MIL-STD-188-216
9 MARCH 1987
SUPERSEDING:
SEE FOREWORD

MILITARY STANDARD

INTEROPERABILITY STANDARDS FOR DATA ADAPTER CONTROL MODE

AMSC N/A

AREA TCTS

FORWARD

1. This military standard is approved and mandatory for use by all Departments and Agencies of the Department of Defense in accordance with OASD (C^3I) Memo; 16 Aug 1983, Subject: Mandatory Use of Military Telecommunications Standards in the MIL-STD-188 Series (see appendix A).

2. Beneficial comments (recommendations, additions, and deletions) and any pertinent data which may be of use in improving this document should be addressed to:

Director
Joint Tactical Command, Control, and Communications Agency
ATTN: C3A-IASO
OASDC3I, ASC
Washington, DC 20301-3160

by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. Originally, Military Standard (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).

4. The Defense Communications Agency (DCA) published DCA Circulars (DCAC) promulgating standards and engineering criteria applicable to the long haul Defense Communications System (DCS) and to the technical support of the National Military Command System (NMCS).

5. 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.

6. This document is the result of JCS action requiring that the technical characteristics of Data Adapter Control Mode procedures previously contained in various specifications be updated and published in the MIL-STD-188 series of standards.

7. The DACM was previously described in JTCO document TT-A3-9013-0048B.

8. This document supercedes paragraphs 3.2.2 through 3.2.4, 3.2.5, and 3.2.6, and Appendix I of the Joint Tactical Communications Office specification TT-A3-9013-0048B.

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1. SCOPE

1.1 Purpose. The purpose of this document is to establish technical standards and design objectives (DOs) that are necessary to ensure interoperability and to promote commonality for communications equipment and subsystems using data adapter control mode (DACM) procedures. Another purpose of this document is to establish acceptable overall system performance in order to satisfy diverse user requirements without the restrictions caused by interface incompatibility problems. Message formats specified for use by the DACM are defined in Allied Communications Procedures (ACP)-127, Communications Instructions Tape Relay Procedures; Defense Operating Instruction (DOI)-103, Defense Special Security Communications System (DSSCS) Operating Instructions (U) System/Data Procedures; and Joint Army Navy Allied Procedures (JANAP)-128, Automatic Digital Network (AUTODIN) Operating Procedures.

1.2 Scope. This document specifies the minimum requirements necessary to develop a Data Adapter Control Mode (DACM) protocol procedure. It is not the intent of this document to specify any particular hardware or software design or implementation.

1.3 Application. This document is applicable to the design and development of new equipment, assemblages, and systems using DACM. This document is applicable also to the engineering and operation of existing DACM systems. It is not intended that existing DACM systems be immediately converted to comply with the standards contained in this document. New DACM systems and those undergoing major modification or rehabilitation shall comply with the standards contained in this document subject to applicable requirements of current procurement regulations. DACM can be used over common long haul and tactical communications circuits. In this case, both this document and Military Standard (MIL-STD)-188-100 shall apply.

1.4 Objectives. The objectives of this document are to provide system performance requirements that ensure interoperation of equipment and systems consistent with military requirements; to achieve the necessary degree of performance and interoperation in the most economical way; and to prevent proliferation of equipment serving the same or a similar function. The variety of equipment shall be the minimum necessary to effectively support the missions of the tactical forces in accordance with Department of Defense Directive (DODD) 4630.5, Compatibility and Commonality of Equipment for Tactical Command, Control, and Communications. These objectives will be accomplished by continuing efforts in the following areas:

a. Standardizing user-to-user performance characteristics.

b. Standarizing the type of signals at various interface points in the applicable system.

c. Specifying maximum permissible degradation of a signal in the process of transmission and allocating the permissible degradation among various parts of a system.

d. Defining performance parameters without specifying the technology that should be used to obtain the required performance.

1.5 System standards and DOs. The parameters and other requirements specified in this document are mandatory system standards (see appendix A) if the word "shall" is used in connection with the parameter value or requirement under consideration. Non mandatory system parameters and DOs are indicated as optional by the word "should" in connection with the parameter value or requirement under consideration. For a definition of the terms "system standards" and "design objective," see federal standard (FED-STD)-1037, Glossary of Telecommunications Terms. Information paragraphs, shown as notes, have been included to better define certain methods currently in use with the DACM.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Standards. The following standards 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.

STANDARDS

FEDERAL

FED-STD-1037	Glossary of Telecommunication Terms

MILITARY

MIL-STD-188-116	Interoperability Standards for Information and Record Traffic Exchange

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard to the extent specified herein.

JANAP - 128	Automatic Digital Network (AUTODIN) Operating Procedures
DOI-103	Defense Special Security Communications System (DSSCS) Operating Instructions (U) System/Data Procedures
DCAC 370 - D175-1	DCS AUTODIN Interface and Control Criteria
ACP-117	Allied Routing Indicator Book
ACP-127	Communications Instructions Tape Relay Procedures

2.2 Order of precedence. In the event of a conflict between the text of this standard and the reference 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.

2.3 Source of documents.

2.3.1 Government specifications, standards, and handbooks. Copies of the referenced federal and military specifications, standards, and handbooks are available from the Department of Defense Single Stock Point, Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099. For specific acquisition functions, these documents should be obtained from the contracting activity or as directed by the contracting activity.

2.3.2 Other Government documents. Copies of other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.

3. DEFINITIONS

3.1 Definition of terms. Definitions of terms used in this document shall be specified in FED-STD-1037. Those definitions of terms unique to DACM and not defined in FED-STD-1037 are provided in the following subparagraphs.

3.1.1 Excessive unexpected characters. A situation where a data adapter/message switch (DA/MS) receives 170 or more contiguous characters that are not acceptable when received.

3.1.2 Glare. A situation where two DA/MSs try to initiate DACM signaling to each other at the same time.

3.1.3 Handback. The process of going from the traffic mode back to the DACM.

3.1.4 Handover. The process of going from DACM to the traffic mode.

3.1.5 Information rate. The minimum number of bits (1's and 0's) per unit of time, usually seconds, required to convey useful information (for example, 2400 bps).

3.1.6 Initiator. The party starting a procedure and leading in the steps of the procedure.

3.1.7 Loop rate. The rate at which bits are exchanged between a DA/MS and the transmission/cryptographic equipment.

3.1.8 Master-slave relationships. On circuit switched connnections, calling equals master, called equals slave. On dedicated connections, predefined data base parameters define the relationship. The master-slave relationship should not be confused with the initiator-responder relationship.

3.1.9 Message synchronization. Message synchronization is the process whereby the DA/MS sharing a connection cooperatively progresses from an unknown or ambiguous message state to a common known start-of-message state, i.e., to either sending the first block of a message or to expecting the next input block to be the first block of a message.

3.1.10 Responder. The party reacting to the start of a procedure and following in the execution of the procedure.

3.1.11 Traffic mode. The mode between DA/MSs in which message traffic (Modes I through VII) is sent.

3.2 Abbreviations and acronyms. Abbreviations and acronyms used in this document are as defined in FED-STD-1037. Those abbreviations and acronyms unique to this document and not defined in FED-STD-1037 are provided in Appendix B.

4. GENERAL REQUIREMENTS

4.1 Data adapter function. The data adapter control mode (DACM) was designed originally for operation over the TRI-TAC system. Figure 1 illustrates a typical circuit switch (CS)/message switch (MS)/data adapter (DA) connection which will use the DACM. Message switches are capable of operation with a DA on a dedicated or circuit switched basis.

4.1.1 DACM network parameters. Data access to a DA/MS shall be accommodated on a duplex digital basis at one of the standard loop and information rates as listed in table I. In addition the DACM shall:

a. Require a duplex circuit.

b. Operate at any information rate during transmission.

c. Initially operate at an information rate of 2400 bps.

4.1.2 Circuit establishment. The DACM should be used to set up circuit parameters. The circuit initialization DACM shall progress through the following five states.

a. Idle line.

b. Idle synchronization.

c. Idle rate DACM (at this time data adapter control blocks (DACBs) are transmitted).

d. Handover synchronization.

e. Traffic mode.

4.1.3 Parameter changes. The changing of circuit parameters shall progress through the following five states.

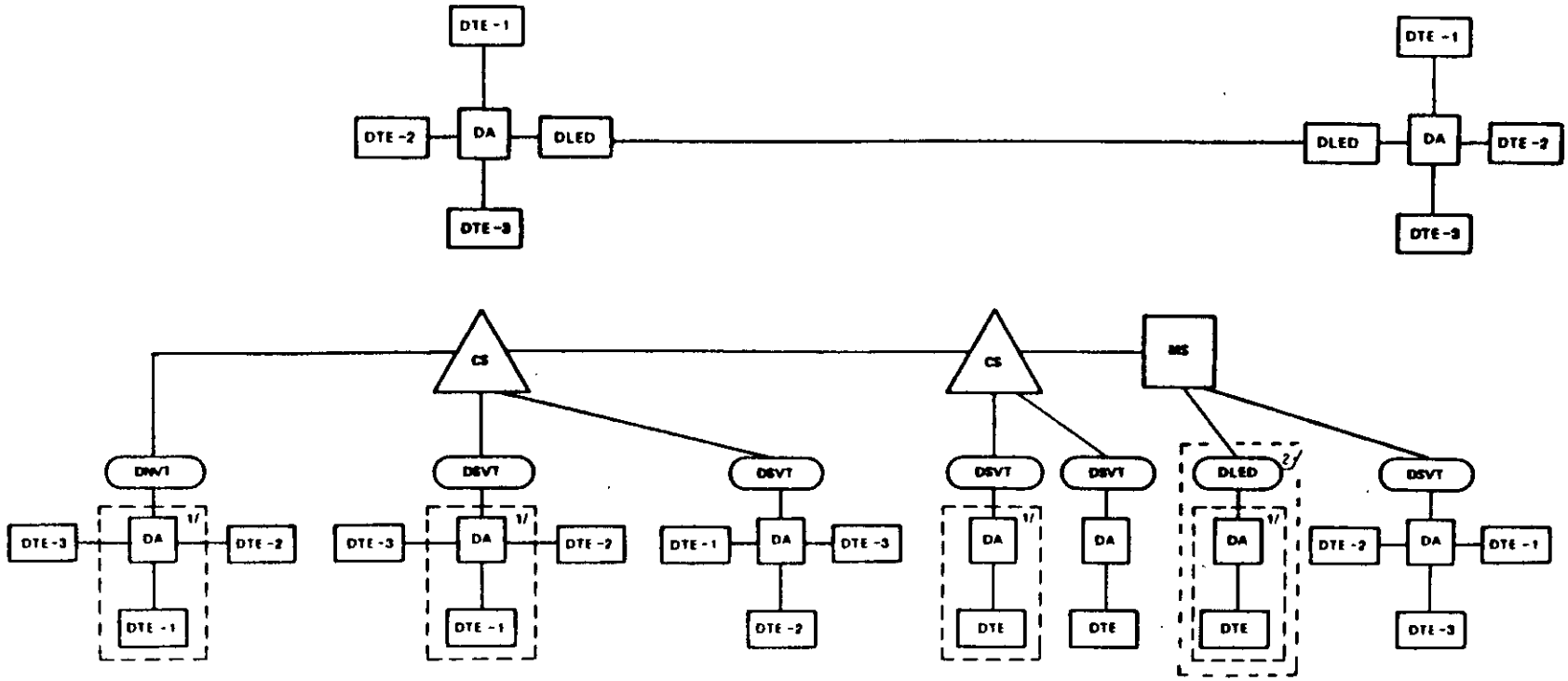
a. Traffic state.

b. Handback synchronization.

c. Message rate DACM (at this time DACBs are transmitted).

d. Handover synchronization.

e. Traffic mode.



NOTE 1/ Although the DA and DTE are shown as individual equipment, they may be combined in one unit.

Note 2/ Although the COMSEC is shown as a seperate function. the COMSEC may be an integral part of the DA/DTE.

FIGURE 1. Data transmission via point to point circuit switch and message switched circuits.

TABLE I. DTE to loop transformations.

INFO RATES (Baud)	LOOP RATES (bps)				
	2400	4800	9600	16000	32000
45.45	X	X	X	X	X
50	X	X	X	X	X
75	X	X	X	X	X
150	X	X	X	X	X
300	X	X	X	X	X
600	X	X	X	X	X
1200	X	X	X	X	X
2000			X	X	X
2400	X	X	X	X	X
4000				X	X
4800		X	X	X	X
8000				X	X
9600			X	X	X
16000				X	X
32000					X

4.2 Operation. The DACM is a duplex synchronous operation. The DACM consists of synchronization characters, control characters, and DACB characters. All characters of the DACM consist of eight bits (see table II).

4.2.1 Synchronization characters. There are two synchronization characters : DC4 and ESC. These characters have an even number of logical 1 bits per character (see table II).

4.2.2 Control characters. There are two sets of control sequences each consisting of four contiguous characters (see tables II and III). Each character of the four character sequence shall contain an even number of logical 1 bits. These sequences are:

a. WBT WBT 31 31.
b. ACK ACK 31 31.

4.2.3 Data adapter control block (DACB). The DACB consists of 37 characters (see figure 2). The DABC is composed of 5 framing and 32 identifier positions.

4.2.3.1 Framing characters. The five framing characters of the DACB are:

a. STX.
b. 31.
c. EM.
d. ETX.
e. BP.

With the exception of BP, all framing characters shall contain an even number of logical 1 bits. Because of the manner that BP is generated, BP may be any character composed of eight bits.

4.2.3.2 Identifier position. There are 42 identifier characters used in the 32 identifier character positions. Not all identifier characters are used in all positions. All identifier characters shall contain an odd number of logical 1 bits. Identifier characters which are not recognized as one of the assigned characters shall be treated as errors.

TABLE II. DACM 8 bit characters.

Bits b_8 b_7 b_6 b_5	Column →	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
		0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
		0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
		0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
b_4 b_3 b_2 b_1	Row ↓																
0 0 0 0	0									NUL			Ø		P		
0 0 0 1	1				1		Q				DC1			A			
0 0 1 0	2				2		R			STX 2/	DC2			B			
0 0 1 1	3	ETX 2/	DC3			C							3		S		
0 1 0 0	4		DC4 2/		4		T							D			
0 1 0 1	5					E				ENQ			5		U		
0 1 1 0	6	ACK 1/				F							6		V		
0 1 1 1	7	INV 2/			7		W							G			
1 0 0 0	8				8		X							H			
1 0 0 1	9					I					EM		9		Y		
1 0 1 0	10					J									Z		
1 0 1 1	11		ESC 3/											K			
1 1 0 0	12					L											
1 1 0 1	13													M			
1 1 1 0	14		WBT 1/											N			
1 1 1 1	15					0					31 2/1/						

NOTES:

Not used, available for future use

1/ Control character

2/ Frame character

3/ Synchronization character

TABLE III. DACB acknowledgment character sequences.

SEQUENCES	CHARACTER BIT POSITION			
	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1
ACK 31	31 1 0 0 1 1 1 1 1	31 1 0 0 1 1 1 1 1	ACK 0 0 0 0 1 1 0	ACK 0 0 0 0 0 1 1 0
WBT 31	31 1 0 0 1 1 1 1 1	31 1 0 0 1 1 1 1 1	WBT 0 0 0 1 1 1 1 0	WBT 0 0 0 1 1 1 1 0

Notes: Bit 1 is LSB
LSB transmitted first
Bits transmitted from right to left.
Characters transmitted from right to left.

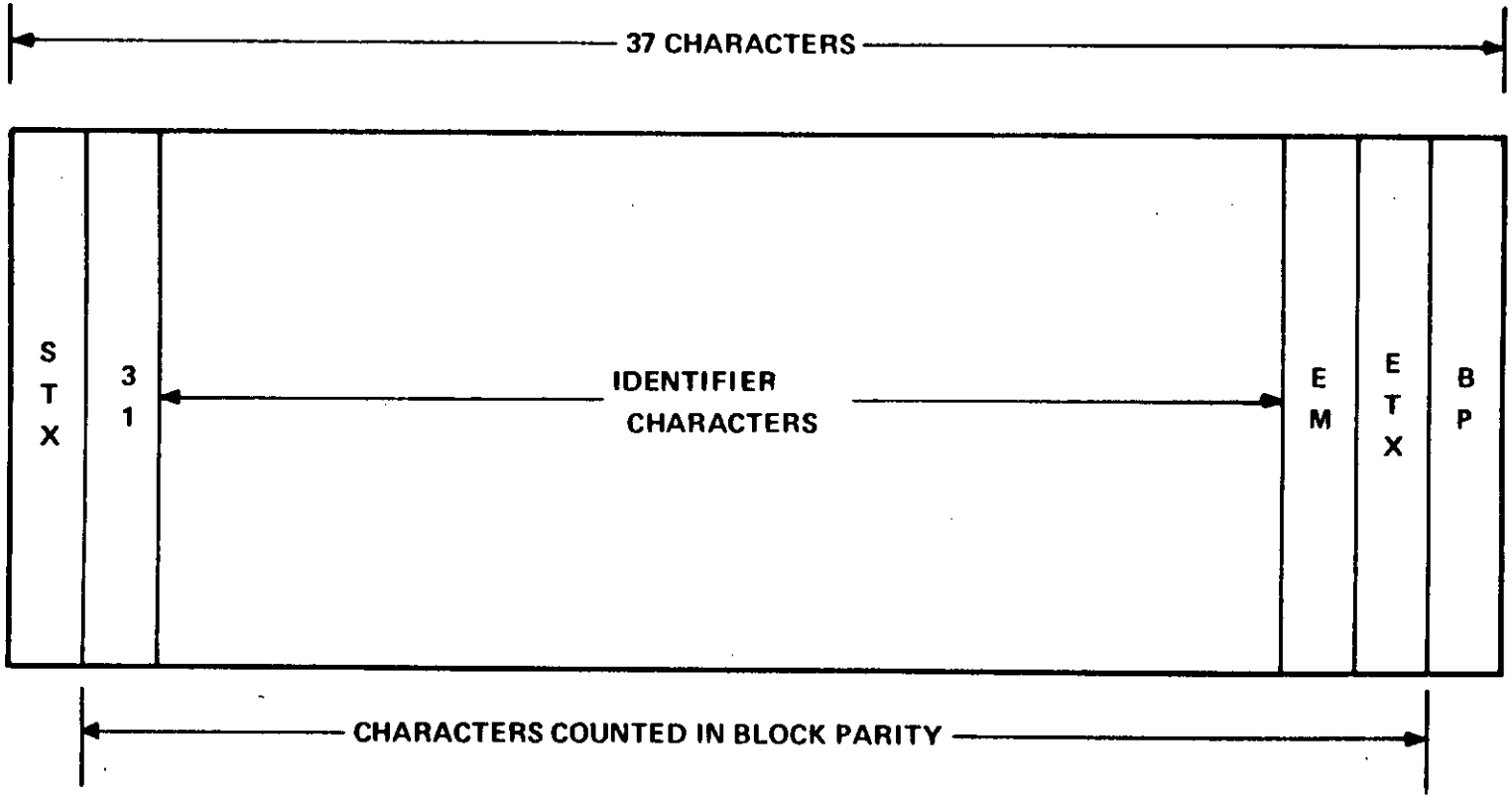


FIGURE 2. Data adapter control block.

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5. DETAILED REQUIREMENTS

5.1 Data adapter protocol. The DA may be a separate device or part of a data terminal equipment (DTE), message switch (MS), or communications center. Figure 1 shows a typical system that may be used to interconnect DA devices to each other and to an MS. This standard defines protocols exchanged and actions taken between DAs or between DAs and MSs. Two levels of interfaces shall exist for circuit switched connections between DAs or between DAs and MSs.

a. Signaling and supervision information exchanged between the telephone and various CSs to establish a data circuit path.

b. After the data circuit path is set up, the DACM coordination between DAs or between DAs and MSs shall take place. This coordination, in all of its forms, is described herein. This coordination also applies to dedicated circuits between DAs or between DAs and MSs.

5.1.1 Protocol control. Circuit switched DA access shall require a control message exchange between DAs. This control message is known as a DACB. The state in which DACBs may be transferred is known as the DACM. Prior to initiation of transmission of one or more traffic messages for either circuit switched calls or dedicated loops, the initiator shall send a DACB which shall be used to establish the parameters for the ensuing data transmission. Any change in DACB characteristics shall cause a new DACB to be transmitted. Following acknowledgment of the DACB and synchronization at DTE information rate, the message traffic itself shall be transmitted. After completion of the message traffic transmission, a DACB may be transmitted (normally by the originating unit) to initiate the call termination sequence. A detailed description of the operation of the DACM is given in appendix C.

5.1.2 Protocol rates

5.1.2.1 DACB rate. DACBs should be sent at idle rate or message rate as defined in 5.2.1.2.

5.1.2.1.1 Idle rate. Idle rate shall be defined as an information rate of 2400 bps. If the loop rate is higher than 2400 bps, the bits shall be transmitted using multisampling techniques (see 5.3.1.1).

5.1.2.1.2 Message rate. Message rate is the information rate at which message traffic shall be exchanged (see 5.2.1.2).

5.2 DACM. The DACM shall consist of the methods and procedures required to establish, control, and interface a digital subscriber voice terminal or dedicated loop encryption device tactical communication channel to the user information rates or equipment connected and as a DTE, CS, or MS. The DACM shall be transparent to the information flow through the channel and shall not be described in terms of protocol modes. The DACM section describes the DACB types, format, acknowledgment, framing characters, and signaling procedure. It also includes the description of the synchronization characters, handback request detection, break sequence, mark detection criteria, error control/message to loop rate transformation, and communications security (COMSEC) control.

5.2.1 DACB format. A DACB shall consist of 37 8-bit characters (see tables II, IV, V, and VI and figures 2 and 3). Framing of a DACB shall be accomplished by a start of text (STX) character in position 1, followed by the DA character 31 in position 2 (see tables II and VI) and end of medium (EM), end of transmission (ETX), and block parity (BP) in positions 35, 36, and 37. All framing characters, with the exception of BP, shall have an even number of logical 1 bits per character (see figure 3). BP may have an odd or an even number of logical 1 bits. All identifier characters shall have an odd number of logical 1's. Valid contents of DACBs shall be as defined in the following subsections. The minimum valid contents of each DACB generated shall be allowed as summarized in table IV. The identifier characters and their eight bit code are shown in table VII.

TABLE IV. Data adapter control block format.

Character Position	Character Description	Function
1	Framing	Start of Block Character - STX
2	Framing	Start of Block Character - 31
3-4	Security	Security of Message Repeated Identifier (2 character)
5	Information Rate	Identifies the Information Rate
6	Spare	Available for Future Use - NUL
7	Codes	Message Code
8	DTE Select	Identifies the DTE Channel Selected or Identified
9	Message Format	Identifies Message Format Utilized
10	Channel Control Procedures	Identifies Channel Control Procedures Utilized
11	Error Control	Identification of Error Control Technique Utilized
12	Precedence	Identifies Precedence of Message
13	DACB Types	Identifies Purpose for Transmission of DACB
14	Mode VI Group Size	Defines Number of Message Per Group
15	Data Mode Control	Identifies Whether Data Mode Control Shall be Inhibited

TABLE IV. Data adapter control block format - Continued.

