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Standardization of Group 3 facsimile terminals for document transmission

ITU-T Recommendation T.4

ITU-T Recommendation T.4

Standardization of Group 3 facsimile terminals for document transmission

Summary

This Recommendation defines the characteristics of Group 3 facsimile terminals which enable black and white documents and also optionally colour documents to be transmitted on the general switched telephone network, international leased circuits and the Integrated Services Digital Network (ISDN). Group 3 facsimile terminals may be operated manually or automatically and document transmission may be requested alternatively with telephone conversation. The procedures used by Group 3 facsimile terminals are defined in ITU-T Rec. T.30.

This revised version consolidates features previously approved as amendments to the text as well as recently approved capabilities, including:

- support of all standardized image resolutions;
- support of mixed raster content for black and white images;
- definitions for transmission of sYCC colour space using facsimile protocol.

Source

ITU-T Recommendation T.4 was approved by ITU-T Study Group 16 (2001-2004) under the ITU-T Recommendation A.8 procedure on 14 July 2003.

FOREWORD

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Introduction

This Recommendation defines the characteristics of Group 3 facsimile terminals which enable documents to be transmitted on the general switched telephone network, international leased circuits and the Integrated Services Digital Network (ISDN). These terminals enable black and white documents to be transmitted and also optionally colour documents. Group 3 facsimile terminals may be operated manually or automatically and document transmission may be requested alternatively with telephone conversation. The procedures to enable Group 3 facsimile terminals to communicate using the above capabilities are defined in ITU-T Recommendation T.30.

Document Sharing Hub

ITU-T Recommendation T.4

Standardization of Group 3 facsimile terminals for document transmission

1 Scanning track

The message area should be scanned in the same direction in the transmitter and receiver. Viewing the message area in a vertical plane, the picture elements should be processed as if the scanning direction were from left to right with subsequent scans adjacent and below the previous scan.

2 Dimensions of terminals

NOTE – The tolerances on the factors of cooperation are subject to further study.

2.1 The following dimensions shall be used for ISO A4, ISO B4, ISO A3, North American Letter (215.9×279.4 mm) and Legal (215.9×355.6 mm):

- a) a standard resolution of 3.85 lines/mm $\pm 1\%$ in vertical resolution;
- b) optional higher resolution of 7.7 lines/mm $\pm 1\%$ and 15.4 lines/mm $\pm 1\%$ in vertical direction;
- c) 1728 black and white picture elements along the standard scan line length of 215 mm $\pm 1\%$;
- d) optionally, 2048 black and white picture elements along a scan line length of 255 mm $\pm 1\%$;
- e) optionally, 2432 black and white picture elements along a scan line length of 303 mm $\pm 1\%$;
- f) optionally, 3456 black and white picture elements along a scan line length of 215 mm $\pm 1\%$;
- g) optionally, 4096 black and white picture elements along a scan line length of 255 mm $\pm 1\%$;
- h) optionally, 4864 black and white picture elements along a scan line length of 303 mm $\pm 1\%$.

Optionally:

- 1) continuous-tone and colour images may be transmitted using Group 3 facsimile terminals as described in Annex E;
- 2) multilevel and bi-level data resulting from the coding of continuous-tone and colour images and text/line-art respectively, may be transmitted on the same page as described in Annex H (Mixed Raster Content);
- 3) continuous-tone colour images (sYCC) may be transmitted using Group 3 facsimile terminals as described in Annex I.

All of the dimensions of Group 3 may be used with the procedures identified in options "1", "2" and "3". Non-square resolutions (i.e., those that do not have the same horizontal and vertical resolution values), such as 8×3.85 lines/mm or 300 pels/25.4 mm $\times$ 600 lines/25.4 mm, are not supported by Annex E, H and/or Annex I.

2.2 The following dimensions for inch-based resolutions shall be used.

The optional inch-based resolution requirements and their picture elements are given in Table 1. Specific values for the number of pels per line are given in Table 1 for all the Group 3 resolutions for ISO A4, ISO B4, ISO A3, North American Letter and Legal.

An alternative standard resolution of 200 pels/25.4 mm horizontally $\times$ 100 lines/25.4 mm vertically may be implemented provided that one or more of 200 pels/25.4 mm $\times$ 200 lines/25.4 mm, 300 pels/25.4 mm $\times$ 300 lines/25.4 mm, 400 pels/25.4 mm $\times$ 400 lines/25.4 mm, 600 pels/25.4 mm $\times$ 600 lines/25.4 mm, 1200 pels/25.4 mm $\times$ 1200 lines/25.4 mm, 300 pels/25.4 mm $\times$ 600 lines/25.4 mm, 400 pels/25.4 mm $\times$ 800 lines/25.4 mm and 600 pels/25.4 mm $\times$ 1200 lines/25.4 mm are included.

2.3 Input documents up to a minimum of ISO A4 size should be accepted.

NOTE – The size of the guaranteed reproducible area is shown in Appendix I.

3 Transmission time per total coded scan line

The total coded scan line is defined as the sum of data bits plus any required fill bits plus the end-of-line (EOL) bits.

For the optional two-dimensional coding scheme as described in 4.2, the total coded scan line is defined as the sum of data bits plus any required fill bits plus the EOL bits plus a tag bit.

To handle various printing methods, several optional minimum total coded scan line times are possible in addition to the 20 milliseconds standard.

