INTERNATIONAL TELECOMMUNICATION UNION

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THE INTERNATIONAL
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CONSULTATIVE COMMITTEE

SERIES T: TERMINAL EQUIPMENT AND PROTOCOLS
FOR TELEMATIC SERVICES

STANDARDIZATION OF GROUP 3 FACSIMILE APPARATUS FOR DOCUMENT TRANSMISSION

Reedition of CCITT Recommendation T.4 published in
the Blue Book, Fascicle VII.3 (1988)

NOTES

1 CCITT Recommendation T.4 was published in Fascicle VII.3 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Recommendation T.4

STANDARDIZATION OF GROUP 3 FACSIMILE APPARATUS FOR DOCUMENT TRANSMISSION

(Geneva, 1980, amended at Malaga-Torremolinos, 1984 and Melbourne, 1988)

The CCITT,

considering

(a) that Recommendation T.2 refers to Group 1 type apparatus for ISO A4 document transmission over a telephone-type circuit in approximately six minutes;

(b) that Recommendation T.3 refers to Group 2 type apparatus for ISO A4 document transmission over a telephone-type circuit in approximately three minutes;

(c) that there is a demand for Group 3 apparatus which enables an ISO A4 document to be transmitted over a telephone-type circuit in approximately one minute;

(d) that for a large number of applications black and white reproduction is sufficient;

(e) that such a service may be requested either alternatively with telephone conversation, or when either or both stations are not attended; in both cases, the facsimile operation will follow Recommendation T.30;

unanimously declares the view

that Group 3 facsimile apparatus for use on the general switched telephone network and international leased circuits should be designed and operated according to the following standards:

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 apparatus

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

2.1 The following dimensions should be used:

a) a standard resolution and an optional higher resolution of 3.85 line/mm ± 1% and 7.7 line/mm ± 1% respectively in vertical direction,

b) 1728 black and white picture elements along the standard scan line length of 215 mm ± 1%,

c) optionally, 2048 black and white picture elements along a scan line length of 255 mm ± 1%,

d) optionally, 2432 black and white picture elements along a scan line length of 303 mm ± 1%,

and, for equipment which provides A5 and/or A6 facilities:

e) optionally, 864 black and white picture elements along a scan line length of 107 mm ± 1%,

f) optionally, 1216 black and white picture elements along a scan line length of 151 mm ± 1%,

g) Optionally, 1728 black and white picture elements along a scan line length of 107 mm ± 1%,

h) Optionally, 1728 black and white picture elements along a scan line length of 151 mm ± 1%.

The normal method of interworking when transmitting from an A5 or A6 machine to an A4 machine not signalling such capabilities, is that the A5 or A6 content will be enlarged to fill the A4 page (see also Note 3). This means that if the document is then retransmitted, or if it has been stored for later retransmission, it will be received without additional reduction.

Where the full image contents being received from an A4 machine need to be maintained, g) or h) respectively should be used.

Interworking between equipments with A5/A6 and A4 facilities and between equipments with combinations of these facilities is shown in Annex C.

Note 1 – Cases e) to h) describe equipments which may be implemented singly or in any combination and would not, for A5/A6 facsimile equipments, require implementation of a) or b). These equipments may be implemented with cases different for sending and receiving.

Note 2 – In cases e) to h), 1728 pels will always be provided to the coder (see Annex C).

In cases e) and f), the additional pels required are produced by pel processing (i.e., either by picture processing or by adding white pels on each side of the central picture information) prior to coding.

Note 3 – It could be possible, by a setting on the A5/A6 transmitting machine, to send the document so that it is received equal size on an A4 machine not signalling such capabilities. In this case the vertical resolution will be 3.85 (or 7.7) line/mm. The user should be made aware that in this particular equal size case if the received copy is transmitted back to the A5/A6 machine the subsequent copy will be reduced.

Note 4 – Some Administrations may require that equipments using e) or f) dimensions, when working with a receiver not signalling such capabilities, insert a message e.g., "ISO A6" or "ISO A5", as the case may be, into the picture at the transmitting side.

2.2 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.

3.1 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 Recommendation T.30 control procedure.

Note – Alternative 2 applies to equipment 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.

3.2 The maximum transmission time of any total coded scan line should be less than 5 seconds. When this transmission time exceeds 5 seconds, the receiver must proceed to disconnect the line.

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 apparatus 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 1/T.4 and 2/T.4. 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: 000000000001

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.

Format: variable length string of 0s.

TABLE 1/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
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 2/T.4

Make-up codes

White run lengths	Code word	Black run lengths	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 machines 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 as follows:

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

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 Recommendation T.30.

Format: 000000000001 000000000001
(total of 6 times)

Figures 1/T.4 and 2/T.4 clarify the relationship of the signals defined herein. Figure 1/T.4 shows several scan lines of data starting at the beginning of a transmitted page. Figure 2/T.4 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 Recommendation T.30 control procedures.

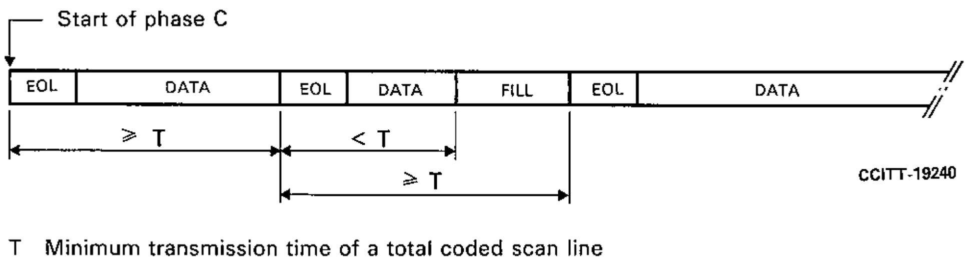


FIGURE 1/T.4

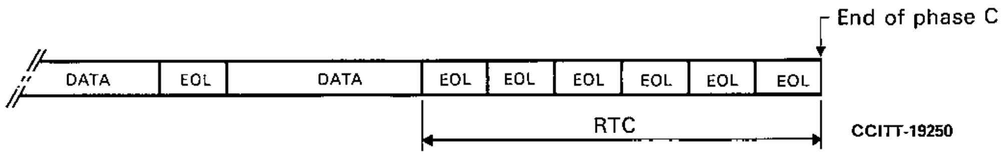


FIGURE 2/T.4

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: $K = 4$.

Note 1 – Some Administrations pointed out that for the optional higher vertical resolution K may optionally be set to a lower value.

Note 2 – Some Administrations reserve the right to approve only such apparatus for use in the facsimile service in their respective countries which will be able to produce a visible sign on its received facsimile message indicating that two-dimensional coding has been used in the transmission process.

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/T.4)

A changing element is defined as an 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.

