodes, two types of tilt can occur:

- a. Barcode skew, in which the entire barcode is skewed with respect to the bottom edge of the mailpiece
- b. Bar rotation, in which the individual bars are rotated with respect to the centerline of the barcode

Barcode skew for letter mail pieces shall be limited to $\pm 5^\circ$, as shown in Figure 12.

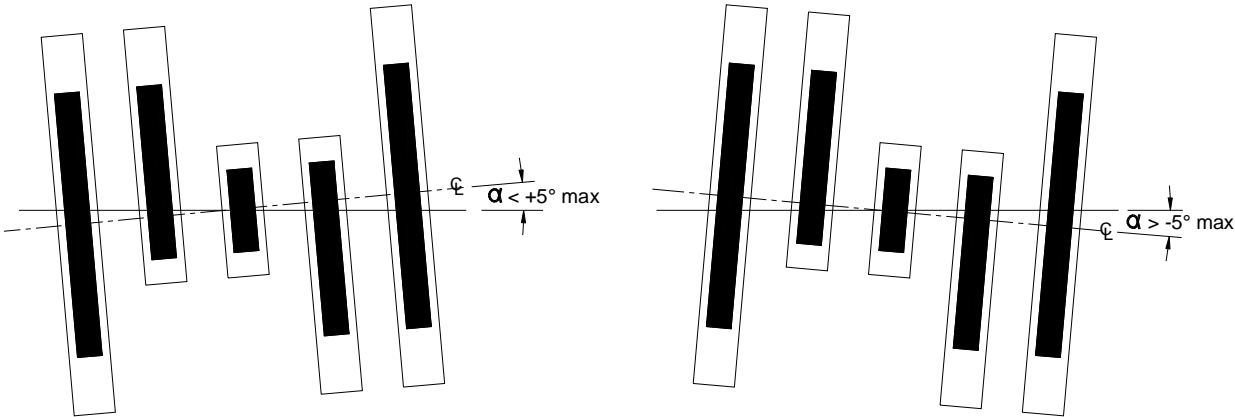


Figure 12. Barcode Skew

Bar rotation for letter mail pieces shall be limited to $\pm 5^\circ$, as shown in Figure 13.

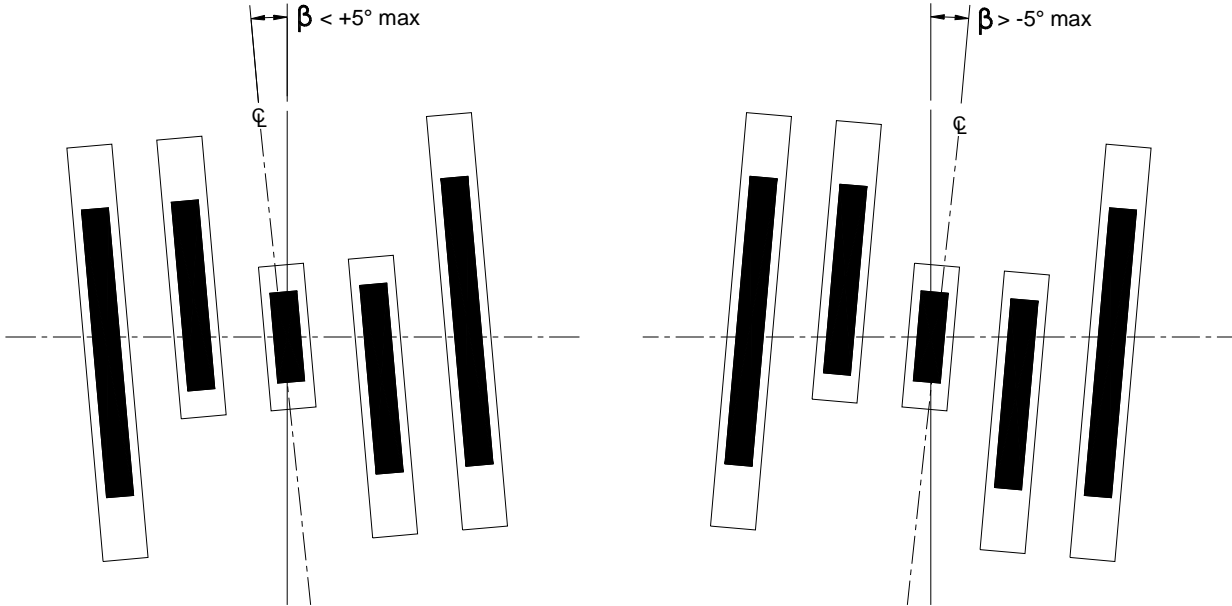


Figure 13. Bar Rotation

Both types of tilt may occur simultaneously. The total tilt for letter mail pieces shall be limited to $\pm 5^\circ$, $|\alpha| + |\beta| < 5^\circ$.

The maximum bar rotation acceptable on flat mail pieces shall be ± 10 degrees from a perpendicular to the base line of the barcode. There is no barcode skew requirement on flat mail pieces. It is, however, preferred that the combined effect of barcode skew and bar rotation be limited to a maximum of ± 10 degrees from a perpendicular to the top or

bottom edges of the mail piece for horizontally oriented barcodes, and left or right edges of the mail piece for vertically oriented barcodes.

3.3.4 Printing Characteristics

3.3.4.1 Background Reflectance – The area of the mailpiece where the barcode is located shall be uniform in color. When measured with a Postal Service envelope reflectance meter or equivalent, the minimum reflectance from the background area shall be 50 percent in the red portions and 45 percent in the green portions of the optical spectrum.

3.3.4.2 Print Reflectance Difference – The print reflectance difference (PRD) shall be the difference between light reflected from the printed barcode and the background when measured with a Postal Service envelope reflectance meter or equivalent. The minimum PRD shall be at least 30 percent in the red and green portions of the optical spectrum.

3.3.4.3 Clear Zone Reflectance – Within the clear areas around the barcode, background patterns, envelope insert “show through,” and all other printing shall be limited to a maximum print contrast ratio (PCR) of 15 percent when measured in the red and green portions of the optical spectrum using a Postal Service envelope reflectance meter or equivalent.

3.3.4.4 Inking Issues – Overinking can cause a bar to exceed its maximum dimensions and prevent successful barcode interpretation. Excessive or extraneous ink shall not cause any bar to exceed the specified dimensions.

Underinking, common with inkjet and dot matrix printers, can cause a bar to fail to meet its minimum dimensions and prevent successful barcode interpretation. Underinking and voids, as shown in Figure 14, shall not cause any bar to fail to meet minimum specified dimensions.

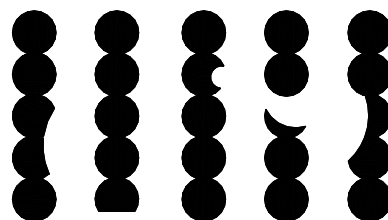


Figure 14. Dot Matrix Pattern Voids

Ideally, inkjet printing, dot matrix printing, or any other similar printing process should yield dots that touch or overlap, as shown in Figure 15.

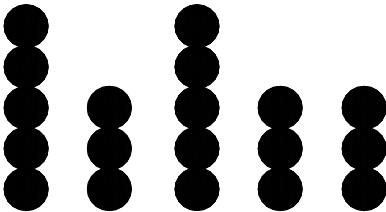


Figure 15. Preferred Dot Matrix Dot Pattern

If the dots do not touch, the space between the dots should not exceed 0.010 inch, as shown in Figure 16.

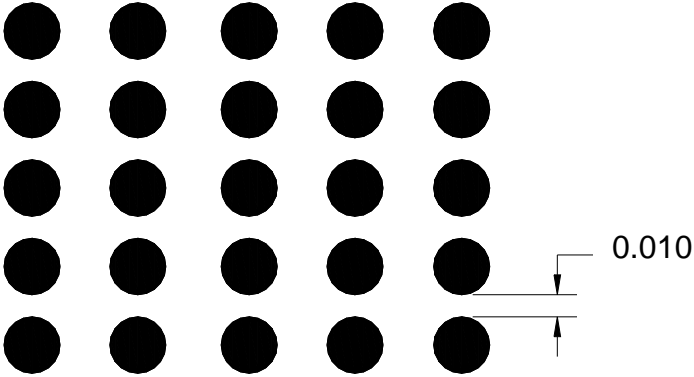


Figure 16. Maximum Dot Matrix Spacing

3.4 Human-Readable Information – Depending on the Service Type Identifier specified by the Intelligent Mail barcode, the human-readable representation of the barcode may need to be printed. The requirement for printing human-readable information is specified by USPS publications that describe these services. An example of this is shown in Figure 17.

