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30 OCTOBER 1991

SUPERSEDING
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30 MARCH 1990

MILITARY STANDARD

INTEROPERABILITY AND PERFORMANCE

STANDARDS FOR

DIGITAL FACSIMILE EQUIPMENT

AMSC N/A

AREA SLHC

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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FOREWORD

* 1.   Originally, Military Standard 188 (MIL-STD-188) covered technical
* standards for tactical and long-haul communications, but later evolved
* through revisions (MIL-STD-188A, MIL-STD-188B) into a document applicable to
* tactical communications only (MIL-STD-188C).

* 2. The Defense Communications Agency (DCA), now Defense Information Systems
* Agency (DISA), published DCA Circulars (DCACs) promulgating standards and
* engineering criteria applicable to the long-haul Defense Communications
* System (DCS) and to technical support of the National Military Command
* System (NMCS).

* 3.   As a result of a Joint Chiefs of Staff (JCS) action, standards for all
* military communications are now being published in a MIL-STD-188 series of
* documents. The MIL-STD-188 series is subdivided into a MIL-STD-188-100
* series covering common standards for tactical and long-haul communications,
* a MIL-STD-188-200 series covering standards for tactical communications
* only, and a MIL-STD-188-300 series covering standards for long-haul
* communications only. Emphasis is being placed on developing common
* standards for tactical and long-haul communications published in the
* MIL-STD-188-100 series.

* 4.   This document contains technical parameters for digital facsimile
* equipment used in tactical and long-haul communications. The parameters
* contained herein are consistent with the mandatory parameters of North
* Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 5000
* and International Telegraph and Telephone Consultative Committee (CCITT)
* Group 3 equipment.

* 5.   This military standard (MIL-STD) is approved and will be used by the
* Office of the Secretary of Defense, the Military Departments, the Chairman
* of the Joint Chiefs of Staff and the Joint Staff, the Unified and Specified
* Commands, the Defense Agencies, and DOD Field Activities.

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SPECIAL CONSIDERATIONS

* 1. MIL-STD-188-161C is being issued to introduce multipage transmission
* capability, to make streamlining editorial changes, and to add a tutorial
* appendix on facsimile modes of operation.

* 2. Department of Defense Instruction (DODI) 5000.2, Part 7c, states that
* the MIL-STD-188 series, appropriately tailored, will be used for all inter-
* and intra-DoD component systems and equipment to ensure interoperability
* and compatibility. The instruction requires that only applicable standards
* are to be used, and those standards must be tailored in order to invoke only
* those requirements which are suitable for the user. The following guidance
* is provided for your use:

    a. Unclassified operations: Users that do not need to send classified information over facsimile equipment, recommend the CCITT Group 3 analog output machine.

    b. Classified operations: Users who require the transmittal of classified information, recommend a Type I and/or Type II digital output facsimile machine. For information, a dual-mode facsimile machine which contains Type I and/or Type II and CCITT Group 3 protocols will satisfy unclassified and classified operations.

    c. Users must understand that this standard covers the minimum requirements. A user must consider the following, prior to purchasing facsimile equipment:

    (1) Interoperability between U.S. and Allied forces, as required.

    (2) Transmission rates required to support all phases of operational requirements (peacetime through war, tactical, and NATO STANAG 5000).

    (3) Multipage requirements.

*   (4) Error correction requirements.

    (5) Classified and unclassified processing.

    (6) The type of cryptographic equipment being used with the facsimile equipment.

    (7) Resolution requirements (low, medium, and high).

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*   (8)   Uncompressed mode requirements.

*   (9)   Backward interoperability requirements to operate with existing facsimile equipment.

*   (10) Cost.

NOTE: See Sections 1 and 6 for further guidance.

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1. SCOPE

1.1 <u>Purpose</u>. The purpose of this document is to establish, in the most economical manner, interoperability and performance parameters necessary to ensure interoperability among long haul and tactical digital facsimile equipment. The technical parameters established by this document represent a set of minimum interoperability and performance characteristics, which may be exceeded to satisfy specific requirements.

It is not the purpose of this document to serve as a stand-alone, comprehensive reference containing all technical parameters and other details required for the design of new equipment or the preparation of specifications. Therefore, parameters for such items as size and weight limitations, connectors, cable assemblies, or power supplies are not contained in this document. These parameters and other design details have to be established, based on specific requirements, and have to be carefully tailored in accordance with the policies of Department of Defense Instruction (DODI) 5000.2, Part 10c.

It is not the purpose of this document to inhibit advances in communications technology. Such advances are facilitated by not specifying the technology that should be used in the design and development of digital facsimile systems to meet the required standards.

1.2 <u>Content</u>. This standard provides technical interoperability and performance parameters for two forms of digital facsimile equipment. The first form is designated Type I and/or Type II, which are interoperable with Type I and Type II NATO tactical digital facsimile equipment respectively, and provide a digital output signal. The second form is designated CCITT Group 3 facsimile equipment in accordance with Federal Information Processing Standard (FIPS) 147 and FIPS 148, and provides an analog output signal.

1.3 <u>Applicability</u>. This standard is mandatory within the Department of Defense (DOD) in the design, development, and acquisition of facsimile equipment. It is not intended that existing equipment and systems be immediately converted to comply with the provisions of this standard. New equipment and systems and those undergoing major modification, or rehabilitation shall also conform to this standard.

1.3.1 <u>Application guidance</u>. Application of this standard shall be
* tailored in accordance with DODI 5000.2. Based on identified requirements, the following applies:

    (1)   Facsimile equipment designated for only digital output shall, at a
* minimum, comply with Type I and/or Type II requirements.

    (2)   Facsimile equipment designated for only analog output shall, at a
* minimum, comply with CCITT Group 3 (FIPS 147 and FIPS 148) requirements.

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(3) Facsimile equipment designated for both digital and analog
* output shall, at a minimum, comply with both Type I and/or Type II (See
sections 4 and 5) and CCITT Group 3 (FIPS 147 and FIPS 148) requirements.

(4) When a CCITT Group 3 analog output facsimile requires interface
* with a digital output facsimile, that interface shall, at a minimum,
* comply with the Type I and/or Type II requirements.

1.4 <u>System standards and design objective</u>. The parameters and other
requirements specified in this document are mandatory system standards if
the word "shall" is used in connection with the parameter value or
requirement under consideration. Nonmandatory design objectives are
indicated in parentheses after a standardized parameter value or by the
word "should" in connection with the parameter value or requirement under
consideration. For a definition of the terms "system standard" and "design
objective" see FED-STD-1037.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 <u>Specifications, standards, and handbooks</u>. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

Federal standards

FED-STD-1037	Glossary of Telecommunication Terms
FIPS 147	Group III Facsimile Apparatus for Document Transmission (Note: DOD Adopted)
FIPS 148	Procedures for Document Facsimile Transmission (Note: DOD Adopted)

Military standards

MIL-STD-188-100	Common Long Haul and Tactical Communications Systems Technical Standards
MIL-STD-188-114	Electrical Characteristics of Digital Interface Circuits
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
* MIL-STD-462	Measurement of Electromagnetic Interference Characteristics

International standards

STANAG 5000	Interoperability of Tactical Digital Facsimile Equipment

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from Standardization Document Order Desk, 700 Robbins Avenue, Building 4, Section D, Philadelphia, PA 19111.)

(Copies of Federal Information Processing Standards (FIPS) are available to Department of Defense activities from the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA.)

19120-5099. Others must request copies of FIPS from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161-2171.)

2.1.2 <u>Other Government documents, drawings, and publications</u>. The following other Government documents, drawings, and publications form a part of this standard to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

NTISSI 7000   TEMPEST Countermeasures for Facilities
                     (U) (SECRET)

* DODI 5000.2   Defense Acquisition Management Policies and Procedures

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

(Copies of DOD Directives are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4, Section D, Philadelphia, PA 19111.)

2.2 <u>Non-Government publications</u>. The following documents form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

    International Telegraph
    and Telephone Consultative
    Committee (CCITT)

        CCITT Recommendation T.4   Standardization of Group 3 Facsimile Apparatus for Document Transmission

        CCITT Recommendation T.30   Procedures for Document Facsimile Transmission in the General Switched Telephone Network

(Applications for copies should be addressed to the U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.)

(Nongovernment standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

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2.3 <u>Order of precedence</u>. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard takes precedence. Nothing in this standard, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

3.1 <u>Acronyms used in this standard</u>.

a. BCH   -   Bose Chandhuri Hocquenghem code, a cyclic code

b. BER   -   Bit Error Ratio

c. BILP   -   Beginning of Intermediate Line Pair

d. BOLP   -   Beginning of Line Pair

e. CCITT   -   International Telegraph and Telephone
                 Consultative Committee

f. COMSEC   -   Communications Security

g. DCA   -   Defense Communications Agency

h. DCE   -   Data Circuit-Terminating Equipment

i. DCS   -   Defense Communications System

* j. DISA   -   Defense Information Systems Agency

k. DOD   -   Department of Defense

* l. DODI   -   Department of Defense Instruction

m. DODISS   -   Department of Defense Index of Specification and
                 Standards

* n. DSVT   -   Digital Secure Voice Terminal (KY-68)

o. DTE   -   Data Terminal Equipment

p. EMSEC   -   Emanations Security

q. EIA   -   Electronic Industries Association

r. EOL   -   End of Line

s. EOM   -   End of Message

* t. EOT   -   End of Transmission

u. FAX   -   Facsimile

v. FEC   -   Forward Error Correction

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	w.	HSOM	-	Handshake Start of Message
*	x.	ISDN	-	Integrated Services Digital Network
	y.	JCS	-	Joint Chiefs of Staff
	z.	LSB	-	Least Significant Bit
	aa.	MSB	-	Most Significant Bit
	ab.	MODEM	-	Modulator-Demodulator
	ac.	NACSIM	-	National COMSEC/EMSEC Information Memorandum
	ad.	NATO	-	North Atlantic Treaty Organization
	ae.	NMCS	-	National Military Command System
*	af.	NSA	-	National Security Agency
*	ag.	PEL	-	Picture Element
	ah.	PN	-	Pseudorandom Noise
	ai.	RTC	-	Return to Control
	aj.	SOM	-	Start of Message
	ak.	STANAG	-	Standardization Agreement (NATO)
*	al.	STU III	-	Secure Telephone Unit, Third Generation
*	am.	TIA	-	Telecommunications Industry Association

3.2 Definitions used in this standard.

3.2.1 Terms. Definitions of terms used in this document shall be as specified in the current edition of FED-STD-1037. In addition, the following definitions are applicable for the purpose of this standard.

3.2.2 Type I facsimile equipment. Facsimile equipment, as defined in this standard, which provides for the transmission and reception of black and white information, is called Type I facsimile equipment.

3.2.3 Type II facsimile equipment. Facsimile equipment, as defined in this standard, which provides for the transmission and reception of Gray scale information, as well as black and white information, is called Type II facsimile equipment.

3.2.4 <u>CCITT Group 3 facsimile equipment</u>. Facsimile equipment which provides for the transmission and reception of black and white information as defined in CCITT Recommendations T.4 and T.30 (FIPS 147 and FIPS 148). (This is an abbreviated definition for comparison with Type I and Type II definitions given above. For the complete definition, see FED-STD-1037.)

3.2.5 <u>Digital facsimile equipment</u>. Facsimile equipment that employs digital techniques to encode the image detected by the scanner.

3.3 <u>Type I and Type II facsimile mode definitions</u>.

3.3.1 <u>Non-handshake mode</u>. In non-handshake mode, no handshake is exchanged between the transmitting and receiving facsimile.

3.3.2 <u>Handshake mode</u>. In handshake mode, a handshake is exchanged between transmitting and receiving facsimiles before black and white or Gray scale information is sent. This is a normal method of operation for CCITT Group 3 facsimile equipment.

4. GENERAL REQUIREMENTS

4.1 <u>Interoperability</u>. The requirements specified in this standard are
* intended to ensure facsimile interoperability among all Services and
Agencies within the DOD. STANAG 5000 requirements are specified for those
DOD users who require interoperability with our NATO allies.

   a.   Digital signal output. Facsimile equipment designated for digital
output shall, at a minimum, comply with the requirements for Type I and/or
Type II, as stated herein. (These requirements are consistent with STANAG
5000 parameters.)

   b.   Analog signal output. Facsimile equipment designated for analog
output shall, at a minimum, comply with CCITT Group 3 requirements as
documented in FIPS 147 and FIPS 148.

   c.   Dual mode signal output. Facsimile equipment designated for both
digital and analog output shall, at a minimum, comply with both CCITT Group
3 and Type I and/or Type II requirements as stated in subparagraphs a. and
b., above.

   d.   CCITT Group 3 interface for digital transmissions. CCITT Group 3
analog output facsimile equipment requiring a digital output shall at a
minimum, comply with Type I or Type II facsimile requirements contained in
this standard.

4.1.1. <u>Dual mode protocols</u>. Type I and/or Type II protocols should always
be used between terminals implementing both CCITT Group 3 and Type I and/or
Type II protocols. Receiving dual mode terminals shall be capable of
recognizing and differentiating between CCITT Group 3 and Type I and/or
Type II transmissions. (Note: There is no requirement for the CCITT
Group 3 protocols and Type I and/or Type II protocols to interoperate.)

4.1.2. <u>Facsimile security</u>. When facsimile equipment is used for
processing classified information, such equipment shall not allow
classified traffic to pass to the outside world through an unsecured path.

4.2 <u>TEMPEST</u>. The facsimile equipment, when provided for secure
operations, shall meet the applicable requirements of National
Telecommunications and Information Systems Security Instruction (NTISSI)
7000(U)(SECRET).

4.3 <u>NATO interoperability</u>. When NATO interoperability is required between
facsimile equipments with digital signal outputs, then the equipment shall
conform with NATO STANAG 5000.

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* 4.4 <u>Electromagnetic Compatibility (EMC) requirements</u>. The facsimile
* equipment shall comply with the applicable requirements of MIL-STD-461.
* Test methods and measurements taken to determine equipment electromagnetic
* interference characteristics shall be accomplished in accordance with the
* requirements of MIL-STD-462.

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5. DETAILED REQUIREMENTS

5.1 <u>General</u>. This section includes detailed requirements for Type I and Type II digital facsimile equipment. To obtain detailed information on CCITT Group 3 analog facsimile equipment, refer to FIPS 147 and 148.

5.1.1 <u>Transmission rates</u>. The facsimile equipment, excluding the modem, shall be able to operate bit-by-bit asynchronously at data rates of 2400 bits per second, 4800 bits per second, and 9600 bits per second, with timing provided by an external clock. Additional standard rates specified in MIL-STD-188-100 may be implemented as required. NATO interoperability requires 2400 bits per second and 16,000 bits per second, as per STANAG 5000.

5.1.2 <u>Digital interfaces</u>. The electrical characteristics of all digital interfaces for data, control, and timing signals shall comply with the applicable requirements as stated in MIL-STD-188-114.

5.1.3 <u>Interchange circuits</u>. The interchange circuits shown in table I are mandatory. Other circuits may be provided for specific applications.

TABLE I. Functional interchange circuits.

CIRCUIT	DIRECTION
REQUEST TO SEND	FROM DTE TO DCE
CLEAR TO SEND	FROM DCE TO DTE
RECEIVE INPUT CONTROL	FROM DTE TO DCE
SEND DATA	FROM DTE TO DCE
RECEIVE DATA	FROM DCE TO DTE
SEND TIMING	FROM DCE TO DTE
RECEIVE TIMING	FROM DCE TO DTE
LOSS OF SYNC	FROM DTE TO DCE
SEND COMMON	RETURN
RECEIVE COMMON	RETURN
SIGNAL GROUND	GROUND

* 5.1.4 <u>Synchronization code words and signaling sequences</u>. The code words
* and signaling sequences used in Type I and Type II facsimile shall be as
* defined in table II.

TABLE II. Code words and signaling sequences for
Type I and Type II.

NAME	MAKE UP
Beginning of Intermediate Line Pair (BILP)	00000000000000011
Beginning of Line Pair (BOLP)	00000000000000010
End of Line (EOL)	000000000001
End of Message (EOM)	Minimum of 16 consecutive S_1 code words
Not End of Message ($\overline{EOM}$)	Minimum of 16 consecutive inverted S_1 code words
* End of Transmission (EOT)	Minimum of 16 consecutive S_0 code words
* Return to Control (RTC)	EOL EOL EOL EOL EOL EOL
* Start of Message (SOM)	S_1 S_0 X clock periods S_0 S_1 (where X is the number of clock periods between the pairs of code words)
* S_0	111100010011010
* S_1	111101011001000
* Fill	Variable length string of 0s
* Stuffing	Variable length string of 1s
* Preamble	Variable length string of all 1s or all 0s

5.2 Type I facsimile equipment.

5.2.1 Image parameters.

5.2.1.1 Tolerance. The tolerance for the image parameters listed in subparagraphs 5.2.1.2 and 5.2.1.3, shall be ±1 percent.

5.2.1.2 Scan line length. The scan line length shall be 215 millimeters (mm).

5.2.1.3 Resolution. The facsimile equipment shall implement the medium resolution. The low and high resolutions are optional. They are:

    a. Medium. 3.85 lines per mm (vertical) by 1728 black and white picture elements (pels) along the horizontal scan line. (Note: This is a nominal medium resolution of 100 by 200 lines per inch.)

    b. Low. 3.85 lines per mm (vertical) by 864 black and white pels along the horizontal scan line. (Note: This is a nominal low resolution of 100 by 100 lines per inch.)

    c. High. 7.7 lines per mm (vertical) by 1728 pels along the horizontal scan line. (Note: This is a nominal high resolution of 200 by 200 lines per inch.)