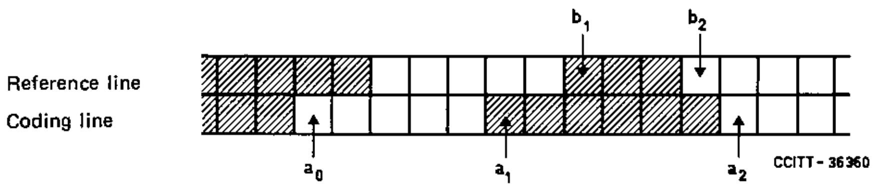


FIGURE 3/T.4

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/T.4, 5/T.4 and 6/T.4.

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).

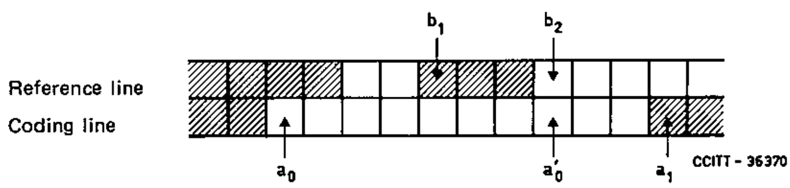


FIGURE 4/T.4

Pass mode

However, the state where b_2 occurs just above a_1, as shown in Figure 5/T.4 is not considered as a pass mode.

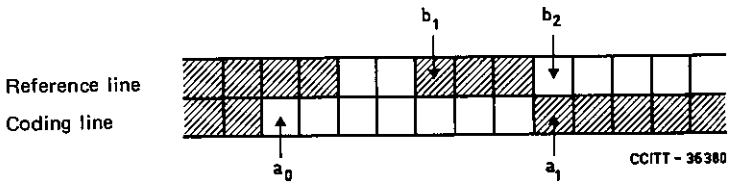


FIGURE 5/T.4

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/T.4).

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 3/T.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 1/T.4 and 2/T.4). After a horizontal mode coding, the position of a_0 is set on a_2 (see Figure 6/T.4).

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 3/T.4. The coding procedure is as shown in the flow diagram of Figure 7/T.4.

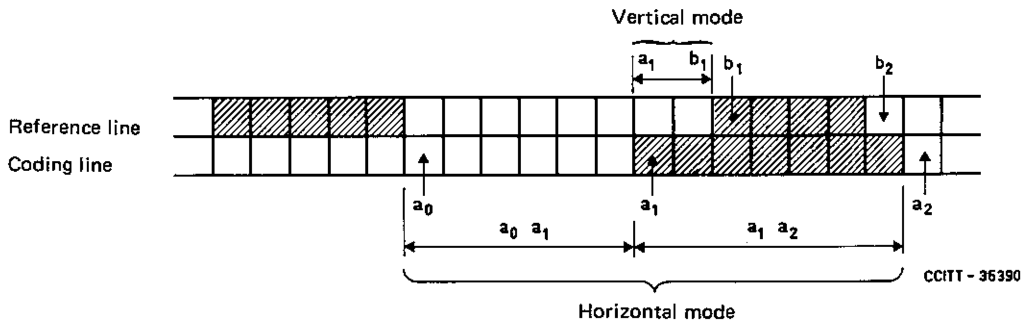


FIGURE 6/T.4

Vertical mode and Horizontal mode

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 3/T.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/T.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 3/T.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 3/T.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 3/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) (see 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 (see Note 2)

Note 1 – Code M( ) of the horizontal mode represents the code words in Tables 1/T.4 and 2/T.4.

Note 2 – It is suggested the uncompressed mode is recognized as an optional extension of two-dimensional coding scheme for Group 3 apparatus. The bit assignment for the xxx bits is 111 for the uncompressed mode of operation whose code table is given in Table 4/T.4.

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-dimensinally coded, 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 4/T.4

Uncompressed mode code words

Entrance code to uncompressed mode	On one-dimensionally coded line: 000000001111 On two-dimensionally coded line: 0000001111	
	Image pattern	*Code word*
Uncompressed mode code	1 01 001 0001 00001 00000	1 01 001 0001 00001 000001
Exit from uncompressed mode code	0 00 000 0000	0000001T 00000001T 000000001T 0000000001T 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/T.4, 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 000000000001. 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

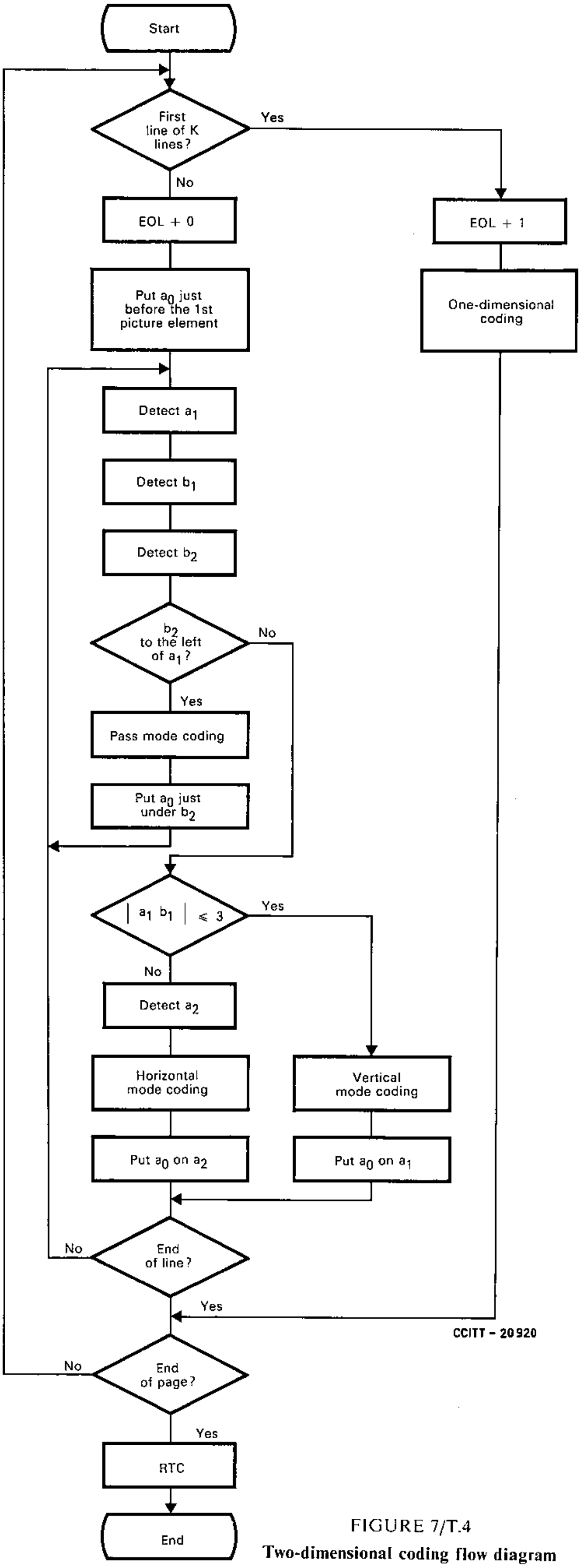


FIGURE 7/T.4

Two-dimensional coding flow diagram

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 0 s.