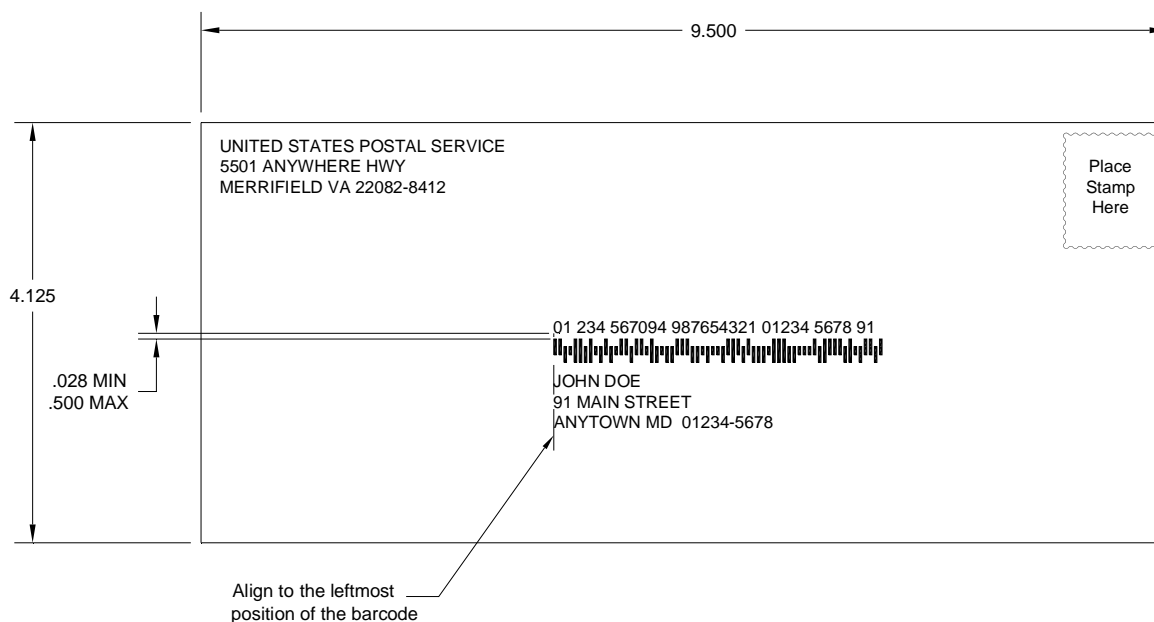


Figure 17. Sample Envelope with Intelligent Mail Barcode and Human-Readable Information (Placed Above the Intelligent Mail Barcode)

3.4.1 Vertical Position – The human-readable information, when required, shall be printed immediately above or below the Intelligent Mail barcode, as specified by the appropriate publications that describe these services. The human-readable information shall be outside the vertical clear zone specified in 3.3.2. When printed above the barcode, the bottom of the human-readable information shall be at least 0.028 inch above the top of the Intelligent Mail barcode but shall not be more than 0.5 inch above the top of the Intelligent Mail barcode. When printed below the barcode, the top of the human-readable information shall be at least 0.028 inch below the bottom of the Intelligent Mail barcode but shall not be more than 0.5 inch below the bottom of the Intelligent Mail barcode. No other printing is allowed between the barcode and the human-readable information.

3.4.2 Horizontal Position – The human-readable information, when required, shall be printed so that the left edge of the leftmost digit aligns with the leftmost bar of the Intelligent Mail barcode.

3.4.3 Content – The human-readable information, when required, shall consist of the 20-digit tracking code and the 5-, 9-, or 11-digit routing code, if present. The fields of the tracking code, as defined in 3.1.3, shall be separated with a space added between data fields. When the barcode contains a routing code, the 5-digit ZIP Code, the 4-digit add-on, and the remaining 2 digits shall be separated with a space added between data

fields. Using the 4th example in Table II in 3.2.1.3, the human-readable information will appear as follows: 01 234 567094 987654321 01234 5678 91.

3.4.4 Font Specification – The human-readable information, when required, shall be printed using a sans serif font and a minimum of 10- to 12-point size type.

4 QUALITY ASSURANCE PROVISIONS

This section is not applicable to this specification.

5 PREPARATION FOR DELIVERY

This section is not applicable to this specification.

6 NOTES

This section is not applicable to this specification.

APPENDIX A

VALID BARCODE FIELD VALUES

Table I – Barcode Identifier

Value	Optional Endorsement Line (OEL) Description
00	Default / No OEL Information
10	Carrier Route (CR), Enhanced Carrier Route (ECR), and FIRM
20	5-Digit/Scheme
30	3-Digit/Scheme
40	Area Distribution Center (ADC)
50	Mixed Area Distribution Center (MADC), Origin Mixed ADC (OMX)


Table II – Service Type Identifier

Value	Mail Class Description
700	First-Class Mail with no services
702	Standard Mail with no services
704	Periodicals with no services
706	Bound Printed Matter with no services
708	Business Reply Mail with no services
710	Priority Mail with no services
712	Priority Mail Flat Rate with no services

APPENDIX B


EXAMPLES

Table I – Example 1

Step	Results
Payload Data	Tracking = 01234567094987654321, routing = none
1 – Binary Data (hexadecimal)	00 00 00 00 00 11 22 10 3B 5C 20 04 B1
2 – FCS (hexadecimal)	051
3 – Codewords	0 0 0 0 559 202 508 451 124 17
4.a – Codewords with orientation in Character J	0 0 0 0 559 202 508 451 124 34
4.b – Codewords with FCS bit in Character A	0 0 0 0 559 202 508 451 124 34
5.a – Characters (hexadecimal)	001F 001F 001F 001F 1524 01A3 043C 1838 012B 0076
5.b – Characters with FCS bits 0–9 (hexadecimal)	1FE0 001F 001F 001F 0ADB 01A3 1BC3 1838 012B 0076
6 – Barcode Letters	ATTFATTDTTADTAATTDTDATTDAFDDFADFDFTFDDFFFTATFAAAATDFFTD AADFTFD TDT
Barcode	


APPENDIX B

Table II – Example 2

Step	Results
Payload Data	Tracking = 01234567094987654321, routing = 01234
1 – Binary Data (hexadecimal)	00 00 00 0D 13 8A 87 BA B5 CF 38 04 B1
2 – FCS (hexadecimal)	065
3 – Codewords	0 0 15 14 290 567 385 48 388 333
4.a – Codewords with orientation in Character J	0 0 15 14 290 567 385 48 388 666
4.b – Codewords with FCS bit in Character A	0 0 15 14 290 567 385 48 388 666
5.a – Characters (hexadecimal)	001F 001F 1D40 0057 0255 0724 04E8 009D 030B 0583
5.b – Characters with FCS bits 0–9 (hexadecimal)	1FE0 001F 02BF 0057 0255 18DB 1B17 009D 030B 0583
6 – Barcode Letters	DTTAFADDTTFTDTFTFDTDADADAFADFATDDFTAAAFDTTADFAAATDFDTDFADDDTDFFT
Barcode	


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Table III – Example 3

Step	Results
Payload Data	Tracking = 01234567094987654321, routing = 012345678
1 – Binary Data (hexadecimal)	00 02 02 BD C0 97 71 12 04 D2 18 04 B1
2 – FCS (hexadecimal)	606
3 – Codewords	0 110 1113 1363 198 413 470 468 1333 513
4.a – Codewords with orientation in Character J	0 110 1113 1363 198 413 470 468 1333 1026
4.b – Codewords with FCS bit in Character A	659 110 1113 1363 198 413 470 468 1333 1026
5.a – Characters (hexadecimal)	1154 00F8 1E01 0110 019A 1298 03A2 03A1 0084 0B11
5.b – Characters with FCS bits 0–9 (hexadecimal)	1154 1F07 01FE 0110 019A 1298 03A2 03A1 0084 14EE
6 – Barcode Letters	ADFTTAFDTTTTFATTADTAAATFTFTATDAAAFDDADATATD TD TTD FDT DATA DADTDFFTF A
Barcode	