5.2.1.4 Scanning direction. Scanning direction shall be from left to right and from top to bottom.

5.2.1.5 Scanned line transmission time. The minimum scanned line transmission time shall be 20 milliseconds (msec).

5.2.1.6 Contrast levels. The contrast levels shall be black and white.

5.2.2 Document dimensions. Input of documents up to a maximum of 215 mm wide by 1000 mm long shall be accepted. Documents up to 230 mm wide may be accepted into the scanner, but only 215 mm of the document shall be scanned.

5.2.3 Image coding modes. The facsimile equipment shall implement the compressed mode and compressed with forward error correction mode. When
* NATO interoperability is required or severely degraded transmission
* conditions are expected, (worse than can be handled by Forward Error Correction (FEC)) the facsimile equipment shall also implement the
* uncompressed mode. (Simplified block diagrams reflecting the image coding
* modes are shown in appendix A.)

5.2.3.1 Uncompressed mode. In the uncompressed mode, facsimile data shall be transmitted pel by pel, with logic 1 representing black. Each line of the output data shall consist of a synchronization code followed by a

number of pels as specified in subparagraph 5.2.1.3. The synchronization code shall be a sequence of two S_0 code words.

5.2.3.2 <u>Compressed mode</u>. In the compressed mode, facsimile data shall be transmitted after compression by the redundancy reduction algorithm. A line of data shall be 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 shall alternate. All data lines shall begin with a white run-length code word to ensure that the receiver maintains color synchronization. A white run-length of zero shall be sent if the actual
* scan line begins with a black run. Black or white run-lengths, up to a maximum length of one scanning line (1728 pels), are defined by the code words in tables III and IV. The code words are of two types: terminating code words and make-up code words. Each run-length shall be represented by either one terminating code word, or one make-up code word followed by a terminating code word.

5.2.3.2.1 <u>Short runs</u>. Run-lengths in the range of 0 through 63 pels shall be encoded with the appropriate terminating code word. (Note: The black run-length code words and the white run-length code words are in separate lists.)

5.2.3.2.2 <u>Long runs</u>. Run-lengths in the range of 64 through 1728 pels shall be encoded first by the make-up code word representing the run-length which is equal to or shorter than that required. The make-up code word shall be followed by the terminating code word representing the difference between the required run-length and the run-length represented by the make-up code word.

5.2.3.2.3 <u>End of line (EOL)</u>. The EOL code word shall follow each line of facsimile data. (Note: This 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, the EOL code word shall also be sent prior to the first data line of a page.

5.2.3.2.4 <u>Fill</u>. Fill may be placed in the data flow to generate a pause. Fill may be inserted between a line of data and an EOL, but never within a line of data. Fill shall be added to ensure that the transmission time of each total coded scan line is not less than the minimum. To prevent premature disconnects, the maximum transmission time of any total coded scan line should be less than the interval specified in the loss of synchronization specifications. (Note: Fill format is a variable length string of 0s.)

5.2.3.2.5 <u>Return to control (RTC)</u>. A minimum of two contiguous RTC signals shall be sent to indicate the end of message transmission. (Note: Each RTC consists of six consecutive EOLs.) Following the RTC signals, the transmitter shall send the post-message commands.

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TABLE III. 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

Note: These codes are identical to those of CCITT Recommendation T.4 of the Red Book

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TABLE IV. 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: These codes are identical to those of CCITT Recommendation T.4 of the Red Book.

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5.2.3.3 <u>Compressed with forward error correction</u>. In the compressed with forward error correction mode, facsimile data shall be further processed by a channel coder and bit interleaving buffer to provide forward error correction. The channel coder shall use a Bose Chandhuri Hocquenghem (BCH) forward error correction code with the capability of correcting two errored
* bits per block. A BCH (63,51) code shall be used defined by the generator polynomial $G=X^{12}+X^{10}+X^{8}+X^{5}+X^{4}+X^{3}+1$. Table V lists the syndromes of the BCH code that shall be used.

5.2.3.3.1 <u>Encoder</u>. An encoder shall be provided in the facsimile transmitter to encode the facsimile data using the BCH code. For information on possible implementation of the encoder, see appendix A.

5.2.3.3.2 <u>Decoder</u>. A decoder shall be provided in the facsimile receiver to decode the received facsimile data. For information on possible implementation of the decoder, see appendix A.

5.2.3.3.3 <u>Interleaving buffer</u>. An interleaving buffer shall be used to improve the error correcting capability of the channel encoder, especially considering transmission bit errors clustered in bursts. The buffer shall be a matrix of 63 x 5 = 315 bits. Figure 1 shows the interleaving buffer configuration on the transmitting side. (Note: The figure labeling follows STANAG 5000 format, hence the long side of the matrix is designated N (N = 63) and the short side is designated W (W = 5).) Data input shall be line-by-line, data output shall be column-by-column. The data input sequence shall be

$$D_0, \ D_1, \ \ldots\ldots, \ D_{313}, \ D_{314}.$$

Accordingly, the data output sequence shall be:

$$D_0, \ D_{63}, \ D_{126}, \ D_{189}, \ D_{252}, \ D_1, \ D_{64}, \ \ldots, \ D_{188}, \ D_{251}, \ D_{314}.$$

At the receiving side, the data input and data output sequence shall be the reverse of the transmitting side (as shown in figure 2).

5.2.3.3.4 <u>Synchronization</u>. The transmitting BCH-encoder and interleaving buffer respectively shall be synchronized with the receiving BCH-decoder and interleaving buffer, before starting the transmission of encoded facsimile data. The FEC control block shall be the synchronization SOM sequence when the BCH-encoder and interleaving buffer are used. Figure 3 illustrates the format for the synchronization SOM sequence. The synchronization process shall be as follows:

a. The transmitter shall send the synchronization SOM sequence without using the BCH-encoder and interleaving buffer. Immediately after the synchronization SOM sequence, the transmitter uses the BCH-encoder and interleaving buffer to send encoded facsimile data.

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TABLE V. Syndromes of the BCH decoder.

|	r11	r10	r9	r8	r7	r6	r5	r4	r3	r2	r1	r0
R1	1	0	0	0	0	0	0	0	0	0	0	0
R2	1	1	0	0	0	0	0	0	0	0	0	0
R3	1	0	1	0	0	0	0	0	0	0	0	0
R4	1	0	0	1	0	0	0	0	0	0	0	0
R5	1	0	0	0	1	0	0	0	0	0	0	0
R6	1	0	0	0	0	1	0	0	0	0	0	0
R7	1	0	0	0	0	0	1	0	0	0	0	0
R8	1	0	0	0	0	0	0	1	0	0	0	0
R9	1	0	0	0	0	0	0	0	1	0	0	0
R10	1	0	0	0	0	0	0	0	0	1	0	0
R11	1	0	0	0	0	0	0	0	0	0	1	0
R12	1	0	0	0	0	0	0	0	0	0	0	1
R13	0	0	1	0	1	0	0	1	1	1	0	0
R14	1	1	0	1	0	1	0	0	1	1	1	0
R15	1	0	1	0	1	0	1	0	0	1	1	1
R16	0	0	1	1	1	1	0	0	1	1	1	1
R17	0	1	1	1	0	1	1	1	1	0	1	1
R18	0	1	0	1	0	0	1	0	0	0	0	1
R19	0	1	0	0	0	0	0	0	1	1	0	0
R20	1	1	1	0	0	0	0	0	0	1	1	0
R21	1	0	1	1	0	0	0	0	0	0	1	1
R22	0	0	1	1	0	0	0	1	1	1	0	1
R23	0	1	1	1	0	0	0	1	0	0	1	0
R24	1	1	1	1	1	0	0	0	1	0	0	1
R25	0	0	0	1	0	1	0	1	1	0	0	0
R26	1	1	0	0	1	0	1	0	1	1	0	0
R27	1	0	1	0	0	1	0	1	0	1	1	0
R28	1	0	0	1	0	0	1	0	1	0	1	1
R29	0	0	1	0	0	0	0	0	1	0	0	1
R30	0	1	1	1	1	0	0	1	1	0	0	0
R31	1	1	1	1	1	1	0	0	1	1	0	0
R32	1	0	1	1	1	1	1	0	0	1	1	0
R33	1	0	0	1	1	1	1	1	0	0	1	1
R34	0	0	1	0	0	1	1	0	0	1	0	1
R35	0	1	1	1	1	0	1	0	1	1	1	0
R36	1	1	1	1	1	1	0	1	0	1	1	1
R37	0	0	0	1	0	1	1	1	0	1	1	1
R38	0	1	1	0	0	0	1	0	0	1	1	1
R39	0	1	0	1	1	0	0	0	1	1	1	1
R40	0	1	0	0	0	1	0	1	1	0	1	1
R41	0	1	0	0	1	0	1	1	0	0	0	1
R42	0	1	0	0	1	1	0	0	0	1	0	0
R43	1	1	1	0	0	1	1	0	0	0	1	0
R44	1	0	1	1	0	0	1	1	0	0	0	1
R45	0	0	1	1	0	0	0	0	0	1	0	0
R46	1	1	0	1	1	0	0	0	0	0	1	0
R47	1	0	1	0	1	1	0	0	0	0	0	1
R48	0	0	1	1	1	1	1	1	1	1	0	0
R49	1	1	0	1	1	1	1	1	1	1	1	0
R50	1	0	1	0	1	1	1	1	1	1	1	1
R51	0	0	1	1	1	1	1	0	0	0	1	1
R52	0	1	1	1	0	1	1	0	1	1	0	1
R53	0	1	0	1	0	0	1	0	1	0	1	0
R54	1	1	1	0	1	0	0	1	0	1	0	1
R55	0	0	0	1	1	1	0	1	0	1	1	0
R56	1	1	0	0	1	1	1	0	1	0	1	1
R57	0	0	0	0	1	1	1	0	1	0	0	1
R58	0	1	1	0	1	1	1	0	1	0	0	0
R59	1	1	1	1	0	1	1	1	0	1	0	0
R60	1	0	1	1	1	0	1	1	1	0	1	0
R61	1	0	0	1	1	1	0	1	1	1	0	1
R62	0	0	1	0	0	1	1	1	0	0	1	0
R63	1	1	0	1	0	0	1	1	1	0	0	1

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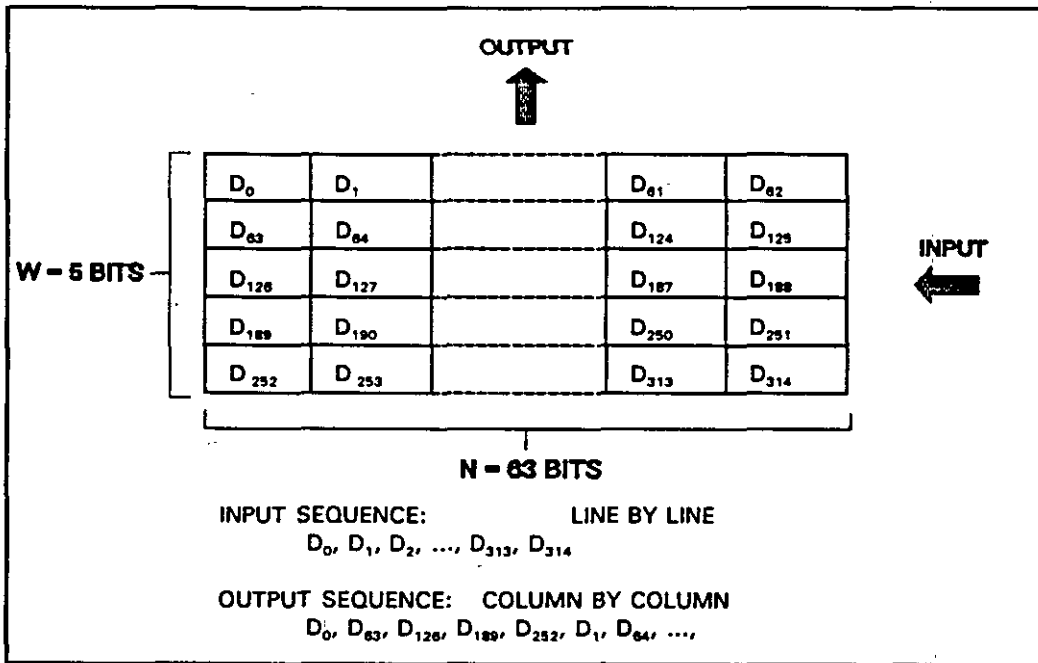
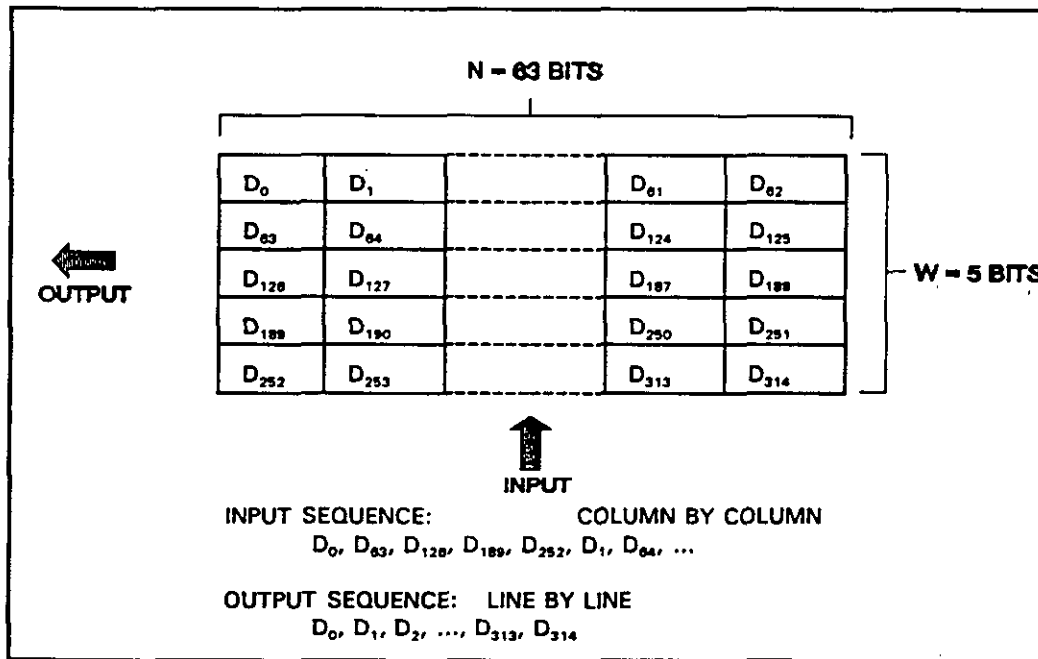MIL-STD-188-161C

FIGURE 1.   Interleaving buffer at the transmitter.

FIGURE 2.   Interleaving buffer at the receiver.
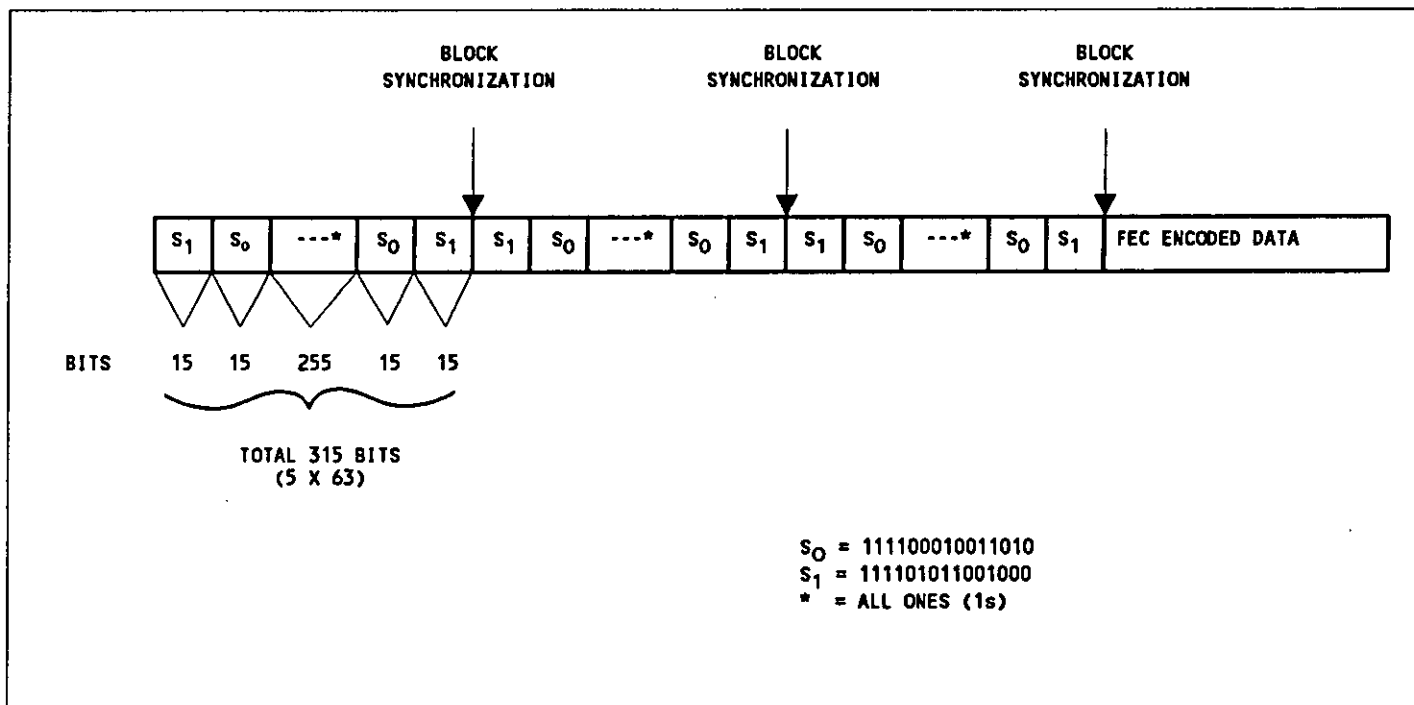
FIGURE 3. Synchronization SOM sequence for BCH coder and interleaver.

b.   At the receiver, the incoming signal shall be initially monitored bit-by-bit without using the BCH-decoder and interleaving buffer. When the first synchronization SOM sequence is detected, synchronization is achieved and, thereafter, the BCH-decoder and interleaving buffer shall be used. Block synchronization can be achieved at any of the three points illustrated in figure 3. After the detection of any block synchronization point, incoming data shall pass through the BCH-decoder/corrector and the interleaving buffer to the facsimile decoder.