4.2.4 *Return to control (RTC)*

The format used is six consecutive line synchronization code words, i.e., 6 × (EOL + 1).

To further clarify the relationship of the signals defined herein, Figures 8/T.4 and 9/T.4 are offered in the case of K = 2. Figure 8/T.4 shows several scan lines of data starting at the beginning of a transmitted page. Figure 9/T.4 shows the last several lines of a page.

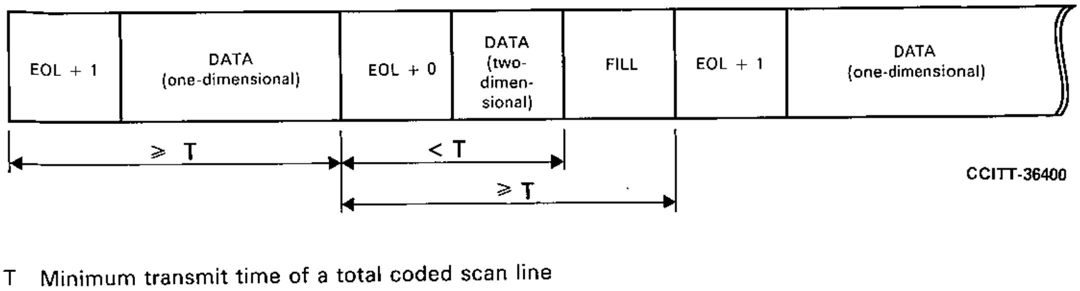


FIGURE 8/T.4

Message transmission (first part of page)

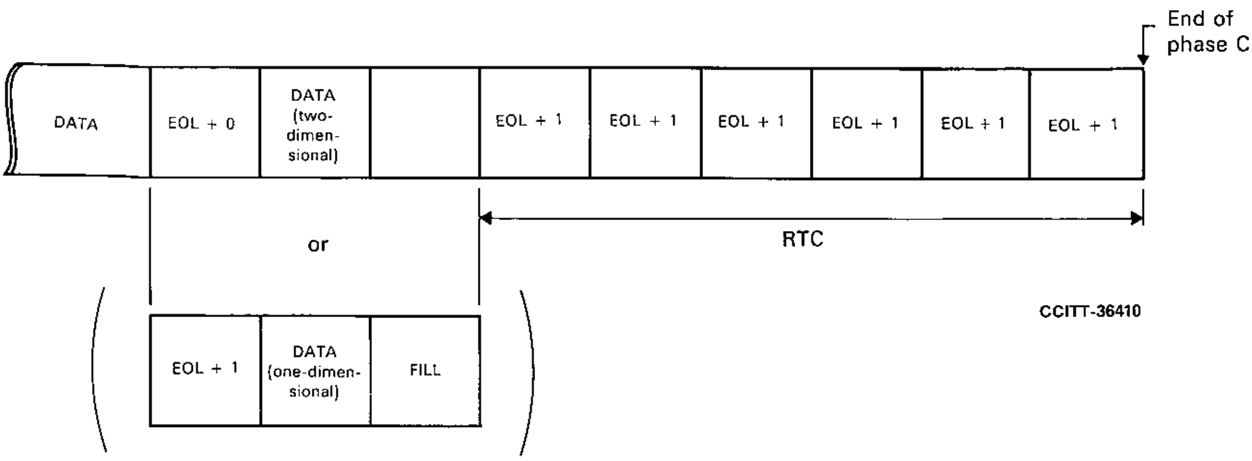


FIGURE 9/T.4

Message transmission (last part of page)

4.2.5 *Coding examples*

Figure 10/T.4 shows coding examples of the first part of scan lines and Figure 11/T.4 coding examples of the last part, while Figure 12/T.4 shows other coding examples. The notations P, H and V in the figures are, as shown in Table 3/T.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.