Character Position	Character Description			Function
16	Address	Telephone Number	Area Code	First Digit of Area Code
17				Second Digit of Area Code
18				Third Digit of Area Code
19			Switch Code	First Digit of Switch Code
20				Second Digit of Switch Code
21				Third Digit of Switch Code
22			Subscriber Address	First Digit of Subscriber Address
23				Second Digit of Subscriber Address
24				Third Digit of Subscriber Address
25				Fourth Digit of Subscriber Address
26		Routing Indicator (RI)		First Character of RI
27				Second Character of RI
28				Third Character of RI
29				Fourth Character of RI
30				Fifth Character of RI
31				Sixth Character of RI
32				Seventh Character of RI (Left Most Character)

TABLE IV. Data adapter control block format - Continued.

Character Position	Character Description	Function
33*	DTE Type	Identification of DA Capabilities or Request for Specifiec DTE Capabilities
34	DACB change	Identification of DACB (same as previous or changed)
35	Framing	EM - End of Medium
36	Framing	ETX - End of Text
37	Framing	BP - Block Parity

* Construction of Character Position 33

Bit Position	Function
1	page printer
2	paper tape
3	card unit
4	display or storage device
5	mag tape
6	facsimile
7	logical ø (spare)
8	sum of logical 1's such that the number of logical 1's are odd

TABLE V. DACB character generation.

DACM Identifier Character Position(s)	Description	Character Setting by DACB Type										
		NUL*	DC2*	ENQ*	INV*	A*	B*	C*	D*	E*	F*	G*
1	Framing	STX	STX	STX	STX	STX	STX	STX	STX	STX	STX	STX
2	Framing	31	31	31	31	31	31	31	31	31	31	31
3 & 4	Security	4/	NUL	NUL	NUL	NUL	4/	NUL	NUL	4/	NUL	NUL
5	Info Rate	4/	Z	H	2/	H	4/	H	H	4/	H	NUL
6	Spare	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL
7	Codes	4/	4/	NUL	2/	NUL	4/	NUL	NUL	4/	NUL	NUL
8	DTE Select	5/	5/	5/	2/	NUL	5/	NUL	NUL	5/	SEL	NUL
9	Format	4/	4/	NUL	2/	NUL	4/	NUL	NUL	4/	NUL	NUL
10	Channel Control	4/	4/	NUL	2/	NUL	4/	NUL	NUL	4/	NUL	NUL
11	Error Control	4/	4/	NUL	2/	NUL	4/	NUL	NUL	4/	NUL	NUL
12	Precedence	4/	4/	NUL	NUL	NUL	4/	NUL	NUL	4/	NUL	NUL
13	DACB Types	NUL	DC2	ENQ	INV	A	B	C	D	E	F	G
14	Mode VI Group Size	4/	4/	NUL	2/	NUL	4/	NUL	NUL	4/	NUL	NUL
15	Data Mode Control	4/	Z	Z	2/	Z	Z	Z	Z	Z	Z	Z
16-32	Address & RI	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/

TABLE V. DACB character generation - Continued.

DACM Identifier Character Position(s)	Description	Character Setting by DACB Type										
		NUL*	DC2*	ENQ*	INV*	A*	B*	C*	D*	E*	F*	G*
$33b_1$	Page Printer	4/	4/	ϕ	2/	ϕ	4/	ϕ	ϕ	4/	4/	ϕ
$33b_2$	Paper Tape	4/	4/	ϕ	2/	ϕ	4/	ϕ	ϕ	4/	4/	ϕ
$33b_3$	Card Unit	4/	4/	ϕ	2/	ϕ	4/	ϕ	ϕ	4/	4/	ϕ
$33b_4$	Display	4/	4/	ϕ	2/	ϕ	4/	ϕ	ϕ	4/	4/	ϕ
$33b_5$	Mag Tape	4/	4/	ϕ	2/	ϕ	4/	ϕ	ϕ	4/	4/	ϕ
$33b_6$	FAX	4/	4/	ϕ	2/	ϕ	4/	ϕ	ϕ	4/	4/	ϕ
$33b_7$ 1/	SPARE	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ
34	DACB Change	4/	NUL	NUL	4/	NUL	4/	NUL	NUL	4/	NUL	NUL
35	Framing	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
36	Framing	ETX	ETX	ETX	ETX	ETX	ETX	ϕ	ETX	ETX	ETX	ETX
37	Framing	6/	6/	6/	6/	6/	6/	6/	6/	6/	6/	6/

NOTES:

1/ - This bit position is a spare and shall be set to logical ϕ.

2/ - If a DACB (INV) is sent because:
a. the received DACB characteristics cannot be accomodated or
b. the received DACB characters are inconsistent with the stored classmarks associated with the RI in the received DACB.

Then each character position shall contain a valid character. The DACB (INV) character positions, except for 3, 4 and 12, shall specify the characteristics acceptable to the MS/DA sending the DACB (INV).

3/ - The Message Switch/Data Adapter shall have the option of placing NUL characters in positions 16 through 25, inclusive where appropriate(i.e. dedicated circuits). Valid RI characters shall always be inserted in positions 26 through 32, inclusive.

4/ - The Message Switch/Data Adapter transmitting this DACB must place one of the valid characters or bits in this position. The characters or bits to be used are those specified in 5.2.1.1 through 5.2.1.15.

5/ - Multiple DTE Data Adapters and Message Switches shall place an appropriate valid character in this position. Single DTE Data Adapters shall place NUL in this position.

6/ - This bit position is a block parity character and is defined in paragraph 5.2.3.1.

* - DACB types (See 5.2.1.10), position 13 of DACB.

TABLE VI. DACM characters - numerically.

DACM CHARACTERS	DACM CHARACTERS Bit Positions							
	b_8	b_7	b_6	b_5	b_4	b_3	b_2	B_1
ETX	0	0	0	0	0	0	1	1
ACK	0	0	0	0	0	1	1	0
INV	0	0	0	0	0	1	1	1
DC3	0	0	0	1	0	0	1	1
DC4	0	0	0	1	0	1	0	0
ESC	0	0	0	1	1	0	1	1
WRT	0	0	0	1	1	1	1	0
1	0	0	1	1	0	0	0	1
4	0	0	1	1	0	1	0	0
7	0	0	1	1	0	1	1	1
8	0	0	1	1	1	0	0	0
C	0	1	0	0	0	0	1	1
E	0	1	0	0	0	1	0	1
F	0	1	0	0	0	1	1	0
I	0	1	0	0	1	0	0	1
J	0	1	0	0	1	0	1	0
L	0	1	0	0	1	1	0	0
O	0	1	0	0	1	1	1	1
Q	0	1	0	1	0	0	0	1
R	0	1	0	1	0	0	1	0
T	0	1	0	1	0	1	0	0
W	0	1	0	1	0	1	1	1
X	0	1	0	1	1	0	0	0
NUL	1	0	0	0	0	0	0	0
STX	1	0	0	0	0	0	1	0
ENQ	1	0	0	0	0	1	0	1
DC1	1	0	0	1	0	0	0	1
DC2	1	0	0	1	0	0	1	0

DACM CHARACTERS	DACM CHARACTERS Bit Positions							
	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1
EM	1	0	0	1	1	0	0	1
31	1	0	0	1	1	1	1	1
0	1	0	1	1	0	0	0	0
2	1	0	1	1	0	0	1	0
3	1	0	1	1	0	0	1	1
5	1	0	1	1	0	1	0	1
6	1	0	1	1	0	1	1	0
9	1	0	1	1	1	0	0	1
A	1	1	0	0	0	0	0	1
B	1	1	0	0	0	0	1	0
D	1	1	0	0	0	1	0	0
G	1	1	0	0	0	1	1	1
H	1	1	0	0	1	0	0	0
K	1	1	0	0	1	0	1	1
M	1	1	0	0	1	1	0	1
N	1	1	0	0	1	1	1	0
P	1	1	0	1	0	0	0	0
S	1	1	0	1	0	0	1	1
U	1	1	0	1	0	1	0	1
V	1	1	0	1	0	1	1	0
Y	1	1	0	1	1	0	0	1
Z	1	1	0	1	1	0	1	0

Notes:

a) b_1 is least significant bit (LSB)

b) LSB is first bit of a character transmitted

c) B_8 is most significant bit (MSB)

d) MSB is last bit of a character transmitted

e) Bits are transmitted from right to left (b_1 first and b_8 last).

TABLE VI(A). DACM characters - alphabetically.

DACM CHARACTERS	DACM CHARACTERS Bit Position							
	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1
A	1	1	0	0	0	0	0	1
ACK	0	0	0	0	0	1	1	0
B	1	1	0	0	0	0	1	0
C	0	1	0	0	0	0	1	1
D	1	1	0	0	0	1	0	0
DC1	1	0	0	1	0	0	0	1
DC2	1	0	0	1	0	0	1	0
DC3	0	0	0	1	0	0	1	1
DC4	0	0	0	1	0	1	0	0
E	0	1	0	0	0	1	0	1
EM	1	0	0	1	1	0	0	1
ENQ	1	0	0	0	0	1	0	1
ETX	0	0	0	0	0	0	1	1
ESC	0	0	0	1	1	0	1	1
F	0	1	0	0	0	1	1	0
G	1	1	0	0	0	1	1	1
H	1	1	0	0	1	0	0	0
I	0	1	0	0	1	0	0	1
INV	0	0	0	0	0	1	1	1
J	0	1	0	0	1	0	1	0
K	1	1	0	0	1	0	1	1
L	0	1	0	0	1	1	0	0
M	1	1	0	0	1	1	0	1
N	1	1	0	0	1	1	1	0
NUL	1	0	0	0	0	0	0	0
O	0	1	0	0	1	1	1	1

DACM CHARACTERS	DACM CHARACTERS Bit Position							
	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1
P	1	1	0	1	0	0	0	0
Q	0	1	0	1	0	0	0	1
R	0	1	0	1	0	0	1	0
S	1	1	0	1	0	0	1	1
STX	1	0	0	0	0	0	1	0
T	0	1	0	1	0	1	0	0
U	1	1	0	1	0	1	0	1
V	1	1	0	1	0	1	1	0
W	0	1	0	1	0	1	1	1
WBT	0	0	0	1	1	1	1	0
X	0	1	0	1	1	0	0	0
Y	1	1	0	1	1	0	0	1
Z	1	1	0	1	1	0	1	0
0	1	0	1	1	0	0	0	0
1	0	0	1	1	0	0	0	1
2	1	0	1	1	0	0	1	0
3	1	0	1	1	0	0	1	1
4	0	0	1	1	0	1	0	0
5	1	0	1	1	0	1	0	1
6	1	0	1	1	0	1	1	0
7	0	0	1	1	0	1	1	1
8	0	0	1	1	1	0	0	0
9	1	0	1	1	1	0	0	1
31	1	0	0	1	1	1	1	1

Notes:

a) b_1 is least significant bit (LSB)

b) LSB is first bit of a character transmitted

c) b_8 is most significant bit (MSB)

d) MSB is last bit of a character transmitte

e) Bits are transmitted from right to left (b_1 first and b_8 last).

TABLE VII. DACB identifier characters.

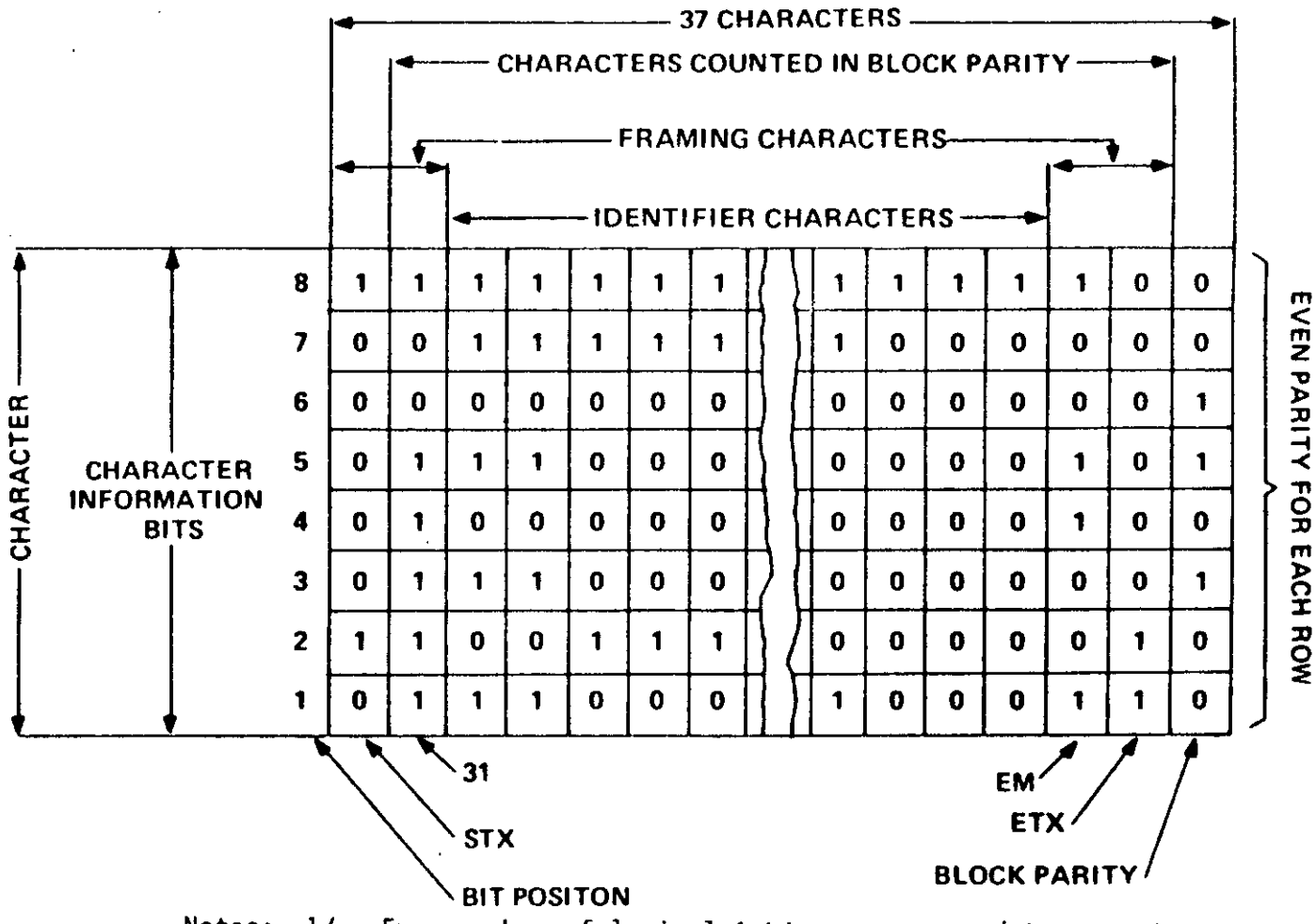
IDENTIFIER CHARACTERS	8 BIT CODE							
	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1
NUL	1	0	0	0	0	0	0	0
ENQ	1	0	0	0	0	1	0	1
INV	0	0	0	0	0	1	1	1
DC1	1	0	0	1	0	0	0	1
DC2	1	0	0	1	0	0	1	0
DC3	0	0	0	1	0	0	1	1
0	1	0	1	1	0	0	0	0
1	0	0	1	1	0	0	0	1
2	0	0	1	1	0	0	1	0
3	1	0	1	1	0	0	1	1
4	0	0	1	1	0	1	0	0
5	1	0	1	1	0	1	0	1
6	1	0	1	1	0	1	1	0
7	0	0	1	1	0	1	1	1
8	0	0	1	1	1	0	0	0
9	1	0	1	1	1	0	0	1
A	1	1	0	0	0	0	0	1
B	1	1	0	0	0	0	1	0
C	0	1	0	0	0	0	1	1
D	1	1	0	0	0	1	0	0
E	0	1	0	0	0	1	0	1
F	0	1	0	0	0	1	1	0
G	1	1	0	0	0	1	1	1
H	1	1	0	0	1	0	0	0
I	0	1	0	0	1	0	0	1
J	0	1	0	0	1	0	1	0
K	1	1	0	0	1	0	1	1
L	1	1	0	0	1	1	0	0
M	1	1	0	0	1	1	0	1
N	1	1	0	0	1	1	1	0

TABLE VII. DACM identifier characters - Continued.

IDENTIFIER CHARACTERS	8 BIT CODE							
	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1
O	0	1	0	0	1	1	1	1
P	1	1	0	1	0	0	0	0
Q	0	1	0	1	0	0	0	1
R	0	1	0	1	0	0	1	0
S	1	1	0	1	0	0	1	1
T	0	1	0	1	0	1	0	0
U	1	1	0	1	0	1	0	1
V	1	1	0	1	0	1	1	0
W	0	1	0	1	0	1	1	1
X	0	1	0	1	1	0	0	0
Y	1	1	0	1	1	0	0	1
Z	1	1	0	1	1	0	1	0

Notes:

a) b_1 is least significant bit (LSB)
b) LSB is first bit of a character transmitted
c) b_8 is most significant bit (MSB)
d) MSB is last bit of a character transmitted
e) Bits are transmitted from right to left (b_1 first and b_8 last).



Notes: 1/ - Even number of logical 1 bits per octet (character)
2/ - Odd number of logical 1 bits per octet (character)
3/ - Even number of logical 1 bits per row.

FIGURE 3. Parity checking rules for DACB.

5.2.1.1 Security classification and handling procedures. These two identifier characters (positions 3 and 4 of DACB) shall identify the classification of the message(s) to be transmitted. These characters shall be NUL when the transmission status control character (position 13) is DC2, ENQ, INV, A, C, D, F, or G. The allowable security classification indicators shall be in accordance with table VIII.

Table VIII. Security classification and handling procedures.

Identifier Characters	Identification
MM	"Y" RI Community
TT	Top Secret
SS	Secret
CC	Confidential (and Restricted)
EE	EFTO (Encrypted for Transmission only)
UU	Unclassified
NUL NUL	No message associated with this DACB

5.2.1.2 Information rate. This identifier character (position 5 of DACB) shall identify the information rate of the message to be transmitted. The information rate indicators shall be in accordance with table IX.

Table IX. Information rate.

Identifier Characters	Identification
A	45.45 baud
B	50 baud
C	75 baud
D	150 baud
E	300 baud
F	600 baud
G	1200 baud
H	2400 baud
I	4800 baud
J	9600 baud
K	16000 baud
L	32000 baud
M	2000 baud
N	4000 baud
O	8000 baud
NUL	No information rate associated with this DACB
Z	Not applicable - remain at current information rate

5.2.1.3 Character 6 of DACB. This identifier character (position 6 of DACB) shall be a NUL, and is a spare.

5.2.1.4 Codes. This identifier character (position 7 of DACB) shall identify the DTE message code. The indicators shall be in accordance with table X.

Table X. Codes.

Identifier Characters	Identification
A	ASCII odd parity
B	ITA 2
C	Continuous random bit stream and facsimile
D	4 out of 8 (IBM) code 10 unit start-stop
E	EBCDIC. (Extended Binary Coded Decimal Interchange Code)
F	Field data
G	ASCII even parity (data)
N	Nonstructured format magnetic tape
O	Structured format magnetic tape
NUL	No code identified by this DACB

5.2.1.5 DTE select. This identifier character (position 8 of DACB) shall identify the DTE terminal requested within the DACB, for DACB(F) (see 5.2.2.4). MSs and DAs with a single DTE channel shall not transmit DACB (INV) due solely to receipt of DC1, DC2, or DC3 in this character position. A multiple DTE DA shall transmit a DACB(INV) if an incompatible identifier character is received in a DACB. The indicators shall be in accordance with table XI.

Table XI. DTE select.

Identifier Characters	Identification
DCI	DTE-1
DC2	DTE-2
DC3	DTE-3
NUL	Only DTE or selection based on character 33 of DACB

5.2.1.6 Message format. This identifier character (position 9 of DACB) shall identify the format of the message(s) to be transmitted. The indicators shall be in accordance with table XII.

Table XII. Message format.

Identifier Characters	Identification
A	ACP-127
B	JANAP-128, Data
C	ACP-127 modified (DOI-103 Special)
D	JANAP-128, Teletypewriter
E	Special Format 1
F	Special Format 2
G	JANAP-128 modified (DOI-103 Standard
H	ACP-127 NATO SUPP 3
NUL	No special format (a valid format coordinated by means other than by DACBs)

5.2.1.7 Channel control procedures. This identifier character (position 10 of DACB) shall identify the operational mode of the DA (or the DTE connected to the DA) or the operational mode of the MS during message transmission. Modes I, II, and V are defined in Defense Communications Agency Circular (DCAC) 370-D175-1. All modes are as specified in MIL-STD-188-116-1 through MIL-STD-188-116-5. The indicators shall be in accordance with table XIII.

Table XIII. Channel control procedures.

Identifier Characters	Identification
A	Mode I - Continuous
B	Mode II
E	Mode V
F	Mode VI
G	Mode I - Block-by-Block
NUL	Unspecified - utilized between DAs for facsimile and special DTE
H	Mode VII

5.2.1.8 Error control. This identifier character (position 11 of DACB) shall identify the error control technique to be used in transmitting or receiving a message. The indicators shall be in accordance with table XIV.

Table XIV. Error control.

Identifier Characters	Identification
A	Multisampling - non bit framing (see 5.2.9.1.2)
D	1/2 rate Golay without multi-sampling (see appendix D)
E	1/4 rate Golay (1/2 rate Golay without multisampling with double codeword transmission, see appendix D)
F	1/8 rate Golay (1/2 rate Golay without multisampling with quadruple codeword trans-mission, see appendix D)
NUL	Multisampling - bit framing (see 5.2.9.1.1)

5.2.1.9 Precedence. This identifier character (position 12 of DACB) shall identify the precedence of the message(s) to be transmitted. The indicators shall be in accordance with table XV.

Table XV. Precedence.

Identifier Characters	Identification
Y	Flash override (CRITIC, ECP)
Z	Flash
O	Immediate
P	Priority
NUL	Routine or precedence stated only in message header(s)

5.2.1.10 DACB types. This identifier character (position 13 of DACB) shall identify the reason for transmission of the DACB, or to request action(s) to be taken by the receiving DA/MS. There are 11 types of DACBs. The type of DACB is determined by the character in position 13. DACBs may be to inquire and verify the identity of the distant end, to establish or change parameters, to terminate a call or return to idle, or to respond to an invalid DACB. Of the 11, 3 DACBs are sent only when a non ARQ channel cancel mode is in use. These non ARQ DACBs are sent either to cancel or reject messages. The indicators and acceptable transmission rates shall be in accordance with table XVI (explained in appendix C).

Table XVI. DACB types.