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Table IV – Example 4

Step	Results
Payload Data	Tracking = 01234567094987654321, routing = 01234567891
1 – Binary Data (hexadecimal)	01 69 07 B2 A2 4A BC 16 A2 E5 C0 04 B1
2 – FCS (hexadecimal)	751
3 – Codewords	14 787 607 1022 861 19 816 1294 35 301
4.a – Codewords with orientation in Character J	14 787 607 1022 861 19 816 1294 35 602
4.b – Codewords with FCS bit in Character A	673 787 607 1022 861 19 816 1294 35 602
5.a – Characters (hexadecimal)	1234 085C 08E4 0B06 1922 1740 0839 1200 0DC0 04D4
5.b – Characters with FCS bits 0–9 (hexadecimal)	0DCB 085C 08E4 0B06 06DD 1740 17C6 1200 123F 1B2B
6 – Barcode Letters	AADTFFDFTDADTAADAATFDTDDAAADDTDTTDAFADADDFTFFDFTTTADF AAADFTDAADA
Barcode	

APPENDIX C

CRC GENERATING CODE

```

/*****
** USPS_MSB_Math_CRC11GenerateFrameCheckSequence
**
** Inputs:
**   ByteArrayPtr is the address of a 13 byte array holding 102 bits which
**   are right justified - ie: the leftmost 2 bits of the first byte do not
**   hold data and must be set to zero.
**
** Outputs:
**   return unsigned short - 11 bit Frame Check Sequence (right justified)
*****/
extern unsigned short
USPS_MSB_Math_CRC11GenerateFrameCheckSequence( unsigned char *ByteArrayPtr )
{
    unsigned short  GeneratorPolynomial = 0x0F35;
    unsigned short  FrameCheckSequence = 0x07FF;
    unsigned short  Data;
    int             ByteIndex, Bit;

    /* Do most significant byte skipping the 2 most significant bits */
    Data = *ByteArrayPtr << 5;
    ByteArrayPtr++;
    for ( Bit = 2; Bit < 8; Bit++ )
    {
        if ( (FrameCheckSequence ^ Data) & 0x400 )
            FrameCheckSequence = (FrameCheckSequence << 1) ^ GeneratorPolynomial;
        else
            FrameCheckSequence = (FrameCheckSequence << 1);
        FrameCheckSequence &= 0x7FF;
        Data <<= 1;
    }

    /* Do rest of the bytes */
    for ( ByteIndex = 1; ByteIndex < 13; ByteIndex++ )
    {
        Data = *ByteArrayPtr << 3;
        ByteArrayPtr++;
        for ( Bit = 0; Bit < 8; Bit++ )
        {
            if ( (FrameCheckSequence ^ Data) & 0x0400 )
                FrameCheckSequence = (FrameCheckSequence << 1) ^ GeneratorPolynomial;
            else
                FrameCheckSequence = (FrameCheckSequence << 1);
            FrameCheckSequence &= 0x7FF;
            Data <<= 1;
        }
    }

    return FrameCheckSequence;
}

```


APPENDIX D

EXAMPLE FOR GENERATING CODEWORD TO CHARACTER TABLE

```

extern unsigned short
ReverseUnsignedShort( unsigned short  Input )

{
    unsigned short  Reverse = 0;
    int             Index;

    for ( Index = 0; Index < 16; Index++ )
    {
        Reverse <<= 1;
        Reverse |= Input & 1;
        Input   >>= 1;
    }

    return Reverse;
}

/*****
** InitializeNof13Table
**
** Inputs:
** N is the type of table (i.e. 5 for 5of13 table, 2 for 2of13 table)
** TableLength is the length of the table requested (i.e. 78 for 2of13 table)
** Output:
** TableNof13 is a pointer to the resulting table
*****/

extern BOOLEAN
InitializeNof13Table( int *TableNof13 ,
                    int  N ,
                    int  TableLength )

{
    int  Count, Reverse;
    int  LUT_LowerIndex, LUT_UpperIndex;
    int  BitCount;
    int  BitIndex;

    /* Count up to 2^13 - 1 and find all those values that have N bits on */
    LUT_LowerIndex = 0;
    LUT_UpperIndex = TableLength - 1;

    for ( Count = 0; Count < 8192; Count++ )
    {
        BitCount = 0;
        for ( BitIndex = 0; BitIndex < 13; BitIndex++ )
            BitCount += ((Count & (1 << BitIndex)) != 0);

        /* If we don't have the right number of bits on, go on to the next value */
        if ( BitCount != N )
            continue;
    }
}

```

APPENDIX D

```

/* If the reverse is less than count, we have already visited this pair before */
Reverse = ReverseUnsignedShort( Count ) >> 3;
if ( Reverse < Count )
    continue;

/* If Count is symmetric, place it at the first free slot from the end of the */
/* list. Otherwise, place it at the first free slot from the beginning of the */
/* list AND place Reverse at the next free slot from the beginning of the list.*/

if ( Count == Reverse )
{
    TableNof13[LUT_UpperIndex] = Count;
    LUT_UpperIndex -= 1;
}
else
{
    TableNof13[LUT_LowerIndex] = Count;
    LUT_LowerIndex += 1;
    TableNof13[LUT_LowerIndex] = Reverse;
    LUT_LowerIndex += 1;
}
}

/* Make sure the lower and upper parts of the table meet properly */
if ( LUT_LowerIndex != (LUT_UpperIndex+1) )
    return FALSE;

#if 1
for ( LUT_LowerIndex = 0; LUT_LowerIndex < TableLength; LUT_LowerIndex++ )
    printf("Index %4d Value %4.4X\n", LUT_LowerIndex, TableNof13[LUT_LowerIndex]);
#endif

return TRUE;
}

```

APPENDIX E

TABLES FOR CONVERTING CHARACTERS

Table I – 5 of 13 Characters

Code-word	Character	
	Base 2	Base 10
0	000000011111	31
1	111110000000	7936
2	000000101111	47
3	111101000000	7808
4	000000110111	55
5	111011000000	7552
6	000000111011	59
7	110111000000	7040
8	000000111101	61
9	101111000000	6016
10	000000111110	62
11	011111000000	3968
12	000001001111	79
13	111100100000	7744
14	000001010111	87
15	111010100000	7488
16	000001011011	91
17	110110100000	6976
18	000001011101	93
19	101110100000	5952
20	000001011110	94
21	011110100000	3904
22	000001100111	103
23	111001100000	7360

Code-word	Character	
	Base 2	Base 10
24	000001101011	107
25	110101100000	6848
26	000001101101	109
27	101101100000	5824
28	000001101110	110
29	011101100000	3776
30	000001110011	115
31	110011100000	6592
32	000001110101	117
33	101011100000	5568
34	000001110110	118
35	011011100000	3520
36	000001111001	121
37	100111100000	5056
38	000001111010	122
39	010111100000	3008
40	000001111100	124
41	001111100000	1984
42	0000010001111	143
43	1111000100000	7712
44	0000010010111	151
45	1110100100000	7456
46	0000010011011	155
47	1101100100000	6944

APPENDIX E

Code-word	Character	
	Base 2	Base 10
48	0000010011101	157
49	1011100100000	5920
50	0000010011110	158
51	0111100100000	3872
52	0000010100111	167
53	1110010100000	7328
54	0000010101011	171
55	1101010100000	6816
56	0000010101101	173
57	1011010100000	5792
58	0000010101110	174
59	0111010100000	3744
60	0000010110011	179
61	1100110100000	6560
62	0000010110101	181
63	1010110100000	5536
64	0000010110110	182
65	0110110100000	3488
66	0000010111001	185
67	1001110100000	5024
68	0000010111010	186
69	0101110100000	2976
70	0000010111100	188
71	0011110100000	1952
72	0000011000111	199
73	1110001100000	7264