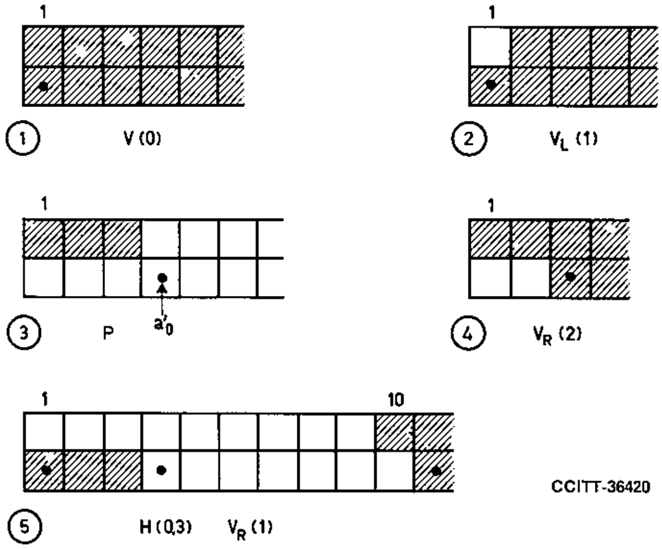


FIGURE 10/T.4

Coding examples: first part of scan line

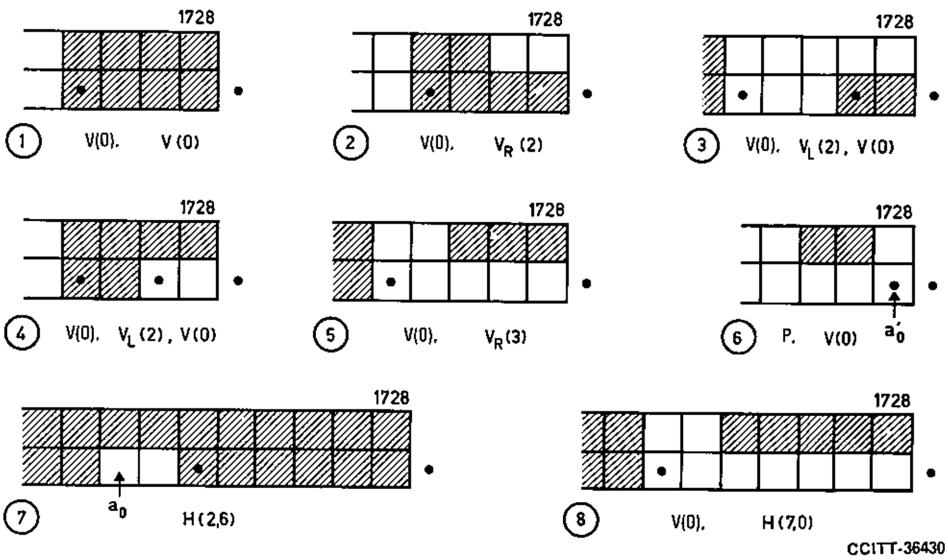


FIGURE 11/T.4

Coding examples: last part of scan line

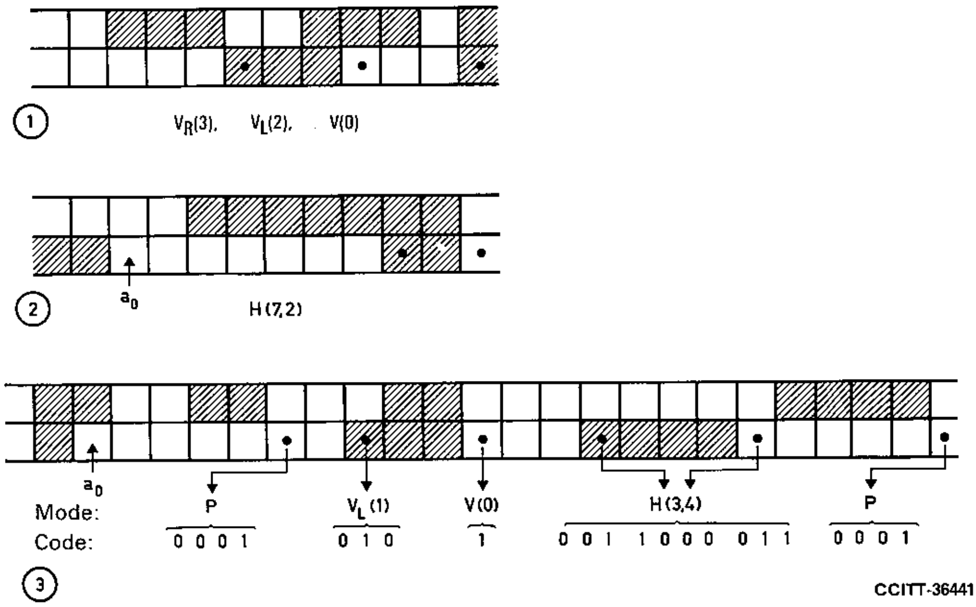


FIGURE 12/T.4

Coding examples

4.3 *Error limiting mode*

One-dimensional coding scheme with the division of scan line into parts.

The one-dimensional coding scheme with the division of scan line into parts is an optional extension of the one-dimensional coding scheme specified in Annex B.

5 Modulation and demodulation

Group 3 apparatus operating on the general switched telephone network shall utilize the modulation, scrambler, equalization and timing signals defined in Recommendation V.27 *ter*, specifically §§ 2, 3, 7, 8, 9, 11 and the Appendix.

5.1 The training signal to be used shall be the long training sequence with protection against talker echo. (See Recommendation V.27 *ter*, § 2.5.1, 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 Recommendation 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 equipments in service using, inter alia, other modulation methods.

Note 3 – Where 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 apparatus may optionally utilize the modulation, scrambler, equalization and timing signals defined in Recommendation V.29, specifically §§ 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.

6 Power at the transmitter output

The average power should be adjustable from –15 dBm to 0 dBm but the equipment should be so designed that there is no possibility of this adjustment being tampered with by an operator.

Note – The power levels over the international circuits will conform to Recommendation V.2.

7 Power at the receiver input

The receiving apparatus should be capable of functioning correctly when the received signal level is within the range of 0 dBm to –43 dBm. No control of receiver sensitivity should be provided for operator use.

8 Implementation of apparatus

Although paper sizes are referred to, this does not always require a physical paper scanner and/or printer to be implemented. Details may be defined by Administrations.

If the message is not generated from a physical scanner or displayed on paper, then the signals appearing across the network interface shall be identical to those which would be generated if paper input and/or output had been implemented.

ANNEX A

(to Recommendation T.4)

Optional error correction mode

A.1 *Introduction*

This annex specifies the message format required for document transmission incorporating the optional error correction capability.

A.2 *Definitions*

The definitions contained in Recommendations T.4 and T.30 shall be applied unless explicitly amended.

A.3 *Message format*

An HDLC frame structure is utilized for all binary coded facsimile message procedures. The basic HDLC structure consists of a number of frames each of which is subdivided into a number of fields. It provides for frame labelling and error checking.

Specific examples are given in Figures A-1/T.4 and A-2/T.4 of formats used for binary coded signalling. These examples show an initial partial page (PP) frame structure and a last PP frame structure.

In the following descriptions of the fields, the order in which the bits are transmitted is from the most to the least significant bit, i.e., from left to right as printed. The exception to this is the frame number (see § A.3.6.1).

The equivalent between binary notation symbols and the significant condition of the signalling code should be in accordance with Recommendation V.1.

A.3.1 *Synchronization*

A synchronization sequence shall precede all binary coded information whenever a new transmission begins. The synchronization shall be a training sequence and a series of flag sequences for nominal 200 ms, tolerance +100 ms.

Note – Continuous flags have two zeros as shown in the following diagram:

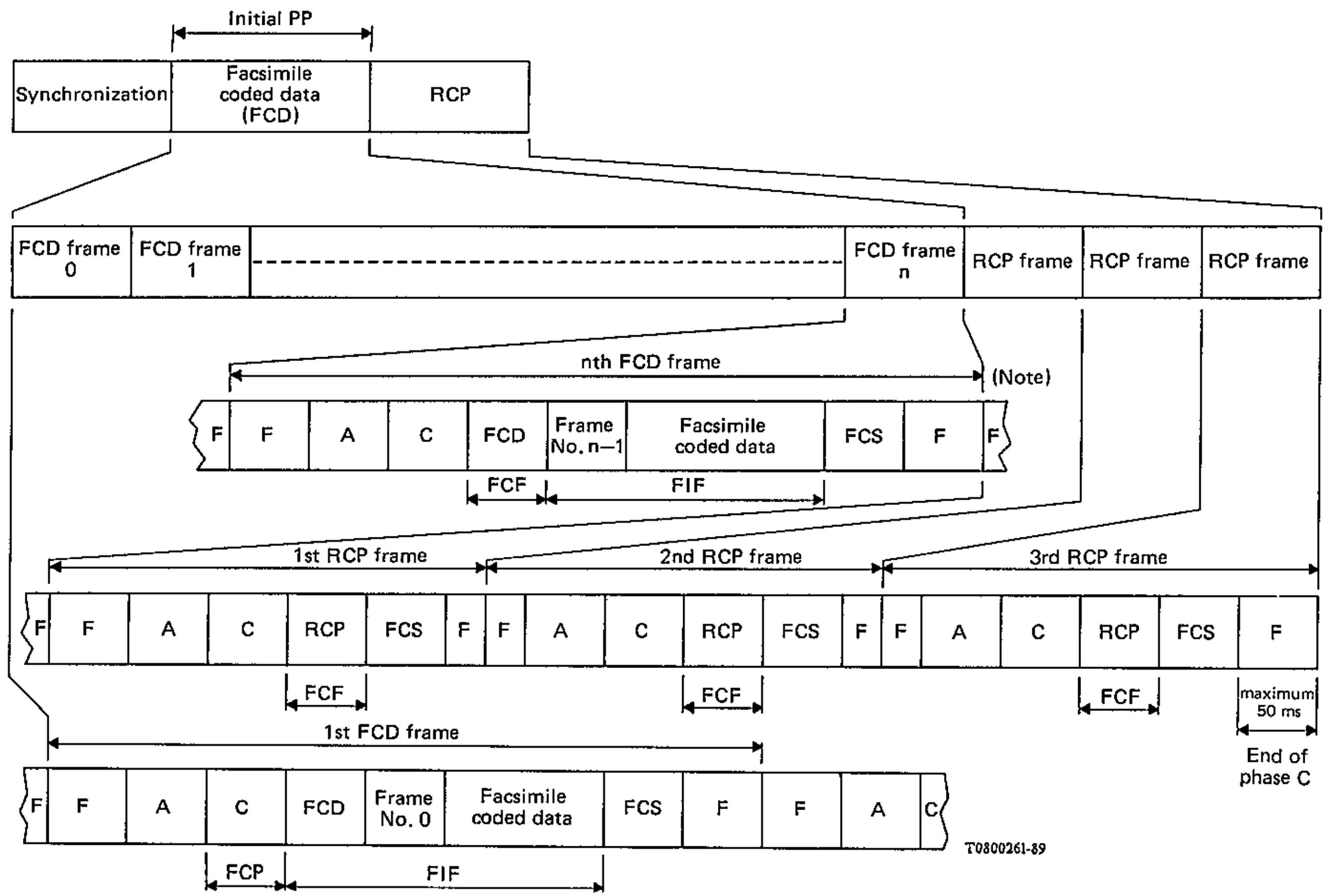
. . . 0111 1110 0111 1110 0111 1110 . . .