Table 1/T.4

Resolution Horizontal (pels/25.4 mm) Vertical (lines/25.4 mm)		Tolerance	Number of picture elements along a scan line		
			ISO A4, North American Letter/Legal	ISO B4	ISO A3
Horizontal 100 Vertical 100		±1%	864/219.46 mm	1024/260.10 mm	1216/308.86 mm
Horizontal 200 Vertical 200		±1%	1728/219.46 mm	2048/260.10 mm	2432/308.86 mm
Horizontal 300 Vertical 300		±1%	2592/219.46 mm	3072/260.10 mm	3648/308.86 mm
Horizontal 300 Vertical 600		±1%	2592/219.46 mm	3072/260.10 mm	3648/308.86 mm
Horizontal 400 Vertical 400		±1%	3456/219.46 mm	4096/260.10 mm	4864/308.86 mm
Horizontal 400 Vertical 800		±1%	3456/219.46 mm	4096/260.10 mm	4864/308.86 mm
Horizontal 600 Vertical 600		±1%	5184/219.46 mm	6144/260.10 mm	7296/308.86 mm
Horizontal 600 Vertical 1200		±1%	5184/219.46 mm	6144/260.10 mm	7296/308.86 mm
Horizontal 1200 Vertical 1200		±1%	10 368/219.46 mm	12 288/260.10 mm	14 592/308.86 mm
NOTE – The resolutions 200 pels/25.4 mm × 200 lines/25.4 mm and 8 × 7.7 lines/mm can be considered as being equivalent. Similarly, the resolutions 400 pels/25.4 mm × 400 lines/25.4 mm and 16 × 15.4 lines/mm can be considered also as being equivalent. Consequently, conversion between mm-based terminals and inch-based terminals is not required for the communications in these cases. However, communication between these resolutions will cause the distortion and the reduction of reproducible area. Non-square resolutions are applicable only to black and white images.					

3.1 Minimum transmission time of total coded scan line

The minimum transmission times of the total coded scan line should conform to the following:

- 1) Alternative 1, where the minimum transmission time of the total coded scan line is the same both for the standard resolution and for the optional higher resolution:
 - a) 20 milliseconds recommended standard;

- b) 10 milliseconds recognized option with a mandatory fall-back to the 20 milliseconds standard;
 - c) 5 milliseconds recognized option with a mandatory fall-back to the 10 milliseconds option and the 20 milliseconds standard;
 - d) 0 millisecond recognized option with a mandatory fall-back to the 5 milliseconds option, the 10 milliseconds option and the 20 milliseconds standard, and an optional fall-back to the 40 milliseconds option;
 - e) 40 milliseconds recognized option.
- 2) Alternative 2, where the minimum transmission time of the total coded scan line for the optional higher resolution is half of that for the standard resolution (see Note). These figures refer to the standard resolution:
- a) 10 milliseconds recognized option with a mandatory fall-back to the 20 milliseconds standard;
 - b) 20 milliseconds recommended standard;
 - c) 40 milliseconds recognized option.

The identification and choice of this minimum transmission time is to be made in the pre-message (phase B) portion of T.30 control procedure.

NOTE – Alternative 2 applies to terminals with printing mechanisms which achieve the standard vertical resolution by printing two consecutive, identical higher resolution lines. In this case, the minimum transmission time of the total coded scan line for the standard resolution is double the minimum transmission time of the total coded scan line for the higher resolution. The minimum transmission time for the optional resolutions of 15.4 lines/mm and 400 lines/25.4 mm can be a quarter of that for the standard resolution.

3.2 Maximum transmission time of total coded scan line

The maximum transmission time of any total coded scan line should be less than 13 seconds except when:

- 1) the horizontal resolution is 600 pels/25.4 mm in which case it shall be less than 19 seconds; and
- 2) when the horizontal resolution is 1200 pels/25.4 mm in which case it shall be less than 37 seconds.

When this transmission time exceeds the above limits, the receiver must proceed to disconnect the line. However, a receiver conforming to the 1993 and previous versions of this Recommendation may disconnect the line when the transmission time exceeds 5 seconds.

3.3 Error correction mode

For the optional error correction mode, an HDLC frame structure is utilized to transmit the total coded scan line. This error correction mode is defined in Annex A.

4 Coding scheme

4.1 One-dimensional coding scheme

The one-dimensional run length coding scheme recommended for Group 3 terminals is as follows.

4.1.1 Data

A line of data is composed of a series of variable length code words. Each code word represents a run length of either all white or all black. White runs and black runs alternate. A total of 1728 picture elements represent one horizontal scan line of 215 mm length.

In order to ensure that the receiver maintains colour synchronization, all data lines will begin with a white run length code word. If the actual scan line begins with a black run, a white run length of zero will be sent. Black or white run lengths, up to a maximum length of one scan line (1728 picture elements or pels) are defined by the code words in Tables 2 and 3. The code words are of two types: terminating code words and make-up code words. Each run length is represented by either one terminating code word or one make-up code word followed by a terminating code word.

Run lengths in the range of 0 to 63 pels are encoded with their appropriate terminating code word. Note that there is a different list of code words for black and white run lengths.

Run lengths in the range of 64 to 1728 pels are encoded first by the make-up code word representing the run length which is equal to or shorter than that required. This is then followed by the terminating code word representing the difference between the required run length and the run length represented by the make-up code.

4.1.2 End-of-line (EOL)

This code word follows each line of data. It is a unique code word that can never be found within a valid line of data; therefore, resynchronization after an error burst is possible.

In addition, this signal will occur prior to the first data line of a page.