5.2.4 Loss of synchronization. In the event of the loss of the synchronization signal, the receiver shall be capable of detecting loss of synchronization. At any time following detection of the first synchronization signal, the receiver shall declare a loss of synchronization if a line synchronization code or an EOM has not been detected within a time-out period. This period shall be sufficiently long to preclude false declaration of loss of synchronization. The signal indicating the loss shall be an "on" state, as defined by MIL-STD-188-114, applied to the loss of synchronization interchange circuit. In addition, criteria for declaring loss of synchronization, based on incorrectly decoded lines, may be applied. (Note: Implementation of this feature is a performance factor and does not bear directly on interoperability.)

5.2.5 Signaling protocols. Signaling protocol frames shall be used to coordinate message transmission. The parameters to be used for each transmission shall be signaled to the receiver using SOM frames and the termination of the facsimile transmission shall be signaled by an EOM sequence. The receive facsimile shall be able to detect and correct inverted data. (Note: The Type I and Type II protocol signals have been specifically designed to provide extremely high assurance of correct receiver operation (automatic start, mode setup, and automatic stop) in error environments as high as a 10^{-2} bit error ratio (BER). This means that a return acknowledgment is not necessary for the non-handshake mode.)

5.2.5.1 Protocol elements and frames.

5.2.5.1.1 Synchronization code words. Two special synchronization code words shall be used, in various combinations, to generate all protocol requirements. The code words are designated as S_0 and S_1. Each code word shall be made up of a 15-bit pseudorandom noise (PN) sequence as shown in
* table II. The composition of the protocol elements in terms of the synchronization code words shall be as shown in table VI. (Note: This lists the probability of detection, P_d, of each protocol element in a noise environment of 10^{-2} BER. All elements have detection probabilities in excess of 99.99 percent in this environment.)

(Note: If either of the PN sequences (code words) are compared, bit-by-bit, with any cyclical shift of the sequence, the number of agreements differs from the number of disagreements by one, except at the

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TABLE VI.   Protocol elements.

Protocol Element	Composition	P_d at 10^{-2} BER	Transmissions Required	Detections Required
SOM	S_1 S_0 X S_0 S_1	0.999945	3	1
EOM	S_1	0.99995	16 minimum	4 in sequence

autocorrelation peak where there are 15 agreements. Consequently, the correlation improvement for exact synchronization is 15 to 1 for noise-free operation, and is reduced by one for every bit perturbed by noise. A significant correlation improvement is achieved, even in extremely noisy environments.)

5.2.5.1.2 <u>Start of message (SOM)</u>. Each SOM frame shall consist of two pairs of synchronization code words, S_0 and S_1, separated by an interval measured in clock periods as shown in figure 4. The mode shall be indicated by the number of clock periods (X) between two pairs of code words. The data bit corresponding to each of these clock periods clock shall be logic 1. The binary value allocations for the command SOM frame shall be as shown in figure 4. The value of X to denote the interoperability modes and the corresponding eight-bit binary designators shall be as shown in table VII. The SOM frame shall be transmitted three times but detection by the receiver of any one frame shall be sufficient. Use of these signals is described in paragraph 5.2.5.2.

Note: The value of X can be calculated from the binary value allocations. For example, to obtain the X value corresponding to black and white operation, a resolution of 3.85 lines/mm times 1728 pels/scanline, and compressed mode, assemble the binary designator from the following binary value allocation:

00---001	black and white
00-01---	3.85 lines/mm x 1728 pels/scanline
000-----	compressed mode

* The binary designator 00001001 is then converted to its decimal equivalent, 9, to get the X value.

5.2.5.1.3 <u>End of message (EOM)</u>. The EOM frame shall consist of at least 16 S_1 code words transmitted in sequence. When four consecutive S_1 code words have been detected by the receiver, EOM shall be declared.

5.2.5.2 <u>Signaling sequence and timing</u>.

5.2.5.2.1 <u>Compressed, forward error correction (FEC) not used</u>. Figure 5 illustrates the signaling sequence for the compressed mode without forward error correction. At the start of a message transmission, a short pattern of data shall be sent for the purpose of establishing the data channel (modem training, encryption synchronization, etc.). No constraint shall be placed upon the duration of this phase, but the data transmitted shall conform with the definition of stuffing. With the data communication channel established, the signaling sequence shall begin with at least 16 inverted S_1 code words. (Note: This enables the receiver to correct a channel inversion.) Three command SOM frames with an appropriate X value shall be sent next, followed by three FEC control SOM frames with an X

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COMMAND SOM FRAME

S_1	S_0	X	S_0	S_1

X REPRESENTS THE NUMBER OF TRANSMITTED BITS DEFINED BY THE NUMERICAL VALUE OF THE BINARY WORD ASSEMBLED ACCORDING TO THE REQUIRED PARAMETERS:

MSB

7	6	5	4	3	2	1	0

7	6	5	4	3	2	1	0	
0	0				0	0	0	UNALLOCATED
0	0				0	0	1	BLACK/WHITE
0	0				0	1	0	4 SHADES OF GREY
0	0				0	1	1	8 SHADES OF GREY
0	0				1	0	0	16 SHADES OF GREY
0	0				1	0	1	UNALLOCATED
0	0					to		
0	0				1	1	1	UNALLOCATED
0	0		0	0				3.85 LINES/MM X 864 PELS/SCANLINE
0	0		0	1				3.85 LINES/MM X 1728 PELS/SCANLINE
0	0		1	0				7.7 LINES/MM X 1728 PELS/SCANLINE
0	0		1	1				UNALLOCATED
0	0	0						COMPRESSED
0	0	1						UNCOMPRESSED
1	1	1	1	1	1	1	1	FEC USED
1	1	1	1	1	1	1	0	FEC NOT USED

* FIGURE 4. Value allocations for the Type I and Type II command SOM frame.

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TABLE VII.   X values with corresponding binary designator.

COMMAND SOM FRAME PARAMETERS			NO. OF CLOCK PERIODS (X)	BINARY DESIGNATOR							
SHADES OF GRAY	RESOLUTION	COMPRESSION		7	6	5	4	3	2	1	0
BLK/WHT	3.85 x 864 (100 x 100)	C	1	0	0	0	0	0	0	0	1
4			2	0	0	0	0	0	0	1	0
8			3	0	0	0	0	0	0	1	1
16			4	0	0	0	0	0	1	0	0
BLK/WHT	3.85 x 1728 (100 x 200)		9	0	0	0	0	1	0	0	1
4			10	0	0	0	0	1	0	1	0
8			11	0	0	0	0	1	0	1	1
16			12	0	0	0	0	1	1	0	0
BLK/WHT	7.7 x 1728 (200 x 200)		17	0	0	0	1	0	0	0	1
4			18	0	0	0	1	0	0	1	0
8			19	0	0	0	1	0	0	1	1
16			20	0	0	0	1	0	1	0	0
BLK/WHT	3.85 x 864 (100 x 100)	U	33	0	0	1	0	0	0	0	1
4			34	0	0	1	0	0	0	1	0
8			35	0	0	1	0	0	0	1	1
16			36	0	0	1	0	0	1	0	0
BLK/WHT	3.85 x 1728 (100 x 200)		41	0	0	1	0	1	0	0	1
4			42	0	0	1	0	1	0	1	0
8			43	0	0	1	0	1	0	1	1
16			44	0	0	1	0	1	1	0	0
BLK/WHT	7.7 x 1728 (200 x 200)		49	0	0	1	1	0	0	0	1
4			50	0	0	1	1	0	0	1	0
8			51	0	0	1	1	0	0	1	1
16			52	0	0	1	1	0	1	0	0

FEC CONTROL SOM FRAME PARAMETERS	NO. OF CLOCK PERIODS (X)	BINARY DESIGNATOR							
		7	6	5	4	3	2	1	0
FEC USED	255	1	1	1	1	1	1	1	1
FEC NOT USED	254	1	1	1	1	1	1	1	0

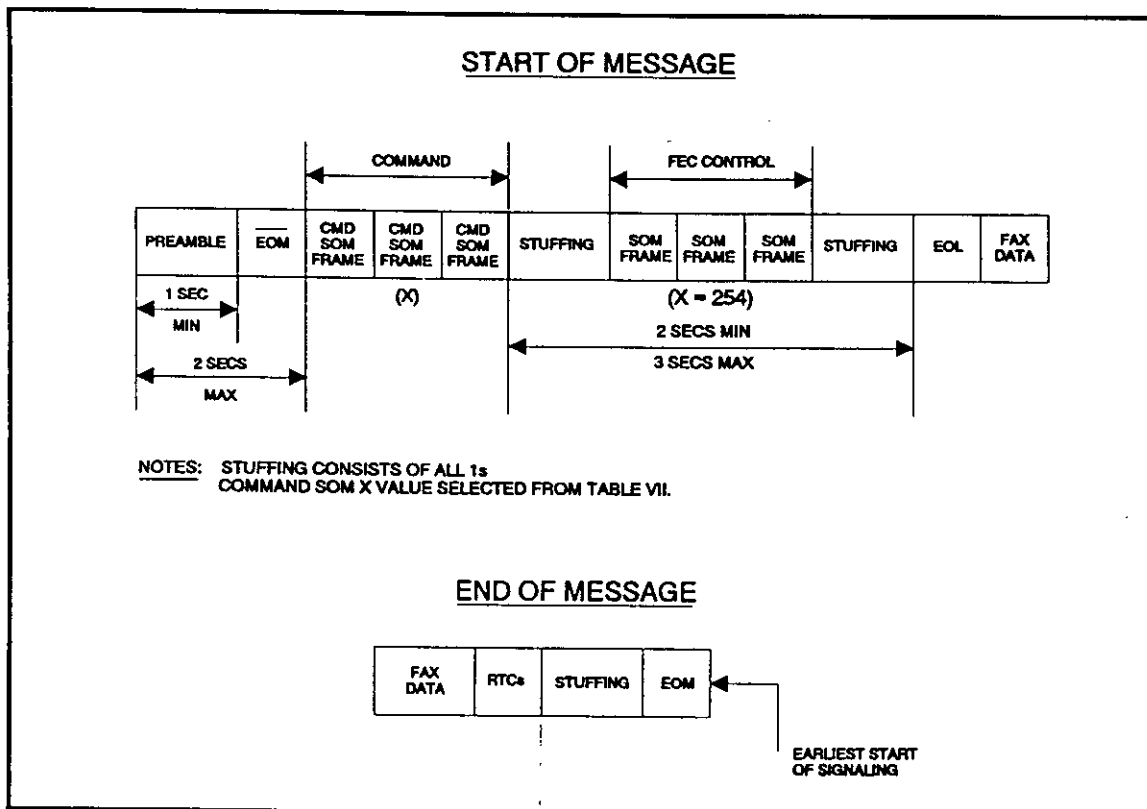| RESPONSE SOM FRAME PARAMETERS	NO. OF CLOCK PERIODS (X)	BINARY DESIGNATOR							
		7	6	5	4	3	2	1	0
ACK - EQUIPMENT READY TO RECEIVE	129	1	0	0	0	0	0	0	1
NAK - EQUIPMENT NOT READY	130	1	0	0	0	0	0	1	0
ILL - AN ILLEGAL SOM WAS RECEIVED	131	1	0	0	0	0	0	1	1

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FIGURE 5. Signal timing, compressed mode, FEC not used.

value of 254 signifying that FEC will not be used. Stuffing shall be
inserted as needed, before and after the FEC control SOM frames. The
facsimile data shall start with an EOL code word no less than two seconds
and no more than three seconds after the end of the third control SOM
frame. At the end of the message, the facsimile data stream shall end with
at least two contiguous RTC signals. Following RTC, an EOM shall signify
the end of the current transmission. Stuffing should be inserted as
required between RTC and EOM.

5.2.5.2.2 <u>Compressed, FEC used</u>. Figure 6 illustrates the signaling
sequence for the compressed mode with FEC. The data communications channel
* shall be established as described in paragraph 5.2.5.2.1. Inverted S_1 code
* words shall be sent as defined in paragraph 5.2.5.2.1. Three command SOM
* frames with an appropriate X value shall then be sent, followed by three
FEC control SOM frames with an X value of 255 to synchronize the FEC
system. The insertion and timing of the start of facsimile data shall be
as in paragraph 5.2.5.2.1. At the end of the message, the facsimile data
* shall end with at least two contiguous RTC signals. To allow freedom of
implementation, EOM shall be sent both before the end and after the end of
FEC coding. To ensure that the first EOM can be decoded correctly, the FEC
* block containing the final bit shall be transmitted in full. Stuffing bits
shall be inserted as required between RTC and EOM. The second EOM (outside
of FEC) shall not commence earlier than 500 msec after the end of the FEC
block containing the final bit of RTC. Further signaling may then commence
immediately after the second EOM.

5.2.5.2.3 <u>Uncompressed</u>. Figures 7 and 10 illustrate the signaling for the
uncompressed mode. The data communications channel shall be established as
described in paragraph 5.2.5.2.1 A minimum of sixteen inverted S_1 code
* words shall be sent followed by three command SOM frames with an
appropriate X value. Facsimile data shall follow no less than two seconds
and no more than three seconds after the end of the last command SOM. At
* the end of the message, the facsimile data stream shall end with a minimum
* of two seconds of S_1 code words. Further signaling may commence
immediately after the S_1 code words. Whenever the receiver does not detect
EOM within fifteen seconds after the last line synchronization code, the
receiver shall assume that the transmission has terminated and proceed as
if it had received an EOM.

5.2.5.3 <u>Handshake mode protocols</u>. This subparagraph provides the details
of the handshaking protocols needed for interoperation in the handshake
mode. Table VII shows the X value assignments for the handshake SOM (HSOM)
frame.