A.3.2 *Flag sequence (F)*

The eight bit HDLC flag sequence is used to denote the beginning and end of the frame for the facsimile message procedure. The flag sequence is also used to establish bit and frame synchronization. To facilitate this the synchronization defined in A.3.1 should be used prior to the first frame. Subsequent frames and end of the last frame need one or more than one flag sequence.

Format: 0111 1110

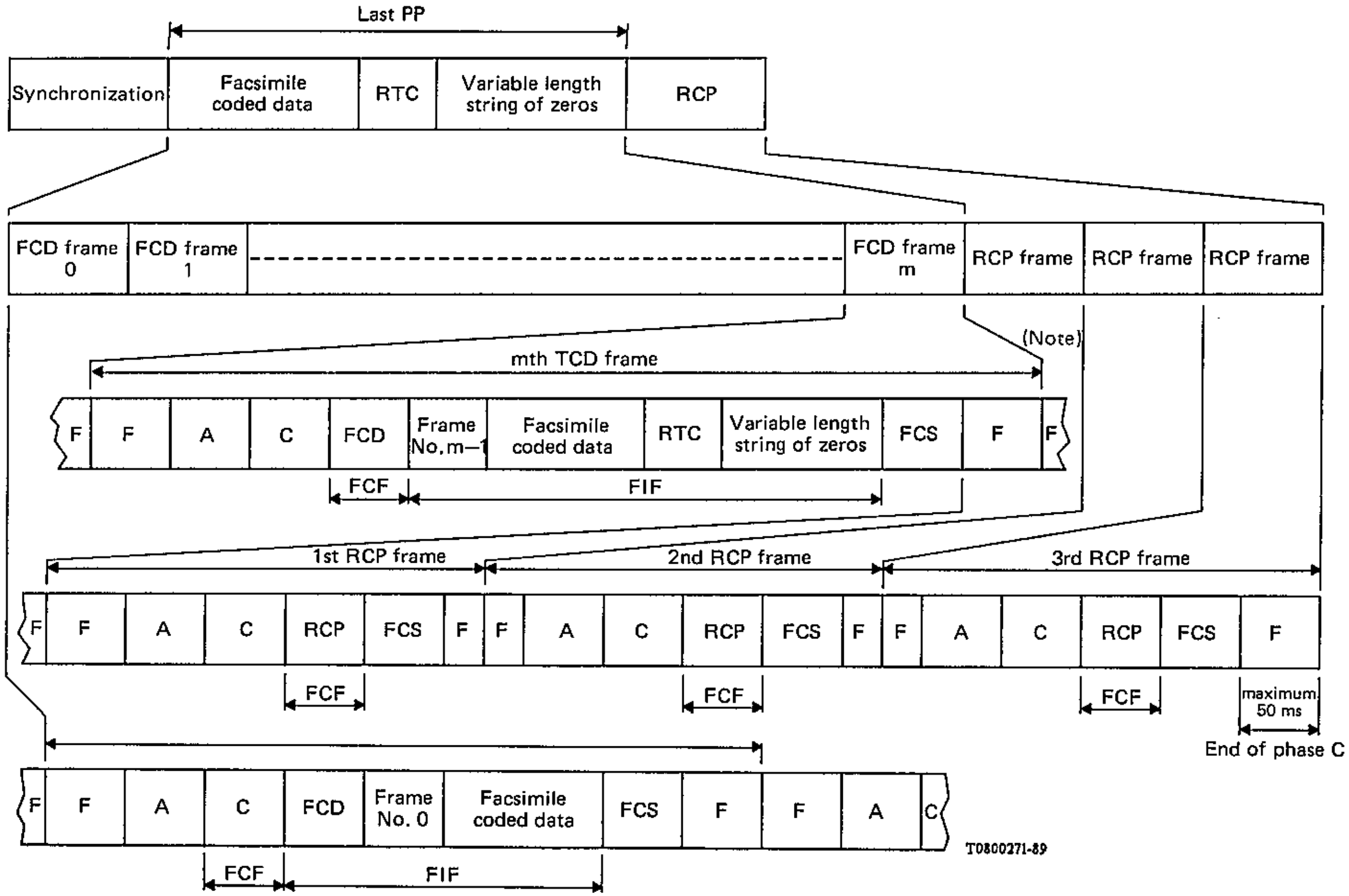
Note – The leading flag of a frame may be the trailing flag of the previous frame.



Note – See § A.3.2.

FIGURE A-1/T.4

Initial partial page (PP) frame structure



Note – See § A.3.2.

FIGURE A-2/T.4

Last partial page (PP) frame structure

A.3.3 *Address field (A)*

The eight bit HDLC address field is intended to provide identification of specific station(s) in a multi-point arrangement. In the case of transmission on the general switched telephone network, this field is limited to a single format.

Format: 1111 1111

A.3.4 *Control field (C)*

The eight bit HDLC control field provides the capability of encoding the command unique to the facsimile message procedure.

Format: 1100 X000

The X bit is set to 0 for the FCD frame (facsimile coded data frame) and the RCP frame (return to control for partial page frame).