Format: 0000000000001

4.1.3 Fill

A pause may be placed in the message flow by transmitting "Fill". Fill may be inserted between a line of Data and an EOL, but never within a line of Data. Fill must be added to ensure that the transmission time of Data, Fill and EOL is not less than the minimum transmission time of the total coded scan line established in the pre-message control procedure. The maximum transmission time of Fill bits shall be less than 5 seconds.

Format: variable length string of 0s.

4.1.4 Return To Control (RTC)

The end of a document transmission is indicated by sending six consecutive EOLs. Following the RTC signal, the transmitter will send the post message commands in the framed format and the data signalling rate of the control signals defined in ITU-T Rec. T.30.

Format: 0000000000001 0000000000001
(total of 6 times)

Figures 1 and 2 clarify the relationship of the signals defined herein. Figure 1 shows several scan lines of data starting at the beginning of a transmitted page. Figure 2 shows the last coded scan line of a page.

The identification and choice of either the standard code table or the extended code table is to be made in the pre-message (phase B) portion of T.30 control procedures.

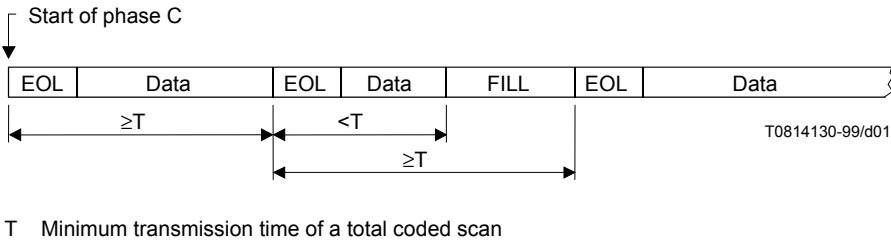


Figure 1/T.4

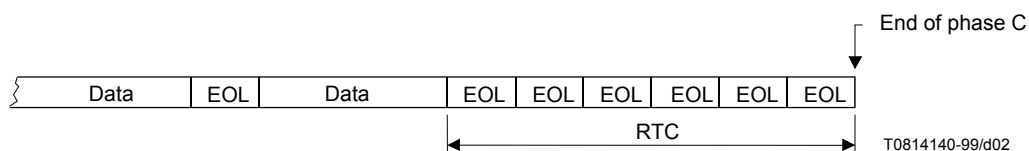


Figure 2/T.4

Table 2/T.4 – Terminating codes

White run length	Code word	Black run length	Code word
0	00110101	0	0000110111
1	000111	1	010
2	0111	2	11
3	1000	3	10
4	1011	4	011
5	1100	5	0011
6	1110	6	0010
7	1111	7	00011
8	10011	8	000101
9	10100	9	000100
10	00111	10	0000100
11	01000	11	0000101
12	001000	12	0000111
13	000011	13	00000100
14	110100	14	00000111
15	110101	15	000011000
16	101010	16	0000010111
17	101011	17	0000011000
18	0100111	18	0000001000
19	0001100	19	00001100111
20	0001000	20	00001101000
21	0010111	21	00001101100
22	0000011	22	00000110111
23	0000100	23	00000101000
24	0101000	24	00000010111
25	0101011	25	00000011000
26	0010011	26	000011001010
27	0100100	27	000011001011
28	0011000	28	000011001100
29	00000010	29	000011001101
30	00000011	30	000001101000
31	00011010	31	000001101001
32	00011011	32	000001101010

Table 2/T.4 – Terminating codes

White run length	Code word	Black run length	Code word
33	00010010	33	000001101011
34	00010011	34	000011010010
35	00010100	35	000011010011
36	00010101	36	000011010100
37	00010110	37	000011010101
38	00010111	38	000011010110
39	00101000	39	000011010111
40	00101001	40	000001101100
41	00101010	41	000001101101
42	00101011	42	000011011010
43	00101100	43	000011011011
44	00101101	44	000001010100
45	00000100	45	000001010101
46	00000101	46	000001010110
47	00001010	47	000001010111
48	00001011	48	000001100100
49	01010010	49	000001100101
50	01010011	50	000001010010
51	01010100	51	000001010011
52	01010101	52	000000100100
53	00100100	53	000000110111
54	00100101	54	000000111000
55	01011000	55	000000100111
56	01011001	56	000000101000
57	01011010	57	000001011000
58	01011011	58	000001011001
59	01001010	59	000000101011
60	01001011	60	000000101100
61	00110010	61	000001011010
62	00110011	62	000001100110
63	00110100	63	000001100111

Table 3a/T.4 – Make-up codes

White run length	Code word	Black run length	Code word
64	11011	64	0000001111
128	10010	128	000011001000
192	010111	192	000011001001
256	0110111	256	000001011011
320	00110110	320	000000110011
384	00110111	384	000000110100
448	01100100	448	000000110101
512	01100101	512	0000001101100
576	01101000	576	0000001101101
640	01100111	640	0000001001010
704	011001100	704	0000001001011
768	011001101	768	0000001001100
832	011010010	832	0000001001101
896	011010011	896	0000001110010
960	011010100	960	0000001110011
1024	011010101	1024	0000001110100
1088	011010110	1088	0000001110101
1152	011010111	1152	0000001110110
1216	011011000	1216	0000001110111
1280	011011001	1280	0000001010010
1344	011011010	1344	0000001010011
1408	011011011	1408	0000001010100
1472	010011000	1472	0000001010101
1536	010011001	1536	0000001011010
1600	010011010	1600	0000001011011
1664	011000	1664	0000001100100
1728	010011011	1728	0000001100101
EOL	000000000001	EOL	000000000001
NOTE – It is recognized that terminals exist which accommodate larger paper widths maintaining the standard horizontal resolution. This option has been provided for by the addition of the make-up code set defined in this table.			