5.2.5.3.1 <u>Timing</u>. Timing in the handshake mode is more complicated
because the sending station shall interrupt transmission after sending the
command SOM frames to listen for an acknowledgment. The FEC control SOM
frames shall be sent after the receipt of acknowledgment. Figures 8 and 9
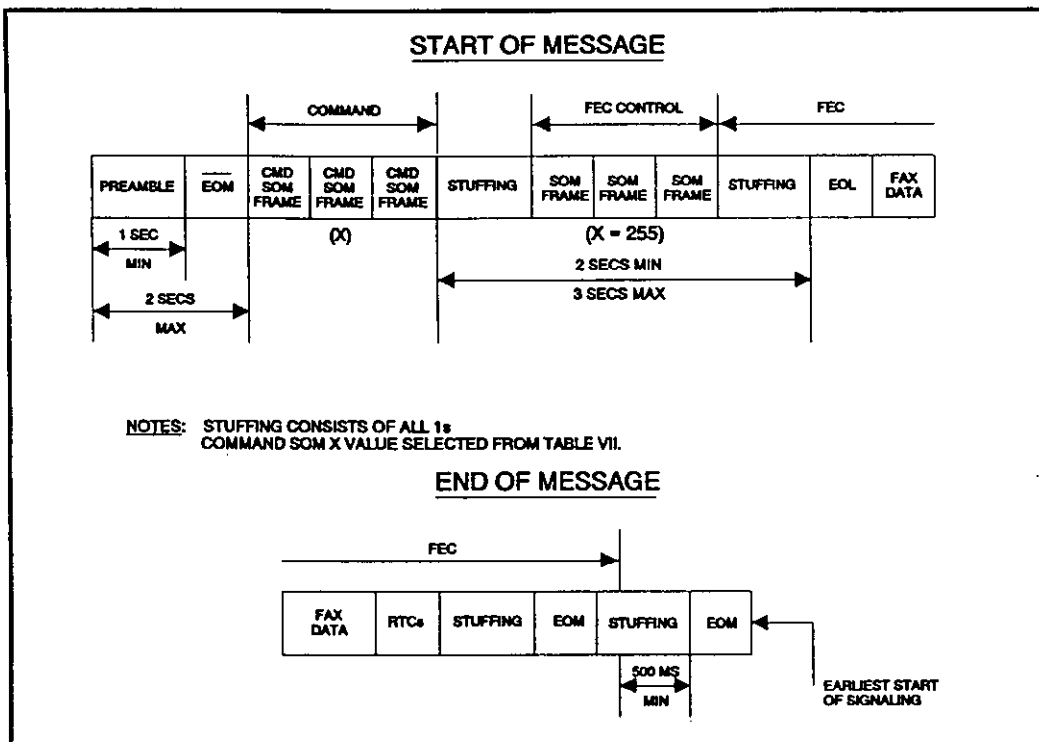
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FIGURE 6. Signal timing, compressed mode, FEC used.
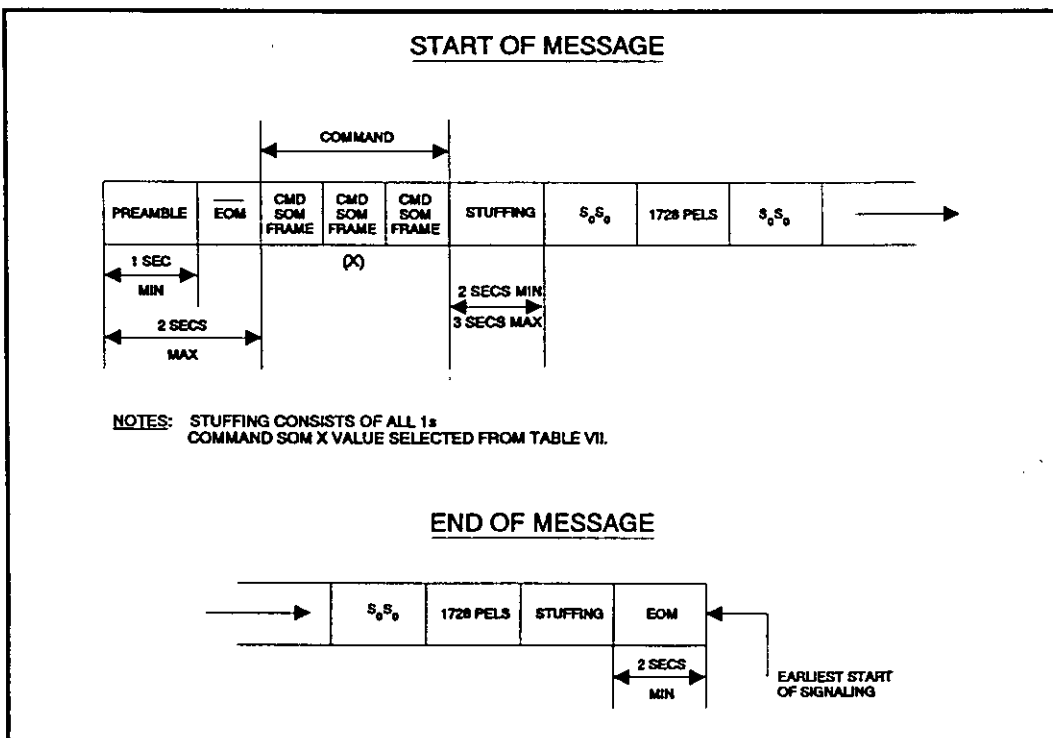

FIGURE 7. Signal timing, uncompressed mode.
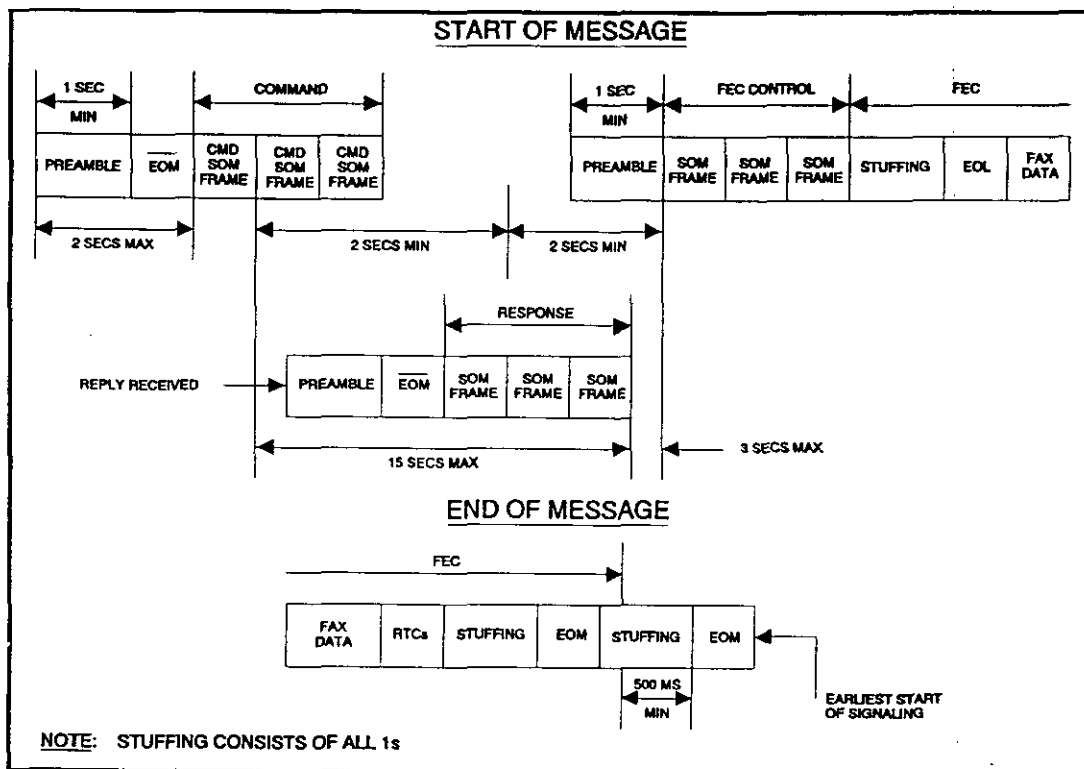
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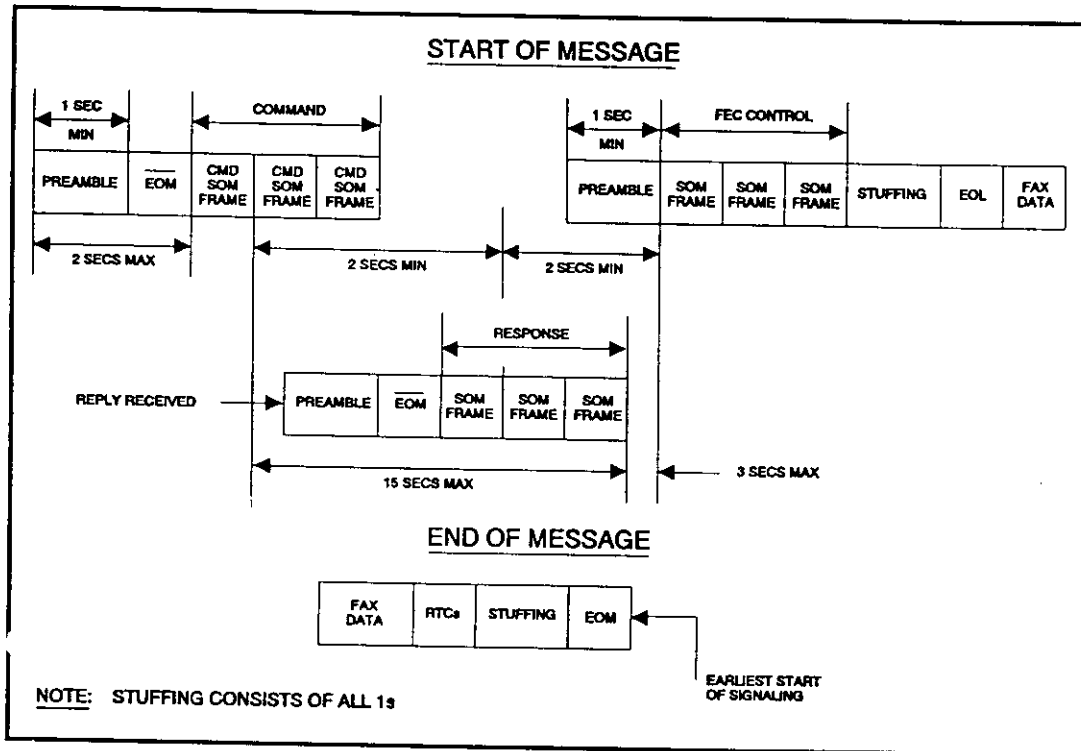FIGURE 8. Signal timing, handshake mode, FEC used.

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FIGURE 9. Signal timing, handshake mode, FEC not used.
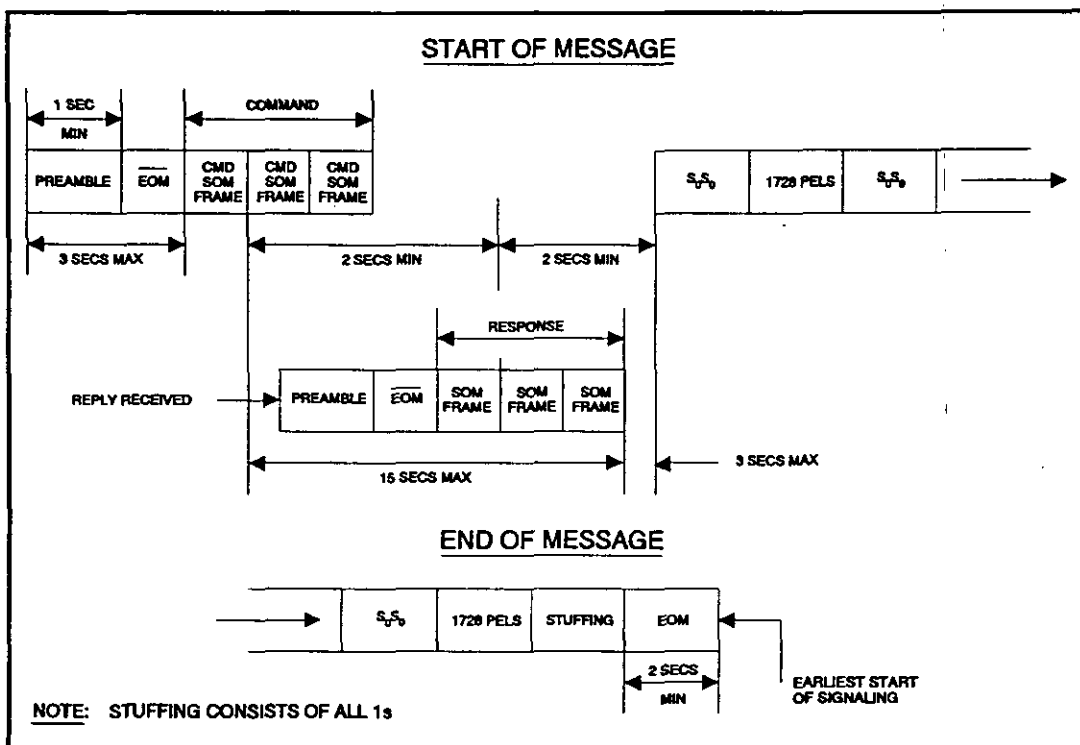
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FIGURE 10. Signal timing, handshake mode, uncompressed mode.

illustrate the timing required to transmit HSOM (with FEC enabled or disabled, respectively) when the receiving equipment's transmitter is in the standby mode. Figures 11 and 12 illustrate the timing required to insert the HSOM within a line of facsimile data when the receiving unit is also transmitting data.

5.2.5.3.2 Format. The signal format for the handshake mode shall be the same as described in subparagraph 5.2.5.2.1 up to the end of the third command SOM frame. At this point, the transmitter shall prepare to receive an acknowledgment. The signal format of the receiver response acknowledging HSOM shall be the same as the command SOM except for the X values defined in table VII. The binary value allocations for the response SOM frame shall be as shown in figure 13.

5.2.5.3.3 Acknowledgment. When satisfactory acknowledgment is received in a period extending from two to fifteen seconds from the end of the first command SOM frame, then the transmission of facsimile data, including the FEC control SOM frames, shall commence no less than two seconds after the detection of a response SOM frame or no more than three seconds from the last response SOM frame.

5.2.5.3.4 Response. When a response SOM frame is not received within the defined period (see subparagraph 5.2.5.3.3), or if a response SOM is received which is not a positive acknowledgment SOM, the equipment shall return to a mode in which it is ready to respond to command SOM frames. Similarly, if a facsimile line synchronization code has not been received within 15 seconds after transmitting the final response SOM frame, the receiver shall return to the mode where it can respond to command SOM frames.

5.2.5.3.5 End of message. The end of message signal format is the same as in subparagraph 5.2.5.1.3 or 5.2.3.2.5.

5.2.5.3.6 Full duplex. Full duplex operation is optional. When operating in full duplex and a transmission is being sent in the opposite direction, the response SOM shall be inserted in the data stream at the end of a line (or a line pair) of data prior to fill and the line synchronization code word.

5.2.5.4 Extended protocols. Some equipment may require additional protocols for the exchange of status and capabilities in excess of those covered by this standard. Bits 0, 1, and 2 of the Command SOM are reserved for Gray Scale Definition in those additional protocols. Bit 6 is "Ø" in all SOM frame designators defined herein. When set to "1" bit 6 will identify the use of an extended protocol involving the transmission of further SOM frames containing additional information. In all of these SOM frames, bit 6 will be set to "1." The precise code allocations for such a protocol are not at present a concern of this standard.

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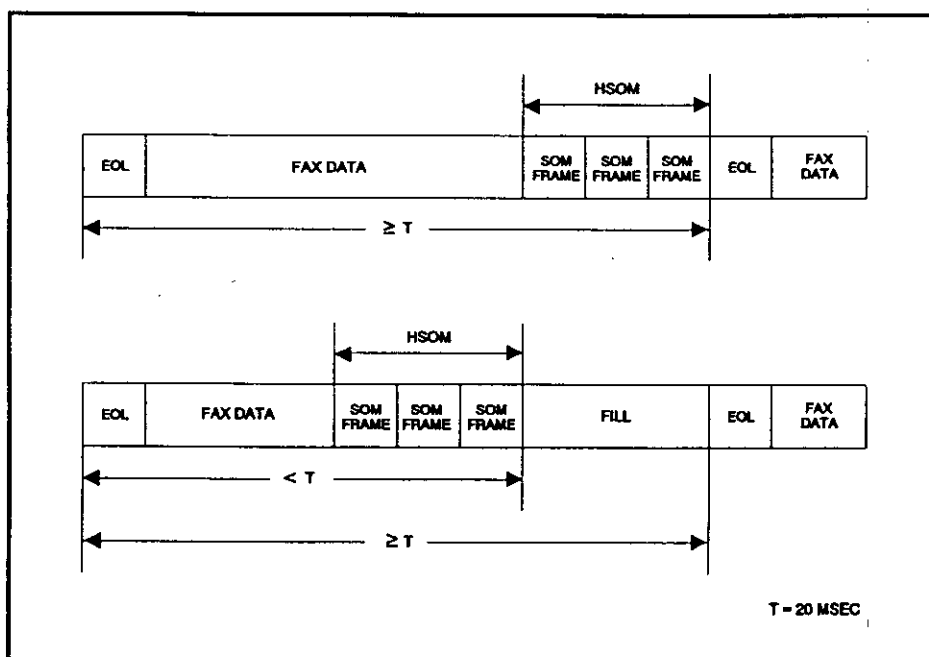
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FIGURE 11.   Transmission of the HSOM within a line of uncompressed data.
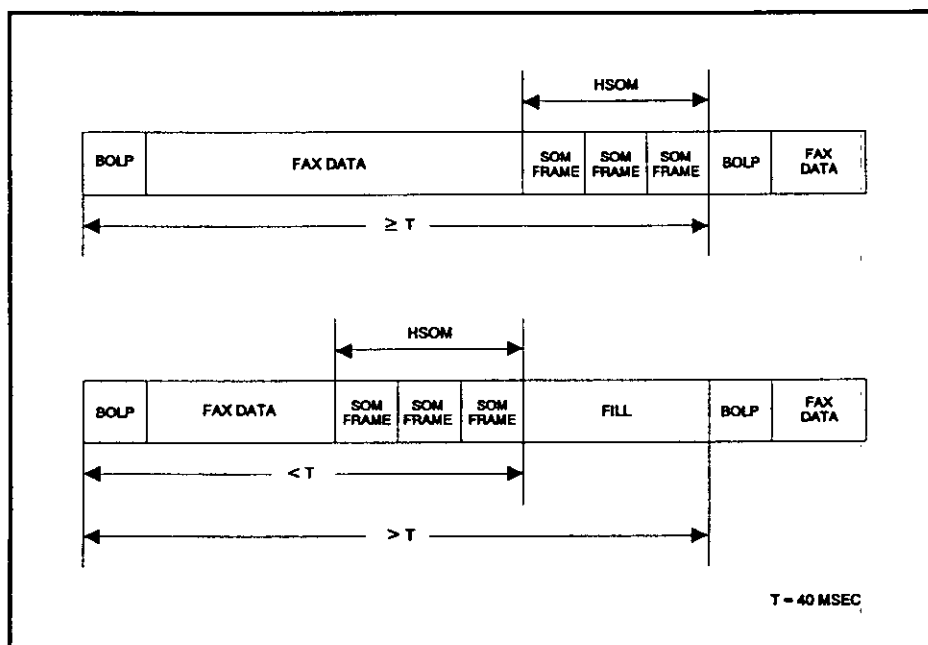
FIGURE 12.   Transmission of the HSOM within a line of
Gray scale compressed data.