Rate	Characters Identifier	Identification
Msg	DC2	DC2 character is sent in a DACB to reject an incoming message (non-ARQ modes only, see note 1)
Idle (circuit establishment)	ENQ	ENQ is sent in a DACB to request a DACB (F) response to verify the identity of the responding DA/MS
Idle/Msg	INV	INV is sent in a DACB to indicate a received DACB cannot be accommodated by the responding DA/MS as specified in 5.2.2.3
Idle/Msg	A	A is sent in a DACB to indicate present transmission has been completed, no further transmission is intended and to terminate the connection or go back to idle if dedicated
Msg	B	B is sent in a DACB to indicate the received DTE to read the contents of this DACB to determine characteristics specified for continued transmission

Table XVI. DACB types. (Continued)

Rate	Characters Identifier	Identification
Msg	C	C is sent in a DACB to indicate transmission of message(s) is complete, hold connection in idle state. Further message transmission will be preceded by another DACB
Msg	D	D is sent in a DACB to indicate cancellation of all transmission since the last start of message sequence, and to terminate the connection or go back to idle if dedicated (non-ARQ modes only) (see note 1)
Msg	E	E is sent in a DACB to indicate cancellation of all transmission since previous start of message sequence and to specify the characteristics for continued transmission (non-ARQ modes only) (see note 1)
Idle	F	F is sent in a DACB to indicate the DACB is being sent in response to a DACB (ENQ)
Idle/Msg	G	G is sent in a DACB to indicate "Go-to-Voice"
Idle/Msg	NUL	NUL character is sent in a DACB during call initiation to specify and validate characteristics for subsequent data transmission

NOTE 1: The provision of special DACB signaling for non-ARQ modes does not imply a requirement to use this signaling. Individual DA/MS specifications defines when this signaling is required.

5.2.1.11 Mode VI group size. This identifier character (position 14 of DACB) shall identify the group size in terms of line blocks to be utilized in the ensuring Mode VI transmission when a DACB(NUL), DACB(B), or DACB(E) is sent. A responder shall not send a DACB(INV) due solely to the initiator requesting a smaller group size capability than the responder can provide. For all modes, except for Mode VI, the DA/MS shall place a NUL in this position. The indicators shall be in accordance with table XVII.

Table XVII. Mode VI group size.

Identifier Characters	Identification
A	32
B	64
C	96
D	16
NUL	Not applicable

5.2.1.12 Data mode control. This identifier character (position 15 of DACB) shall identify whether data mode control (DMC) mode of operation shall be used (see 5.5.2) or inhibited. Upon initial establishment of a call (circuit), the DMC shall be enabled. The indicators shall be in accordance with table XVIII.

Table XVIII. Data mode control.

Identifier Characters	Identification
NUL	Data mode control employed
A	Data mode control inhibited
Z	Not applicable - remains in present state

5.2.1.13 Address. The address (positions 16 through 32 of the DACB) shall contain addressing information of the DA/MS originating the DACB and shall consist of two fields; the telephone number of the station and the routing indicator (RI) of the station. The station telephone number shall be constructed in accordance with the associated digital circuit switch numbering plan. The 10-digit number (area code, switch code and subscriber address) shall be used. The RI field shall be constructed in accordance with the applicable community RI directory; e.g., ACP-117. The RI shall be left-justified in the field. Unused portions in the RI field shall be filled with NUL characters. For DA/MSs with multiple channel capability, the RI, for the specific DTE channel in character position 8 of the DACB, shall be inserted in characters 26-32 of DACB. If no DTE is connected to a specific channel, positions 26-32 of DACB shall be filled with "NULS."

5.2.1.14 DTE type. This identifier character (position 33 of the DACB) shall identify specific terminal equipment. A DA/MS sending a DACB(F) or DACB(INV) shall set the appropriate bit(s) for the DTE(s) attached to the specific DTE channel when position 8 of the DACB being responded to is DC1, DC2, or DC3 or set the "logical or" of all the DTE types on all channels in character position 33 when position 8 of the DACB is NUL. In DACB (NUL), DACB(B), and DACB(E) a specific bit shall be set for the type of terminal equipment requested. If a specified DTE channel (DC1, DC2, DC3, or NUL in position 8) does not have specified terminal type, a DACB(INV) shall be sent indicating the terminal types available on the specified DTE channel as follows.

a. A logical 1 in bit position 1 shall indicate page printer.
b. A logical 1 in bit position 2 shall indicate a paper tape unit.
c. A logical 1 in bit position 3 shall indicate a card unit.
d. A logical 1 in bit position 4 shall indicate a display or storage device.
e. A logical 1 in bit position 5 shall indicate a magnetic tape unit.
f. A logical 1 in bit position 6 shall indicate a facsimile unit.
g. Bit position 7 shall be a spare and shall be set to logical 0.
h. A logical 1 in more than one position shall indicate a combination of the above devices and capabilities.

5.2.1.15 DACB change. This identifier character (position 34 of the DACB) shall identify whether the DA/MS transmitting a DACB is capable of changing its characteristics or has changed any of its characteristics from the previously transmitted DACB (provided position 13, DACB type, has not changed). Whenever DACB (DC2), DACB (ENQ), DACB(A), DACB(C), DACB(D), DACB(F), or DACB(G) is transmitted, character position 34 shall always be a NUL character. Whenever a DACB (INV) is transmitted, character position 34 of the DACB(INV) shall be the same as that of the received DACB to which the DACB(INV) responds. Whenever DACB(NUL), DACB(B), or DACB(E) is transmitted, character position 34 shall be in accordance with table XIX.

Table XIX. DACB change.

Identifier Characters	Identification
A	DA/MS is capable of changing its characteristics. This ASCII character (A) shall be used with first DACB transmission. It shall also be transmitted with each changed DACB when previously transmitted DACB had a "B" in position 34
B	DA/MS is capable of changing its characteristics. Transmitted with each changed DACB when previously transmitted DACB had an "A" in position 34
NUL	DA/MS not capable of changing its DACB characteristics

5.2.2 DACB acknowledgment. Upon reception of a correctly framed DACB with correct parity, the receiver shall send one of the following.

a. Positive acknowledgment.
b. Interim acknowledgment.
c. Invalid response.
d. Inquiry response.

Note: If any identifier position contains a character other than members of the set defined for that position, the entire DACB shall be ignored.

5.2.2.1 Positive acknowledgment. The positive acknowledgment sequence shall be sent by the receiver in response to a DACB with correct parity and compatible identifiers specifying parameters acceptable to the receiver. The acknowledgment sequence shall consist of ACK ACK 31 31 (see table III). During the transmission of the positive acknowledgment sequence, no other character (data, framing, or control) shall interrupt this four character sequence.

5.2.2.2 Interim acknowledgment. The wait before transmit (WBT) sequence shall consist of WBT WBT 31 31 (see table II). The WBT sequence shall be sent to acknowledge receipt of a properly framed correct parity DACB and to request the transmitter to stop further transmission of DACBs. During the transmission of this sequence, no other characters (data, framing, or control) shall interrupt this four character sequence.

5.2.2.3 Invalid response. The invalid reply shall consist of a DACB with INV in position 13. DACB (INV) shall be sent only in response to a DACB(NUL), DACB(B), DACB(E), or unimplemented DACB type, which is received correctly (no parity errors) and at a logical time, but which is received with contents specifying parameters unacceptable to the receiver. In all cases, the DACB(INV) shall contain the proper identifiers except security and precedence. A NUL character shall be inserted for security and precedence.

5.2.2.4 Enquiry response. The response to a DACB(ENQ) shall be a DACB(F). If the DACB(ENQ) contains DC1, DC2, or DC3 in character position 8, a DA with only one DTE shall respond with a DACB(F) with NUL in character position 8. A DA with more than one DTE shall respond with the same DC1, DC2, or DC3 received in character position 8.

5.2.3 DACB framing characters. The DACB shall consist of 5 framing characters and 32 identifier characters (see 5.2.1.1 through 5.2.1.15) for a total of 37 characters (see figure 2 and tables II, IV, and VI). The DACB framing characters shall serve to delineate the beginning and end of the DACB. Two of these characters (STX and 31) shall precede the identifier characters and three of these characters (EM, ETX, and BP) shall succeed the identifier characters. The transmission of a DACB shall never be interrupted by the transmission of any other characters except at termination of DACB transmission. The DACB framing characters are described in 5.2.3.1 through 5.2.3.5 and are listed in table XX.

5.2.3.1 Block parity (BP). BP shall be the last framing character of the DACB. BP shall always follow ETX. BP shall be formed by the binary addition without carry of each of the bits in each row of a block starting with the second framing character (31), including all identifier characters, the EM character, and ETX character. When ETX is detected, the next character should be compared bit for bit with the receiver generated BP character. These two characters should be identical. If they are not, the block shall be considered to have a parity error (see figure 3).

5.2.3.2 Start of text (STX). STX shall be the first framing character of the DACB. STX shall not be included in the BP check.

5.2.3.3 Data adapter character 31. Character 31 shall be the second framing character of the DACB. Character 31 shall be included in the BP check. Character 31 shall be followed by 32 identifier characters (see table VII).

5.2.3.4 End of medium (EM). EM shall be the third character of the DACB and shall be the thirty fifth character of the DACB. EM shall be included in the BP check. EM shall be followed by the framing character sequence ETX BP.

5.2.3.5 End of transmission text (ETX). ETX shall be the fourth framing character of the DACB and shall be the thirty sixth character of the DACB. ETX shall be included in the BP check. ETX shall always be preceded by EM and followed by BP.

5.2.4 DACB signaling procedures. All DACBs transmitted and all acknowledgment sequences (ACK or WBT) to DACBs shall be sent with contiguous characters. No idle characters or other characters shall be sent between the defined DACB or acknowledgment sequence character positions.

TABLE XX. DACM framing and control characters.

FRAMING, IDLE AND CONTROL CHARACTERS	8 BIT CODE							
	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1
STX	1	0	0	0	0	0	1	0
ETX	0	0	0	0	0	0	1	1
ACK	0	0	0	0	0	1	1	0
EM	1	0	0	1	1	0	0	1
ESC	0	0	0	1	1	0	1	1
DC4	0	0	0	1	0	1	0	0
WBT	0	0	0	1	1	1	1	0
31	1	0	0	1	1	1	1	1

Notes:

a) b_1 is least significant bit (LSB)
b) LSB is first bit of a character transmitted
c) b_8 is most significant bit (MSB)
d) MSB is last bit of a character transmitted
e) Bits are transmitted from right to left (b_1 first and b_8 last).

5.2.4.1 DACB transmission. A DACB shall be sent continuously until receipt of the WBT sequence or until other appropriate action is taken. Idle characters shall be required between DACBs (see 5.2.5.1). After receipt of a WBT sequence, no new DACB shall be initiated until after receipt of ACK sequence or DACB(INV) or a time-out has occurred. Transmission of continuous DACBs shall be terminated upon receipt of an acknowledgment (ACK, WBT, DACB(INV), or DACB(F)) for the DACB. The termination shall occur at any character boundary during the transmission of a DACB. Once a WBT has been sent, any incoming DACBs shall be ignored until an ACK sequence, DACB(F), or DACB(INV) has been transmitted.

5.2.4.2 DACB acknowledgment transmission. An ACK sequence (ACK ACK 31 31 or WBT WBT 31 31) shall be sent 10 times in response to a DACB. Idle characters shall be allowed between acknowledgment sequences. The receipt of a complete ACK ACK 31 31 or WBT WBT 31 31 sequence by a receiver shall be required for validation of these control character sequences. Termination of an ACK sequence shall occur on any character boundary following the detection, by the responder, of the advancement of the initiator to the next signaling state.

5.2.4.3 DACB response transmission. If the responder continues to receive the same DACB after having sent a response other than WBT - i.e., ACK, DACB(F) or DACB(INV), it shall be assumed that the response sequence has been lost or not yet received and/or acted upon by the initiator. The duplicate block(s) shall be disregarded; however, the response to the previously answered DACB shall be retransmitted. In the case of duplicate block(s) received after the transmission of WBT, those blocks shall be disregarded and no response shall be sent.

5.2.4.4 Multiple DTE channel usage arbitration. In case of channel use "contention" with DTEs of a multiple DTE DA, the precedences of DTE message shall be utilized to determine the order in which the messages shall be transmitted.

5.2.5 Synchronization characters. The synchronization characters shall be DC4 and ESC and are listed in table XX.

5.2.5.1 Idle characters (DC4). The DC4 character shall be the idle character used to establish and maintain DACM character synchronization. It shall also be used to signal handback. DC4 shall be transmitted at idle rate or at message rate. At least 10 contiguous DC4 characters shall be transmitted between each DACB.

5.2.5.2 Escape characters (ESC). The ESC character is the transition synchronization character which shall be used during the transition between two lines states; e.g., idle rate to message rate or old message rate to new message rate. The ESC shall be sent as a synchronous character with the necessary encoding. When a transition is being made to a new message rate, the forward error correction (FEC), bit stuffing, or multisampling that is specified for the new message rate shall be used to encode the ESC. When a transition is being made to idle rate, multisampling to 2400 baud information rate shall be used if the loop rate is greater than 2400 baud.

5.2.6 Handback request detection. While in the traffic state, the decoded information rate bit stream shall be constantly examined for synchronous DC4 characters. A DC4 character boundary may be different than the character boundary of the traffic mode. The detection of the DC4 stream shall indicate that the distant end is requesting a handback to DACM. Appendix C gives details of handback synchronization.

5.2.7 Break sequence. A break sequence shall be sent to "wake up" a distant end and shall force a return to the idle line state (see table XXI).

5.2.7.1 Break generation. A generated break sequence shall consist of one second of continuous "space" (logic zero) loop bits. After having sent a break sequence, the sender shall go to idle line state.

5.2.7.2 Break detection. A break shall be recognized when 750 milliseconds of spacing line are detected. The break detector shall be implemented using a loop bit error filtering algorithm to ensure that a break, in a worst case noise environment, shall be detected. False detection shall also be guarded against by use of a filtering algorithm. To protect against false detection of break during idle-to-information and information-to-idle rate transitions, marks shall be sent (see tables XXII and XXIII). The break detector shall be active at all times.

TABLE XXI. Example of generation of break - return to idle.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
IDLE LINE	Break (Loop Rate) →		IDLE LINE	Initiator recognizes loss of SYNC during DACM and performs Crypto Resync then sends break (logical zero (Ø) for one second) at loop rate. FEC and bit stuffing and inhibited as required. Initiator prepares for Idle sync by sending ESC.
		← MARK (Loop Rate)		Responder recognizes break and sends Mark. FEC and bit stuffing inhibited as required.
IDLE SYNC	ESC (2400) →		IDLE SYNC	Initiator sends ESC.
		← ESC (2400)		Responder detects ESC and sends ESC.
	DC4 (2400) →			Initiator syncs on ESC and sends DC4.
		← DC4 (2400)		Responder syncs on DC4 and sends DC4.
	DC4 (2400) →			Initiator syncs on DC4. System is ready for transmission of DACBs.

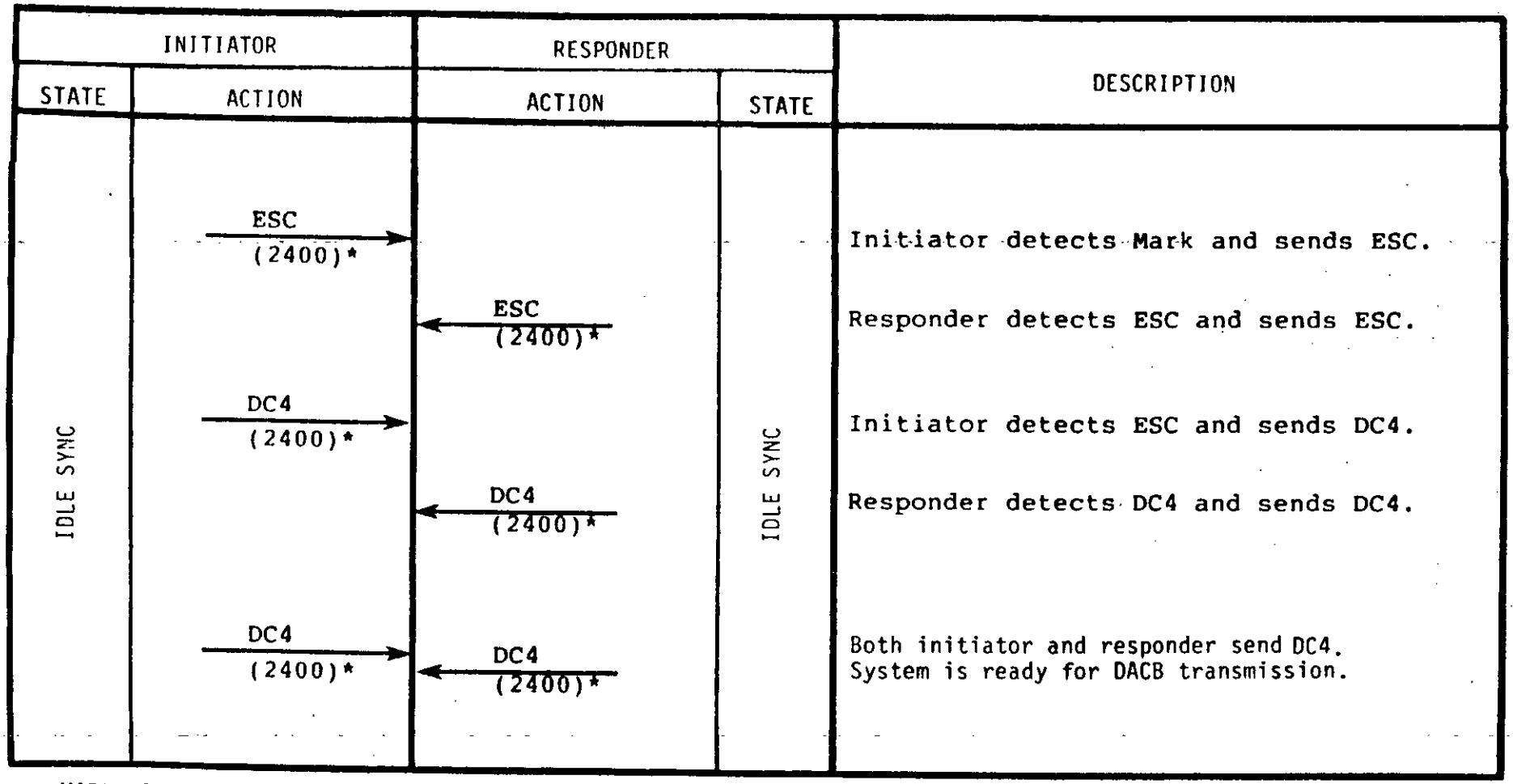
TABLE XXII. Example of call termination.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
TRAFFIC	SYN/MARK/DATA (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)	TRAFFIC	Initiator completes message transmission and sends encoded SYN/MARK.
HANDBACK SYNC	DC4 (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)		Initiator desires termination and signals hand-back by sending DC4s.
	DC4 (Encoded)** (Msg Rate) →	← DC4 (Encoded)** (Msg Rate)	HANDBACK SYNC	Responder detects and syncs on DC4 and sends DC4.
MSG RATE DACM	DACB (A/D) (Encoded)** (Msg Rate) →	← DC4 (Encoded)** (Msg Rate)		The initiater syncs on DC4 and sends DACB (A/D) continuously.

TABLE XXII. Example of call termination - Continued.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
MSG RATE DACM	DACB (A/D) (Encoded)** (Msg Rate) →	← ACK 31 (Encoded)** (Msg Rate)	MSG RATE DACM	The responder ACKs DACB. Responder sends 10 ACKs for each DACB received.
		IF DEDICATED		
	MARK + (Loop Rate) →			If circuit switched call, initiator detects ACK 31 and goes on hook. Responder detects Mark and goes on hook.
	MARK + (2400) →			If dedicated connection, initiator detects ACK 31 sequence, inhibits FEC coding and stuffing, if applicable, and sends Mark.
		← MARK + (2400)		Responder detects loss of DACB/DC4 and inhibits FEC coding and stuffing, if applicable, and searches for Mark.
				Responder detects Mark and sends Mark.

TABLE XXII. Example of call termination - Continued.



\+ MARK always sent at loop rate and unencoded. The () associated rate indicates MS/DA transmit/receive baud rate clock during MARK transmission.

* Information rate. If loop rate is greater, multisampling, and bit stuffing are used as appropriate.

** Encoded - Multisampled - FEC Coded
- Bit Stuffed

TABLE XXIII. Example of change of call characteristics.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
TRAFFIC MODE	SYN/MARK/DATA (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)	TRAFFIC MODE	Traffic mode
HANDBACK SYNC	DC4 (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)		Initiator signals for handback.
	DC4 (Encoded)** (Msg Rate) →	← DC4 * (Encoded)** (Msg Rate)	HANDBACK SYNC	Responder detects and syncs on DC4 and then sends DC4.
MSG RATE DACM	DACB (B/E) (Encoded)** (Msg Rate) →	← DC4 (Encoded)** (Msg Rate)		Initiator syncs on DC4 and sends DACB to request handover with new characteristics.
	DACB (B/E) (Encoded)** (Msg Rate) →	← ACK31 (Encoded)** (Msg Rate)	MSG RATE DACM	Responder ACKs DACB. Responder sends 10 ACKs for each DACB received.
	DC4 (Encoded)** (Msg Rate) →	← DC4 (Encoded)** (Msg Rate)		

TABLE XXIII. Example of change of call characteristics - Continued.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
HANDOVER SYNC	MARK + (Loop Rate) →		HANDOVER SYNC	Initiator detects ACK, stops DACB (B/E) transmission, and sends Mark sequence to indicate reception of ACK, inhibits FEC coding and stuffing, if applicable.
		← MARK + (Loop Rate)		Responder detects loss of DACB(B/E) and DC4. Searches for Mark. Inhibits FEC coding and stuffing, if applicable. Responder detects Mark, sends Mark and searches for transitional Idle (ESC).
	ESC (Encoded)** (Msg Rate) →			Initiator detects Mark and sends transitional Idle (ESC) with FEC, bit stuffing, multisampling as required.
		← ESC (Encoded)** (Msg Rate)		Responder does all levels of sync to encoded ESC and sends encoded ESC.
	SYN/MARK (Encoded)** (Msg Rate) →			Initiator does all sync to encoded ESC and hands over to the traffic mode idle pattern.

TABLE XXIII. Example of change of call characteristics - Continued.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
HANDOVER SYNC		SYN/MARK (Encoded)** (Msg Rate) ←	HANDOVER SYNC	Responder detects SYN/MARK and sends SYN/MARK. Initiator detects encoded SYN/MARK (traffic idle character) and prepares for traffic.
TRAFFIC	SYN/MARK/DATA (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)	TRAFFIC	Traffic mode.

\+ MARK always sent at loop rate and unencoded. The () associated rate indicates MS/DA transmit/receive baud rate clock during MARK transmission.