Code-word	Character	
	Base 2	Base 10
74	0000011001011	203
75	1101001100000	6752
76	0000011001101	205
77	1011001100000	5728
78	0000011001110	206
79	0111001100000	3680
80	0000011010011	211
81	1100101100000	6496
82	0000011010101	213
83	1010101100000	5472
84	0000011010110	214
85	0110101100000	3424
86	0000011011001	217
87	1001101100000	4960
88	0000011011010	218
89	0101101100000	2912
90	0000011011100	220
91	0011101100000	1888
92	0000011100011	227
93	1100011100000	6368
94	0000011100101	229
95	1010011100000	5344
96	0000011100110	230
97	0110011100000	3296
98	0000011101001	233
99	1001011100000	4832

APPENDIX E

Code-word	Character	
	Base 2	Base 10
100	0000011101010	234
101	0101011100000	2784
102	0000011101100	236
103	0011011100000	1760
104	0000011110001	241
105	1000111100000	4576
106	0000011110010	242
107	0100111100000	2528
108	0000011110100	244
109	0010111100000	1504
110	0000011111000	248
111	0001111100000	992
112	0000100001111	271
113	1111000010000	7696
114	0000100010111	279
115	1110100010000	7440
116	0000100011011	283
117	1101100010000	6928
118	0000100011101	285
119	1011100010000	5904
120	0000100011110	286
121	0111100010000	3856
122	0000100100111	295
123	1110010010000	7312
124	0000100101011	299
125	1101010010000	6800

Code-word	Character	
	Base 2	Base 10
126	0000100101101	301
127	1011010010000	5776
128	0000100101110	302
129	0111010010000	3728
130	0000100110011	307
131	1100110010000	6544
132	0000100110101	309
133	1010110010000	5520
134	0000100110110	310
135	0110110010000	3472
136	0000100111001	313
137	1001110010000	5008
138	0000100111010	314
139	0101110010000	2960
140	0000100111100	316
141	0011110010000	1936
142	0000101000111	327
143	1110001010000	7248
144	0000101001011	331
145	1101001010000	6736
146	0000101001101	333
147	1011001010000	5712
148	0000101001110	334
149	0111001010000	3664
150	0000101010011	339
151	1100101010000	6480

APPENDIX E

Code-word	Character	
	Base 2	Base 10
152	0000101010101	341
153	1010101010000	5456
154	0000101010110	342
155	0110101010000	3408
156	0000101011001	345
157	1001101010000	4944
158	0000101011010	346
159	0101101010000	2896
160	0000101011100	348
161	0011101010000	1872
162	0000101100011	355
163	1100011010000	6352
164	0000101100101	357
165	1010011010000	5328
166	0000101100110	358
167	0110011010000	3280
168	0000101101001	361
169	1001011010000	4816
170	0000101101010	362
171	0101011010000	2768
172	0000101101100	364
173	0011011010000	1744
174	0000101110001	369
175	1000111010000	4560
176	0000101110010	370
177	0100111010000	2512

Code-word	Character	
	Base 2	Base 10
178	0000101110100	372
179	0010111010000	1488
180	0000101111000	376
181	0001111010000	976
182	0000110000111	391
183	1110000110000	7216
184	0000110001011	395
185	1101000110000	6704
186	0000110001101	397
187	1011000110000	5680
188	0000110001110	398
189	0111000110000	3632
190	0000110010011	403
191	1100100110000	6448
192	0000110010101	405
193	1010100110000	5424
194	0000110010110	406
195	0110100110000	3376
196	0000110011001	409
197	1001100110000	4912
198	0000110011010	410
199	0101100110000	2864
200	0000110011100	412
201	0011100110000	1840
202	0000110100011	419
203	1100010110000	6320

APPENDIX E

Code-word	Character	
	Base 2	Base 10
204	0000110100101	421
205	1010010110000	5296
206	0000110100110	422
207	0110010110000	3248
208	0000110101001	425
209	1001010110000	4784
210	0000110101010	426
211	0101010110000	2736
212	0000110101100	428
213	0011010110000	1712
214	0000110110001	433
215	1000110110000	4528
216	0000110110010	434
217	0100110110000	2480
218	0000110110100	436
219	0010110110000	1456
220	0000110111000	440
221	0001110110000	944
222	0000111000011	451
223	1100001110000	6256
224	0000111000101	453
225	1010001110000	5232
226	0000111000110	454
227	0110001110000	3184
228	0000111001001	457
229	1001001110000	4720

Code-word	Character	
	Base 2	Base 10
230	0000111001010	458
231	0101001110000	2672
232	0000111001100	460
233	0011001110000	1648
234	0000111010001	465
235	1000101110000	4464
236	0000111010010	466
237	0100101110000	2416
238	0000111010100	468
239	0010101110000	1392
240	0000111011000	472
241	0001101110000	880
242	0000111100001	481
243	1000011110000	4336
244	0000111100010	482
245	0100011110000	2288
246	0000111100100	484
247	0010011110000	1264
248	0000111101000	488
249	0001011110000	752
250	0001000001111	527
251	1111000001000	7688
252	0001000010111	535
253	1110100001000	7432
254	0001000011011	539
255	1101100001000	6920

APPENDIX E

Code-word	Character	
	Base 2	Base 10
256	0001000011101	541
257	1011100001000	5896
258	0001000011110	542
259	0111100001000	3848
260	0001000100111	551
261	1110010001000	7304
262	0001000101011	555
263	1101010001000	6792
264	0001000101101	557
265	1011010001000	5768
266	0001000101110	558
267	0111010001000	3720
268	0001000110011	563
269	1100110001000	6536
270	0001000110101	565
271	1010110001000	5512
272	0001000110110	566
273	0110110001000	3464
274	0001000111001	569
275	1001110001000	5000
276	0001000111010	570
277	0101110001000	2952
278	0001000111100	572
279	0011110001000	1928
280	0001001000111	583
281	1110001001000	7240

Code-word	Character	
	Base 2	Base 10
282	0001001001011	587
283	1101001001000	6728
284	0001001001101	589
285	1011001001000	5704
286	0001001001110	590
287	0111001001000	3656
288	0001001010011	595
289	1100101001000	6472
290	0001001010101	597
291	1010101001000	5448
292	0001001010110	598
293	0110101001000	3400
294	0001001011001	601
295	1001101001000	4936
296	0001001011010	602
297	0101101001000	2888
298	0001001011100	604
299	0011101001000	1864
300	0001001100011	611
301	1100011001000	6344
302	0001001100101	613
303	1010011001000	5320
304	0001001100110	614
305	0110011001000	3272
306	0001001101001	617
307	1001011001000	4808

APPENDIX E

Code- word	Character	
	Base 2	Base 10
308	0001001101010	618
309	0101011001000	2760
310	0001001101100	620
311	0011011001000	1736
312	0001001110001	625
313	1000111001000	4552
314	0001001110010	626
315	0100111001000	2504
316	0001001110100	628
317	0010111001000	1480
318	0001001111000	632
319	0001111001000	968
320	0001010000111	647
321	1110000101000	7208
322	0001010001011	651
323	1101000101000	6696
324	0001010001101	653
325	1011000101000	5672
326	0001010001110	654
327	0111000101000	3624
328	0001010010011	659
329	1100100101000	6440
330	0001010010101	661
331	1010100101000	5416
332	0001010010110	662
333	0110100101000	3368

Code- word	Character	
	Base 2	Base 10
334	0001010011001	665
335	1001100101000	4904
336	0001010011010	666
337	0101100101000	2856
338	0001010011100	668
339	0011100101000	1832
340	0001010100011	675
341	1100010101000	6312
342	0001010100101	677
343	1010010101000	5288
344	0001010100110	678
345	0110010101000	3240
346	0001010101001	681
347	1001010101000	4776
348	0001010101010	682
349	0101010101000	2728
350	0001010101100	684
351	0011010101000	1704
352	0001010110001	689
353	1000110101000	4520
354	0001010110010	690
355	0100110101000	2472
356	0001010110100	692
357	0010110101000	1448
358	0001010111000	696
359	0001110101000	936