A.3.5 *Facsimile control field (FCF)*

In order to distinguish between the FCD frame (facsimile coded data frame) and the RCP frame (return to control for partial page frame), the FCF for the in-message procedure is defined as follows:

1) FCF for the FCD frame

   Format: 0110 0000

2) FCF for the RCP frame

   Format: 0110 0001

A.3.6 *Facsimile information field (FIF)*

The facsimile information field is a length of 257 or 65 octets (see Note 1) and is divided into two parts, the frame number and the facsimile data field (see Note 2).

Note 1 – This does not include bit stuffing to preclude non-valid flag sequences.

Note 2 – There is no information field in the RCP frame.

A.3.6.1 *Frame number*

This is an eight bit binary number. The frame number is defined to be the first eight bits of the facsimile information field. The least significant bit is transmitted first.

The frame number 0-255 (maximum number is 255) is used to identify the facsimile data field (see Recommendation T.30, Annex A).

The frame 0 is transmitted first in each block.

A.3.6.2 *Facsimile data field*

The coding schemes specified in § 4 are valid with the following notes.

1) The facsimile data field is a length of 256 or 64 octets.

2) The total coded scan line is defined as the sum of DATA bits plus the 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 the EOL bits plus a tag bit.

3) At the end of facsimile data field, if necessary, Pad bits may be used to align on octet boundaries and frame boundaries (see Notes 1 and 2). The format is a variable length string of zeros.

Note 1 – The receiver is able to receive both Pad bits and Fill bits.

Note 2 – The facsimile data field length of the final frame including RTC signal may be less than 256 or 64 octets.

A.3.7 *Frame checking sequence (FCS)*

The FCS shall be a 16 bit sequence (see Recommendation T.30, § 5.3.7).

A.3.8 *Return to control for partial page (RCP)*

The end of a partial page transmission is indicated by sending three consecutive RCP frames (see Note).

Following these RCP frames, the transmitter will send the post message commands in the framed format and the data signalling rate of the control signals defined in Recommendation T.30, Annex A.

Note – The flag sequence following the last RCP frame shall be less than 50 ms.

ANNEX B

(to Recommendation T.4)

Optional error limiting mode

Note – The text of Annex B shall be refined and studied during the next study period.

B.1 *Data*

B.1.1 *The division of a scan line into parts*

In order to limit the disturbed area in the event of transmission error, the scan lines are divided into parts before coding.

The number of parts shall be used as follows:

a) standard, 12 parts in a line composed of 1728 black and white picture elements,

b) optionally, 15 parts in a line composed of 2048 black and white picture elements,

c) optionally, 17 parts in a line composed of 2432 black and white picture elements.

Note – For alternatives b) and c), the last part of a scan line can be shortened and then will contain 32 and 128 pels respectively.

B.1.2 *Scan line coding*

All parts of a scan line are divided into whites (W) if they are composed of all white picture elements and not-white (NW) if they contain at least one black element.

The coding procedure is as shown in the flow diagram of Figure B-1/T.4.

B.1.2.1 *Shaping the extended* d*escription of a scan line*

For each coded scan line the extended scan line description (ELD) is shaped. ELD represents a sequence, where the bit number is equal to the part number in a scan line, i.e., each part has corresponding bit in the sequence. This bit is equal to “1”, if the part is “NW” and it is equal to “0” if the part is “W”.

B.1.2.2 *Scan line part coding*

W-parts are not encoded. The coding of each NW-part is independent of the coding of other parts in the given scan line. In the NW-part the white and black runs alternate. The coding always begins with a white run. If the actual scan line begins with a black run then a white run length of zero will be sent. Run lengths are encoded using Tables 1/T.4 and 2/T.4 as described in § 4.1.1. The last run of each NW-part is not encoded. Resulted coded run lengths (CRL) are sent directly one after another.

B.1.2.3 *Code bit number variation (CBNV)*

It is necessary to code and send the number of coded bits for each NW-part. For this purpose the code bit number of the previous NW-part q_{i-1} is subtracted from the code bit number of the given NW-part q_i. The resulting difference $q_i - q_{i-1}$ is coded by using code words listed in Table B-1/T.4. For the first NW-part in a scan line q_0 is taken to be 40. In the code words given in Table B-1/T.4 the bit X corresponds to the sign of the difference $q_i - q_{i-1}$. When the difference is positive, bit X equals “0”, but when the difference is negative bit X equals “1”.

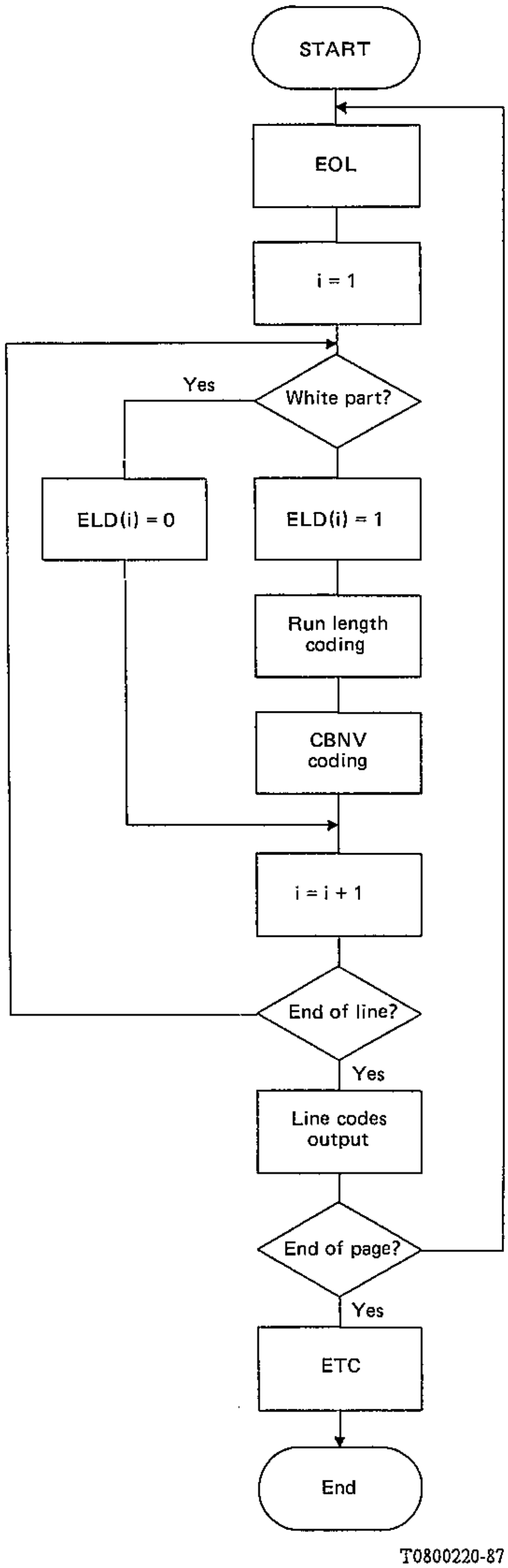

START
EOL
i = 1
White part?
Yes
ELD(i) = 0
ELD(i) = 1
Run length coding
CBNV coding
i = i + 1
End of line?
Yes
Line codes output
End of page?
Yes
ETC
End
T0800220-87