** Encoded - Multisampled - FEC Coded
- Bit Stuffed

5.2.8 Mark detection criteria.

5.2.8.1 Mark sequence. A detection of 32 contiguous bits at information rate in the Mark (logical 1) state shall be considered as "detecting mark."

5.2.8.2 Detection of loss of mark sequence. When in the mark detection sequence state, the DA/MS shall declare itself out of mark sequence state if any 720 bit sample contains less than 32 contiguous mark bits.

5.2.9 Error control/message to loop rate transformation. The DA/MS shall implement bit stuffing, multisampling, FEC (see appendix D), and automatic repeat-request (ARQ) error control techniques. Depending on the DA/MS capabilities, various combinations of these shall be used as specified in table XXIV. Error control and message to loop rate transformation configuration compatibility shall be coordinated through the DACB.

5.2.9.1 Multisampling. The multisampling technique shall be used with information rates as specified in table XXIV. Multisampling shall not be used in conjunction with bit stuffing or FEC.

5.2.9.1.1 Bit framing. In this mode of operation, all bits (data and idle) shall be transmitted using the information rate clock, which shall be derived from the loop rate clock according to the sampling sequences shown in table XXIV. This shall ensure that information bits contained in the loop rate data stream between the transmitter and receiver have a fixed and known relationship to the loop bits.

5.2.9.1.1.1 Start-stop data. The DA and MS shall only transmit an integral number of stop bits. For ITA #2 start-stop code, one start, five data, and at least two stop bits (eight unit ITA #2 code) shall be transmitted. In all cases, if there are no characters available for transmission, an integral number of information bit times of marking line shall be generated before starting the next character.

5.2.9.1.1.2 Quantizing information bits. When the message rate to loop rate transformation results in a fractional number of loop samples per information bit, the fractional loop bit shall be integerized by addition or subtraction of the fractional unit in a manner such that the average information rate is maintained (see figure 4).

TABLE XXIV. Conversion tables from loop rates to information rates.

Loop Transmission Rate (bps)	Information Rate (Bauds	Sampling Rate	Sampling Sequence 2/
2400	45.45	52.8	52,53,53,53,...
	50	48	48, 48, 48, 48, . . .
	75	32	32, 32, 32, 32, . . .
	150	16	16, 16, 16, 16, . . .
	300	8	8,8,8,8,8, ...
	600	4	4, 4, 4, 4, 4, ...
	1200	2	2, 2, 2, 2, 2,...
	2400	1	1, 1, 1, 1, 1,...
4800	45.45	105.6	105,106,105,106,106,..
	50	96	96, 96, 96, 96, ...
	75	64	64, 64, 64, 64, ...
	150	32	32, 32, 32, 32, ...
	300	16	16, 16, 16, 16, ...
	600	8	8, 8, 8, 8, 8, ...
	1200	4	4, 4, 4, 4, 4, ...
	2400	2	2, 2, 2, 2, 2, ...
	4800	1	1, 1, 1, 1, 1, ...
9600	45.45	211.2	211,211,211,211,212...
	50	192	192, 192, 192,...
	75	128	128, 128, 128,...
	150	64	64, 64, 64, 64,...
	300	32	32, 32, 32, 32,...
	600	16	16, 16, 16, 16,...
	1200	8	8,8,8,8,8, ...
	2000	4.8	4, 5, 5, 5, 4, 5, 5,...
	2400	4	4, 4, 4, 4, 4, ...
	4800	2	2, 2, 2, 2, 2,...
	9600	1	1, 1, 1, 1, 1,...

TABLE XXIV. Conversion tables from loop rates to information rates - Continued.

Loop Transmission Rate (bps)	Information Rate (Baud)	Sampling Rate	Sampling Sequence 2/
16000	45.45	352.0	352, 352, 352, 352,...
	50	320	320, 320, 320, 320,...
	75	213-1/3	213, 213, 214, ...
	150	106-2/3	106, 107, 107, ...
	300	53-1/3	53,53,54,53,53,54,...
	600	26-2/3	26, 27, 27, ...
	1200	13-1/3	13, 13, 14, ...
	2400	6-2/3	6, 7, 7, 6, 7, 7, ...
	4800	3-1/3	3, 3, 4, 3, 3, 4,...
	9600	Stuffed to 16000	3+2, 3+2, 3+2, ... 1/
	2000	8	8, 8, 8, 8, 8, ...
	4000	4	4, 4, 4, 4, 4, ...
	8000	2	2, 2, 2, 2, 2, ...
	16000	1	1, 1, 1, 1, 1, ...
32000	45.45	704.1	704,704,704,...
	50	640	640, 640, 640, ...
	75	426-2/3	426, 427, 427, ...
	150	213-1/3	213, 213, 214, ...
	300	106-2/3	106, 107, 107, ...
	600	53-1/3	53, 53, 54, ...
	1200	26-2/3	26, 27, 27, ...
	2400	13-1/3	13, 13, 14, ...
	4800	6-2/3	6, 7, 7, 6, 7, 7,...
	9600	3-1/3	3, 3, 4, 3, 3, 4, 3,...
	2000	16	16, 16, 16, ...
	4000	8	8, 8, 8, 8, ...
	8000	4	4, 4, 4, 4, 4,...
	16000	2	2, 2, 2, 2, 2,...
	32000	1	1, 1, 1, 1, 1,...

NOTE: 1/ 3+2 = 3 data bits plus 2 stuff bits

2/ ... ; repeat previous sequences

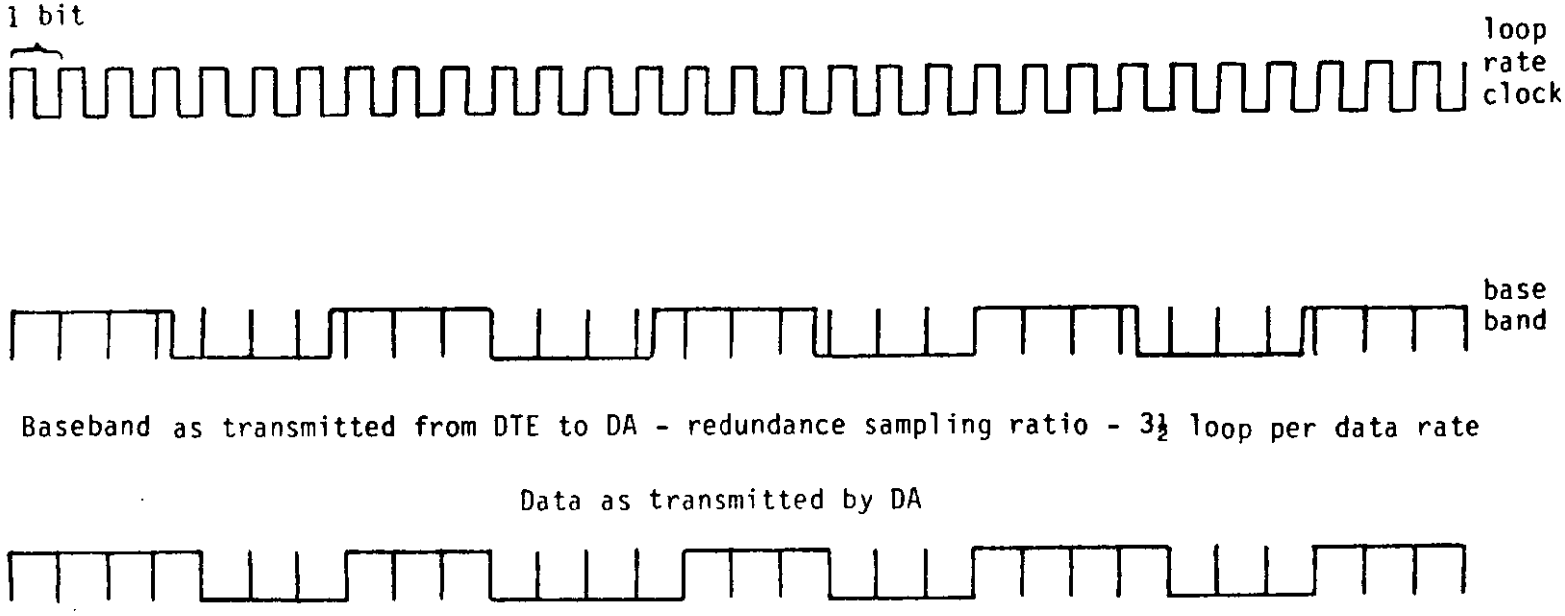


Figure 4. Example of quantizing information bits.
Data rate = 4800 bps, loop rate = 16000 bps.

5.2.9.1.2 Non-bit framing. In this mode of operation, all information (data and idle) transmitted shall be multisampled at the loop clock rate i.e., bit framing (5.2.9.1.1) and bit integerization (5.2.9.1.1.1) need not be performed.

5.2.9.1.3 Reconstruction of multisampled data. The receiver shall reconstruct the data which has been transmitted by means of multisampling.

5.2.9.2 Bit stuffing. Bit stuffing shall be utilized to adjust certain message rates to 8000N (N = 2 or 4) rates (see table XXIV). Bit stuffing shall be accomplished by transmitting three data bits followed by two stuff bits. If FEC is used, bit stuffing shall be accomplished subsequent to FEC (see note).

NOTE: The receiver must be aware that the relationship of stuff bits to the FEC codeword may not have a fixed relationship.

5.3 Synchronization and time-out.

5.3.1 Synchronization sequences. Synchronization is the process whereby a transmitter/receiver sharing a connection, cooperatively progresses from a common starting point to a commonly desired end state. During the stages of synchronization, a receiver shall utilize the incoming encoded idle characters (DC4, ESC, and SYN) to achieve synchronization (encoded by multisampling, bit stuffing, and FEC encoding as applicable). During the various synchronization processes (see appendix C), an initiator/responder relationship shall be used to determine the synchronization leader/follower respectively. This relationship shall be established dynamically. The types of synchronization are multisampling, bit stuffing without FEC encoding, bit stuffing with FEC encoding, FEC without bit stuffing, and character synchronization. Examples of some typical character synchronization sequences are contained in the tables listed below.

Generation of break, return to idle - table XXI.
Normal call termination - table XXII.
Change of call characteristics - table XXIII.
Call initiation - table XXV.
Reject message - table XXVI.
Transmission complete, return to idle - table XXVII.

TABLE XXV. Example of call initiation with ID establishment.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
IDLE LINE	MARK + (Unencoded)** (Loop Rate) →	← MARK + (Unencoded)** (Loop Rate)	IDLE LINE	No connection between devices (on-hook/channel out of service). Dedicated or switched, initiator and responder in Mark state.
IDLE SYNC	ESC (2400)* →	← MARK + (Unencoded)** (Loop Rate)	IDLE LINE	Initiator sends ESC while searching for ESC. Responder sends Marks while searching for ESC.
IDLE SYNC	ESC (2400)* →	← ESC (2400)*	IDLE SYNC	Initiator sends ESC while searching for ESC. Responder syncs on ESC and sends ESC.
IDLE SYNC	DC4 (2400)* →	← ESC (2400)*	IDLE SYNC	Initiator syncs on ESC and sends DC4.
IDLE SYNC	DC4 (2400)* →	← DC4 (2400)*	IDLE SYNC	Responder syncs on DC4 and sends DC4.
IDLE RATE DACM	DACB (ENQ) (2400)* →	← DC4 (2400)*	IDLE RATE DACM	Initiator syncs on DC4 and sends DACB (ENQ) to request identification.

TABLE XXV. Example of call initiation with ID establishment - Continued.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
IDLE RATE DACM	DACB (ENQ) (2400)* →	← DACB (F) (2400)*	IDLE RATE DACM	Responder recognizes DACB (ENQ) and responds with DACB (F). Responder sends DACB (F) for each DACB (ENQ) received.
	DC4 (2400)* →	← DC4 (2400)*		Initiator recognizes DACB (F) and stops sending DACB (ENQ).
	DACB (NUL) (2400)* →	← DC4 (2400)*		Initiator sends a DACB (NUL) to initiate a DTE handover.
	DACB (NUL) (2400)* →	← ACK 31 (2400)*		Responder answers.
	DACB (NUL) (2400)* →	← DC4 (2400)*		Responder sends 10 ACKs for each DACB (NUL) received and waits for DACB (NUL) transmission to stop.
HANDOVER SYNC	MARK + (Loop Rate) →		HANDOVER SYNC	Initiator detects ACK 31 and sends Mark.
		← MARK + (Loop Rate)		Responder detects loss of DACB/DC4 and searches for Mark. Responder detects Mark and sends Mark.
	ESC → (Encoded)** (Msg Rate)			Initiator detects Mark and changes DMC, if required, and sends transitional Idle (ESC) with FEC, bit stuffing, multisampling as required. Initiator searches for ESC.

TABLE XXV. Example of call initiation with ID establishment - Continued.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
HANDOVER SYNC		MARK + (Loop Rate) ←	HANDOVER SYNC	Responder, if DMC is changed, searches for loss of Mark, while sending Mark.
				Responder, if DMC is changed by initiator, detects loss of Mark, and changes DMC while continuing Mark transmission. Responder searches for encoded ESC at message rate (MSG Rate).
	ESC (Encoded)** (Msg Rate) →			
		← ESC (Encoded)** (Msg Rate)		Responder does all levels of sync to the encoded ESC and sends encoded ESC.
	SYN/MARK (Encoded)** (Msg Rate) →			Initiator does all levels of sync to encoded ESC and hands over to the traffic mode idle pattern.
		← SYN/MARK (Encoded)** (Msg Rate)		Responder detects SYN/MARK and transmits SYN/MARK. Initiator detects encoded SYN/MARK (traffic idle character) and prepares for traffic.
TRAFFIC	SYN/MARK/DATA (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)	TRAFFIC	Traffic mode

\+ MARK always sent at loop rate and unencoded. The () associated rate indicates MS/DA transmit/receive baud rate clock during MARK transmission.

* Information rate. If loop rate is greater, multisampling, and bit stuffing are used as appropriate.

** Encoded - Multisampled - FEC Coded.
- Bit Stuffed

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TABLE XXVI. Example of reject message.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
TRAFFIC	MARK/DATA/SYN (Msg Rate) →	← MARK/DATA/SYN (Msg Rate)	TRAFFIC	Traffic mode
HANDBACK SYNC	DC4 (Encoded)** (Msg Rate) →	← MARK/DATA (Encoded)** (Msg Rate)	TRAFFIC	Initiator signals for "Handback."
HANDBACK SYNC	DC4 (Encoded)** (Msg Rate) →	← DC4 (Encoded)** (Msg Rate)	HANDBACK SYNC	Responder detects and syncs on DC4 and then sends DC4.
MSG RATE DACM	DACB (DC2) (Encoded)** (Msg Rate) →	← DC4 (Encoded)** (Msg Rate)	MSG RATE DACM	Initiator syncs on DC4 and sends DACB (DC2).
MSG RATE DACM	DACB (DC2) (Encoded)** (Msg Rate) →	← ACK 31 (Encoded)** (Msg Rate)	MSG RATE DACM	Responder sends 10 ACKs for each DACB (DC2) received.
MSG RATE DACM	DC4 (Encoded)** (Msg Rate) →	← DC4 (Encoded)** (Msg Rate)	MSG RATE DACM	

TABLE XXVI. Example of reject message - Continued.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
HANDOVER SYNC	MARK (Encoded)** (Msg Rate) →		HANDOVER SYNC	Initiator detects ACK 31 sequence, stops transmission of DACB (DC2) and DC4 and sends Mark.
		← MARK (Encoded)** (Msg Rate)		Responder detects Mark and sends Mark. Responder searches for ESC.
	ESC (Encoded)** (Msg Rate) →			Initiator detects Mark and sends ESC.
		← ESC (Encoded)** (Msg Rate)		Responder detects ESC and sends ESC.
	SYN/MARK (Encoded)** (Msg Rate) →			Initiator does all sync on encoded ESC and hands over to traffic code idle pattern.
		← SYN/MARK (Encoded)** (Msg Rate)		Responder detects loss of ESC, searches for traffic code idle pattern. When idle pattern is detected, responder hands over to traffic code idle pattern. Responder searches for traffic.
TRAFFIC	SYN/MARK/DATA (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)	TRAFFIC	Traffic mode.

* Information rate. If loop rate is greater, multisampling, FEC coding and bit stuffing are used as appropriate.

** Encoded - Multisampled - FEC Coded.
- Bit Stuffed

TABLE XXVII. Example of transmission complete return to idle.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
TRAFFIC	SYN/MARK/DATA (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)	TRAFFIC	Traffic mode
HANDBACK SYNC	DC4 (Encoded)** (Msg Rate) →	← SYN/MARK/DATA (Encoded)** (Msg Rate)		Initiator signals for "Handback."
	DC4 (Encoded)** (Msg Rate) →	← DC4 * (Encoded)** (Msg Rate)	HANDBACK SYNC	Responder detects and syncs on DC4 and then sends DC4.
MSG RATE DACM	DACB (C) (Encoded)** (Msg Rate) →	← DC4 * (Encoded)** (Msg Rate)	MSG RATE DACM	Initiator syncs on DC4 and sends DACB(C).
	DACB (C) (Encoded)** (Msg Rate) →	← ACK-31 * (Encoded)** (Msg Rate)		Responder sends 10 ACKs for each DACB received.

TABLE XXVII. Example of transmission complete return to idle - Continued.

INITIATOR		RESPONDER		DESCRIPTION
STATE	ACTION	ACTION	STATE	
MSG RATE DACM	MARK + (Loop Rate) →		MSG RATE DACM	Initiator detects ACK, stops DACB (C) transmission and sends Mark to indicate reception of ACK, inhibits FEC coding and stuffing, if applicable.
		← MARK + (Loop Rate)		Responder detects loss of DACB (C) and DC4 and searches for Mark. Inhibits FEC coding and stuffing, if applicable.
				Responder detects Mark and sends Mark.
IDLE SYNC	ESC (2400)* →		IDLE SYNC	Initiator detects Mark and sends transitional idle (ESC).
		← ESC (2400)*		Responder syncs on ESC and sends ESC.
	DC4 (2400)* →	← ESC (2400)*		Initiator syncs on ESC and sends DC4.
	DC4 (2400)* →	← DC4 (2400)*		Responder syncs on DC4 and sends DC4.
	DC4 (2400)* →	← DC4 (2400)*		System ready for transmission of DACBs.

\+ MARK always sent at loop rate and unencoded. The () associated rate indicates MS/DA transmit/receive baud rate clock during MARK transmission.

* Information rate. If loop rate is greater, multisampling, and bit stuffing are used as appropriate.
** Encoded - Multisampled - FEC coded.
- Bit Stuffed

5.3.1.1 Multisampling. When multisampling is employed, the transmitter shall send the current idle character encoded with multisampling. The receiver shall establish bit synchronization on the information rate bits of the idle pattern. The responder shall declare itself "in sync" upon detection of four contiguous decoded sync characters.

5.3.1.2 Bit stuffing without FEC encoding. The initiator, having attained synchronization, shall send ESC idle characters with stuff bits and data bits positioned as shown in figure 5. The responder shall strip stuff bits from the incoming bit stream using the previously acquired frame synchronization. The responder shall declare itself "in sync" upon detection of four contiguous decoded ESC characters.

5.3.1.3 Bit stuffing with FEC encoding. The initiator, having attained synchronization, shall send FEC encoded ESC idle characters with stuff bits, data bits, and FEC code bits positioned as required by appendix D for Golay coding. The responder shall declare itself "in sync" upon detection of four contiguous decoded ESC characters (see note).

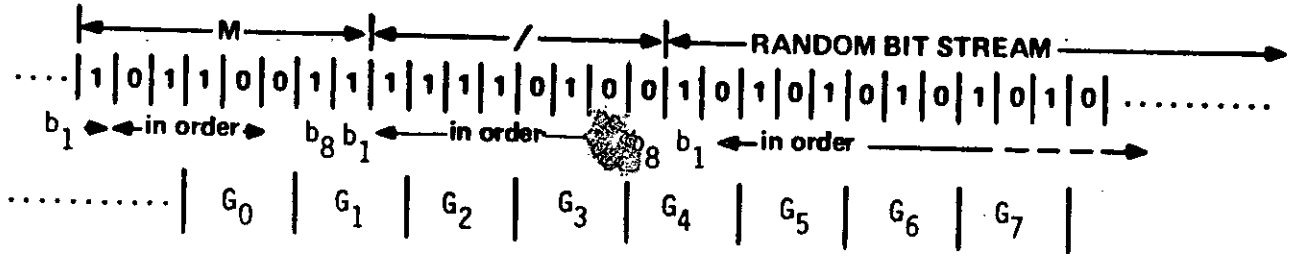
NOTE: The receiver must be aware that the relationship of stuff bits to the FEC codeword may not have a fixed relationship.

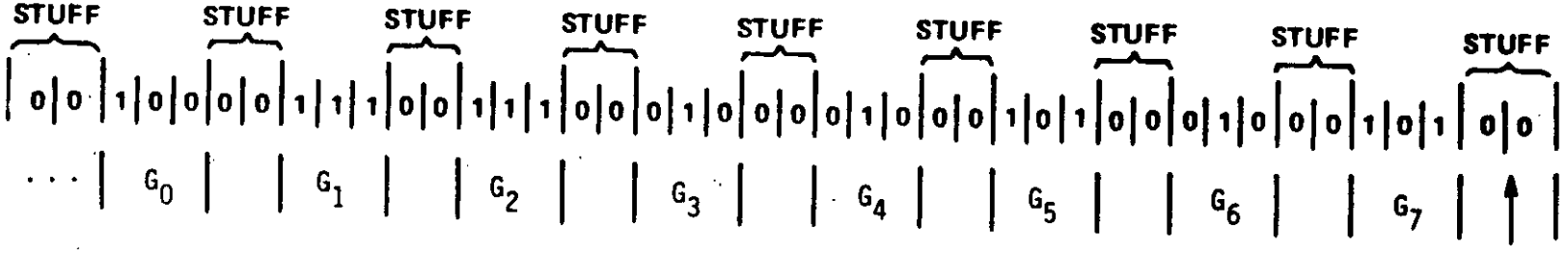
5.3.1.4 FEC encoding without bit stuffing. The initiator shall send FEC encoded ESC idle characters (1/2 rate, 1/4 rate, or 1/8 rate) as required by appendix D for Golay coding. The responder shall declare itself "in sync" upon detection of four contiguous decoded ESC characters.

5.3.1.5 Character synchronization. A DA/MS shall obtain character synchronization by searching the decoded information rate bit stream, bit by bit for an eight-bit pattern which corresponds to the current idle character. Upon finding a match, the DA/MS shall tentatively establish character boundary synchronization and then examine the next three characters and ensure that they are also the idle character. If so, character synchronization shall be considered acquired. If any one of the three characters is not the current idle character, the entire process shall be reinitiated starting with the bit-by-bit search of the encoded information rate bit stream. The detailed synchronization requirements are given in appendix C.