Table 3b/T.4 – Make-up codes

Run length (black and white)	Make-up codes
1792	00000001000
1856	00000001100
1920	00000001101
1984	000000010010
2048	000000010011
2112	000000010100
2176	000000010101
2240	000000010110
2304	000000010111
2368	000000011100
2432	000000011101
2496	000000011110
2560	000000011111
NOTE – Run lengths in the range of lengths longer than or equal to 2624 pels are coded first by the make-up code of 2560. If the remaining part of the run (after the first make-up code of 2560) is 2560 pels or greater, additional make-up code(s) of 2560 are issued until the remaining part of the run becomes less than 2560 pels. Then the remaining part of the run is encoded by terminating code or by make-up code plus terminating code according to the range as mentioned above.	

4.2 Two-dimensional coding scheme

The two-dimensional coding scheme is an optional extension of the one-dimensional coding scheme specified in 4.1 and is as follows:

4.2.1 Data

4.2.1.1 Parameter K

In order to limit the disturbed area in the event of transmission errors, after each line coded one-dimensionally, at most $K-1$ successive lines shall be coded two-dimensionally. A one-dimensionally coded line may be transmitted more frequently than every K lines. After a one-dimensional line is transmitted, the next series of $K-1$ two-dimensional lines is initiated. The maximum value of K shall be set as follows:

- Standard vertical resolution: $K = 2$.
- Optional higher vertical resolution:
 - 200 Lines/25.4 mm, $K = 4$
 - 300 Lines/25.4 mm, $K = 6$
 - 400 Lines/25.4 mm, $K = 8$
 - 600 Lines/25.4 mm, $K = 12$
 - 800 Lines/25.4 mm, $K = 16$
 - 1200 Lines/25.4 mm, $K = 24$

4.2.1.2 One-dimensional coding

This conforms with the description of data in 4.1.1.

4.2.1.3 Two-dimensional coding

This is a line-by-line coding method in which the position of each changing picture element on the current or coding line is coded with respect to the position of a corresponding reference element situated on either the coding line or the reference line which lies immediately above the coding line. After the coding line has been coded, it becomes the reference line for the next coding line.

4.2.1.3.1 Definition of changing picture elements (see Figure 3)

changing element: Element whose "colour" (i.e., black or white) is different from that of the previous element along the same scan line.

- a_0 The reference or starting changing element on the coding line. At the start of the coding line, a_0 is set on an imaginary white changing element situated just before the first element on the line. During the coding of the coding line, the position of a_0 is defined by the previous coding mode. (See 4.2.1.3.2.)
- a_1 The next changing element to the right of a_0 on the coding line.
- a_2 The next changing element to the right of a_1 on the coding line.
- b_1 The first changing element on the reference line to the right of a_0 and of opposite colour to a_0 .
- b_2 The next changing element to the right of b_1 on the reference line.

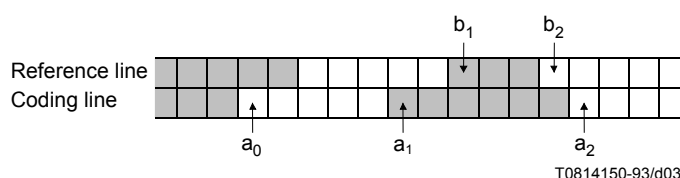


Figure 3/T.4 – Changing picture elements

4.2.1.3.2 Coding modes

One of the three coding modes are chosen according to the coding procedure described in 4.2.1.3.3 to code the position of each changing element along the coding line. Examples of the three coding modes are given in Figures 4, 5 and 6.

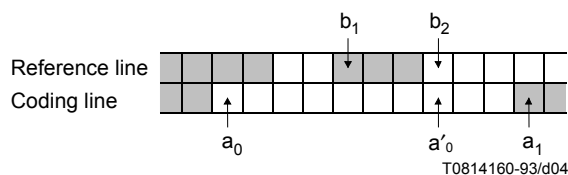


Figure 4/T.4 – Pass mode

a) Pass mode

This mode is identified when the position of b_2 lies to the left of a_1 . When this mode has been coded, a_0 is set on the element of the coding line below b_2 in preparation for the next coding (i.e., on a'_0).

However, the state where b_2 occurs just above a_1 , as shown in Figure 5, is not considered as a pass mode.

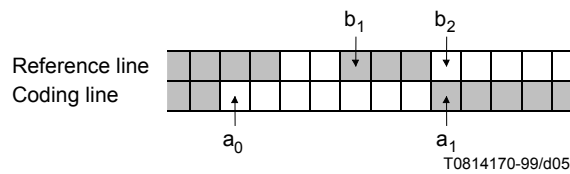


Figure 5/T.4 – An example not corresponding to a pass mode

b) *Vertical mode*

When this mode is identified, the position of a_1 is coded relative to the position of b_1 . The relative distance a_1b_1 can take on one of seven values $V(0)$, $V_R(1)$, $V_R(2)$, $V_R(3)$, $V_L(1)$, $V_L(2)$ and $V_L(3)$, each of which is represented by a separate code word. The subscripts R and L indicate that a_1 is to the right or left respectively of b_1 , and the number in brackets indicates the value of the distance a_1b_1 . After vertical mode coding has occurred, the position of a_0 is set on a_1 (see Figure 6).

c) *Horizontal mode*

When this mode is identified, both the run-lengths a_0a_1 and a_1a_2 are coded using the code words $H + M(a_0a_1) + M(a_1a_2)$. H is the flag code word 001 taken from the two-dimensional code table (Table 4). $M(a_0a_1)$ and $M(a_1a_2)$ are code words which represent the length and "colour" of the runs a_0a_1 and a_1a_2 respectively and are taken from the appropriate white or black one-dimensional code tables (Tables 3a and 3b). After a horizontal mode coding, the position of a_0 is set on a_2 (see Figure 6).