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RESPONSE SOM FRAME

S₁	S₀	X	S₀	S₁

X REPRESENTS THE NUMBER OF
TRANSMITTED BITS DEFINED
BY THE NUMERICAL VALUE OF
THE BINARY WORD ASSEMBLED
ACCORDING TO THE REQUIRED
PARAMETERS:

MSB

7	6	5	4	3	2	1	0

7	6	5	4	3	2	1	0	
1	0	0	0	0	0	0	0	UNALLOCATED
1	0	0	0	0	0	0	1	ACK - EQUIPMENT IS READY TO RECEIVE
1	0	0	0	0	0	1	0	NAK - EQUIPMENT IS NOT READY
1	0	0	0	0	0	1	1	ILL - AN ILLEGAL SOM WAS RECEIVED
1	0	0	0	0	1	0	0	UNALLOCATED
				to				
1	0	1	1	1	1	1	1	UNALLOCATED

FIGURE 13. Value allocations for the response SOM frame.

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* 5.2.5.5 Inter-message timing. Further signaling may commence
* immediately after the final EOM (see figures 5, 6, 7, 8, 9, and 10 for the
* point marked "EARLIEST START OF SIGNALING"). The receiving facsimile shall
* be capable of accepting the preamble for the next message immediately after
* the final EOM.

* 5.2.5.6 Multi-page transmissions (optional capability). Multi-page
* transmissions shall be accomplished by repeating the single message
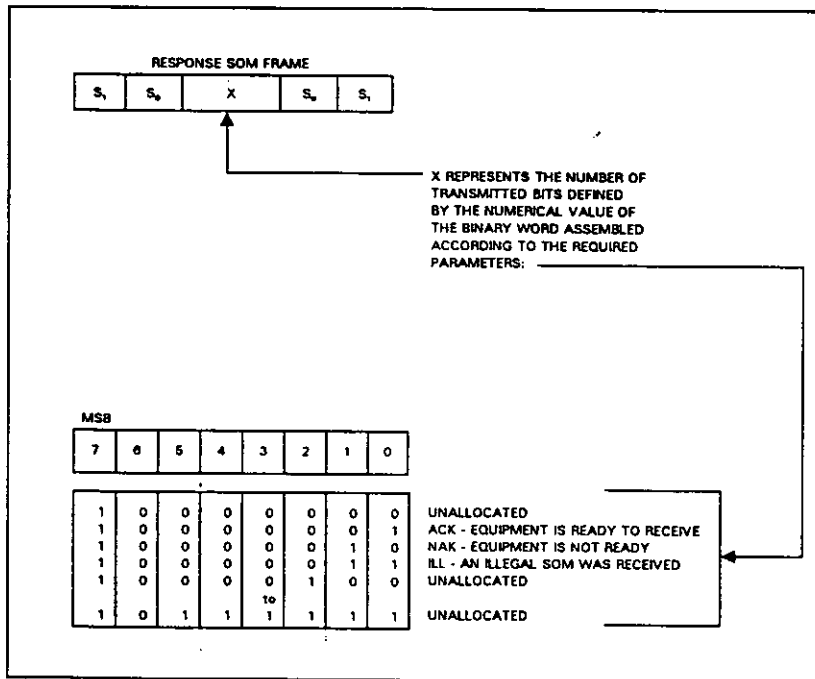* signaling sequence and timing to form a multi-message transmission.
* Facsimile equipment with multi-page capability shall maintain
* interoperability with Type I and Type II facsimile equipment defined by
* this standard. A multi-message transmission shall be terminated by
* timeout and, also, may be terminated by either end of transmission (EOT)
* signal or interface control signals or both. The transmitter shall not
* start the preamble and EOM of a new transmission until after 15 seconds
* from the last data line of the last message of a previous transmission.

* 5.2.5.6.1 Timeout. For a multi-message transmission, the facsimile shall
* send the next message's preamble and EOM within 12 seconds of the end of
* the previous message's final fax data line (see figures 14 and 15). If a
* subsequent message's preamble and EOM are received within 15 seconds of the
* receipt of the last data line of the previous message, then the subsequent
* message shall be considered another message of the previous transmission.
* Otherwise it shall be considered the first message of a new transmission.

* 5.2.5.6.2 End of transmission signal. A transmitter may signal the end of
* a multi-message or a single-message transmission by sending an EOT signal.
* An EOT shall consist of at least 16 S_o code words transmitted in sequence.
* When four consecutive S_o code words have been detected by the receiver, EOT
* may be declared. The final EOM and the EOT shall be separated by at least
* one second of stuffing (see figures 16 and 17).

* 5.2.5.6.3 Interface control signals. The end of a multi-message sequence
* may also be signaled by proper use of the interface control signals.

* 5.2.5.6.4 Polarity. The transmitter shall maintain the same data polarity
* throughout a multi-message transmission. The receiver should assume that
* the data polarity will not change within a multi-message transmission. The
* receiver shall assume that the polarity may change between the last message
* of one multi-message transmission and the first message of the next.

5.3 Type II facsimile equipment.

5.3.1 Image parameters. The image parameters listed in subparagraph 5.2.1
apply to the Type II facsimile equipment. The Type II facsimile equipment
shall implement the medium and high resolutions. The low resolution is
optional. The minimum transmission time of any scanned line pair shall be
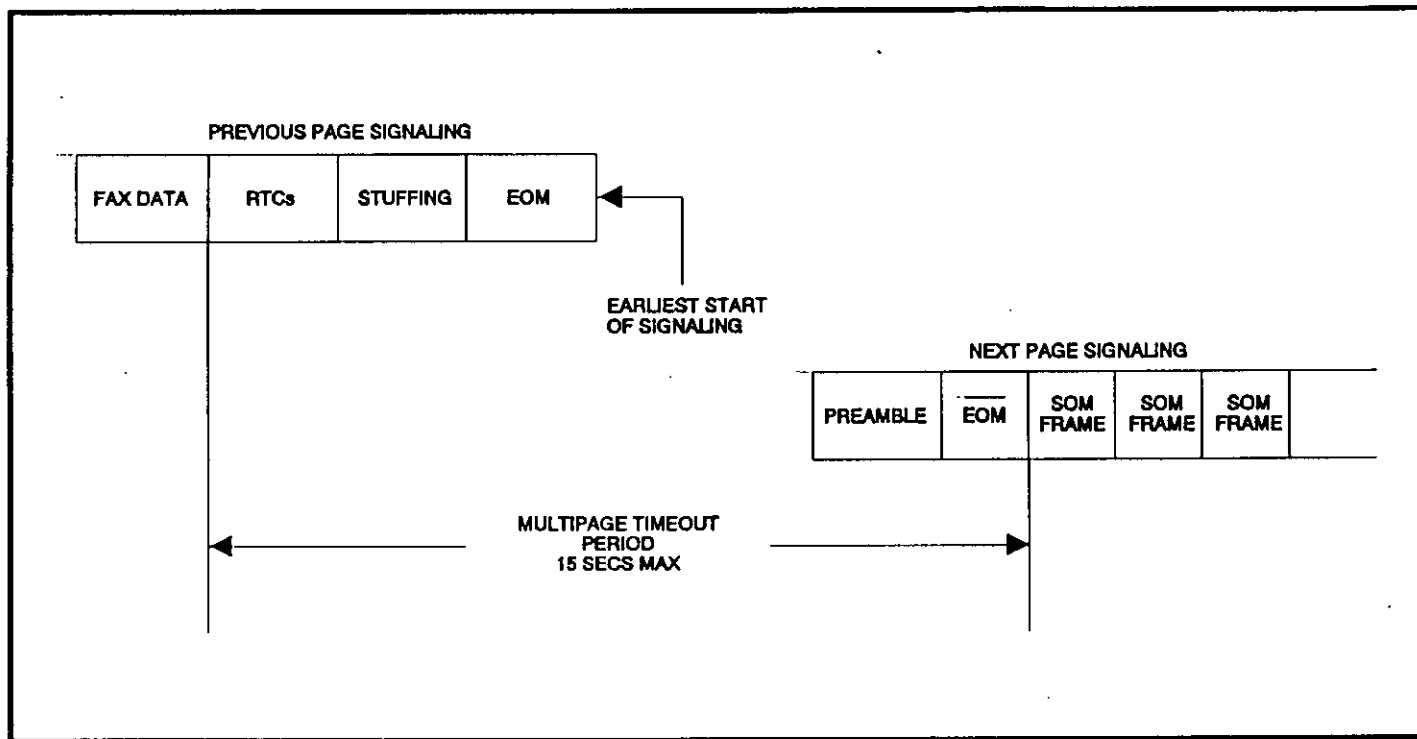
FIGURE 14. Signal timing for multiple page transmission (compressed and compressed with FEC).

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PREVIOUS PAGE SIGNALING

FAX DATA	STUFFING	EOM

EARLIEST START
OF SIGNALING

NEXT PAGE SIGNALING

PREAMBLE	EOM	SOM FRAME	SOM FRAME	SOM FRAME	

MULTIPAGE TIMEOUT
PERIOD
15 SECS MAX

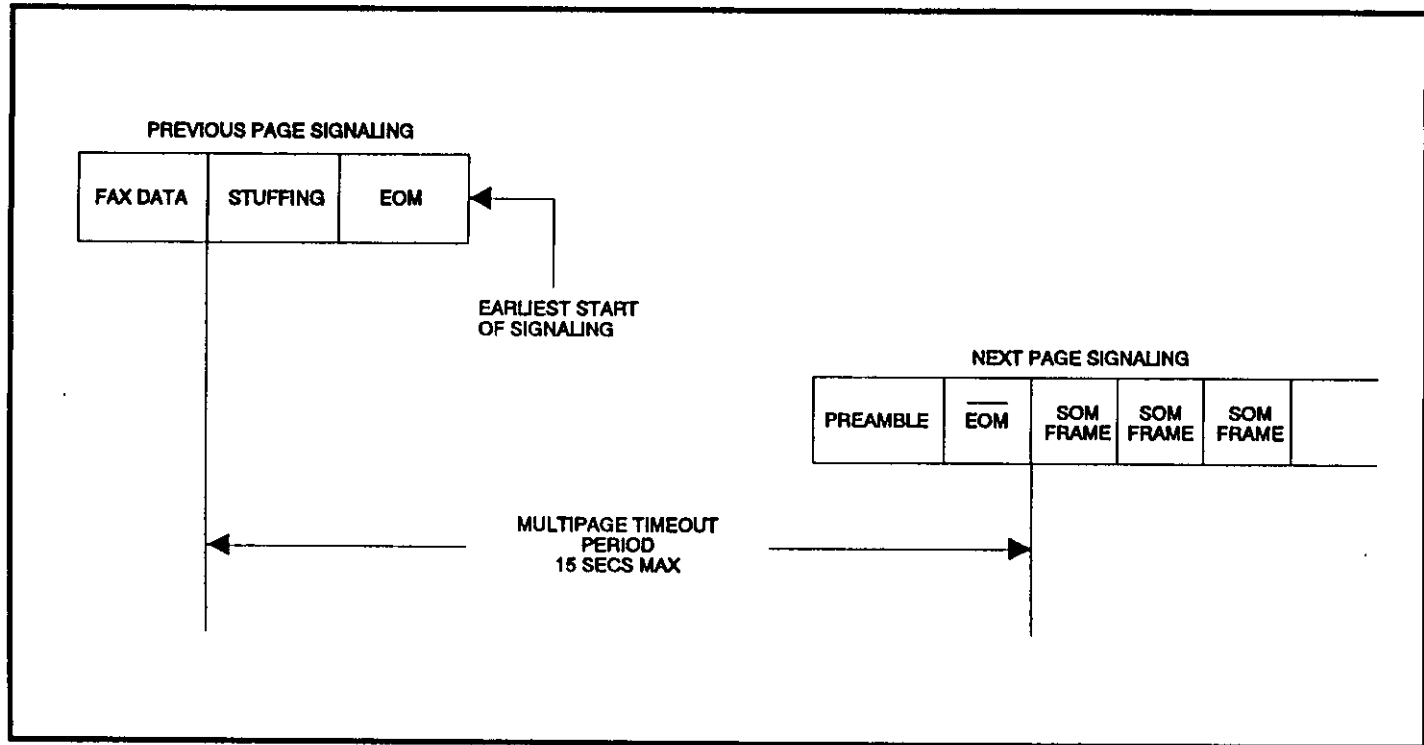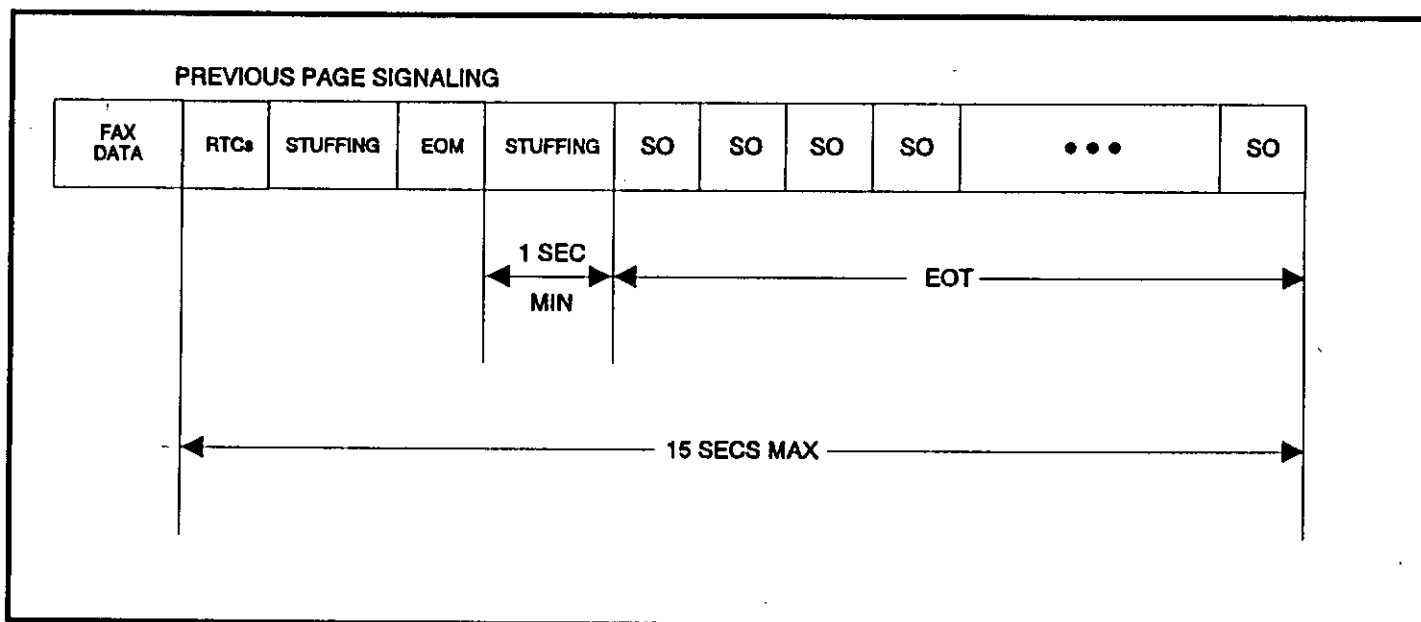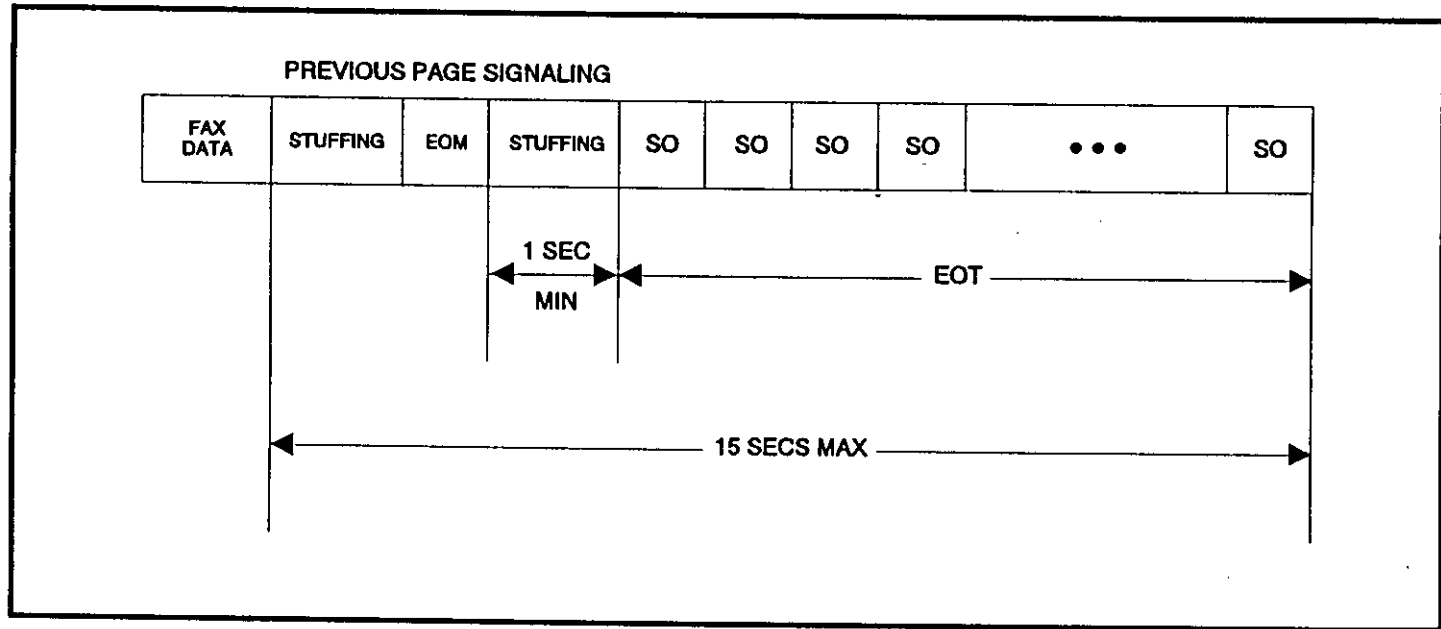FIGURE 15. Signal timing for multiple page transmission (uncompressed).