INFORMATION BIT STREAM AT MESSAGE RATE

NOTE: BIT STREAM NOT NECESSARILY CHARACTER SYNCHRONOUS (TERMINAL TYPE DEPENDENT) OR CHARACTER ORIENTED (RANDOM BIT STREAM)





BIT STREAM AT LOOP RATE

FIGURE 5. Bit stuffing without error control.

5.3.2 Loss of synchronization and resynchronization. Upon having progressed through many levels of synchronization to a desired level, it is then possible for any one of those levels of synchronization to be lost. The means for detecting loss of synchronization are described in 5.3.2.1, 5.3.2.2, and appendix C.

5.3.2.1 Methods for detecting loss of synchronization. The methods for detecting loss of synchronization shall be by:

a. Excessive unexpected characters (in a mode where such recognition is possible).

b. Excessive start/stop bit position errors (Modes II or V).

c. Failure to progress to the next state of DACM.

d. Excessive parity errors in traffic state.

e. The operator.

5.3.2.2 Recovery procedures. Recovery procedures shall range from simple operator alarms with manual recovery to completely automatic link resynchronization including automatic message cancellation and retransmission. The general capabilities provided by the DACM protocol are specified in appendix C. For all recovery procedures other than a character resynchronization, the DA/MS shall verify loss of synchronization before attempting recovery procedures.

5.3.3 Time-out. The DA/MS shall time-out when synchronization, signaling and traffic procedures are not executing properly after a predetermined lapsed time. Timers shall be implemented as described in appendix C. Upon timing out, the DA/MS shall follow the procedures in 5.3.3.1 and 5.3.3.2.

5.3.3.1 Dedicated or circuit switched with high precedence traffic. For dedicated or circuit switches with high precedence traffic, the DA/MS shall return to idle rate and institute recovery procedures (see appendix C).

5.3.3.2 Circuit switched with low precedence traffic. For circuit switches with low precedence traffic, the DA/MS shall release connection.

5.4 Structural validation of DACB. The DA/MS shall validate the DACB using the following rules (see figure 2).

a. The five framing characters shall be validated (STX, 31, EM, ETX, and BP).

b. Each character shall be checked (see table II).

c. BP shall be checked.

d. Position 13 of the DACB shall be validated and depending upon the character present, additional positional character content validation may be performed according to table III.

5.5 Operation with cryptographic equipment

5.5.1 Cryptographic resynchronization. Loss of cryptographic synchronization and its recovery is a subset of overall loss of synchronization and resynchronization (see 5.3.2).

5.5.2 Data mode control (DMC). Data transmission between transmitter/receiver shall be capable of operating with or without the DMC of the associated COMSEC equipment enabled. Changing of the DMC status shall be accomplished during handover synchronization. For circuit switched data calls the DMC shall be enabled before entering the idle synchronization state.

5.5.2.1 Dedicated lines. On dedicated lines, the status of DMC during the connection shall be pre-coordinated by the operators.

5.5.2.2 Switched lines. During call connection using DACBs, the associated COMSEC equipment of the DA/MS shall utilize the DMC feature. The successful transmission of a DACB (NUL) shall establish the state of DMC as specified by the identifier characters in position 15 of the DACB. Once the state of the DMC is determined by the first DACB(NUL), the state of the DMC shall be fixed until the call is terminated.

5.6 Glare. A glare situation shall arise when both parties simultaneously attempt to initiate DACB signaling. In such a case, the master's signaling shall be allowed to succeed (master wins glare) and the slave shall back down (lose glare) and shall respond to the master's signaling.

6. INFORMATION FOR GUIDANCE ONLY

6.1 Subject term (key word) listing.

bit framing
block format
block parity
control character
data adapter
data adapter control block
data adapter control mode
data control mode
data rate
data transmission
error detection
framing
glare
golay code
identifier character
idle rate
information exchange
message rate
protocol
synchronization
traffic mode

APPENDIX A

MEMORANDUM FROM THE UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING 16 AUGUST 1983 SUBJECT: MANDATORY USE OF MILITARY TELECOMMUNICATIONS STANDARDS IN THE MIL-STD-188 SERIES

This appendix contains information related to MIL-STD-188-216. Appendix A is a mandatory part of this document.

THE UNDER SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

RESEARCH AND ENGINEERING

16 AUG 1983

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS, LOGISTICS & FINANCIAL MANAGEMENT)
ASSISTANT SECRETARY OF THE NAVY (SHIPBUILDING & LOGISTICS)
ASSISTANT SECRETARY OF THE AIR FORCE (RESEARCH DEVELOPMENT & LOGISTICS)
COMMANDANT OF THE MARINE CORPS
DIRECTOR, DEFENSE COMMUNICATIONS AGENCY
DIRECTOR, NATIONAL SECURITY AGENCY

SUBJECT: Mandatory Use of Military Telecommunications Standards in the MIL-STD-188 Series

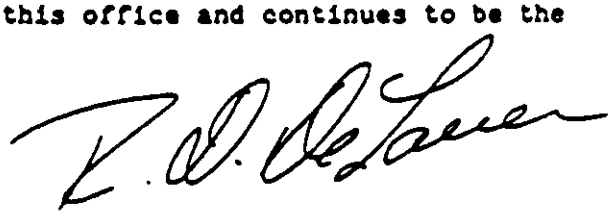
On May 10, 1977, Dr. Gerald Dinneen, then Assistant Secretary of Defense(C^3I), issued the following policy statement regarding the mandatory nature of the MIL-STD-188 series telecommunications standards:

"...standards as a general rule are now cited as 'approved for use' rather than 'mandatory for use' in the Department of Defense.

This deference to the judgment of the designing and procuring agencies is clearly appropriate to standards dealing with process, component ruggedness and reliability, paint finishes, and the like. It is clearly not appropriate to standards such as those in the MIL-STD-188 series which address telecommunication design parameters. These influence the functional integrity of telecommunication systems and their ability to efficiently interoperate with other functionally similar Government and commercial systems. Therefore, relevant military standards in the 188 series will continue to be mandatory for use within the Department of Defense.

To minimize the probability of misapplication of these standards, it is incumbent upon the developers of the MIL-STD-188 series to insure that each standard is not only essential but of uniformly high quality, clear and concise as to application, and wherever possible compatible with existing or proposed national, international and Federal telecommunication standards. It is also incumbent upon the users of these standards to cite in their procurement specifications only those standards which are clearly necessary to the proper functioning of the device or systems over its projected lifetime."

This statement has been reviewed by this office and continues to be the policy of the Department of Defense.



APPENDIX B

LIST OF ABBREVIATIONS AND ACRONYMS USED IN MIL-STD-188-216

This appendix contains general information in support of MIL-STD-188-216. Appendix B is a non mandatory part of this document.

APPENDIX B

ACRONYMS AND ABBREVIATIONS

This appendix provides definitions of acronyms and abbreviations used in this standard. This appendix is not a mandatory part of this standard.

ACK	Positive acknowledgement
ACP	Allied communication publication
ARQ	Automatic repeat - request
ASCII	American Standard Code for Information Interchange
AUTODIN	Automatic digital network
BP	Block parity - framing character
bps	Bits per second
COMSEC	Communications security
CS	Circuit switch
CTL	Control
DA	Data adapter
DACB	Data adapter control block
DACB(A)	DACB with identifier character A in position 13. Transmission complete - terminate call (GO-ON-HOOK if switched).
DACB(B)	DACB with identifier character B in position 13. Transmission complete - read contents of this DACB for new characteristics and continue.
DACB(C)	DACB with identifer character C in position 13. Transmission complete - return to idle rate.

APPENDIX B

DACB(D)	DACB with identifier character D in position 13. Cancel all transmission since last start of message sequence then terminate the call (GO-ON-HOOK if switched.
DACB(DC2)	DACB with identifier characters 'DC2' in position 13 - reject message.
DACB(E)	DACB with identifier character E in position 13. Cancel reading of DACB contents for new characteristics and continue.
DACB(ENQ)	DACB with identifier characters 'ENQ' in position 13. Request receiving DA send its DACB(F).
DACB(G)	DACB with identifier character G in position 13. Go to voice.
DACB(INV)	DACB with identifier characters 'INV' in position 13. Response when invalid DACB is received.
DACB(NUL)	DACB with identifier characters 'NUL' in position 13. Sent during call initiation.
DACM	Data adapter control mode. This is the state between DA/MSs in which DACBs may be sent.
DA/MS	Data adapter/message switch; data adapter to message switch; between data adapter and message switch.
DCAC	Defense Communications Agency Circular
DC4	DACM idle character
DLED	Dedicated loop encryption device
DMC	Data mode control
DO	Design objective
DODD	Department of Defense Directive

APPENDIX B

DODISS	Department of Defense Index of Specifications and Standards
DOI	DSSCS operating instruction
DSSCS	Defense Special Security Communications System
DSVT	Digital subscriber voice terminal - secure voice/data digital telephone
DTE	Data terminal equipment
DTE-1	DTE connected to terminal 1 of DA
DTE-2	DTE connected to terminal 2 of DA
DTE-3	DTE connected to terminal 3 of DA
EBCDIC	Extended Binary Coded Decimal Interchange Code
ECP	Emergency command precedence
EFTO	Encrypted for transmission only
EM	End of Medium framing character
ENABLE AUTO RESYNC	Enable automatic resynchronization
ENQ	Enquiry DACM character
ESC	DACM message rate idle character and/or idle synchronization character
ETX	End of transmission - framing character
FEC	Forward error correction
FED-STD	Federal standard
INV	Invalid DACM character
IR	Idle rate
ITA #2	International telegraph alphabet number 2 (Baudot Code)

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JANAP	Joint Army, Navy, Air Force Publication
LB	Line block
LSB	Least significant bit
MIL-STD	Military standard
MR	Message rate
MRC	Message rate and coded
MS	Message switch or store and forward module
MSB	Most significant bit
MS/DA	Message switch/data adapter
MSG	Message
MSG RATE	Message rate
N/A	Not applicable
SEL	Select
WBT	Wait before transmitting, DACM character

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APPENDIX C

STATE DIAGRAMS FOR DACM PROTOCOL

Appendix C contains specific information in support of MIL-STD-188-216. Appendix C is a non mandatory part of this document.

APPENDIX C

10. GENERAL

10.1 Purpose. The purpose of this appendix is to define the DACM protocol as a tool with many capabilities in a manner which provides for a consistent but flexible implementation.

10.2 Scope. This appendix contains state diagrams illustrating the DACM protocol. The intent is to clearly define both the normal and abnormal data and control system modes.

20. APPLICABLE DOCUMENTS

20.1 Government documents. The following documents form a part of this appendix to the extent specified:

Military Standards

MIL-STD-188-116, Interoperability Standards for Information and Record Traffic Exchange.

20.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard to the extent specified herein:

Other Government documents

DCAC-370-0175-1, DCA AUTODIN Interface and Control Criteria

30. DEFINITIONS

For purposes of this appendix, the definitions of FED-STD-1037 apply.

APPENDIX C

40. GENERAL REQUIREMENTS

The DACM protocol described herein is general in its nature. It describes a function which may be implemented within simple adapter boxes, intelligent terminals, or large switching centers. Each of these pieces of equipment have system-level requirements which dictate how this protocol is to be implemented. The DACM protocol function can be subdivided into a set of basic functions (tools, assets, processes) under the control of a "supervisor." This is illustrated in figure 6. In the supervisory function, the "supervisor" will decide how information flows between these functions, what task a given function performs at any given time, and what functions are active at any given time. It is also responsible for communicating with the higher-level function.

The basic functions are:

a. input bit processing.

   (1) Performs serial to parallel conversion.

   (2) Performs Golay decoding, bit unstuffing, demultisampling, and framing checking.

   (3) Performs input synchronization.

   (4) Performs break detection.

b. output bit processing.

   (1) Performs parallel to serial conversion.

   (2) Performs Golay encoding, bit stuffing, multisampling, and framing.

   (3) Performs output sychronization.

c. DACM signaling.

   (1) Performs the mechanics of DACM signaling.

d. traffic mode functions.

   (1) Performs the mechanics of Modes I-VII.

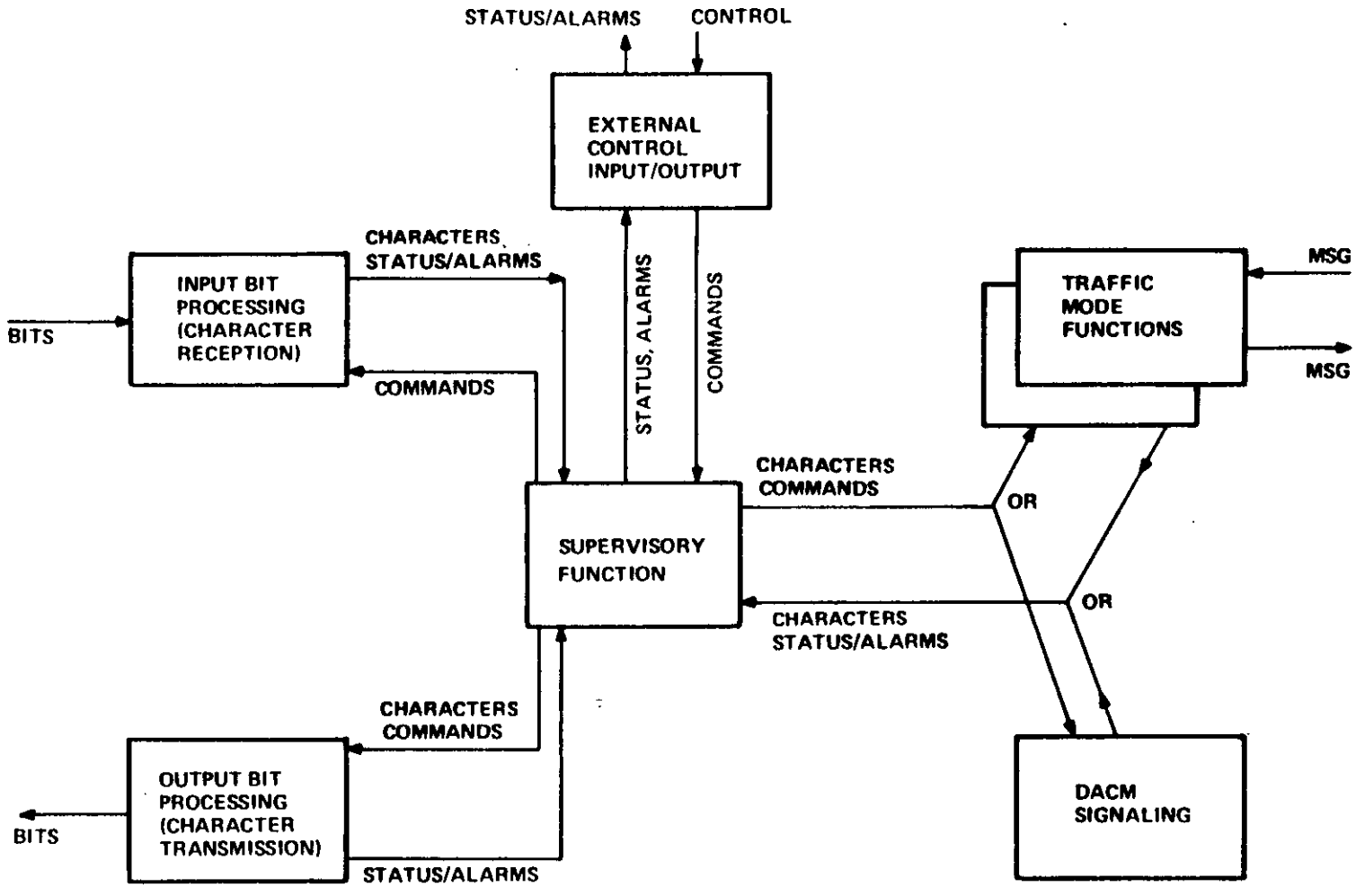

FIGURE 6. DACM protocol function internal representation.

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40.1 Documentation approach. A hierarchical approach is used to divide the documentation into manageable pieces. Figure 7 shows only the structure of the documentation of DACM signaling, traffic mode functions, and supervisor functions. The representation contained in figure 7 corresponds to that in figure 6. The top-level diagram, figure 8, shows each of the high-level processes which the DACM protocol supervisor can perform and the interrelationship with the other high-level processes. Each process is in turn defined by an individual process diagram or explanation, illustrating all possible actions, both normal operation and abnormal operation or fault conditions available to the supervisor, while performing that process. To use this appendix one must determine the active states. At each level there will be an active state; e.g., the DA/MS is awaiting the answer to a DACB(NUL). On the top level diagram, figure 8, the call initiation signaling process is active. Within the call initiation signaling process, figure 9, the "supervisor" is constantly monitoring the "basic functions" of figure 6, awaiting output from them. Although output is expected from DACM signaling, a break or an external command can be received at any time. Within DACM signaling (figure 10), "waiting for response" is active. One then determines from the state diagrams the response for any given stimulus.

40.1.1 The documentation convention. The documentation convention that is used is shown in figure 11.

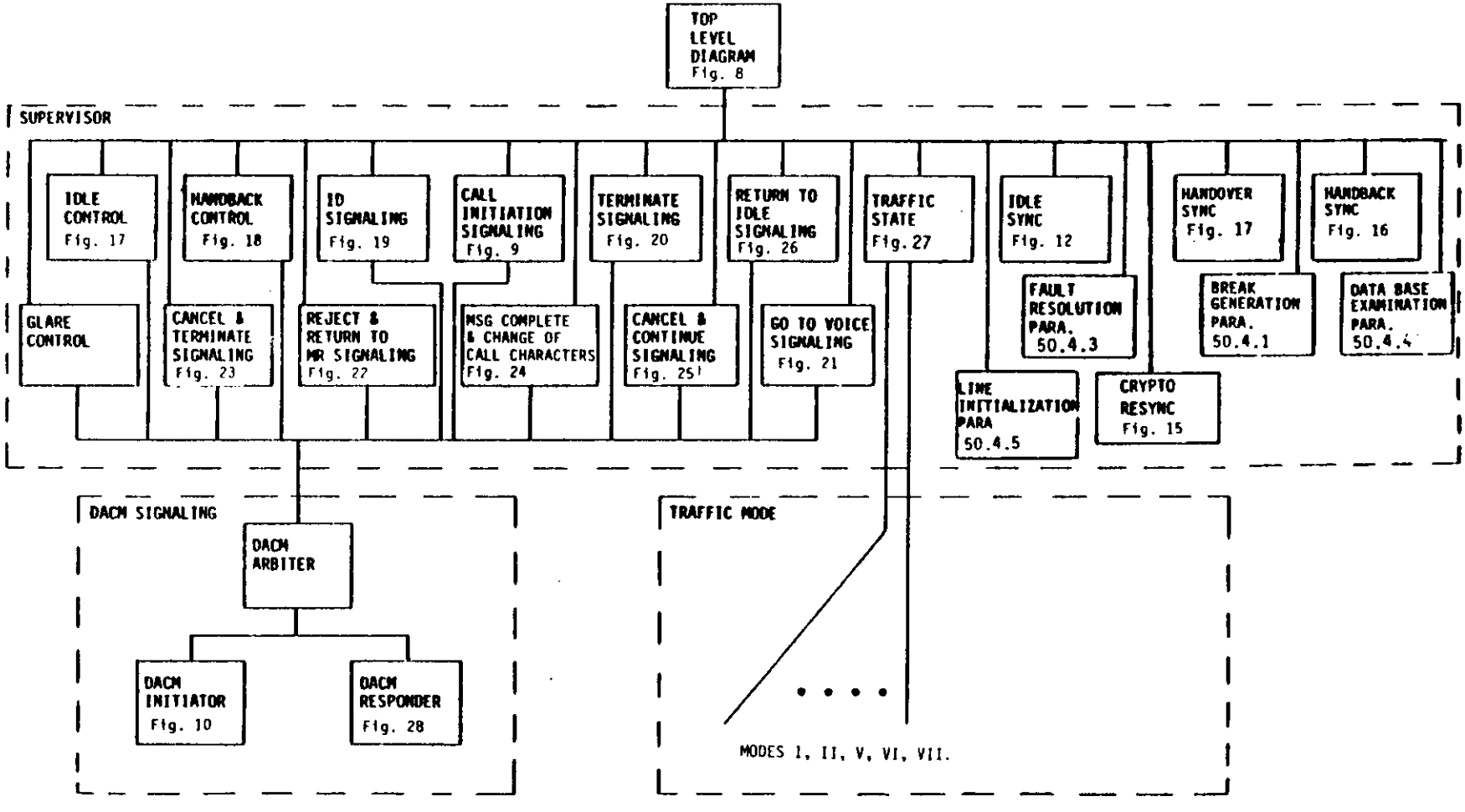


FIGURE 7. Documentation structure.