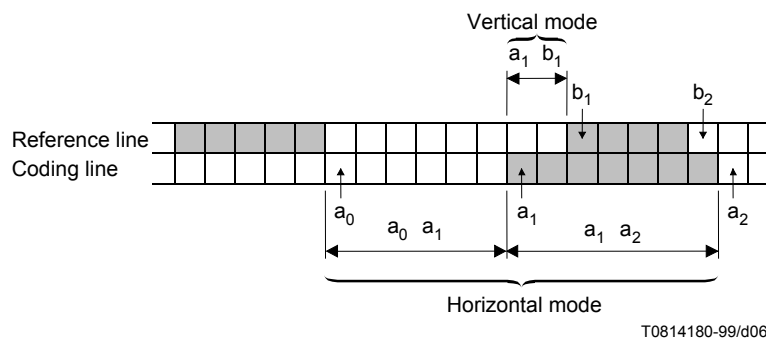


Figure 6/T.4 – Vertical mode and horizontal mode

4.2.1.3.3 Coding procedure

The coding procedure identifies the coding mode that is to be used to code each changing element along the coding line. When one of the three coding modes has been identified according to step 1 or step 2 mentioned below, an appropriate code word is selected from the code table given in Table 5. The coding procedure is as shown in the flow diagram of Figure 7.

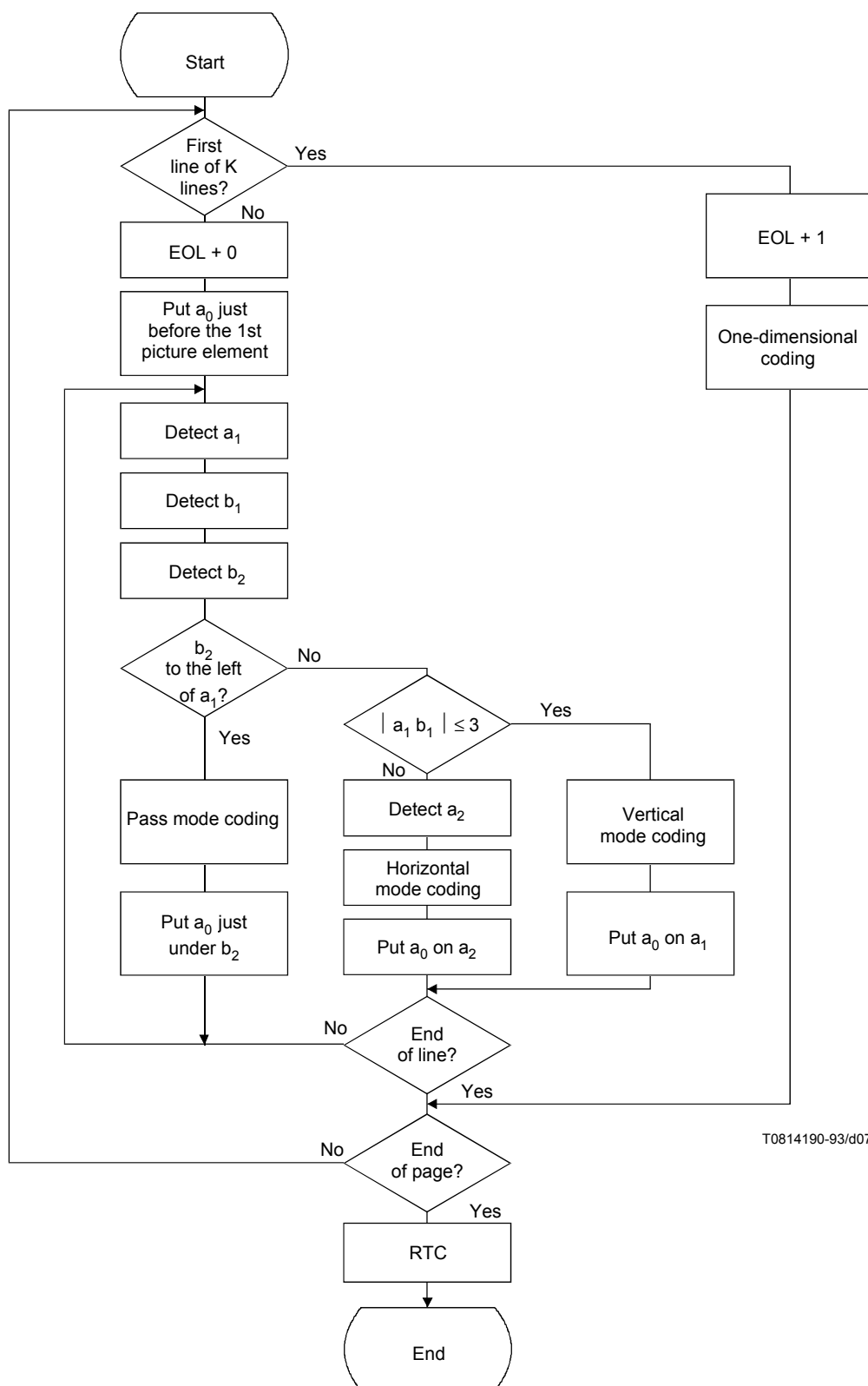


Figure 7/T.4 – Two-dimensional coding flow diagram

NOTE – It does not affect compatibility to restrict the use of pass mode in the encoder to a single pass mode. Variations of the algorithm which do not affect compatibility should be the subject of further study.