APPENDIX E

Code-word	Character	
	Base 2	Base 10
360	0001011000011	707
361	1100001101000	6248
362	00010110000101	709
363	1010001101000	5224
364	00010110000110	710
365	0110001101000	3176
366	0001011001001	713
367	1001001101000	4712
368	0001011001010	714
369	0101001101000	2664
370	0001011001100	716
371	0011001101000	1640
372	0001011010001	721
373	1000101101000	4456
374	0001011010010	722
375	0100101101000	2408
376	0001011010100	724
377	0010101101000	1384
378	0001011011000	728
379	0001101101000	872
380	0001011100001	737
381	1000011101000	4328
382	0001011100010	738
383	0100011101000	2280
384	0001011100100	740
385	0010011101000	1256

Code-word	Character	
	Base 2	Base 10
386	0001100000111	775
387	1110000011000	7192
388	0001100001011	779
389	1101000011000	6680
390	0001100001101	781
391	1011000011000	5656
392	0001100001110	782
393	0111000011000	3608
394	0001100010011	787
395	1100100011000	6424
396	0001100010101	789
397	1010100011000	5400
398	0001100010110	790
399	0110100011000	3352
400	0001100011001	793
401	1001100011000	4888
402	0001100011010	794
403	0101100011000	2840
404	0001100011100	796
405	0011100011000	1816
406	0001100100011	803
407	1100010011000	6296
408	0001100100101	805
409	1010010011000	5272
410	0001100100110	806
411	0110010011000	3224

APPENDIX E

Code-word	Character	
	Base 2	Base 10
412	0001100101001	809
413	1001010011000	4760
414	0001100101010	810
415	0101010011000	2712
416	0001100101100	812
417	0011010011000	1688
418	0001100110001	817
419	1000110011000	4504
420	0001100110010	818
421	0100110011000	2456
422	0001100110100	820
423	0010110011000	1432
424	0001100111000	824
425	0001110011000	920
426	0001101000011	835
427	1100001011000	6232
428	0001101000101	837
429	1010001011000	5208
430	0001101000110	838
431	0110001011000	3160
432	0001101001001	841
433	1001001011000	4696
434	0001101001010	842
435	0101001011000	2648
436	0001101001100	844
437	0011001011000	1624

Code-word	Character	
	Base 2	Base 10
438	0001101010001	849
439	1000101011000	4440
440	0001101010010	850
441	0100101011000	2392
442	0001101010100	852
443	0010101011000	1368
444	0001101100001	865
445	1000011011000	4312
446	0001101100010	866
447	0100011011000	2264
448	0001101100100	868
449	0010011011000	1240
450	0001110000011	899
451	1100000111000	6200
452	0001110000101	901
453	1010000111000	5176
454	0001110000110	902
455	0110000111000	3128
456	0001110001001	905
457	1001000111000	4664
458	0001110001010	906
459	0101000111000	2616
460	0001110001100	908
461	0011000111000	1592
462	0001110010001	913
463	1000100111000	4408

APPENDIX E

Code- word	Character	
	Base 2	Base 10
464	0001110010010	914
465	0100100111000	2360
466	0001110010100	916
467	0010100111000	1336
468	0001110100001	929
469	1000010111000	4280
470	0001110100010	930
471	0100010111000	2232
472	0001110100100	932
473	0010010111000	1208
474	0001111000001	961
475	1000001111000	4216
476	0001111000010	962
477	0100001111000	2168
478	0001111000100	964
479	0010001111000	1144
480	0010000001111	1039
481	1111000000100	7684
482	0010000010111	1047
483	1110100000100	7428
484	0010000011011	1051
485	1101100000100	6916
486	0010000011101	1053
487	1011100000100	5892
488	0010000011110	1054
489	0111100000100	3844

Code- word	Character	
	Base 2	Base 10
490	0010000100111	1063
491	1110010000100	7300
492	0010000101011	1067
493	1101010000100	6788
494	0010000101101	1069
495	1011010000100	5764
496	0010000101110	1070
497	0111010000100	3716
498	0010000110011	1075
499	1100110000100	6532
500	0010000110101	1077
501	1010110000100	5508
502	0010000110110	1078
503	0110110000100	3460
504	0010000111001	1081
505	1001110000100	4996
506	0010000111010	1082
507	0101110000100	2948
508	0010000111100	1084
509	0011110000100	1924
510	0010001000111	1095
511	1110001000100	7236
512	0010001001011	1099
513	1101001000100	6724
514	0010001001101	1101
515	1011001000100	5700

APPENDIX E

Code-word	Character	
	Base 2	Base 10
516	0010001001110	1102
517	0111001000100	3652
518	0010001010011	1107
519	1100101000100	6468
520	0010001010101	1109
521	1010101000100	5444
522	0010001010110	1110
523	0110101000100	3396
524	0010001011001	1113
525	1001101000100	4932
526	0010001011010	1114
527	0101101000100	2884
528	0010001011100	1116
529	0011101000100	1860
530	0010001100011	1123
531	1100011000100	6340
532	0010001100101	1125
533	1010011000100	5316
534	0010001100110	1126
535	0110011000100	3268
536	0010001101001	1129
537	1001011000100	4804
538	0010001101010	1130
539	0101011000100	2756
540	0010001101100	1132
541	0011011000100	1732

Code-word	Character	
	Base 2	Base 10
542	0010001110001	1137
543	1000111000100	4548
544	0010001110010	1138
545	0100111000100	2500
546	0010001110100	1140
547	0010111000100	1476
548	0010010000111	1159
549	1110000100100	7204
550	0010010001011	1163
551	1101000100100	6692
552	0010010001101	1165
553	1011000100100	5668
554	0010010001110	1166
555	0111000100100	3620
556	0010010010011	1171
557	1100100100100	6436
558	0010010010101	1173
559	1010100100100	5412
560	0010010010110	1174
561	0110100100100	3364
562	0010010011001	1177
563	1001100100100	4900
564	0010010011010	1178
565	0101100100100	2852
566	0010010011100	1180
567	0011100100100	1828

APPENDIX E

Code-word	Character	
	Base 2	Base 10
568	0010010100011	1187
569	1100010100100	6308
570	0010010100101	1189
571	1010010100100	5284
572	0010010100110	1190
573	0110010100100	3236
574	0010010101001	1193
575	1001010100100	4772
576	0010010101010	1194
577	0101010100100	2724
578	0010010101100	1196
579	0011010100100	1700
580	0010010110001	1201
581	1000110100100	4516
582	0010010110010	1202
583	0100110100100	2468
584	0010010110100	1204
585	0010110100100	1444
586	0010011000011	1219
587	1100001100100	6244
588	0010011000101	1221
589	1010001100100	5220
590	0010011000110	1222
591	0110001100100	3172
592	0010011001001	1225
593	1001001100100	4708

Code-word	Character	
	Base 2	Base 10
594	0010011001010	1226
595	0101001100100	2660
596	0010011001100	1228
597	0011001100100	1636
598	0010011010001	1233
599	1000101100100	4452
600	0010011010010	1234
601	0100101100100	2404
602	0010011010100	1236
603	0010101100100	1380
604	0010011100001	1249
605	1000011100100	4324
606	0010011100010	1250
607	0100011100100	2276
608	0010100000111	1287
609	1110000010100	7188
610	0010100001011	1291
611	1101000010100	6676
612	0010100001101	1293
613	1011000010100	5652
614	0010100001110	1294
615	0111000010100	3604
616	0010100010011	1299
617	1100100010100	6420
618	0010100010101	1301
619	1010100010100	5396

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Code-word	Character	
	Base 2	Base 10
620	0010100010110	1302
621	0110100010100	3348
622	0010100011001	1305
623	1001100010100	4884
624	0010100011010	1306
625	0101100010100	2836
626	0010100011100	1308
627	0011100010100	1812
628	0010100100011	1315
629	1100010010100	6292
630	0010100100101	1317
631	1010010010100	5268
632	0010100100110	1318
633	0110010010100	3220
634	0010100101001	1321
635	1001010010100	4756
636	0010100101010	1322
637	0101010010100	2708
638	0010100101100	1324
639	0011010010100	1684
640	0010100110001	1329
641	1000110010100	4500
642	0010100110010	1330
643	0100110010100	2452
644	0010100110100	1332
645	0010110010100	1428