*FIGURE 16. Signal timing for End of Transmission (EOT) signal (compressed and compressed with FEC).

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PREVIOUS PAGE SIGNALING

| FAX DATA | STUFFING | EOM | STUFFING | SO | SO | SO | SO | • • • | SO |

1 SEC MIN

EOT

15 SECS MAX

*FIGURE 17. Signal timing for End of Transmission (EOT) signal (uncompressed).

40 msec for all compressed Gray scale modes; and 20 msec per line for all black and white, and uncompressed Gray scale modes.

5.3.2 Black and white operation. All Type II facsimile equipment shall be capable of being operated as Type I black and white facsimile equipment. All of the requirements of paragraph 5.2 shall apply.

5.3.3 Gray scale operation. In addition to black and white operation, Type II facsimile equipments shall be capable of transmitting and receiving in 4, 8, and 16 shades of gray. The scanned dynamic range (D_{max}/Step 16 to Paper White/Step 1) shall be selected and the linear distribution of steps between these two shall be determined by the fractional values of table VIII. The recorded dynamic range (D_{max}/Step 16 to Paper White/Step 1) shall be determined by the reprographic process capability. The distribution of steps over the dynamic range is determined by the fractional values of table VIII. Recorded gray shade values shall be in accordance with table IX. (Note: The separation of this specification for the scanner and recorder allows a different dynamic range capability for each.)

5.3.3.1 Gray-coding the Gray scale. Gray scale shall be processed by initial conversion of each picture element of the scanned signal to a four bit, Gray-code data unit (image data) representating one of the 16 shades of gray. A Gray-code in accordance with table IX shall be used so that a minimum number of transitions occur between adjacent gray levels. Gray-coding applies to all three image coding modes (uncompressed, compressed, and compressed with forward error correction).

5.3.3.2 Bit plane encoding the Gray scale. After Gray-coding, the data shall be processed as bit planes. The most significant bit (MSB) plane contains the MSB of each Gray-coded pel. Similarly, plane two shall contain the next most significant bit of each Gray-coded pel. (Note: Each plane, consisting of black and white pels, can be treated as a black and white image.) For 16 gray shades, the four bit planes shall be passed directly to the transmission process. For eight gray shades, bit plane four shall be discarded by discarding bit four and the remaining three bit codes representing eight gray shades shall be passed to the transmission process. Similarly, for four gray shades, plane three shall be discarded in addition to plane four. The remaining two bit codes represent four gray shades as shown in table IX.

5.3.3.3 Gray scale transmission. See appendix A for general information (including block diagrams) relating to the modular make-up of the facsimile transmitter and receiver. Three output modes shall be available:
(1) Uncompressed facsimile data with line synchronization codes added:
(2) Compressed facsimile data using a two-dimensional algorithm; and
(3) Compressed as in (2) with the addition of FEC using a BCH code and bit interleaving buffer. The scheme selected for a given transmission shall be

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TABLE VIII. Normalized Gray scale shades.

	STEP NUMBER	NORMALIZED DENSITY
PAPER WHITE	1	0.000
	2	0.067
	3	0.133
	4	0.200
	5	0.267
	6	0.333
	7	0.400
	8	0.467
	9	0.533
	10	0.600
	11	0.667
	12	0.733
	13	0.800
	14	0.867
	15	0.933
D MAXIMUM	16	1.000

TABLE IX. Gray-codes for 4, 8, and 16 gray shades.

16 SHADES		8 SHADES		4 SHADES	
STEPS	GRAY CODE	STEPS	GRAY CODE	STEPS	GRAY CODE
1	0000	1	000	1	00
2	0001				
3	0011				
4	0010	4	001		
5	0110				
6	0111	6	011	6	01
7	0101				
8	0100	8	010		
9	1100				
10	1101	10	110		
11	1111				
12	1110	12	111	12	11
13	1010				
14	1011	14	101		
15	1001				
16	1000	16	100	16	10

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signaled to the receiver. This signaling protocol shall be the same as covered in subparagraphs 5.2.5.2 and 5.2.5.3.

5.3.3.3.1 Uncompressed. Uncompressed facsimile data shall be transmitted pel-by-pel per bit plane, with logic 1 representing black. Each scan line of the output data shall consist of a synchronization code followed by 1728 pels of the MSB plane followed by the 1728 pels of the next MSB planes in order until all bit planes of the line have been transmitted. (Note: Each bit plane is made up of black and white pels. The first bit plane contains the most significant bits of each gray encoded pel, the second bit plane contains the second MSB of each gray encoded pel, and the following bit planes are made up in a corresponding manner.) The synchronization codes
* shall consist of a sequence of two code words designated S_0, and are identical to the codes utilized for Type I facsimile uncompressed transmission. See appendix A for examples of the format used to transmit facsimile data with multiple gray shades.

5.3.3.3.2 Compressed. Compressed facsimile data shall be transmitted after compression by using a two-dimensional procedure.
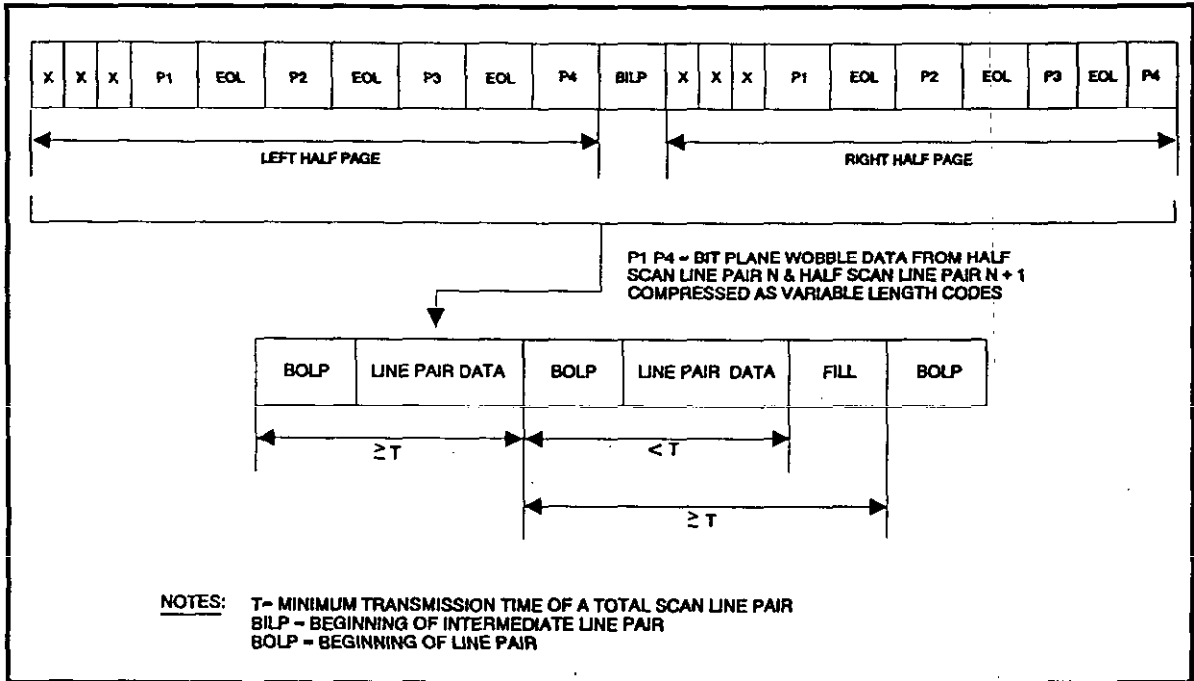
5.3.3.3.2.1 Compressed data format. A line pair of compressed data (shown in figure 18) shall be composed of a series of variable length code words forming the bit planes (designated P1 through P4) representing the first 864 picture elements of each of the two adjacent horizontal scan lines (1728 total), followed by the second 864 elements of the two adjacent horizontal scan lines. Each half line pair of the output data shall consist of the bit planes in order (MSB plane first), each bit plane separated by a synchronization code word, EOL (000000000001). (Note: It is a unique code word that can never be found within a valid line pair of data. Therefore, resynchronization after an error burst is possible.)

5.3.3.3.2.2 Scan line pair. Each half line pair of output data shall be preceded by a three bit auto resolution code word (see subparagraph 5.3.3.3.3). The relative placement of the BOLP and BILP code words, auto resolution signaling bits, encoded data, EOL, RTC, and fill shall be as
* illustrated in figures 18 and 19. (Note: Transmission of 16 gray shades is shown. For the transmission of fewer gray shades, the appropriate bit planes and preceding EOL are not present.)

5.3.3.3.2.3 Wobbled scan lines. The two adjacent scan lines of data shall be "wobbled" on a bit plane by bit plane basis prior to variable-length encoding, by combining the spatially related data bits per bit plane in a
* wobble fashion as illustrated in figure 20. (Note: L_{11}, L_{12}, L_{13}, etc., represent the sequentially scanned bits derived from line N; and L_{21}, L_{22}, L_{23}, etc., represent the sequentially scanned bits derived from line N+1. This produces a combined output of:

$$L_{11}, \ L_{21}, \ L_{22}, \ L_{12}, \ L_{13}, \ L_{23}, \ L_{24}, \ L_{14}, \ \text{etc.}$$

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X	X	X	P1	EOL	P2	EOL	P3	EOL	P4	BILP	X	X	X	P1	EOL	P2	EOL	P3	EOL	P4

LEFT HALF PAGE

RIGHT HALF PAGE

P1 P4 – BIT PLANE WOBBLE DATA FROM HALF
SCAN LINE PAIR N & HALF SCAN LINE PAIR N + 1
COMPRESSED AS VARIABLE LENGTH CODES

BOLP	LINE PAIR DATA	BOLP	LINE PAIR DATA	FILL	BOLP

$\geq T$

$< T$

$\geq T$

NOTES: T– MINIMUM TRANSMISSION TIME OF A TOTAL SCAN LINE PAIR
BILP – BEGINNING OF INTERMEDIATE LINE PAIR
BOLP – BEGINNING OF LINE PAIR

* FIGURE 18. Encoded scan line pair of 16 gray shades starting at
the beginning of a page

DATA	BOLP	DATA	RTC		RTC	POST-MESSAGE

MINIMUM

TWO RTCs
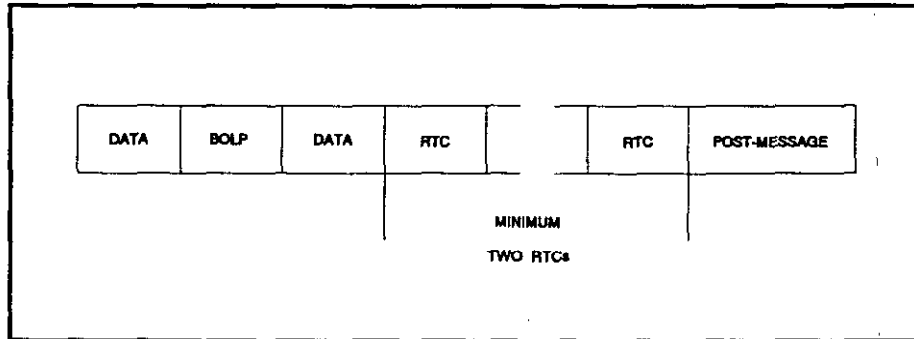
* FIGURE 19. Example of an encoded scan line pair showing the last
scan line pair of the last page of a message.

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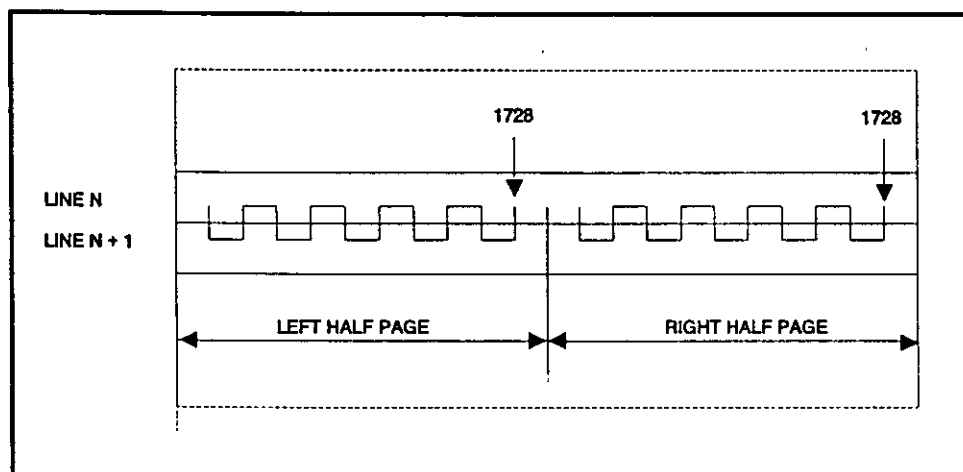
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*   FIGURE 20.   Bit plane wobble data format

The purpose of this wobble pattern is to take advantage of both horizontal and vertical correlations of adjacent pels. This leads to a higher compression than can be achieved when one scan line (thus one dimensional coding) is processed at a time).

5.3.3.3.2.4 <u>Variable length code words</u>. Each of the variable length code words shall represent a run-length of either all white or all black in a bit plane. White and black runs shall alternate. In order to ensure that the receiver maintains color (black and white) synchronization, each of the bit planes for each half of the data line pair shall begin with a white run-length code word. If an actual half data line of a bit plane begins with a black run, a white run-length of zero shall be sent first. Black or white run-lengths, up to a maximum length of one half scan line pair (1728 bits) shall be defined by the table III terminating codes and table IV make-up codes for each bit plane presentation of the image.

5.3.3.3.2.5 <u>Run-length representation</u>. Each run-length shall be represented by either one terminating code word, or one make-up code word followed by a terminating code word. (Note: Each bit plane represents a black and white image and four images comprise a total gray shade image.) Run-lengths in a range of 0 through 63 pels shall be encoded with their appropriate terminating code word. Run-lengths in the range of 64 through 1728 pels shall be encoded first by the make-up code word representing the run-length which is equal to or shorter than that required. This shall be followed by the terminating code word representing the difference between the required run-length and the run-length represented by the make-up code.

5.3.3.3.3 <u>Auto resolution</u>. Means shall be provided to implement a half (low) resolution function, on a selected bit plane basis to increase the achievable compression. (Note: This takes advantage of the fact that not all regions of a Gray scale image contain high resolution information. Lower order bit planes have little effect on the perceived resolution and, as a consequence, may be transmitted at a lower resolution in regions of slow intensity variations.) Bit-plane activity shall be determined and low resolution operation shall be automatically applied on a half scan line
* pair (bit plane) basis when the number of transitions of a given bit plane
* is less than 60. (Note: The number of transitions is not an issue of interoperability and a threshold of sixty is a suggested implementation
* number.) (Note: The total number of decoded pels for a line pair with
* auto resolution is 432 decoded pels before expanding for use by the
* recorder.)

5.3.3.3.3.1 <u>Auto resolution algorithm</u>. The auto resolution algorithm is illustrated in table X. When half resolution processing is applied, a majority logic decision shall take place for each bit-plane group of four bits (L_{11}, L_{12}, L_{13}, etc.) being read in prior to run-length encoding. The process shall create a single bit which represents the average of the four bits.

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5.3.3.3.3.2 <u>Transmitter</u>. The transmitter performs a majority logic decision such that if three or four bits are black, a black bit shall be substituted for the group of four. If zero, one, or two bits are black, a white bit shall be substituted for the group of four.

5.3.3.3.3.3 <u>Receiver</u>. The receiver shall expand each black data bit, or white data bit, received into four identical bits prior to processing the data stream for use by the recorder.

5.3.3.3.3.4 <u>Signaling the auto resolution mode</u>. Auto resolution processing shall be signaled to the receiving unit on a half scan line pair basis by preceding each half scan line pair, as shown in figure 14, with one of the three bit codes of table XI. If the first bit (as a consequence of majority logic decision) of a half scan line pair bit plane is black, a white run-length of zero shall be sent prior to the coded half line pair of bit plane data.

5.3.3.3.3.5 <u>Beginning of line pair (BOLP)</u>. The BOLP code word shall precede each line pair of coded data (see figure 12). (Note: This is a unique code word than can never be found within a valid half line pair of coded data. Therefore, resynchronization after an error burst is possible (BOLP = 00000000000000010).)

5.3.3.3.3.6 <u>Beginning of intermediate line pair (BILP)</u>. The BILP code word shall precede each (right half page) half line pair of data (see figure 18). (Note: This is a unique code word that can never be found within a valid half line pair of coded data. Therefore, resynchronization after an error burst is possible (BILP = 00000000000000011).)