Step 1

- i) If a pass mode is identified, this is coded using the word 0001 (Table 4). After this processing, picture element a'_0 just under b_2 is regarded as the new starting picture element a_0 for the next coding (see Figure 4).
- ii) If a pass mode is not detected, then proceed to step 2.

Step 2

- i) Determine the absolute value of the relative distance a_1b_1 .
- ii) If $|a_1b_1| \leq 3$, as shown in Table 4, a_1b_1 is coded by the vertical mode, after which position a_1 is regarded as the new starting picture element a_0 for the next coding.
- iii) If $|a_1b_1| > 3$, as shown in Table 4, following horizontal mode code 001, a_0a_1 and a_1a_2 are respectively coded by one-dimensional coding. After this processing position, a_2 is regarded as the new starting picture element a_0 for the next coding.

Table 4/T.4 – Two-dimensional code table

Mode	Elements to be coded		Notation	Code word
Pass	b_1, b_2		P	0001
Horizontal	a_0a_1, a_1a_2		H	001 + M(a_0a_1) + M(a_1a_2) (Note 1)
Vertical	a_1 just under b_1	$a_1b_1 = 0$	V(0)	1
	a_1 to the right of b_1	$a_1b_1 = 1$	$V_R(1)$	011
		$a_1b_1 = 2$	$V_R(2)$	000011
		$a_1b_1 = 3$	$V_R(3)$	0000011
	a_1 to the left of b_1	$a_1b_1 = 1$	$V_L(1)$	010
		$a_1b_1 = 2$	$V_L(2)$	000010
		$a_1b_1 = 3$	$V_L(3)$	0000010
Extension	2-D (extensions) 1-D (extensions)			0000001xxx 000000001xxx (Note 2)

NOTE 1 – Code M() of the horizontal mode represents the code words in Tables 2 and 3.

NOTE 2 – It is suggested the uncompressed mode is recognized as an optional extension of two-dimensional coding scheme for Group 3 terminals. The bit assignment for the xxx bits is 111 for the uncompressed mode of operation whose code table is given in Table 5.

NOTE 3 – Further study is needed to define other unspecified xxx bit assignments and their use for any further extensions.

NOTE 4 – If the suggested uncompressed mode is used on a line designated to be one-dimensionally code, the coder must not switch into uncompressed mode following any code word ending in the sequence 000. This is because any code word ending in 000 followed by a switching code 000000001 will be mistaken for an end-of-line code.

Table 5/T.4 – Uncompressed mode code words

Entrance code to uncompressed mode	On one-dimensionally coded line: 000000001111 On two-dimensionally coded line: 0000001111	
Uncompressed mode code	Image pattern	Code word
	1	1
	01	01
	001	001
	0001	0001
	00001	00001
	00000	000001
Exit from uncompressed mode code	0	0000001T
	00	00000001T
	000	000000001T
	0000	0000000001T
	0000	00000000001T
T Denotes a tag bit which tells the colour of the next run (black = 1, white = 0)		

4.2.1.3.4 Processing the first and last picture elements in a line

a) *Processing the first picture element*

The first starting picture element a_0 on each coding line is imaginarily set at a position just before the first picture element, and is regarded as a white picture element (see 4.2.1.3.1).

The first run length on a line a_0a_1 is replaced by $a_0a_1 - 1$. Therefore, if the first run is black and is deemed to be coded by horizontal mode coding, then the first code word $M(a_0a_1)$ corresponds to a white run of zero length (see Figure 10, example 5).

b) *Processing the last picture element*

The coding of the coding line continues until the position of the imaginary changing element situated just after the last actual element has been coded. This may be coded as a_1 or a_2 . Also, if b_1 and/or b_2 are not detected at any time during the coding of the line, they are positioned on the imaginary changing element situated just after the last actual picture element on the reference line.

4.2.2 Line synchronization code word

To the end of every coded line is added the end-of-line (EOL) code word 0000000000001. The EOL code word is followed by a single tag bit which indicates whether one- or two-dimensional coding is used for the next line.

In addition, EOL plus the tag bit 1 signal will occur prior to the first data line of a page.

Format:

EOL + 1: one-dimensional coding of next line.

EOL + 0: two-dimensional coding of next line.

4.2.3 Fill

Fill is inserted between a line of Data and the line synchronization signal, EOL + tag bit, but is not inserted in Data. Fill must be added to ensure that the transmission time of Data, Fill and EOL plus tag bit is not less than the minimum transmission time of the total coded scan line.

Format: variable length string of 0s.

4.2.4 Return To Control (RTC)

The format used is six consecutive line synchronization code words, i.e., $6 \times (\text{EOL} + 1)$.

To further clarify the relationship of the signals defined herein, Figures 8 and 9 are offered in the case of $K = 2$. Figure 8 shows several scan lines of data starting at the beginning of a transmitted page. Figure 9 shows the last several lines of a page.