Code-word	Character	
	Base 2	Base 10
646	0010101000011	1347
647	1100001010100	6228
648	0010101000101	1349
649	1010001010100	5204
650	0010101000110	1350
651	0110001010100	3156
652	0010101001001	1353
653	1001001010100	4692
654	0010101001010	1354
655	0101001010100	2644
656	0010101001100	1356
657	0011001010100	1620
658	0010101010001	1361
659	1000101010100	4436
660	0010101010010	1362
661	0100101010100	2388
662	0010101100001	1377
663	1000011010100	4308
664	0010101100010	1378
665	0100011010100	2260
666	0010110000011	1411
667	1100000110100	6196
668	0010110000101	1413
669	1010000110100	5172
670	0010110000110	1414
671	0110000110100	3124

APPENDIX E

Code-word	Character	
	Base 2	Base 10
672	0010110001001	1417
673	1001000110100	4660
674	0010110001010	1418
675	0101000110100	2612
676	0010110001100	1420
677	0011000110100	1588
678	0010110010001	1425
679	1000100110100	4404
680	0010110010010	1426
681	0100100110100	2356
682	0010110100001	1441
683	1000010110100	4276
684	0010110100010	1442
685	0100010110100	2228
686	0010111000001	1473
687	1000001110100	4212
688	0010111000010	1474
689	0100001110100	2164
690	0011000000111	1543
691	1110000001100	7180
692	0011000001011	1547
693	1101000001100	6668
694	0011000001101	1549
695	1011000001100	5644
696	0011000001110	1550
697	0111000001100	3596

Code-word	Character	
	Base 2	Base 10
698	0011000010011	1555
699	1100100001100	6412
700	0011000010101	1557
701	1010100001100	5388
702	0011000010110	1558
703	0110100001100	3340
704	0011000011001	1561
705	1001100001100	4876
706	0011000011010	1562
707	0101100001100	2828
708	0011000011100	1564
709	0011100001100	1804
710	0011000100011	1571
711	1100010001100	6284
712	0011000100101	1573
713	1010010001100	5260
714	0011000100110	1574
715	0110010001100	3212
716	0011000101001	1577
717	1001010001100	4748
718	0011000101010	1578
719	0101010001100	2700
720	0011000101100	1580
721	0011010001100	1676
722	0011000110001	1585
723	1000110001100	4492

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Code-word	Character	
	Base 2	Base 10
724	0011000110010	1586
725	0100110001100	2444
726	0011001000011	1603
727	1100001001100	6220
728	0011001000101	1605
729	1010001001100	5196
730	0011001000110	1606
731	0110001001100	3148
732	0011001001001	1609
733	1001001001100	4684
734	0011001001010	1610
735	0101001001100	2636
736	0011001010001	1617
737	1000101001100	4428
738	0011001010010	1618
739	0100101001100	2380
740	0011001100001	1633
741	1000011001100	4300
742	0011001100010	1634
743	0100011001100	2252
744	0011010000011	1667
745	1100000101100	6188
746	0011010000101	1669
747	1010000101100	5164
748	0011010000110	1670
749	0110000101100	3116

Code-word	Character	
	Base 2	Base 10
750	0011010001001	1673
751	1001000101100	4652
752	0011010001010	1674
753	0101000101100	2604
754	0011010010001	1681
755	1000100101100	4396
756	0011010010010	1682
757	0100100101100	2348
758	0011010100001	1697
759	1000010101100	4268
760	0011010100010	1698
761	0100010101100	2220
762	0011011000001	1729
763	1000001101100	4204
764	0011011000010	1730
765	0100001101100	2156
766	0011100000011	1795
767	1100000011100	6172
768	0011100000101	1797
769	1010000011100	5148
770	0011100000110	1798
771	0110000011100	3100
772	0011100001001	1801
773	1001000011100	4636
774	0011100001010	1802
775	0101000011100	2588

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Code-word	Character	
	Base 2	Base 10
776	0011100010001	1809
777	1000100011100	4380
778	0011100010010	1810
779	0100100011100	2332
780	0011100100001	1825
781	1000010011100	4252
782	0011100100010	1826
783	0100010011100	2204
784	0011101000001	1857
785	1000001011100	4188
786	0011101000010	1858
787	0100001011100	2140
788	0011110000001	1921
789	1000000111100	4156
790	0011110000010	1922
791	0100000111100	2108
792	0100000001111	2063
793	1111000000010	7682
794	0100000010111	2071
795	1110100000010	7426
796	0100000011011	2075
797	1101100000010	6914
798	0100000011101	2077
799	1011100000010	5890
800	0100000011110	2078
801	0111100000010	3842

Code-word	Character	
	Base 2	Base 10
802	0100000100111	2087
803	1110010000010	7298
804	0100000101011	2091
805	1101010000010	6786
806	0100000101101	2093
807	1011010000010	5762
808	0100000101110	2094
809	0111010000010	3714
810	0100000110011	2099
811	1100110000010	6530
812	0100000110101	2101
813	1010110000010	5506
814	0100000110110	2102
815	0110110000010	3458
816	0100000111001	2105
817	1001110000010	4994
818	0100000111010	2106
819	0101110000010	2946
820	0100001000111	2119
821	1110001000010	7234
822	0100001001011	2123
823	1101001000010	6722
824	0100001001101	2125
825	1011001000010	5698
826	0100001001110	2126
827	0111001000010	3650

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Code-word	Character	
	Base 2	Base 10
828	0100001010011	2131
829	1100101000010	6466
830	0100001010101	2133
831	1010101000010	5442
832	0100001010110	2134
833	0110101000010	3394
834	0100001011001	2137
835	1001101000010	4930
836	0100001011010	2138
837	0101101000010	2882
838	0100001100011	2147
839	1100011000010	6338
840	0100001100101	2149
841	1010011000010	5314
842	0100001100110	2150
843	0110011000010	3266
844	0100001101001	2153
845	1001011000010	4802
846	0100001101010	2154
847	0101011000010	2754
848	0100001110001	2161
849	1000111000010	4546
850	0100001110010	2162
851	0100111000010	2498
852	0100010000111	2183
853	1110000100010	7202

Code-word	Character	
	Base 2	Base 10
854	0100010001011	2187
855	1101000100010	6690
856	0100010001101	2189
857	1011000100010	5666
858	0100010001110	2190
859	0111000100010	3618
860	0100010010011	2195
861	1100100100010	6434
862	0100010010101	2197
863	1010100100010	5410
864	0100010010110	2198
865	0110100100010	3362
866	0100010011001	2201
867	1001100100010	4898
868	0100010011010	2202
869	0101100100010	2850
870	0100010100011	2211
871	1100010100010	6306
872	0100010100101	2213
873	1010010100010	5282
874	0100010100110	2214
875	0110010100010	3234
876	0100010101001	2217
877	1001010100010	4770
878	0100010101010	2218
879	0101010100010	2722

APPENDIX E

Code-word	Character	
	Base 2	Base 10
880	0100010110001	2225
881	1000110100010	4514
882	0100010110010	2226
883	0100110100010	2466
884	0100011000011	2243
885	1100001100010	6242
886	0100011000101	2245
887	1010001100010	5218
888	0100011000110	2246
889	0110001100010	3170
890	0100011001001	2249
891	1001001100010	4706
892	0100011001010	2250
893	0101001100010	2658
894	0100011010001	2257
895	1000101100010	4450
896	0100011010010	2258
897	0100101100010	2402
898	0100011100001	2273
899	1000011100010	4322
900	0100100000111	2311
901	1110000010010	7186
902	0100100001011	2315
903	1101000010010	6674
904	0100100001101	2317
905	1011000010010	5650