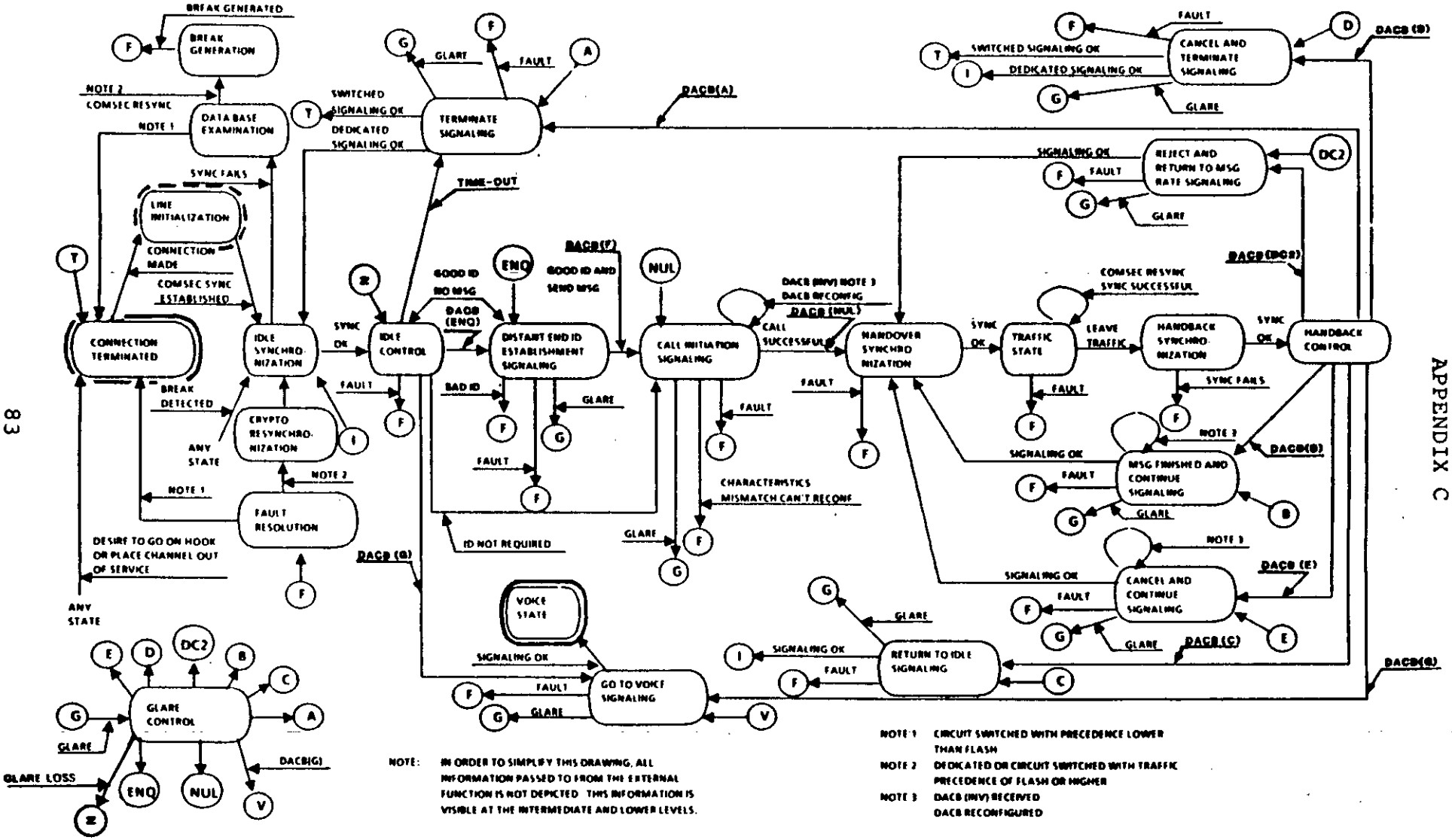
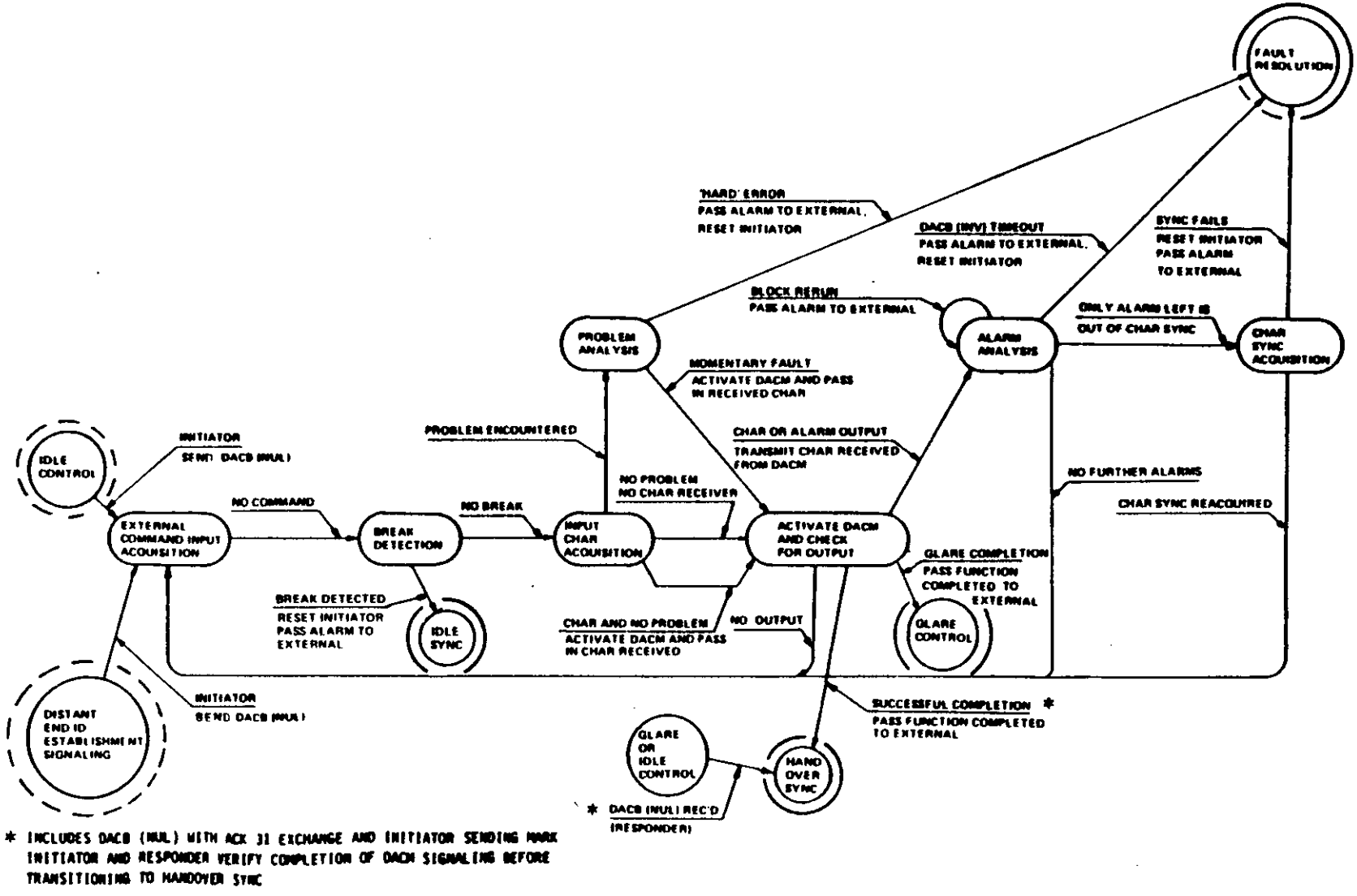


FIGURE 8. Top-level diagram.



* INCLUDES DACB (NUL) WITH ACK 31 EXCHANGE AND INITIATOR SENDING MARK INITIATOR AND RESPONDER VERIFY COMPLETION OF DACM SIGNALING BEFORE TRANSITIONING TO HANDOVER SYNC

FIGURE 9. Call initiation.

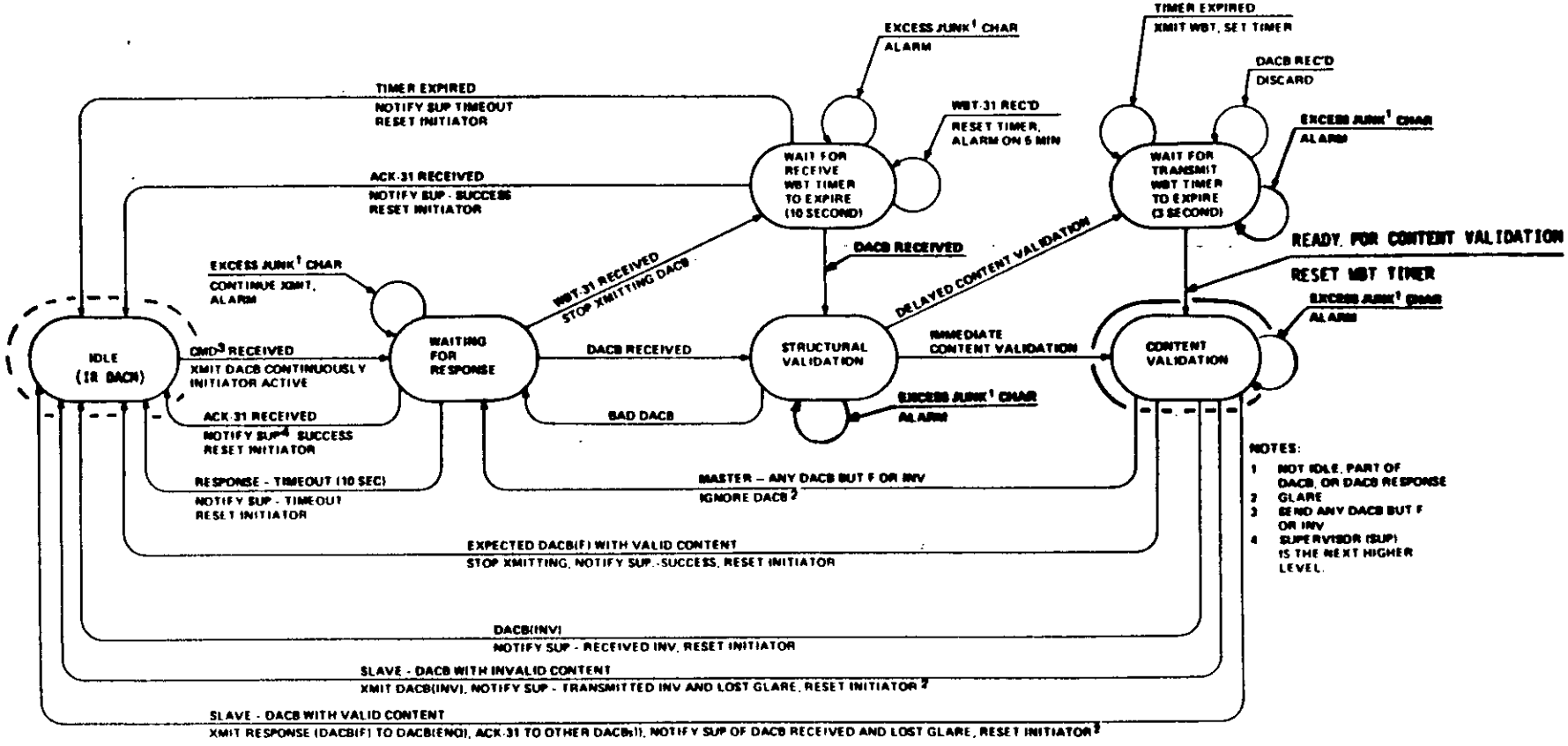


FIGURE 10. DACM initiator.

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LEGEND :

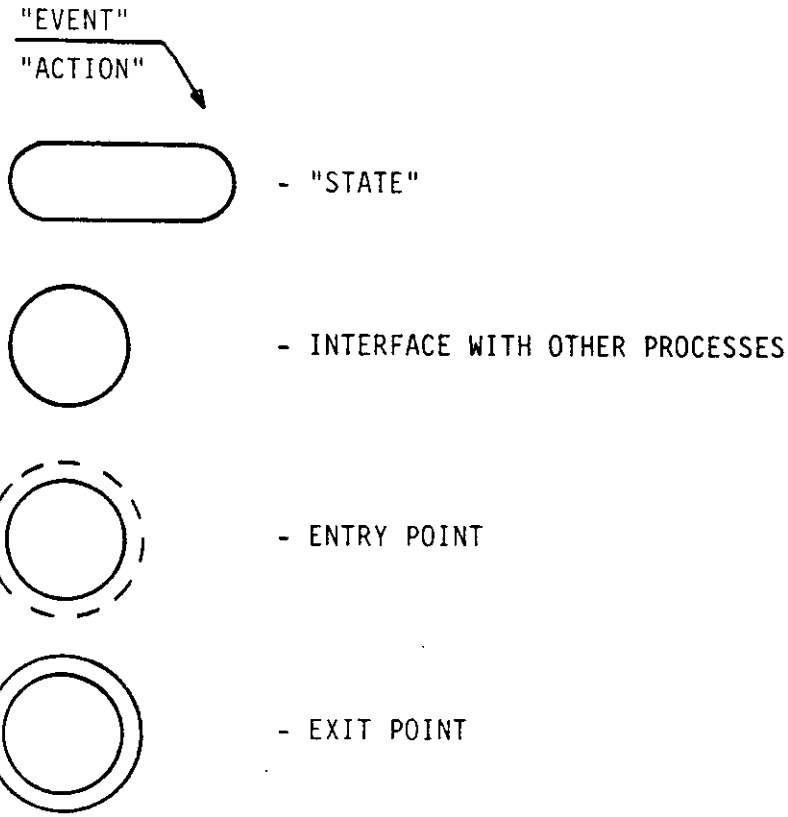

FIGURE 11. Document convention.

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40.2 Introduction to top-level diagram. The top-level diagram (figure 8) divides the DACM protocol into processes and defines the relationships among these processes. These processes fall into several categories defined in the following subparagraphs.

40.2.1 Processes external to the DACM protocol.

a. Connection terminated.
b. Voice state.
c. Crypto synchronization.

40.2.2 DACM protocol subdivisions. The DACM protocol is subdivided into the synchronization process, the DACM protocol process, and other processes. These processes are broken down in subparagraphs 40.2.2.1 through 40.2.2.3.

40.2.2.1 Synchronization process.

a. Idle synchronization.
b. Handover synchronization.
c. Handback synchronization.

40.2.2.2 DACM protocol process.

a. Control
   (1) Idle
   (2) Handback
   (3) Glare.

b. Signaling
   (1) Distant end I.D. establishment
   (2) Call initiation
   (3) Terminate
   (4) Go to voice
   (5) Reject and return to message rate
   (6) Cancel and terminate
   (7) Message finished and continue
   (8) Cancel and continue
   (9) Return to Idle.

40.2.2.3 Other processes.

a. Break generation.
b. Traffic state.
c. Fault resolution.
d. Data base examination.

APPENDIX C

40.3 Introduction to intermediate-level diagram. The processes described in 40.2.1 and 40.2.2 which require a more detailed description have these details provided in intermediate-level diagrams. These diagrams divide the process into functions and their relationships. Although all of these processes have something in common, the DACM protocol and traffic-state processes are similar enough that it is worth while to describe their details generally.

Each process is made up of:

a. Transitions to and from other processes.

b. Communication to and from the high-level functions described in 40.1.

c. Process-dependent functions (DACB signaling, timer functions, etc.).

d. Basic functions.
   (1) External input acquisition.
   (2) Break detection.
   (3) Input line character acquisition.
   (4) Problem analysis.
   (5) Alarm analysis.
   (6) Character synchronization.
   (7) Output line character transmission.

40.4 Relationship of functions. This appendix presents the functions as a serial loop with exits (transactions) to other processes. To simulate simultaneity, an event or lack of event causes transition to the next function (state). This documentation approach neither excludes a simultaneous implementation nor requires a serial implementation. It requires only that all functions be implemented.

APPENDIX C

50. DETAILED REQUIREMENTS

50.1 Details of basic functions.

50.1.1 External input acquisition. This external input acquisition function covers the input of commands and data base parameters. A command is an external input (see 40.1) requesting a function to be performed by DACB signaling or traffic signaling (examples - cancel, reject, go to idle, and terminate). The commands can cause transition to another process or actions within this process. An example of action within the process is message cancellation. An example of transition to another state command is leave traffic state.

50.1.2 Break detection. See 5.2.7.2.

50.1.3 Input line character acquisition. This is the process of decoding the bits received and transforming them into characters. Some of the possible errors which may be encountered are listed in 5.3.1.1, 5.3.1.4, and 5.3.1.5. This function is also assigned (for documentation purposes) the task of detecting the incoming DC4s that force handback (see 5.2.6).

50.1.4 Problem verification. This is a process-independent function. It determines whether any errors of input line character acquisition are "hard" or are the product of a momentary line disturbance (see 5.3.2).

50.1.5 Alarm analysis. This is a process-dependent function. Different processes have different alarms. Alarm processing falls into four categories.

a. Fatal - cause alarm and exit from process.

b. Non fatal - cause alarm but do not exit from process.

c. Loss of character synchronization.

d. No alarms.

50.1.6 Character synchronization. See 5.3.1.5.

50.1.7 Output line character transmission. This is the process of transforming a character into encoded bits and transmitting them.

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50.2 Synchronization processes. See 5.3.1.

50.2.1 Idle synchronization. This process (figure 12) is used to establish character synchronization at the link idle rate of 2400 pbs (information rate). Only multisampling is used for rate conversion and error correction. Idle synchronization may be preceded by the following processes, for which initiator and responder relationships are defined to resolve potential glare.

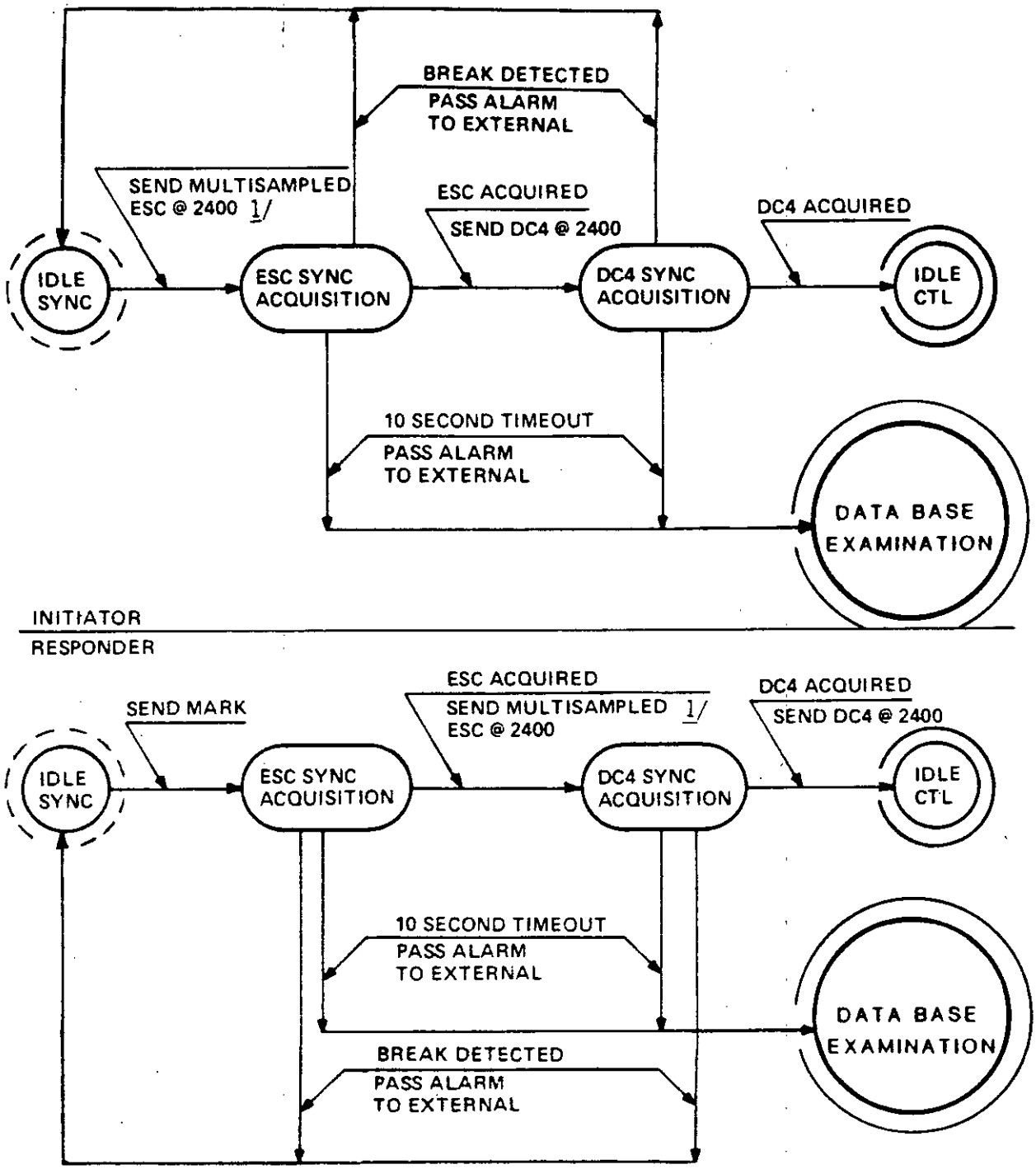
a. Call initiation - The master is the initiator and the slave is the responder for the idle synchronization process.

b. Break sequence - Regardless of who initiates the break sequence, afterwards the master is the initiator of the idle synchronization process. The slave is the responder for the idle synchronization process.

c. DACB sent - The initiator is the DA/MS successfully transmitting the DACB (i.e., DACB is ACKed), independent of the master/slave relationship.

d. Fault resolution and cryptographic synchronization - The master is the initiator and the slave is the responder for the idle synchronization process.

50.2.2 Handover synchronization. This process (figures 13, 14, and 15) is used to progress from the current DACM state to the traffic state (where subscriber messages are exchanged). This progression involves a step-by-step handshaking procedure between the two DA/MSs, wherein the old set of rate conversion and error correction procedures and COMSEC operation are exchanged for those required in the new traffic state. When handover synchronization is successfully completed, the link will be in character synchronization with the idle character to be used in the traffic state. The MS/DA successfully transmitting the DACB that initiates handover synchronization is the initiator, independent of the master/slave relationship.



1/ If loop rate greater than 2400 bps

FIGURE 12. Idle synchronization.

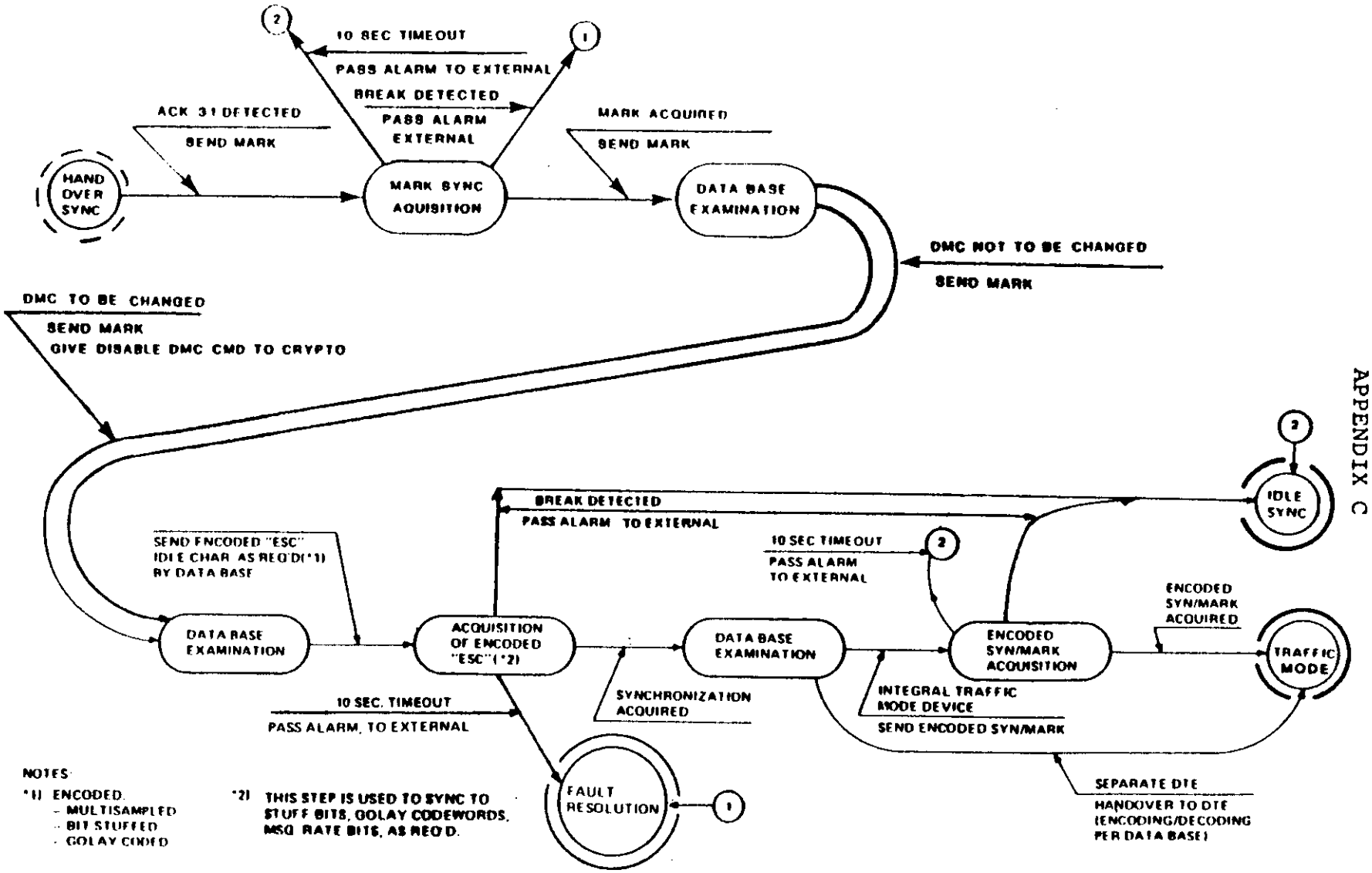


FIGURE 13. Handover synchronization - initiator.