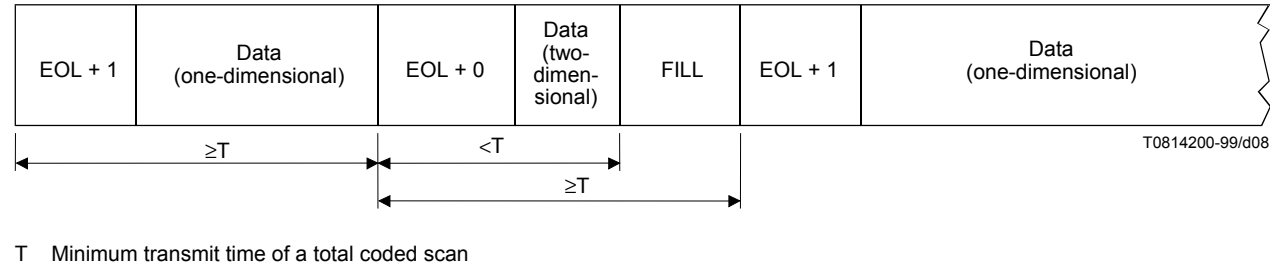


Figure 8/T.4 – Message transmission (first part of page)

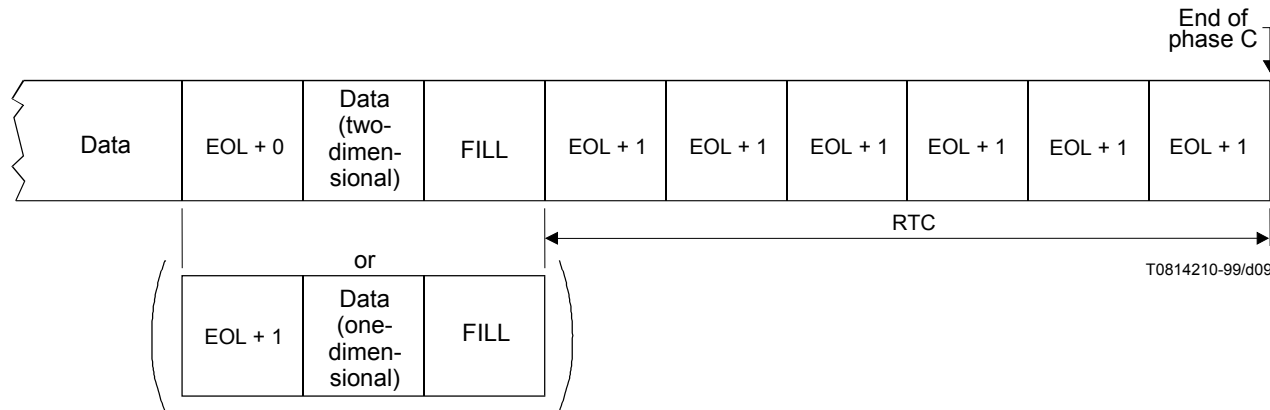


Figure 9/T.4 – Message transmission (last part of page)

4.2.5 Coding examples

Figure 10 shows coding examples of the first part of scan lines and Figure 11 coding examples of the last part, while Figure 12 shows other coding examples. The notations P, H and V in the figures are, as shown in Table 4, the symbols for pass mode, horizontal mode and vertical mode respectively. The picture elements marked with black spots indicate the changing picture elements to be coded.

4.3 Extended two-dimensional coding scheme

The basic facsimile coding scheme specified in 2.2/T.6 may be used as an option in Group 3 facsimile terminals. This coding scheme is limited to the use of the error correction mode specified in 3.3.

4.4 Progressive bi-level image compression

The usage of the progressive bi-level image compression scheme defined in ITU-T Rec. T.82 for Group 3 facsimile terminals should be in accordance with the application rules described in the corresponding clauses of ITU-T Rec. T.85. This coding scheme is limited to use with the error correction mode specified in 3.3.