FIGURE B-1/T.4

TABLE B-1/T.4

Code table for the code bit number variation

Absolute value of variation	Code	Absolute value of variation	Code
0	100000	51	X11111 010101
1	X00001	52	X11111 010110
2	X00010	53	X11111 010111
3	X00011	54	X11111 011000
4	X00100	55	X11111 011001
5	X00101	56	X11111 011010
6	X00110	57	X11111 011011
7	X00111	58	X11111 011100
8	X01000	59	X11111 011101
9	X01001	60	X11111 011110
10	X01010	61	X11111 100000
11	X01011	62	X11111 100001
12	X01100	63	X11111 100010
13	X01101	64	X11111 100011
14	X01110	65	X11111 100100
15	X01111	66	X11111 100101
16	X10000	67	X11111 100110
17	X10001	68	X11111 100111
18	X10010	69	X11111 101000
19	X10011	70	X11111 101001
20	X10100	71	X11111 101010
21	X10101	72	X11111 101011
22	X10110	73	X11111 101100
23	X10111	74	X11111 101101
24	X11000	75	X11111 101110
25	X11001	76	X11111 101111
26	X11010	77	X11111 110000
27	X11011	78	X11111 110001
28	X11100	79	X11111 110010
29	X11101	80	X11111 110011
30	X11110	81	X11111 110100
		82	X11111 110101
31	X11111 000001	83	X11111 110110
32	X11111 000010	84	X11111 110111
33	X11111 000011	85	X11111 111000
34	X11111 000100	86	X11111 111001
35	X11111 000101	87	X11111 111010
36	X11111 000110	88	X11111 111011
37	X11111 000111	89	X11111 111100
38	X11111 001000	90	X11111 111101
39	X11111 001001	91	X11111 X11110 010000
40	X11111 001010	92	X11111 X11111 000001
41	X11111 001011	93	X11111 X11111 000010
42	X11111 001100	94	X11111 X11111 000011
43	X11111 001101	95	X11111 X11111 000100
44	X11111 001110	96	X11111 X11111 000101
45	X11111 001111	97	X11111 X11111 000110
46	X11111 010000	98	X11111 X11111 000111
47	X11111 010001	99	X11111 X11111 001000
48	X11111 010010	100	X11111 X11111 001001
49	X11111 010011	101	X11111 X11111 001010
50	X11111 010100	102	X11111 X11111 001011

TABLE B-1/T.4 *(cont.)*

Absolute value of variation	Code	Absolute value of variation	Code
103	X11111 X11111 001100	119	X11111 X11111 011100
104	X11111 X11111 001101	120	X11111 X11111 011101
105	X11111 X11111 001110	121	X11111 X11111 011110
106	X11111 X11111 001111	122	X11111 X11111 100000
107	X11111 X11111 010000	123	X11111 X11111 100001
108	X11111 X11111 010001	124	X11111 X11111 100010
109	X11111 X11111 010010	125	X11111 X11111 100011
110	X11111 X11111 010011	126	X11111 X11111 100100
111	X11111 X11111 010100	127	X11111 X11111 100101
112	X11111 X11111 010101	128	X11111 X11111 100110
113	X11111 X11111 010111	129	X11111 X11111 100111
114	X11111 X11111 010111	130	X11111 X11111 101000
115	X11111 X11111 011000	131	X11111 X11111 101001
116	X11111 X11111 011001	132	X11111 X11111 101010
117	X11111 X11111 011010	133	X11111 X11111 101011
118	X11111 X11111 011011	134	X11111 X11111 101100

Note – Bit X corresponds to the sign of the variation.

B.1.3 *Data format*

The data format for the scan line containing several NW-parts is shown in Figure B-2/T.4 and containing only one NW-part is shown in Figure B-3/T.4. The data format for the scan line containing all whites is shown in Figure B-4/T.4.

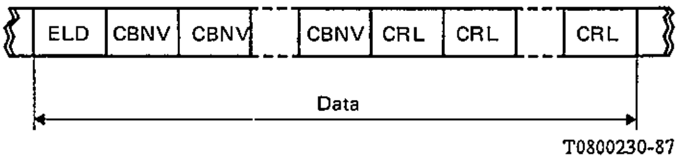


FIGURE B-2/T.4

Data format for the scan line containing several NW-parts

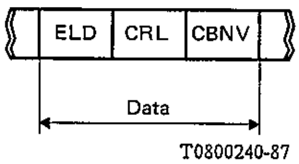


FIGURE B-3/T.4

Data format for the scan line containing one NW-part

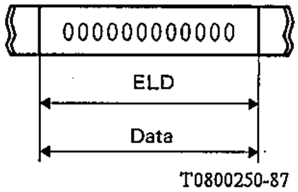


FIGURE B-4/T.4

Data format for the scan line containing 1728 white picture elements

B.2 *End of line (EOL)*

This code word follows each line of data. There is a slight probability of occurrence of the same bit combination for ELD and the code word EOL. This should be taken account in the decoding algorithm. In addition, EOL is sent prior to the format data line of the page.

Format: 000000000001

B.3 *Fill*

A pause in the message may be filled as described in § 4.1.3.

B.4 *Return to control (RTC)*

The return to control should comply with § 4.1.4.

Note – When decoding, the correction of the corrupted parts can be performed by replacing the corrupted part with the corresponding uncorrupted part from the previous line. The exceeding of the value 144 by the decoded part length or the absence of code word of the given part in the code table vocabulary can be shown as a sign for replacement.

(to Recommendation T.4)

Interworking between equipments with A5/A6 and A4 facilities and between equipments with combinations of these facilities