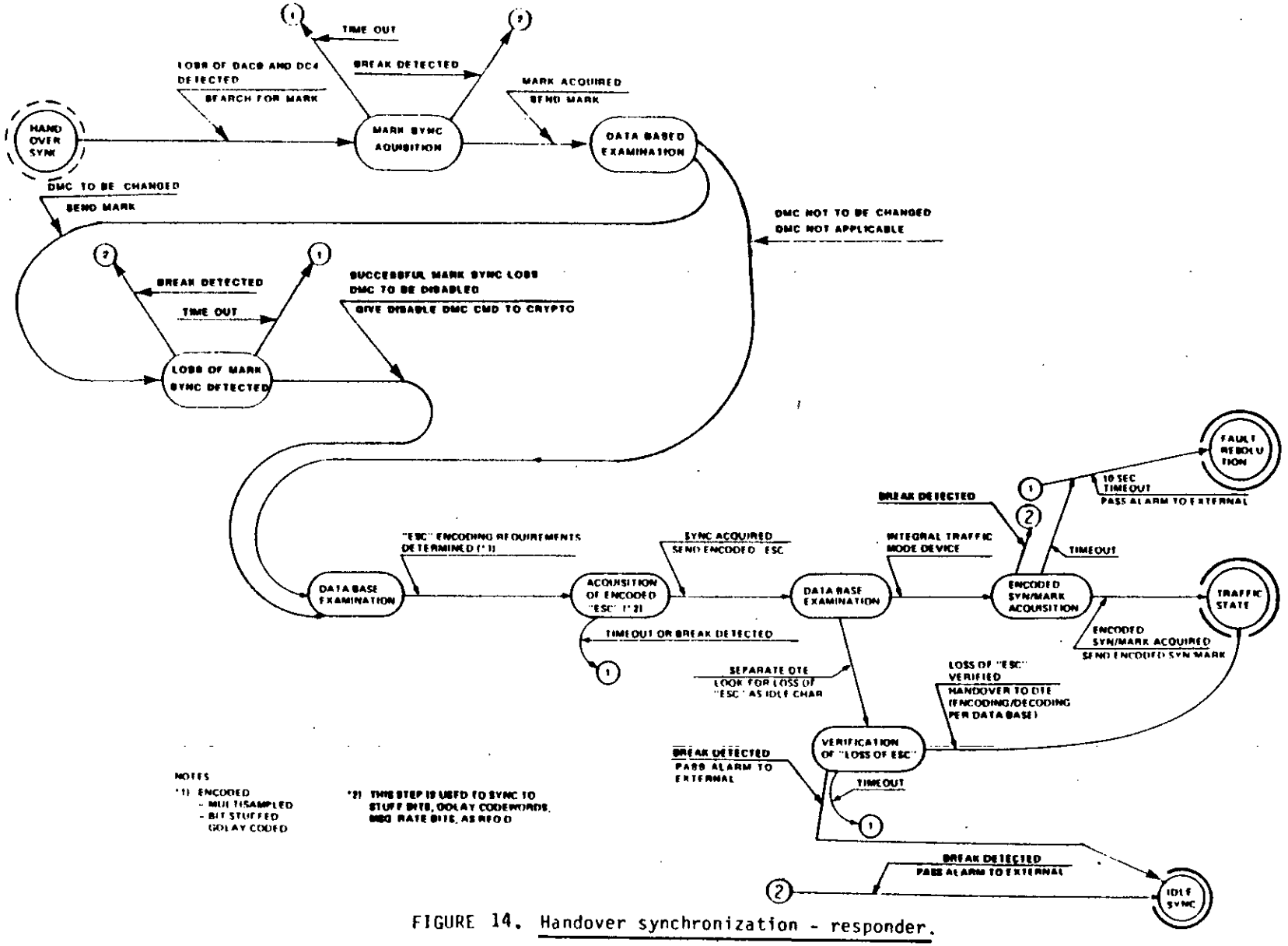
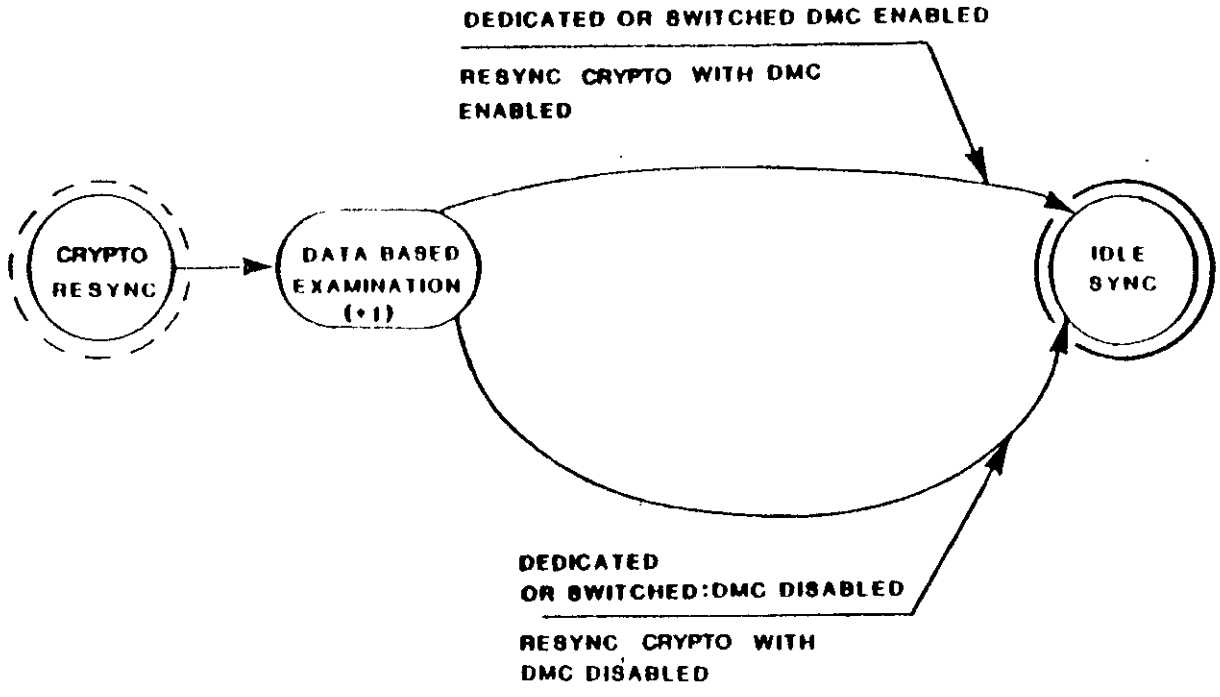


FIGURE 14. Handover synchronization - responder.



NOTE:
(•1) DATABASE INCLUDES CHARACTERISTICS SPECIFIED IN DACB EXCHANGE

FIGURE 15. Crypto resynchronization state.

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50.2.3 Handback Synchronization. This process (figure 16) is used to leave the current traffic mode and go back to DACM. However, the methods of rate conversion and error correction which were in use in the described traffic state remain in use. The idle pattern is DC4. The lower levels of synchronization (Golay, bit stuff, and framing) which where in effect in the traffic state are maintained during handback synchronization. Only character synchronization shall be done and a transition between traffic mode and DACM shall be made. Either the master or the slave may initiate handback synchronization.

50.3 DACM protocol processes

50.3.1 Control processes. In addition to the basic functions provided by all DACM processes, the control processes provide the transition between signaling and synchronization processes. The transition is caused either by an external command or a received DACB.

50.3.1.1 Idle control. This process is used at idle rate when DA/MS is waiting for something (an external input or received DACB) to transition it to a signaling process (see figure 17).

50.3.1.2 Handback control. This process is used at the message rate when the DA/MS is waiting for an external input or received DACB to send it to a signaling process (see figure 18).

50.3.1.3 Glare control. A glare situation exists when both ends of a line try to initiate DACB signaling. Glare is recognized by the end that cannot complete its signaling (the loser). Glare control is an approach to allow the loser to transfer to the signaling process desired by the winner.

50.3.2 Signaling processes. The DACB signaling processes provide for a transition to the next state. The transition is dependent upon:

a. signaling success or failure
b. signaling type and the DACM signaling function.

50.3.2.1 Distant end I.D. establishment. See figure 19.

50.3.2.2 Call initiation. See figure 9.

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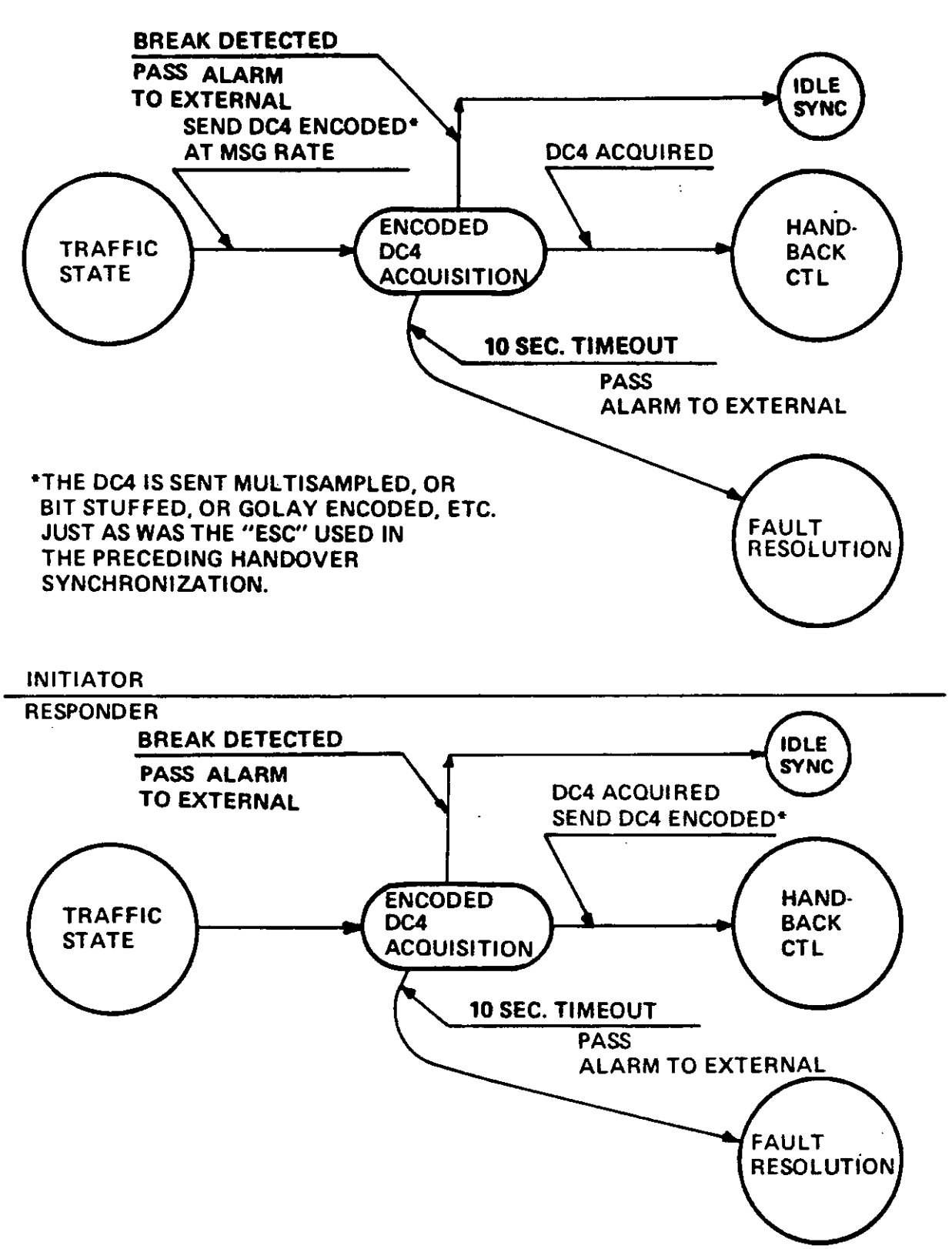
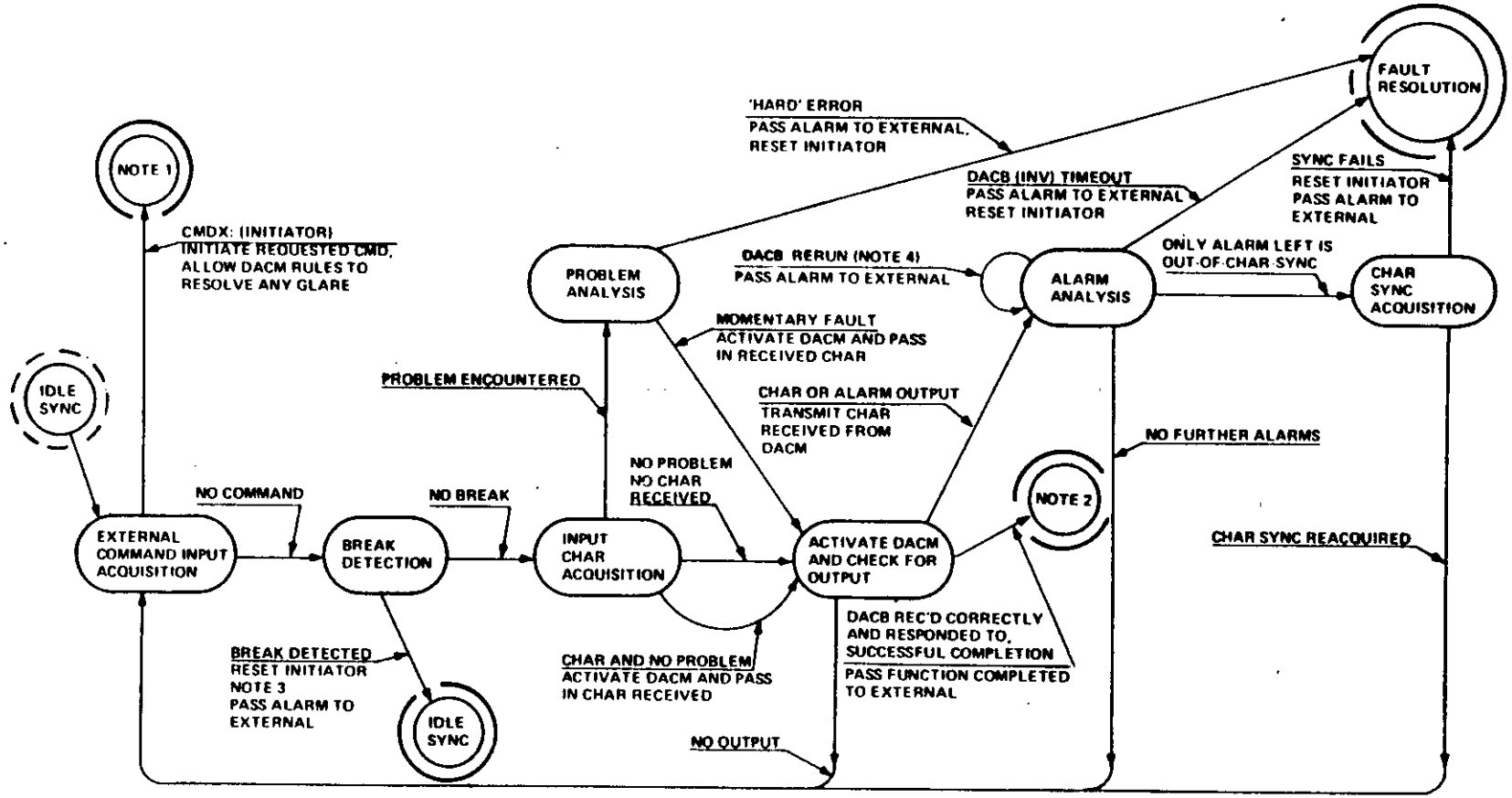


FIGURE 16. Handback synchronization.



NOTE 1: THIS IS ANY OF THE FOLLOWING STATES
- TERMINATE
- GO TO VOICE
-- CALL INITIATION
- DISTANT END ID ESTABLISHMENT

NOTE 2: THIS STATE IS THE SUCCESSFUL COMPLETION EXIT OF ANY OF THE ABOVE

NOTE 3: SEE 50.5.1.1 FOR EXPLANATION OF RESET INITIATOR

NOTE 4 TWO DIFFERENT DACBs ANSWERED BY DACB(INV). THE DACBs ARE OF THE SAME TYPE

FIGURE 17. Idle control.

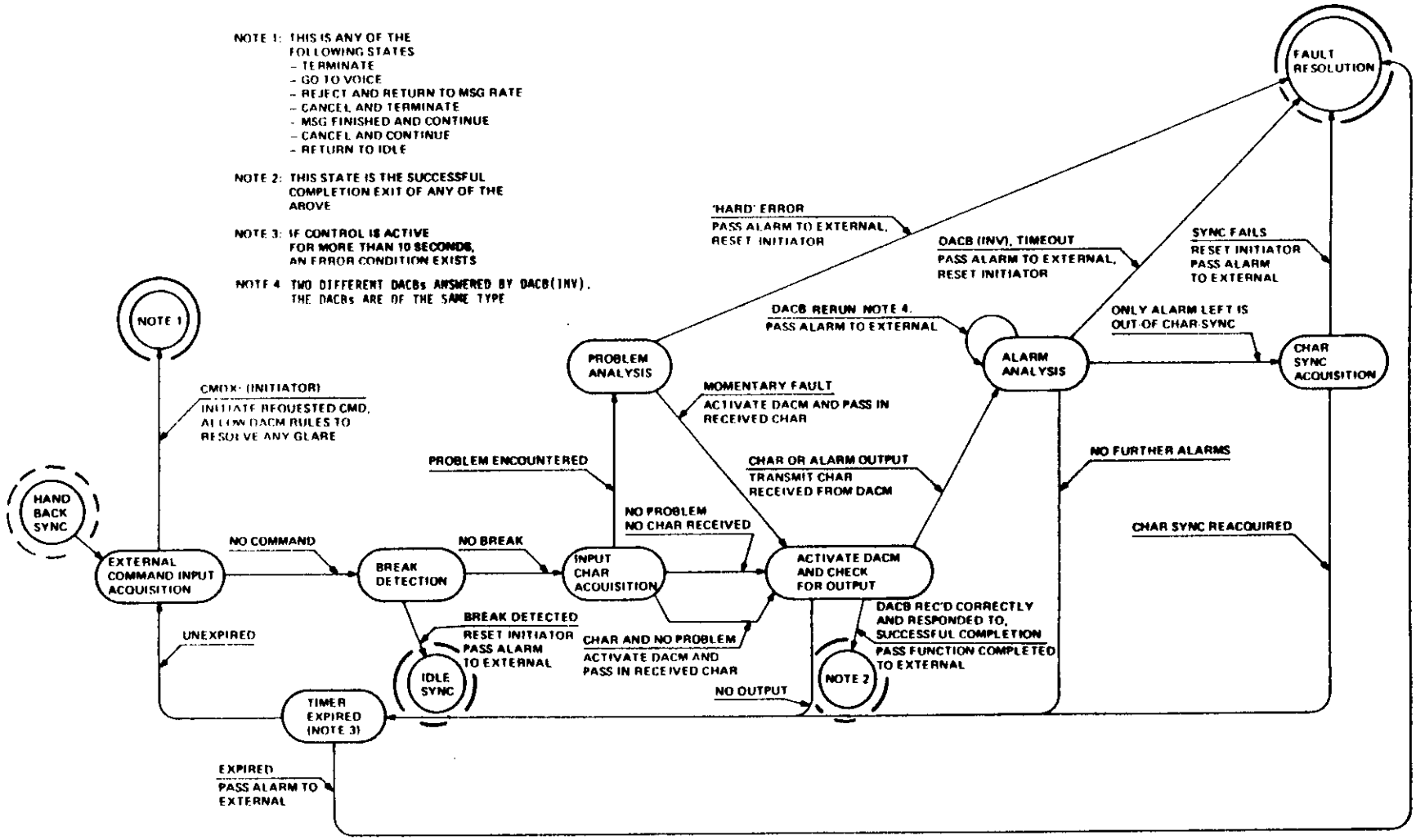


FIGURE 18. Handback control.