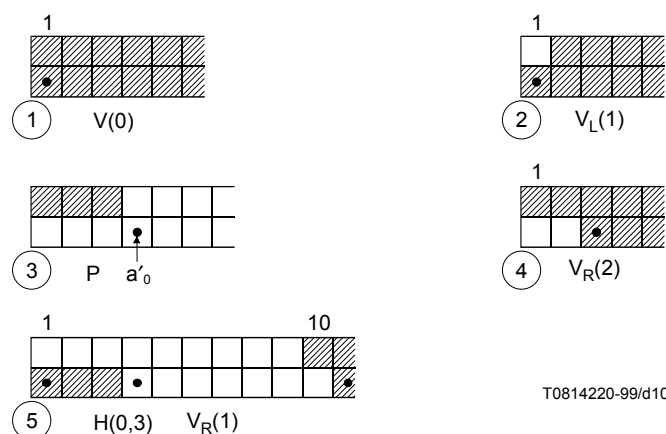


Figure 10/T.4 – Coding examples: First part of scan line

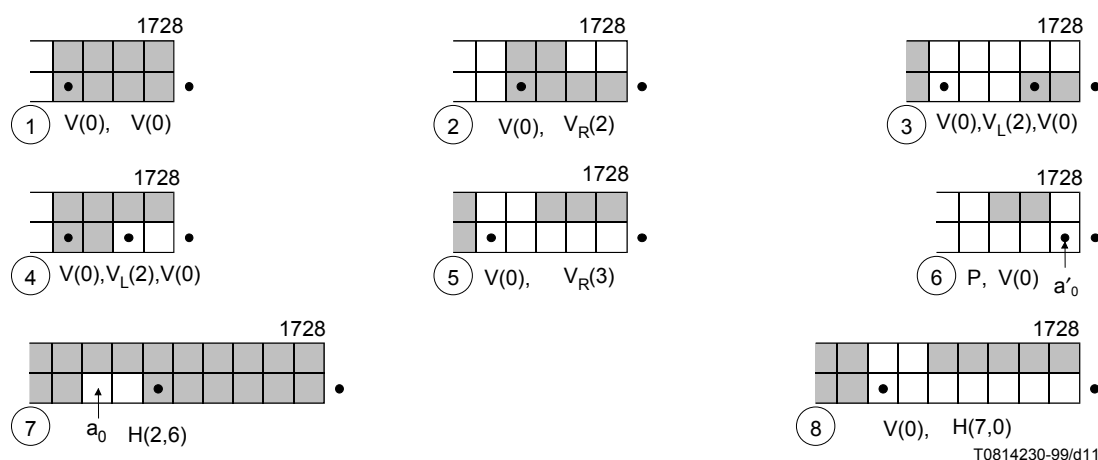


Figure 11/T.4 – Coding examples: Last part of scan line

4.4.1 Normative references

- [1] ITU-T Recommendation T.82 (1993) | ISO/IEC 11544:1993, *Information technology – Coded representation of picture and audio information – Progressive bi-level image compression*.
- [2] ITU-T Recommendation T.85 (1995), *Application profile for Recommendation T.82 – Progressive bi-level image compression (JBIG coding scheme) for facsimile apparatus*.

4.4.2 Single-progression sequential coding scheme

The usage of the single-progression sequential coding scheme described in 3.31/T.82 for Group 3 facsimile terminals should be in accordance with the application rules described in clause 2/T.85. This coding scheme is used as an option in Group 3 facsimile terminals.

4.4.3 Progressive-compatible sequential coding

For further study.

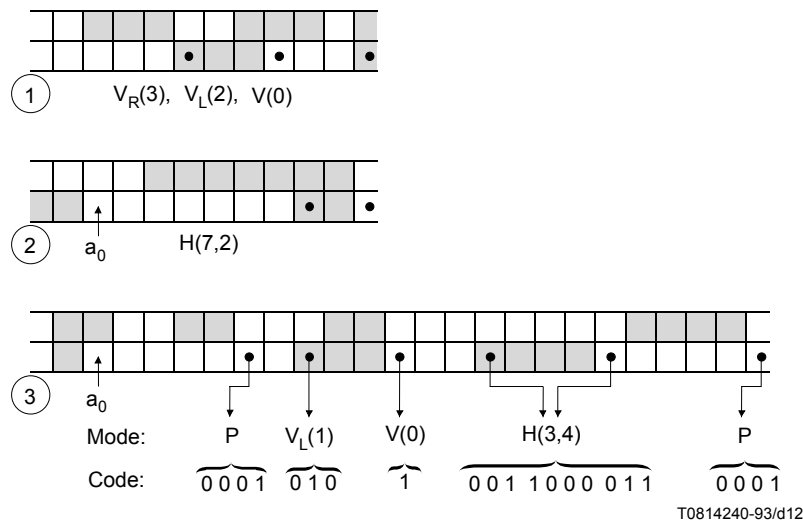


Figure 12/T.4 – Coding examples

4.4.4 Progressive coding

For further study.

5 Modulation and demodulation

Group 3 terminals operating on the general switched telephone network shall utilize the modulation, scrambler, equalization and timing signals defined in clauses 2, 3, 7, 8, 9 and 11/V.27 *ter* and in Appendix I/V.27 *ter*.

5.1 The training signal to be used shall be the long training sequence with protection against talker echo (see 2.5.1/V.27 *ter* and Table 3/V.27 *ter*).

5.2 The data signalling rates to be used are 4800 bit/s and 2400 bit/s as defined in ITU-T Rec. V.27 *ter*.

NOTE 1 – Some Administrations pointed out that it would not be possible to guarantee the service at a data signalling rate higher than 2400 bit/s.

NOTE 2 – It should be noted that there are terminals in service using, *inter alia*, other modulation methods.

NOTE 3 – When quality of communication service can successfully support higher speed operation, such as may be possible on leased circuits or high-quality switched circuits, Group 3 terminals may optionally utilize the modulation, scrambler, equalization and timing signals defined in ITU-T Recs V.29 and V.17. For ITU-T Rec. V.29, this specifically refers to clauses 1, 2, 3, 4, 7, 8, 9, 10 and 11. Under this option the data should be non-multiplexed and limited to the data signalling rates of 9600 bit/s and 7200 bit/s. For ITU-T Rec. V.17, this specifically refers to clauses 1 through 5. For ITU-T Rec. V.34, this specifically refers to clauses 1 through 12 and to Annex C/T.30 and Annex F/T.30.

NOTE 4 – When V.17 signalling is used, the training signal shall include the Talker Echo Protection (TEP) signal defined in 5.3/V.17.

NOTE 5 – Terminals operating in the V.34 modulation mode shall use the ECM (Error Correction Mode) defined in Annex A and in Annex A/T.30.

NOTE 6 – When V.29 signalling is used, a Talker Echo Protection (TEP) signal may, optionally, be transmitted prior to the transmission of training and synchronization sequences. The TEP signal shall consist of an unmodulated carrier for a duration of 185 to 200 ms followed by a silence period of 20 to 25 ms. It should be noted that this signal may cause compatibility problems with some existing terminals that still conform to the 1996 version and previous versions of this Recommendation.