Code-word	Character	
	Base 2	Base 10
906	0100100001110	2318
907	0111000010010	3602
908	0100100010011	2323
909	1100100010010	6418
910	0100100010101	2325
911	1010100010010	5394
912	0100100010110	2326
913	0110100010010	3346
914	0100100011001	2329
915	1001100010010	4882
916	0100100011010	2330
917	0101100010010	2834
918	0100100100011	2339
919	1100010010010	6290
920	0100100100101	2341
921	1010010010010	5266
922	0100100100110	2342
923	0110010010010	3218
924	0100100101001	2345
925	1001010010010	4754
926	0100100101010	2346
927	0101010010010	2706
928	0100100110001	2353
929	1000110010010	4498
930	0100100110010	2354
931	0100110010010	2450

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Code- word	Character	
	Base 2	Base 10
932	0100101000011	2371
933	1100001010010	6226
934	01001010000101	2373
935	1010001010010	5202
936	0100101000110	2374
937	0110001010010	3154
938	0100101001001	2377
939	1001001010010	4690
940	0100101001010	2378
941	0101001010010	2642
942	0100101010001	2385
943	1000101010010	4434
944	0100101100001	2401
945	1000011010010	4306
946	0100110000011	2435
947	1100000110010	6194
948	0100110000101	2437
949	1010000110010	5170
950	0100110000110	2438
951	0110000110010	3122
952	0100110001001	2441
953	1001000110010	4658
954	0100110001010	2442
955	0101000110010	2610
956	0100110010001	2449
957	1000100110010	4402

Code- word	Character	
	Base 2	Base 10
958	0100110100001	2465
959	1000010110010	4274
960	0100111000001	2497
961	1000001110010	4210
962	0101000000111	2567
963	1110000001010	7178
964	0101000001011	2571
965	1101000001010	6666
966	0101000001101	2573
967	1011000001010	5642
968	0101000001110	2574
969	0111000001010	3594
970	0101000010011	2579
971	1100100001010	6410
972	0101000010101	2581
973	1010100001010	5386
974	0101000010110	2582
975	0110100001010	3338
976	0101000011001	2585
977	1001100001010	4874
978	0101000011010	2586
979	0101100001010	2826
980	0101000100011	2595
981	1100010001010	6282
982	0101000100101	2597
983	1010010001010	5258

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Code-word	Character	
	Base 2	Base 10
984	0101000100110	2598
985	0110010001010	3210
986	0101000101001	2601
987	1001010001010	4746
988	0101000101010	2602
989	0101010001010	2698
990	0101000110001	2609
991	1000110001010	4490
992	0101001000011	2627
993	1100001001010	6218
994	0101001000101	2629
995	1010001001010	5194
996	0101001000110	2630
997	0110001001010	3146
998	0101001001001	2633
999	1001001001010	4682
1000	0101001010001	2641
1001	1000101001010	4426
1002	0101001100001	2657
1003	1000011001010	4298
1004	0101010000011	2691
1005	1100000101010	6186
1006	0101010000101	2693
1007	1010000101010	5162
1008	0101010000110	2694
1009	0110000101010	3114

Code-word	Character	
	Base 2	Base 10
1010	0101010001001	2697
1011	1001000101010	4650
1012	0101010010001	2705
1013	1000100101010	4394
1014	0101010100001	2721
1015	1000010101010	4266
1016	0101011000001	2753
1017	1000001101010	4202
1018	0101100000011	2819
1019	1100000011010	6170
1020	0101100000101	2821
1021	1010000011010	5146
1022	0101100000110	2822
1023	0110000011010	3098
1024	0101100001001	2825
1025	1001000011010	4634
1026	0101100010001	2833
1027	1000100011010	4378
1028	0101100100001	2849
1029	1000010011010	4250
1030	0101101000001	2881
1031	1000001011010	4186
1032	0101110000001	2945
1033	1000000111010	4154
1034	0110000000111	3079
1035	1110000000110	7174

APPENDIX E

Code-word	Character	
	Base 2	Base 10
1036	0110000001011	3083
1037	1101000000110	6662
1038	0110000001101	3085
1039	1011000000110	5638
1040	0110000001110	3086
1041	0111000000110	3590
1042	0110000010011	3091
1043	1100100000110	6406
1044	0110000010101	3093
1045	1010100000110	5382
1046	0110000010110	3094
1047	0110100000110	3334
1048	0110000011001	3097
1049	1001100000110	4870
1050	0110000100011	3107
1051	1100010000110	6278
1052	0110000100101	3109
1053	1010010000110	5254
1054	0110000100110	3110
1055	0110010000110	3206
1056	0110000101001	3113
1057	1001010000110	4742
1058	0110000110001	3121
1059	1000110000110	4486
1060	0110001000011	3139
1061	1100001000110	6214

Code-word	Character	
	Base 2	Base 10
1062	0110001000101	3141
1063	1010001000110	5190
1064	0110001001001	3145
1065	1001001000110	4678
1066	0110001010001	3153
1067	1000101000110	4422
1068	0110001100001	3169
1069	1000011000110	4294
1070	0110010000011	3203
1071	1100000100110	6182
1072	0110010000101	3205
1073	1010000100110	5158
1074	0110010001001	3209
1075	1001000100110	4646
1076	0110010010001	3217
1077	1000100100110	4390
1078	0110010100001	3233
1079	1000010100110	4262
1080	0110011000001	3265
1081	1000001100110	4198
1082	0110100000011	3331
1083	1100000010110	6166
1084	0110100000101	3333
1085	1010000010110	5142
1086	0110100001001	3337
1087	1001000010110	4630

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Code-word	Character	
	Base 2	Base 10
1088	0110100010001	3345
1089	1000100010110	4374
1090	0110100100001	3361
1091	1000010010110	4246
1092	0110101000001	3393
1093	1000001010110	4182
1094	0110110000001	3457
1095	1000000110110	4150
1096	0111000000011	3587
1097	1100000001110	6158
1098	0111000000101	3589
1099	1010000001110	5134
1100	0111000001001	3593
1101	1001000001110	4622
1102	0111000010001	3601
1103	1000100001110	4366
1104	0111000100001	3617
1105	1000010001110	4238
1106	0111001000001	3649
1107	1000001001110	4174
1108	0111010000001	3713
1109	1000000101110	4142
1110	0111100000001	3841
1111	1000000011110	4126
1112	1000000001111	4111
1113	1111000000001	7681

Code-word	Character	
	Base 2	Base 10
1114	1000000010111	4119
1115	1110100000001	7425
1116	1000000011011	4123
1117	1101100000001	6913
1118	1000000011101	4125
1119	1011100000001	5889
1120	1000000100111	4135
1121	1110010000001	7297
1122	1000000101011	4139
1123	1101010000001	6785
1124	1000000101101	4141
1125	1011010000001	5761
1126	1000000110011	4147
1127	1100110000001	6529
1128	1000000110101	4149
1129	1010110000001	5505
1130	1000000111001	4153
1131	1001110000001	4993
1132	1000001000111	4167
1133	1110001000001	7233
1134	1000001001011	4171
1135	1101001000001	6721
1136	1000001001101	4173
1137	1011001000001	5697
1138	1000001010011	4179
1139	1100101000001	6465

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Code-word	Character	
	Base 2	Base 10
1140	100001010101	4181
1141	1010101000001	5441
1142	1000001011001	4185
1143	1001101000001	4929
1144	1000001100011	4195
1145	1100011000001	6337
1146	1000001100101	4197
1147	1010011000001	5313
1148	1000001101001	4201
1149	1001011000001	4801
1150	1000001110001	4209
1151	1000111000001	4545
1152	1000010000111	4231
1153	1110000100001	7201
1154	1000010001011	4235
1155	1101000100001	6689
1156	1000010001101	4237
1157	1011000100001	5665
1158	1000010010011	4243
1159	1100100100001	6433
1160	1000010010101	4245
1161	1010100100001	5409
1162	1000010011001	4249
1163	1001100100001	4897
1164	1000010100011	4259
1165	1100010100001	6305