5.3.3.3.3.7 <u>Fill</u>. A pause may be placed in the message flow by transmitting fill. Fill shall be inserted between a line pair of data and a BOLP but never within the bit planes. Fill shall be added to ensure that each line pair of data, fill, BOLP, and HSOM (when sent) exceeds the minimum transmission time of a total scan line pair. The minimum scan line transmission time shall be 40 msec for all compressed Gray-scale modes and 20 msec for all black/white and uncompressed Gray-scale modes (see figure 18). (Note: The maximum transmission time for a single line pair is bounded by the limits set for the loss of synchronization check. See subparagraph 5.3.4.)

5.3.3.3.3.8 <u>Return to control (RTC)</u>. The end of a message transmission shall be indicated by sending at least two RTC code words. Each RTC shall consist of six consecutive EOLs. Following the RTC signals, the transmitter shall send the post-message commands. (RTC = EOL code word 000000000001 repeated six times.)

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TABLE X.   Bit plane vs auto resolution function.

Bit Plane	Auto Resolution Algorithm		
	16 Gray Shades	8 Gray Shades	4 Gray Shades
1 (MSBP)	Not invoked	Not invoked	Not invoked
2	Automatic decision	Automatic decision	Automatic decision
3	Automatic decision	Automatic decision	Discard
4 (LSBP)	Low resolution	Discard	Discard
	Always invoked		

TABLE XI.   Auto resolution - signaling codes.

16 Gray Shades		8 Gray Shades		4 Gray Shades	
Code	Meaning	Code	Meaning	Code	Meaning
110	HHHL	110	HHH	---	---
100	HHLL	100	HHL	100	HH
000	HLLL	000	HLL	000	HL

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5.3.3.3.4 <u>Compressed with forward error correction (FEC)</u>. Since each bit plane of a Gray-scale image is in itself a black and white image, the requirements for channel coder and decoder, bit interleaving buffer, and synchronization techniques described in subparagraph 5.2.3.3 shall apply.

5.3.4 <u>Loss of facsimile synchronization</u>. The Type II facsimile shall be capable of detecting loss of synchronization. The technique used shall be the same as for Type I facsimile (see paragraph 5.2.4).

5.3.5 <u>Signaling protocols</u>. The protocol signal structure shall be identical to the protocol signal structure used for Type I facsimile equipment (see paragraph 5.2.5).

5.3.5.1 <u>Synchronization code words</u>. The synchronization code words to be used for Type II facsimile equipment shall be identical to the words used for Type I facsimile equipment (see subparagraph 5.2.5.1.1).

5.3.5.1.1 <u>Start of message (SOM)</u>. Each SOM frame shall consist of two pairs of synchronization code words $S_1 S_0$ and $S_0 S_1$, the pairs separated by
* several (X) clock periods as shown in figure 4. The mode shall be indicated by the number of clock periods (X) between the two pairs of synchronization code words. The values of X that shall be used are shown in Table VII. (Note: The polarity of the bits in the X interval is irrelevant as it is the count of clock intervals between pairs of synchronization code words which designates the mode.) The data bits transmitted in this interval shall be all 1s. The SOM frame shall be transmitted three times, but detecting any one frame at the receiver shall be sufficient. Uses of these signals are covered in subparagraph 5.2.5.2.

5.3.5.1.2 <u>End of message (EOM)</u>. EOM shall consist of at least 16 S_1 code words transmitted in sequence. When four consecutive S_1 code words have been detected at the receiver, EOM shall be declared. This procedure shall be identical to Type I facsimile equipment as covered in subparagraph 5.2.5.1.3.

5.3.5.2 <u>Signaling sequence and timing</u>. The signaling sequences and timing procedures for compressed mode, with and without FEC, and the uncompressed mode shall be identical to signaling sequences and timing procedures described in subparagraph 5.2.5.2.

5.3.5.3 <u>Handshake mode protocol</u>. The handshake mode protocol shall be identical to the protocol presented in subparagraph 5.2.5.3.

5.3.5.4 <u>Extended protocols</u>. See subparagraph 5.2.5.4 for methods that may be used when an exchange of status signal not covered in this standard needs to be implemented for Type II facsimile equipment.

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* 5.3.5.5 <u>Inter-message timing</u>. Inter-message timing shall be
* identical to that described in subparagraph 5.2.5.5.

* 5.3.5.6 <u>Multi-page transmissions (optional capability)</u>. Multi-page
* transmissions are accomplished as presented in subparagraph 5.2.5.6.

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6. NOTES

(This section contains information of a general or explanatory
nature that may be helpful, but is not mandatory.)

6.1 Subject term (key word) listing. The following key words and phrases
apply to MIL-STD-188-161:

bit plane
code word
compressed mode
facsimile synchronization
gray code
gray scale
Group 3 facsimile
handshake mode
image coding
military standard
non-handshake mode
scan line
signaling protocols
STANAG 5000
type I facsimile
type II facsimile
uncompressed mode
wobbled scan

6.2 International standardization agreement. Certain provisions of this
standard are the subject of international standardization agreement STANAG
5000. When change notice, revision, or cancellation of this standard is
proposed that will modify the international agreement concerned, the
preparing activity will take appropriate action through international
standardization channels, including departmental standardization offices,
to change the agreement or make other appropriate accommodations.

6.3 Changes from previous issue. The margins of this standard are marked
with asterisks to indicate where changes from the previous issue were made.
This was done as a convenience only and the Government assumes no liability
whatsoever for any inaccuracies in these notations. Bidders and
contractors are cautioned to evaluate the requirements of this document
based on the entire content irrespective of the marginal notations and
relationship to the last previous issue.

6.4 Facsimile equipment configurations. To ensure end-to-end DOD
* interoperability, this document mandates standards for Type I and/or
Type II (digital output), and CCITT Group 3 (analog output) facsimile
equipment. Although other facsimile equipment designs and configurations
* exist, such as CCITT Group 3 modified to have a non-standard digital

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* output, these nonstandard configurations are not recommended, and could
* cause interoperability problems.

6.5 <u>DOD/Industry coordination</u>. DOD coordinates its facsimile standards
* with the Telecommunications Industry Association's (TIA) TR-29 Facsimile
* Systems and Equipment Engineering Committee and its sub-committees. This
* is a cooperative effort between DOD and the industry/commercial standards
* organization. The TR-29 committee continues to study new facsimile
* features for recommended inclusion in this standard adopting commercial
* standards wherever feasible.

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APPENDIX A

SUGGESTED IMPLEMENTATIONS FOR
DIGITAL FACSIMILE

This appendix contains general information in
support of MIL-STD-188-161C. Appendix A is not
a mandatory part of this standard.

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APPENDIX

10   GENERAL

10.1   Scope. Tutorial information related to digital facsimile.

20   REFERENCE DOCUMENTS

STANAG 5000, Interoperability of Tactical Digital Facsimile Equipment.

30   DEFINITIONS

Not applicable.

40   GENERAL REQUIREMENTS

40.1   The facsimile shall be implemented with the latest technology that is available within reasonable cost and time constraints.

50   SPECIFIC REQUIREMENTS

50.1   Transmitter. The general make-up of the facsimile transmitter is shown in block diagram form in figure 1-A. Illustrated are the three outputs: lead A for the uncompressed mode, lead B for the compressed mode, and lead C for the compressed with forward error correction mode. These outputs are in agreement with the NATO needs as covered in STANAG 5000.

50.2   Receiver. The general make-up of the facsimile receiver is illustrated in block diagram form in figure 2-A. The uncompressed mode, compressed mode, and compressed with forward error correction mode are shown. The mode inputs are depicted by points A, B, and C, respectively.

50.3   Encoder. Figure 3-A illustrates an implementation of the BCH-encoder using a feedback-shift-register. The length of the feedback-shift-register is 12 bits according to the generator polynomial shown in the figure. During one cycle of 63 clocks, one block of data is sent at the output of the BCH-encoder. At the beginning of the cycle, the contents of the feedback-shift-register (r_0, ..., r_{11}) are equal to 0. Initially 51 information bits are transmitted from the data input to the output. At the same time, the information bits are running into the feedback loop of the shift register ($C_0 = 1$). After 51 clocks the contents of the feedback-shift-register (r_0, ..., r_{11}) are transmitted with 12 clocks $C_0 = 0$. These 12 bits are the check bits for the block of 63 data bits. After every cycle of 63 clocks, the contents of the feedback-shift-register
* should be zero (r, ..., $r_{11} = 0$). The next 51 information bits can then be encoded.

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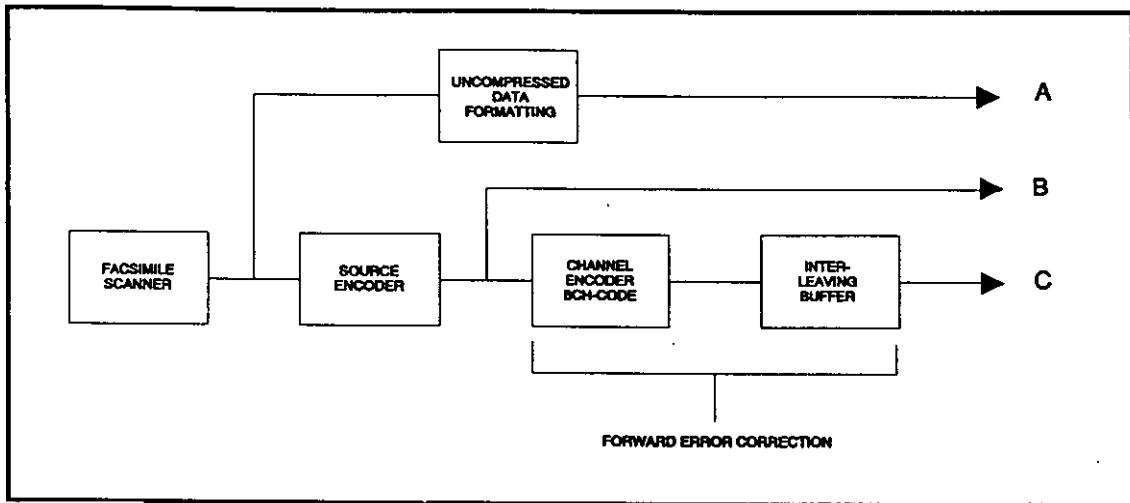**MIL-STD-188-161C**

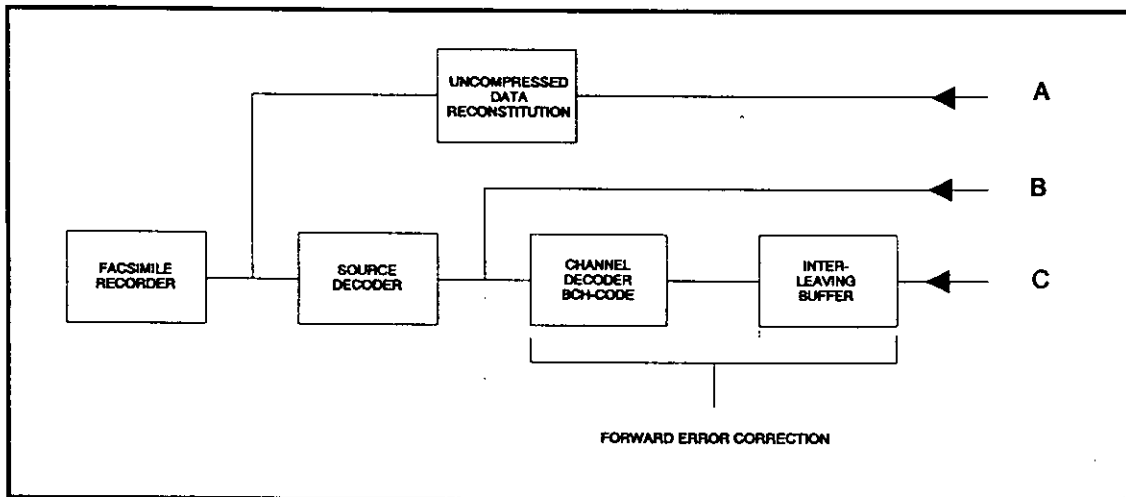**APPENDIX**

FIGURE 1-A.   Block diagram of the encoder.
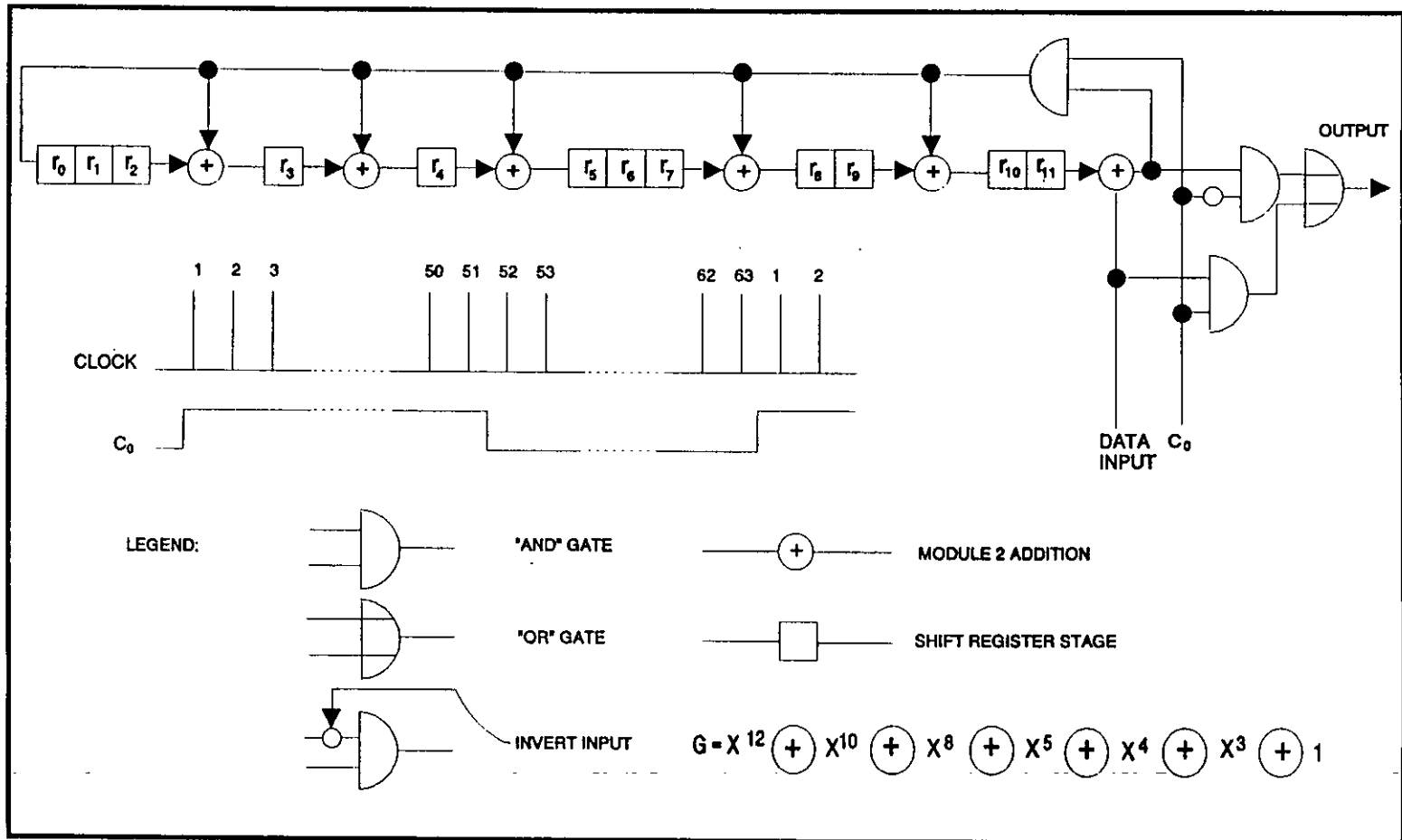

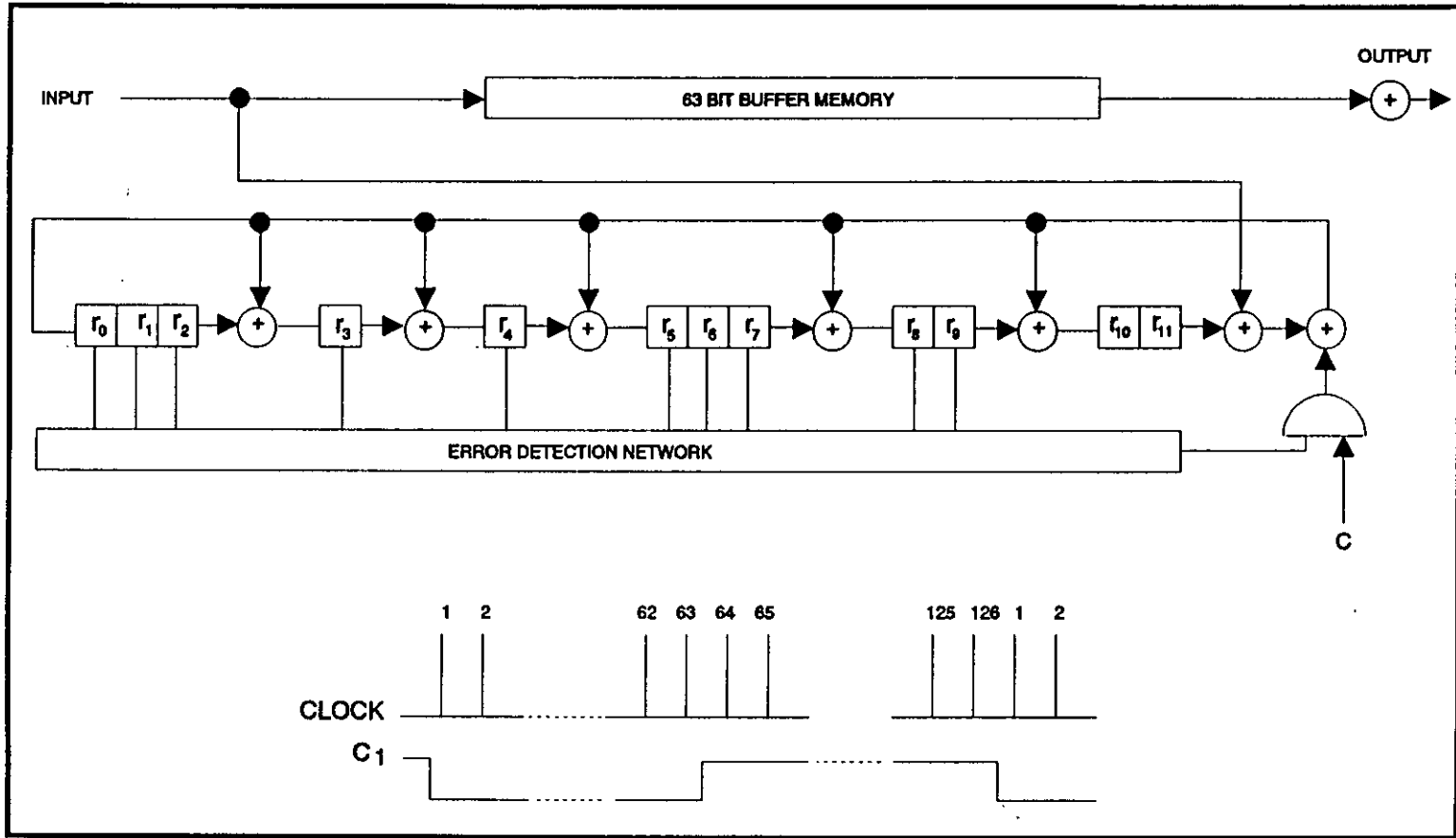FIGURE 2-A.   Block diagram of the decoder.