TABLE C-1/T.4

Terminal capabilities at reception side / Situation at transmission side				Case from § 2.1	b)	e)	f)	g)	h)
				Horizontal resolution	1728 pels/ 215 mm	864 pels/ 107 mm	1216 pels/ 151 mm	1728 pels/ 107 mm	1728 pels/ 151 mm
				Vertical resolution	3.85 l/mm 7.7 l/mm	7.7 l/mm 15.4 l/mm	5.44 l/mm 10.9 l/mm	7.7 l/mm 15.4 l/mm	5.44 l/mm 10.9 l/mm
				Pel process	1728 Original	864 (≈ 1728 × 0.70) (Note 1)	1216 (≈ 1728 × 0.70) (Note 2)	1728 Original	1728 Original
Case from § 2.1	Horizontal resolution	Vertical resolution	Pel process	DIS-DTC / DCS	–	Bit 33 = 1 Bit 35 = 1	Bit 33 = 1 Bit 34 = 1	Bit 33 = 1 Bit 37 = 1	Bit 33 = 1 Bit 36 = 1
b)	1728 pels/ 215 mm	3.85 l/mm 7.7 l/mm	Original 1728	(Notes 1, 2) Bit 17 = 0 Bit 18 = 0 Bit 33 = 0	Equal (A4)	Reduced (A4 → A6)	Reduced (A4 → A5)	Reduced (A4 → A6)	Reduced (A4 → A5)
e)	864 pels/ 107 mm	7.7 l/mm 15.4 l/mm	864 × 2 (Note 1)		Enlarged (A6 → A4)	Equal (A6) (Note 1)	Enlarged (A6 → A5)	Equal (A6)	Enlarged (A6 → A5)
f)	1216 pels/ 151 mm	5.44 l/mm 10.9 l/mm	1216 × 1.42 (Note 2)		Enlarged (A5 → A4)	Reduced (A5 → A6)	Equal (A5) (Note 2)	Reduced (A5 → A6)	Equal (A5)
g)	1728 pels/ 107 mm	7.7 l/mm 15.4 l/mm	Original 1728		Enlarged (A6 → A4)	Equal (A6)	Enlarged (A6 → A5)	Equal (A6)	Enlarged (A6 → A5)
h)	1728 pels/ 151 mm	5.44 l/mm 10.9 l/mm	Original 1728		Enlarged (A5 → A4)	Reduced (A5 → A6)	Equal (A5)	Reduced (A5 → A6)	Equal (A5)

Note 1 – Bit 33 = 1 Transmit pel process = 432(W) + 864 + 432(W)
Bit 35 = 1 Receive pel process extracts central 864 pels

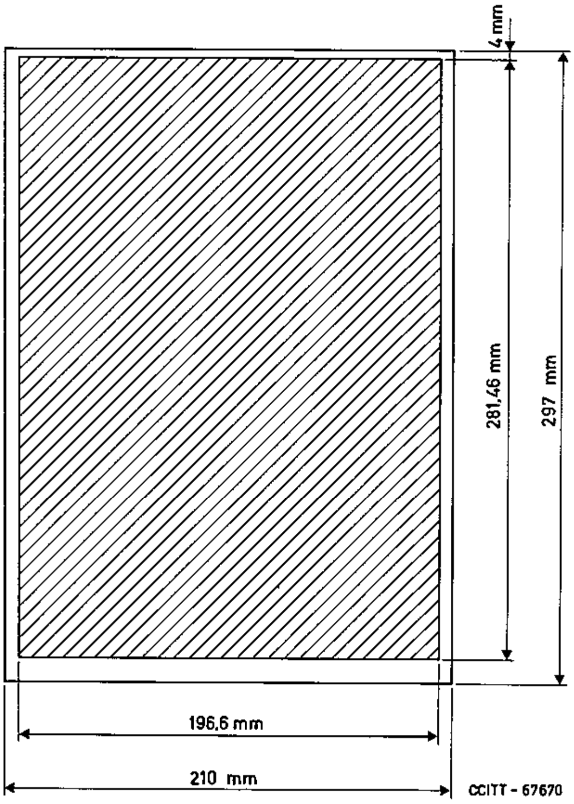
Note 2 – Bit 33 = 1 Transmit pel process = 256(W) + 1216 + 256(W)
Bit 34 = 1 Receive pel process extracts central 1216 pels

(W) = white pels
l = line

APPENDIX I

(to Recommendation T.4)

Guaranteed reproducible area for Group 3 apparatus conforming to Recommendation T.4



Note 1 – Paper characteristics (i.e. weight) are important parameters. Lightweight paper may cause additional paper handling errors and may result in a reduced guaranteed reproducible area.

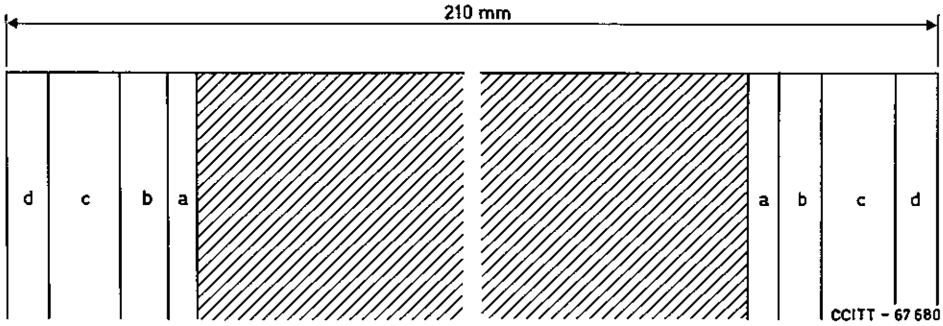
Note 2 – Sheet feed mechanisms may reduce the guaranteed reproducible area.

Note 3 – All calculations were done using worst case values. Using nominal values increases the reproducible area.

Note 4 – The exact horizontal position of this area within the ISO A4 paper size as well as sizes larger than the above are subject to national recommendations and/or definitions.

FIGURE I-1/T.4

Guaranteed reproducible area for Group 3 machines for use on facsimile services referring to ISO A4 paper size



a : Printer/scanner tolerances
b : Loss caused by the enlarging effect due to TLL tolerance
c : Loss caused by skew
d : Record medium positioning errors

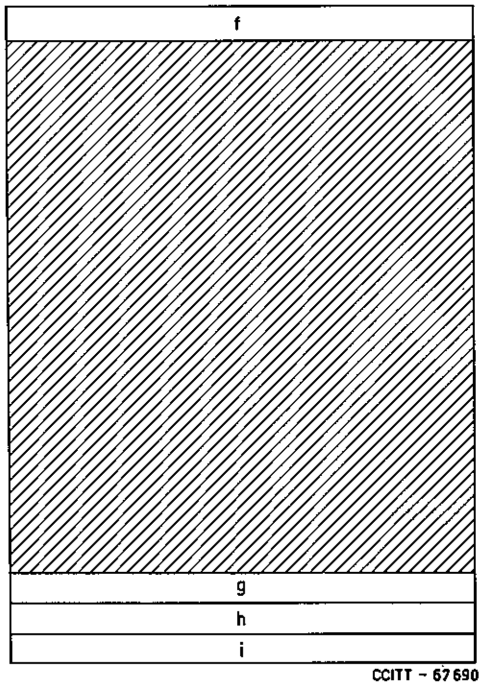
FIGURE I-2/T.4

Horizontal loss

TABLE I-1/T.4

Horizontal losses

Printer/scanner	a	± 0.5 mm
Enlarging	b	± 2.1 mm
Skew	c	± 2.6 mm
Positioning errors	d	± 1.5 mm



T f : Paper insertion loss
g : Loss caused by skew
h : Scanning density tolerance
i : Gripping loss

FIGURE I-3/T.4

TABLE I-2/T.4

Vertical losses

Paper insertion	f	± 4.0 mm
Skew	g	± 1.8 mm
Scanning density tolerance	h	± 2.97 mm
Gripping loss	I	± 2.0 mm

Note – Scanning density tolerance will reduce to 0 mm on roll-fed machines.

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