Code-word	Character	
	Base 2	Base 10
1166	1000010100101	4261
1167	1010010100001	5281
1168	1000010101001	4265
1169	1001010100001	4769
1170	1000010110001	4273
1171	1000110100001	4513
1172	1000011000011	4291
1173	1100001100001	6241
1174	1000011000101	4293
1175	1010001100001	5217
1176	1000011001001	4297
1177	1001001100001	4705
1178	1000011010001	4305
1179	1000101100001	4449
1180	1000100000111	4359
1181	1110000010001	7185
1182	1000100001011	4363
1183	1101000010001	6673
1184	1000100001101	4365
1185	1011000010001	5649
1186	1000100010011	4371
1187	1100100010001	6417
1188	1000100010101	4373
1189	1010100010001	5393
1190	1000100011001	4377
1191	1001100010001	4881

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Code-word	Character	
	Base 2	Base 10
1192	1000100100011	4387
1193	1100010010001	6289
1194	1000100100101	4389
1195	1010010010001	5265
1196	1000100101001	4393
1197	1001010010001	4753
1198	1000100110001	4401
1199	1000110010001	4497
1200	1000101000011	4419
1201	1100001010001	6225
1202	1000101000101	4421
1203	1010001010001	5201
1204	1000101001001	4425
1205	1001001010001	4689
1206	1000110000011	4483
1207	1100000110001	6193
1208	1000110000101	4485
1209	1010000110001	5169
1210	1000110001001	4489
1211	1001000110001	4657
1212	1001000000111	4615
1213	1110000001001	7177
1214	1001000001011	4619
1215	1101000001001	6665
1216	1001000001101	4621
1217	1011000001001	5641

Code-word	Character	
	Base 2	Base 10
1218	1001000010011	4627
1219	1100100001001	6409
1220	1001000010101	4629
1221	1010100001001	5385
1222	1001000011001	4633
1223	1001100001001	4873
1224	1001000100011	4643
1225	1100010001001	6281
1226	1001000100101	4645
1227	1010010001001	5257
1228	1001000101001	4649
1229	1001010001001	4745
1230	1001001000011	4675
1231	1100001001001	6217
1232	1001001000101	4677
1233	1010001001001	5193
1234	1001010000011	4739
1235	1100000101001	6185
1236	1001010000101	4741
1237	1010000101001	5161
1238	1001100000011	4867
1239	1100000011001	6169
1240	1001100000101	4869
1241	1010000011001	5145
1242	1010000000111	5127
1243	1110000000101	7173

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Code-word	Character	
	Base 2	Base 10
1244	1010000001011	5131
1245	1101000000101	6661
1246	1010000001101	5133
1247	1011000000101	5637
1248	1010000010011	5139
1249	1100100000101	6405
1250	1010000010101	5141
1251	1010100000101	5381
1252	1010000100011	5155
1253	1100010000101	6277
1254	1010000100101	5157
1255	1010010000101	5253
1256	1010001000011	5187
1257	1100001000101	6213
1258	1010010000011	5251
1259	1100000100101	6181
1260	1010100000011	5379
1261	1100000010101	6165
1262	1011000000011	5635
1263	1100000001101	6157
1264	1100000000111	6151
1265	1110000000011	7171
1266	1100000001011	6155
1267	1101000000011	6659
1268	1100000010011	6163
1269	1100100000011	6403

Code-word	Character	
	Base 2	Base 10
1270	1100000100011	6179
1271	1100010000011	6275
1272	1100001000011	6211
1273	1010001000101	5189
1274	1001001001001	4681
1275	1000101010001	4433
1276	1000011100001	4321
1277	0110001000110	3142
1278	0101001001010	2634
1279	0100101010010	2386
1280	0100011100010	2274
1281	0011001001100	1612
1282	0010101010100	1364
1283	0010011100100	1252
1284	0001101011000	856
1285	0001011101000	744
1286	0000111110000	496

APPENDIX E

Table II – 2 of 13 Characters

Code-word	Character	
	Base 2	Base 10
0	000000000011	3
1	110000000000	6144
2	000000000101	5
3	101000000000	5120
4	000000000110	6
5	011000000000	3072
6	000000001001	9
7	100100000000	4608
8	000000001010	10
9	010100000000	2560
10	000000001100	12
11	001100000000	1536
12	000000010001	17
13	100010000000	4352
14	000000010010	18
15	010010000000	2304
16	000000010100	20
17	001010000000	1280
18	000000011000	24
19	000110000000	768
20	000000100001	33
21	100001000000	4224
22	000000100010	34
23	010001000000	2176

Code-word	Character	
	Base 2	Base 10
24	000000100100	36
25	001001000000	1152
26	000000101000	40
27	000101000000	640
28	000000110000	48
29	000011000000	384
30	000001000001	65
31	100000100000	4160
32	000001000010	66
33	010000100000	2112
34	0000001000100	68
35	001000100000	1088
36	0000001001000	72
37	000100100000	576
38	0000001010000	80
39	0000101000000	320
40	0000001100000	96
41	0000011000000	192
42	0000010000001	129
43	1000000100000	4128
44	0000010000010	130
45	0100000100000	2080
46	0000010000100	132
47	0010000100000	1056

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Code-word	Character	
	Base 2	Base 10
48	0000010001000	136
49	0001000100000	544
50	0000010010000	144
51	0000100100000	288
52	0000100000001	257
53	1000000010000	4112
54	0000100000010	258
55	0100000010000	2064
56	0000100000100	260
57	0010000010000	1040
58	0000100001000	264
59	0001000010000	528
60	0001000000001	513
61	1000000001000	4104
62	0001000000010	514

Code-word	Character	
	Base 2	Base 10
63	0100000001000	2056
64	0001000000100	516
65	0010000001000	1032
66	0010000000001	1025
67	1000000001000	4100
68	0010000000010	1026
69	0100000001000	2052
70	0100000000001	2049
71	1000000000010	4098
72	1000000000001	4097
73	0100000000010	2050
74	0010000000100	1028
75	0001000001000	520
76	0000100010000	272
77	0000010100000	160

APPENDIX E

Table III – FCS Characters

Frame Check Sequence Bit	Usage
10 (leftmost)	If bit is on, add 659 to Codeword A
9	If bit is on, negate Character J (rightmost)
8	If bit is on, negate Character I
7	If bit is on, negate Character H
6	If bit is on, negate Character G
5	If bit is on, negate Character F
4	If bit is on, negate Character E
3	If bit is on, negate Character D
2	If bit is on, negate Character C
1	If bit is on, negate Character B
0 (rightmost)	If bit is on, negate Character A (leftmost)

APPENDIX E

Table IV – Bar-to-Character Mapping

Bar Position	Descender		Ascender	
	Character	Bit	Character	Bit
1	H	2	E	3
2	B	10	A	0
3	J	12	C	8
4	F	5	G	11
5	I	9	D	1
6	A	1	F	12
7	C	5	B	8
8	E	4	J	11
9	G	3	I	10
10	D	9	H	6
11	F	11	B	4
12	I	5	C	12
13	J	10	A	2
14	H	1	G	7
15	D	6	E	9
16	A	3	I	6
17	G	4	C	7
18	B	1	J	9
19	H	10	F	2
20	E	0	D	8
21	G	2	A	4
22	I	11	B	0
23	J	8	D	12
24	C	6	H	7
25	F	1	E	10

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Bar Position	Descender		Ascender	
	Character	Bit	Character	Bit
26	B	12	G	9
27	H	3	I	0
28	F	8	J	7
29	E	6	C	10
30	D	4	A	5
31	I	4	F	7
32	H	11	B	9
33	G	0	J	6
34	A	6	E	8
35	C	1	D	2
36	F	9	I	12
37	E	11	G	1
38	J	5	H	4
39	D	3	B	2
40	A	7	C	0
41	B	3	E	1
42	G	10	D	5
43	I	7	J	4
44	C	11	F	6
45	A	8	H	12
46	E	2	I	1
47	F	10	D	0
48	J	3	A	9
49	G	5	C	4
50	H	8	B	7
51	F	0	E	5

APPENDIX E

Bar Position	Descender		Ascender	
	Character	Bit	Character	Bit
52	C	3	A	10
53	G	12	J	2
54	D	11	B	6
55	I	8	H	9
56	F	4	A	11
57	B	5	C	2
58	J	1	E	12
59	I	3	G	6
60	H	0	D	7
61	E	7	H	5
62	A	12	B	11
63	C	9	J	0
64	G	8	F	3
65	D	10	I	2