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FIGURE 3-A. Block diagram of the BCH encoder.

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FIGURE 4-A. Block diagram of a BCH decoder.

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50.4 <u>Decoder</u>. Figure 4-A illustrates an implementation of the BCH-
decoder. The BCH-decoder uses the same feedback-shift-register as the
BCH-encoder, plus a 63 bit buffer memory (shift register) and a network.
One complete decoding cycle consists of 126 clocks (2 X 63). At the
beginning of every cycle, the contents of the feedback-shift-register (r_0,
....., r_{11}) must be equal to 0. The clock appears at the same time to the
feedback-shift-register and the 63 bit buffer memory. During the first 63
clocks, the block of 63 data bits are written into the 63 bit buffer memory
and at the same time, run into the feedback loop of the shift-register
($C_1 = 0$). During the next 63 clocks ($C_1 = 1$) the transmission bit errors
are corrected, if there are any. The contents of the
feedback-shift-register (r_0, ..., r_{11}) are analyzed after every clock by
the error detection network. If the network detects any one of the 12 bit
patterns (syndromes) listed in table V (see subparagraph 5.2.3.3) as the
* contents of the feedback-shift-register, then the position of a
transmission bit error is found to be at the output of the 63 bit buffer
memory. At that time, the output of the network will correct the
transmission bit error by sending a 1 to the modulo 2-adder at the output
of the 63 bit buffer memory. Note that only the first 51 bits are
information bits. After every cycle of 126 clocks, the
feedback-shift-register must be reset to zero (r_0, ..., $r_{11} = 0$),   and
the next block of 63 data bits can be encoded.

50.4 <u>Scan line data format</u>. The scan line data format (code words plus
data) for 16 gray shades, in the uncompressed mode is:

	Plane 1	Plane 2	Plane 3	Plane 4
SO SO	1728 bits	1728 bits	1728 bits	1728 bits

The scan line data format for 8 gray shades (uncompressed) is:

	Plane 1	Plane 2	Plane 3
SO SO	1728 bits	1728 bits	1728 bits

The scan line data format for 4 gray shades (uncompressed) is:

	Plane 1	Plane 2
SO SO	1728 bits	1728 bits

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The general format for scan line data is a pair of SO code words followed by the number of bit planes needed to convey each Gray shade being used. Table 1-A presents examples of the information makeup of uncompressed, medium resolution scan line data.

TABLE 1-A. Examples of the information makeup for uncompressed, medium resolution scan line data.

Gray Shades	Bit Planes	Information Bits
16	4	4 x 1728 = 6912
8	3	3 x 1728 = 5184
4	2	2 x 1728 = 3456
Black/White	1	1 x 1728 = 1728

NOTE: For uncompressed facsimile data, the number of bits in a bit plane corresponds to the number of pels in the scan line.

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* APPENDIX B

TUTORIAL ON FACSIMILE CONFIGURATIONS

This appendix contains general information
in support of MIL-STD-188-161C. Appendix B
is not a mandatory part of this standard.

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* 10. <u>SCOPE</u>. Tutorial information related to configurations of facsimile
* equipment.

* 20. <u>APPLICABLE DOCUMENTS</u>. This section is not applicable to this
* appendix.

* 30. <u>DEFINITIONS</u>. This section is not applicable to this appendix.

* 40. <u>GENERAL INFORMATION ON CONFIGURATIONS</u>.

* 40.1 <u>Type I & Type II</u>. This digital facsimile equipment is suitable
* for operation over noisy communications links, e.g., tactical channels and
* poor quality outside the continental United States (OCONUS) Public Switched
* Telephone Networks (PSTNs). Type I and Type II equipment is used to
* provide interoperability with NATO allies, as specified in STANAG 5000.
* This equipment can operate over various digital interfaces such as crypto
* devices, including the Digital Secure Voice Terminal (DSVT) and the Secure
* Telephone Unit-Third Generation (STU III). CAUTION: Since STU III
* equipment is susceptible to analog to digital conversions and channel
* noise, limitations exist concerning its use over tactical networks.

* Type I facsimile equipment provides for the transmission and reception of
* bi-level (black and white) information such as text and graphs. As an
* option, photographs can be transmitted using electronic half tones.
* Electronic half tones have lower resolution than Type II Gray scale
* photographs.

* Type II facsimile equipment provides for the transmission and reception of
* multi-level (Gray scale) information (photographs), as well as bi-level
* information. In the black and white mode, this equipment interoperates
* with Type I equipment.

* 40.2 <u>CCITT Group 3</u>. Facsimile equipment providing for the transmission
* and reception of bi-level (black and white) information is defined in CCITT
* Recommendations T.4 and T.30, and in Federal Information Processing
* Standard (FIPS) 147 and 148. Internally, Group 3 facsimile equipment is
* digital, but provides only an analog output through a built-in modem for
* operation over Public Service Telephone Network (PSTN) circuits. Group 3
* equipment without an external interface as described in paragraph 40.3 is
* not intended for connection to STU III or other encryption equipment.

* 40.3 <u>CCITT Group 3 Interfaces for Digital Transmission</u>. DOD employed
* Group 3 facsimile equipment requiring a digital output shall, at a minimum,
* comply with Type I or Type II requirements. It is usually accomplished
* through an external interfacing controller (black box). The user's
* operational requirements determine if use of an external interfacing
* controller is acceptable.

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* 40.4 <u>CCITT Group 3, Modified</u>. This is the term commonly used when the
* modem in Group 3 facsimile equipment is by-passed and NON-STANDARDIZED
* protocols are used for digital interfacing. The most common application of
* such facsimile equipment is operation through the STU III data port.
* National Security Agency (NSA) approval of individual facsimile models for
* operation over STU III equipment does not indicate interoperability between
* the different models. These non-standard configurations are not
* recommended for new equipment, and could cause interoperability problems.
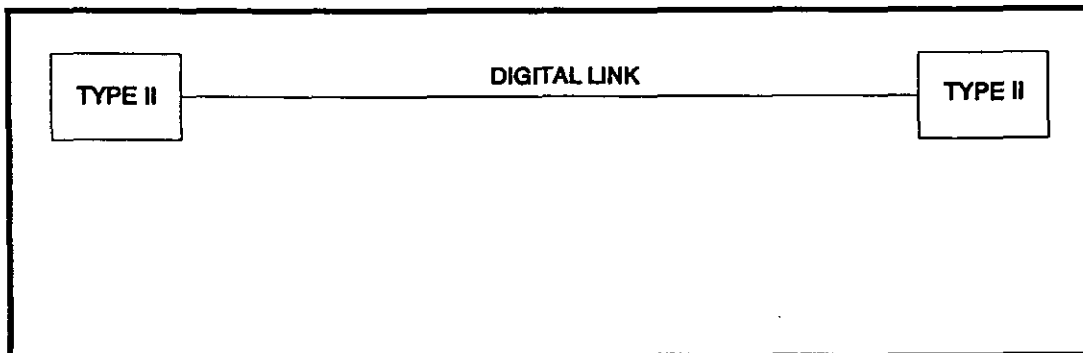
* 40.5 <u>CCITT Group 3 - 64 Kb/s for ISDN</u>. This is an enhancement to Group 3
* that is under development within CCITT. This mode will provide improved
* capabilities for operation over forthcoming digital networks such as
* Integrated Services Digital Network (ISDN). Upon completion of the new
* standard, the MIL-STD-188-161 Working Group will examine its adoption for
* DOD use.

* 40.6 <u>CCITT Group 4</u>. This is a standard developed for digital facsimile
* equipment for operation over digital networks. This equipment provides for
* the transmission and reception of bi-level (black and white) information
* and is defined in CCITT Recommendation T.503. With the introduction of the
* Group 3 for ISDN capability (which has many Group 4 capabilities), Group 4
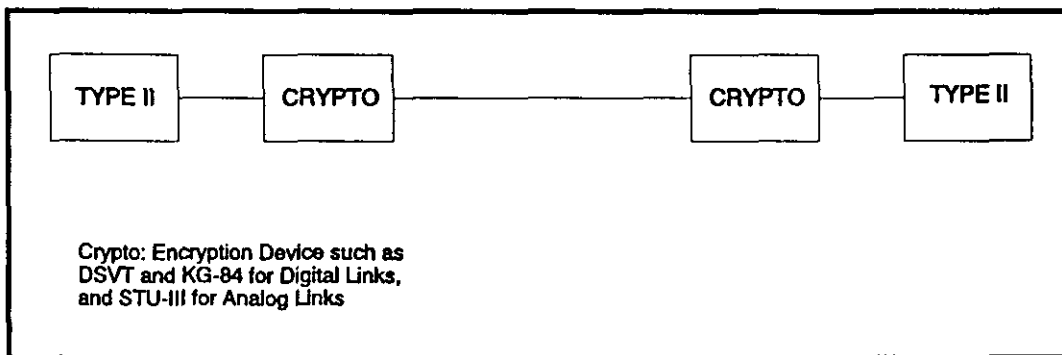* employment is expected to be limited.

* 40.7 <u>Interoperability of Facsimile Units</u>. Interoperable facsimile
* configurations are shown in figures 1-B through 5-B.
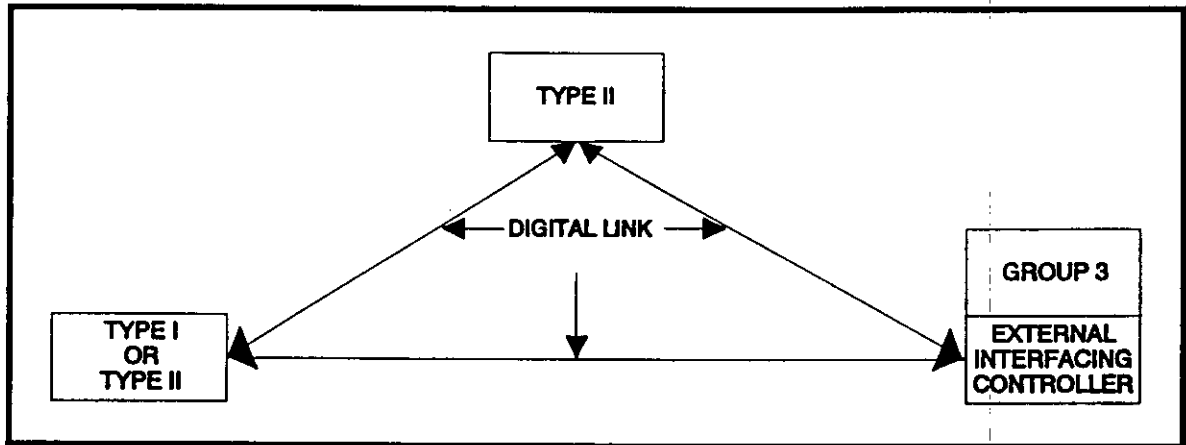
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┌─────────────────────────────────────────────────────────────────┐
│                                                                   │
│  ┌──────────┐          DIGITAL LINK              ┌──────────┐     │
│  │ TYPE II  │─────────────────────────────────── │ TYPE II  │     │
│  └──────────┘                                    └──────────┘     │
│                                                                   │
│                                                                   │
│                                                                   │
└─────────────────────────────────────────────────────────────────┘
```

* FIGURE 1-B.   Unencrypted multi-level digital configuration for photographs.

```
┌─────────────────────────────────────────────────────────────────┐
│                                                                   │
│ ┌────────┐   ┌────────┐              ┌────────┐   ┌────────┐      │
│ │TYPE II │───│ CRYPTO │──────────────│ CRYPTO │───│ TYPE II│      │
│ └────────┘   └────────┘              └────────┘   └────────┘      │
│                                                                   │
│  Crypto: Encryption Device such as                                │
│  DSVT and KG-84 for Digital Links,                                │
│  and STU-III for Analog Links                                     │
└─────────────────────────────────────────────────────────────────┘
```
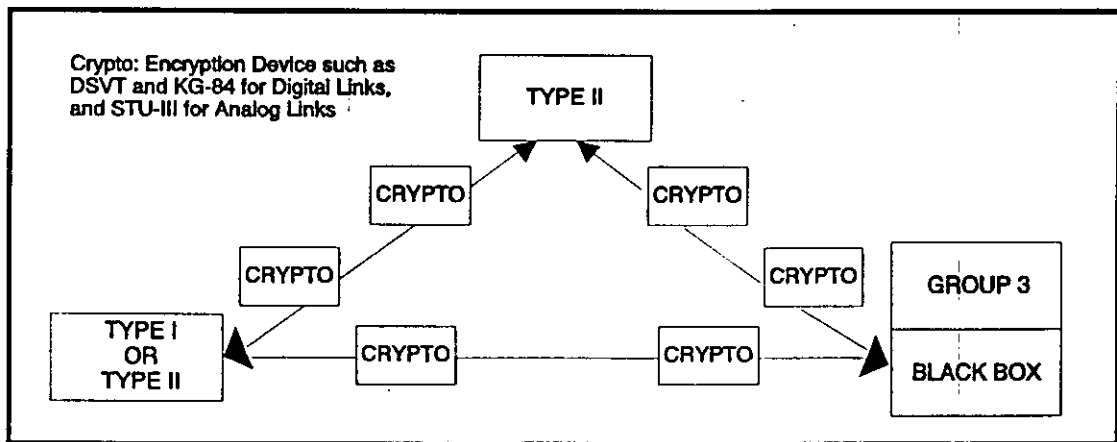
* FIGURE 2-B.   Encrypted multi-level digital configuration for photographs.
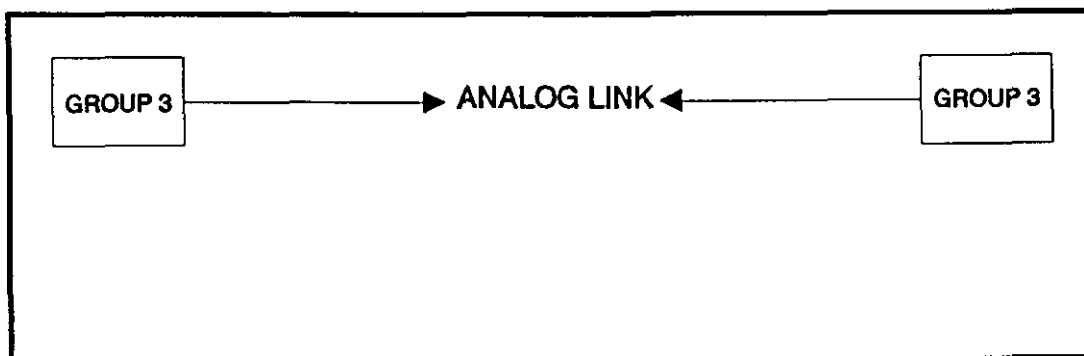
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* FIGURE 3-B. Unencrypted bi-level digital configuration for text, graphics, and photographs.

* FIGURE 4-B. Encrypted bi-level digital configuration for text, graphics, and photographs.

* FIGURE 5-B.   Unencrypted Group 3 configuration for text, graphics, and photographs.

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APPENDIX

Custodians:
Army - SC
Navy - EC
Air Force - 90
* DISA - DC
* NSA-NS

Review Activities:
Army - CR
Navy - OM, NOSC, MC
Air Force - 02
NCS - NCS

Other Interest:
Applicable International Organizations
North Atlantic Treaty Organization
* EIA/TIA

Preparing Activity
* JTC3A - DC

* (Project SLHC-1614)

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4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

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