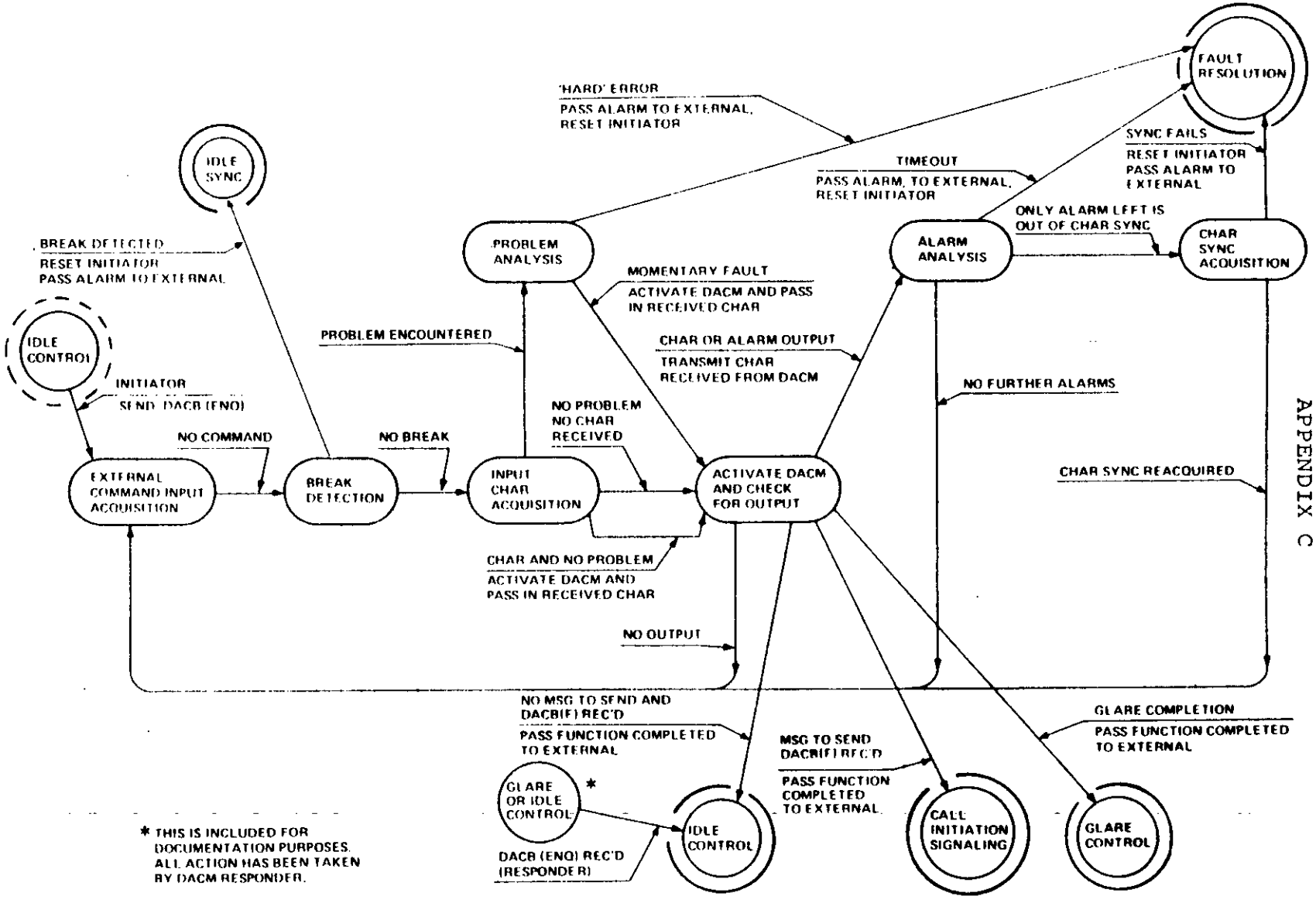


FIGURE 19. Distant end ID establishment initiator.

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50.3.2.3 Terminate. See figure 20.

50.3.2.4 Go to voice. See figure 21.

50.3.2.5 Reject and return to message rate. See figure 22.

50.3.2.6 Cancel and terminate. See figure 23.

50.3.2.7 Message complete and change characteristics. See figure 24.

50.3.2.8 Cancel and continue with new characteristics. See figure 25.

50.3.2.9 Return to idle. See figure 26.

50.4 Others.

50.4.1 Break generation. This process is used to force idle synchronization when normal processing has failed to obtain successful synchronization. Break generation is passed as an alarm to external. Break generation can be accomplished as described in 5.2.7.

50.4.2 Traffic state. The purpose of figure 27 is to show the general functions affecting the overall processing of message data. This figure shows the internal processing of the traffic mode activation state shown on the intermediate-level diagram. The type of alarms generated by the lower-level processing functions will cause the alarm analysis state to determine if the traffic mode state can continue normal message processing or if termination may be required by the fault resolution state.

50.4.3 Fault resolution. The purpose of this process is to determine if the connection will continue or be released. The basis for the decision is as shown in 5.3.3.1 and 5.3.3.2 for time-outs.

50.4.4 Data base examples. The purpose of this process is to determine the action to be taken depending on both the fixed line characters and the information specified in the last DACB transaction.

50.4.5 Line initialization. The purpose of this process is to allow for delays in establishment of the data connection and to provide for initial COMSEC synchronization.

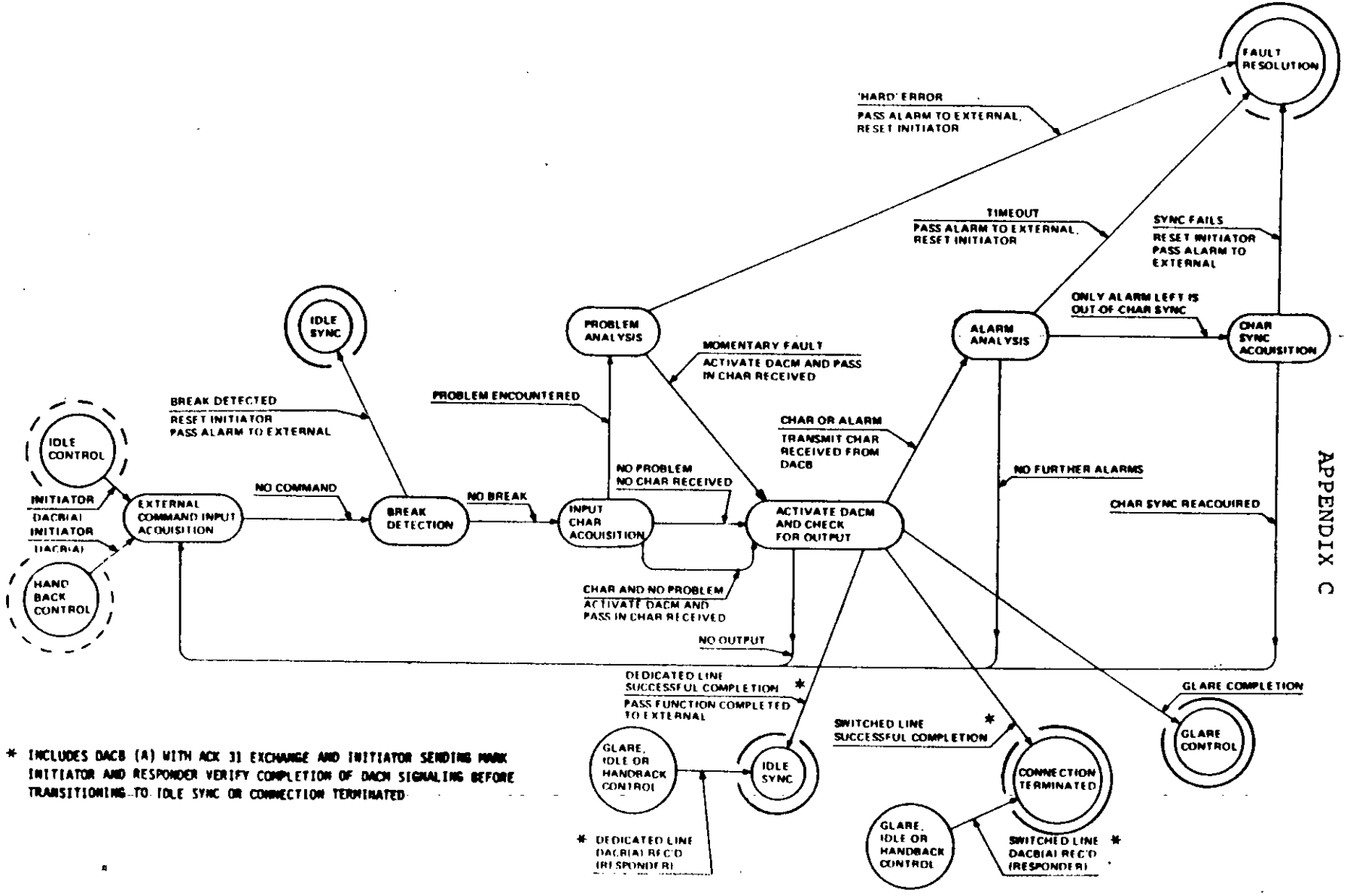
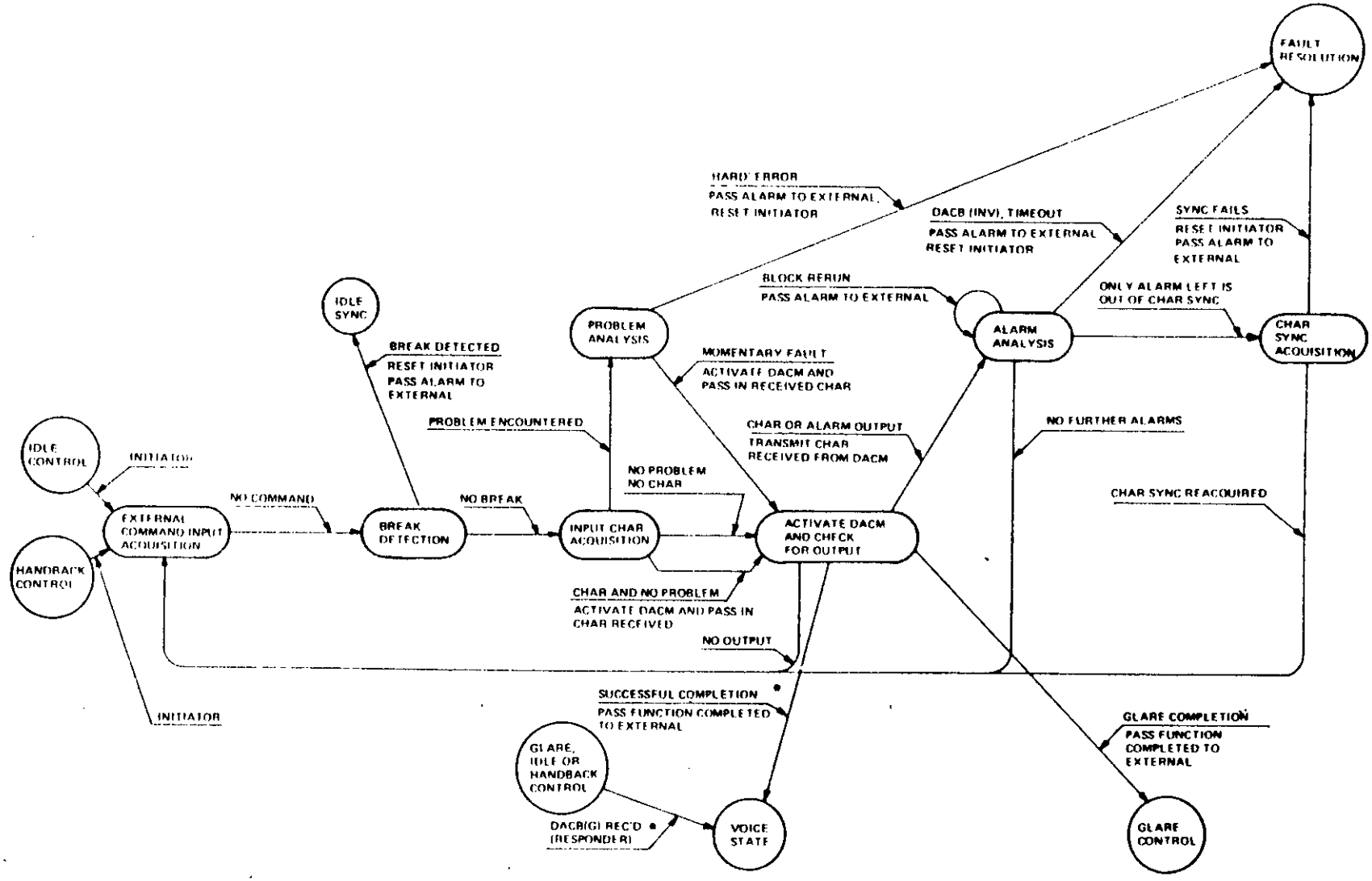


FIGURE 20. Terminate.



* INCLUDES DACB (G) WITH ACK 31 EXCHANGE AND INITIATOR SENDING MARK INITIATOR AND RESPONDER VERIFY COMPLETION OF DACM SIGNALING BEFORE TRANSITIONING TO VOICE STATE

FIGURE 21. Go to voice.

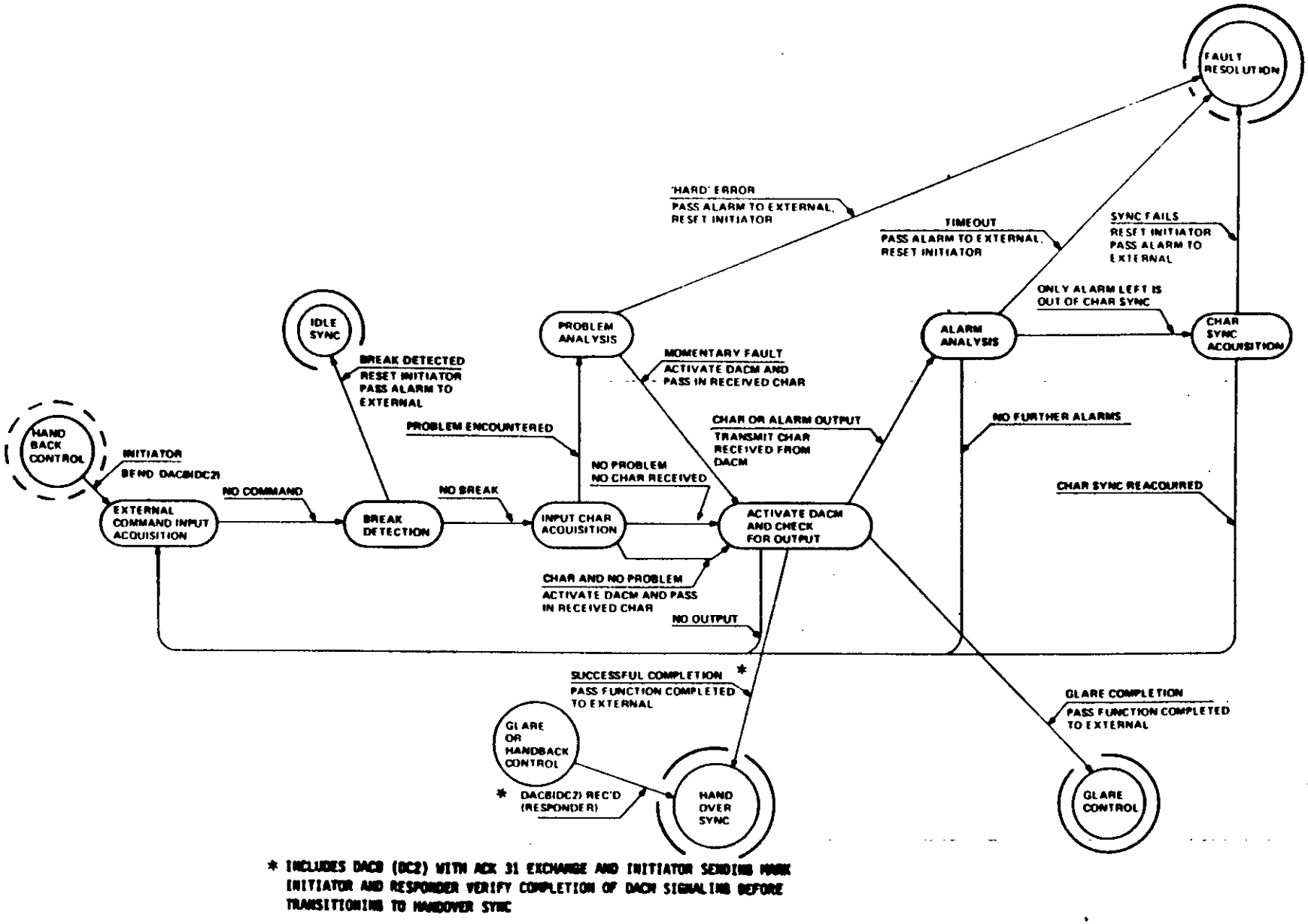


FIGURE 22. Reject and return to MSG rate.

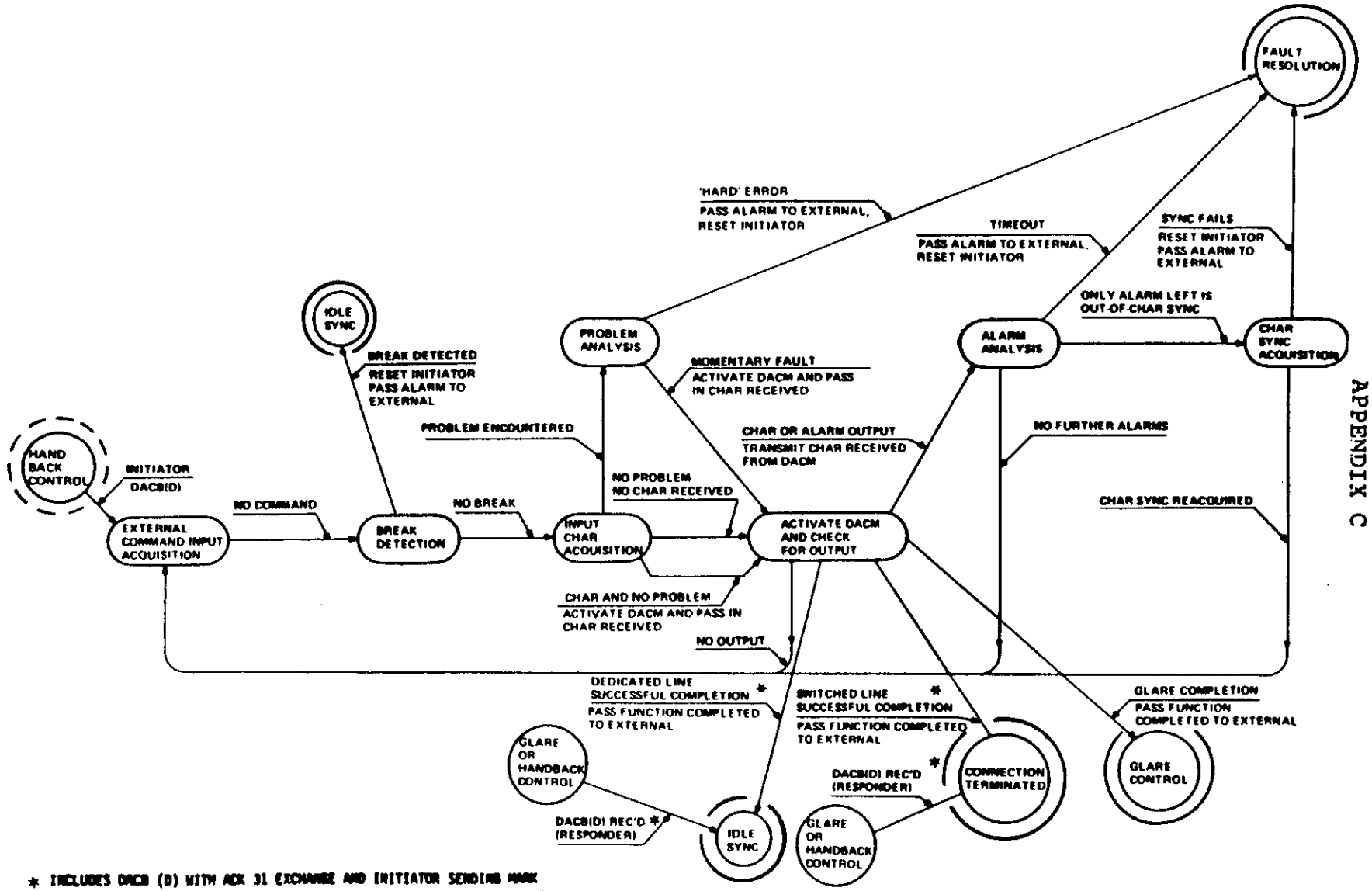


FIGURE 23. Cancel and terminate.

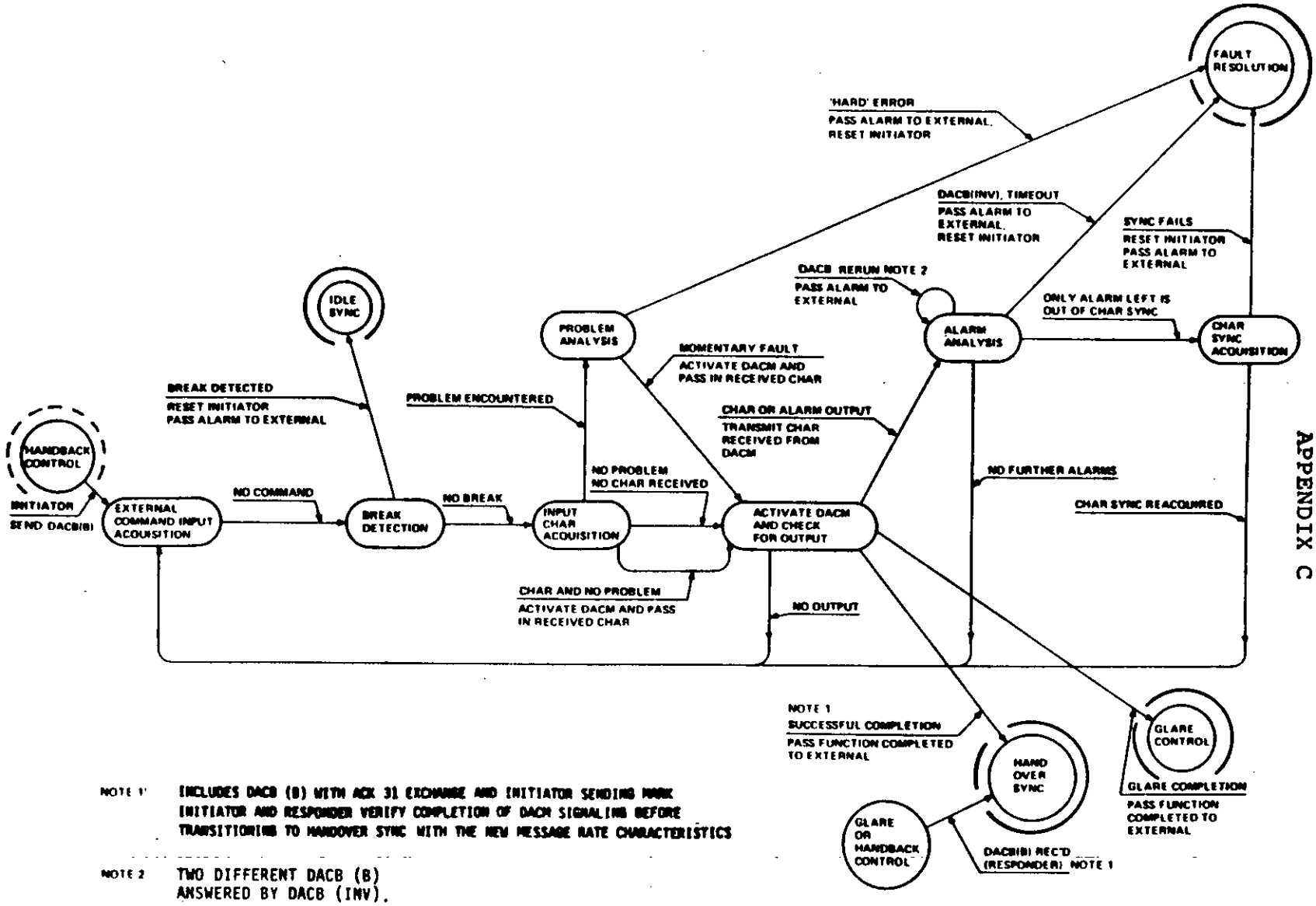
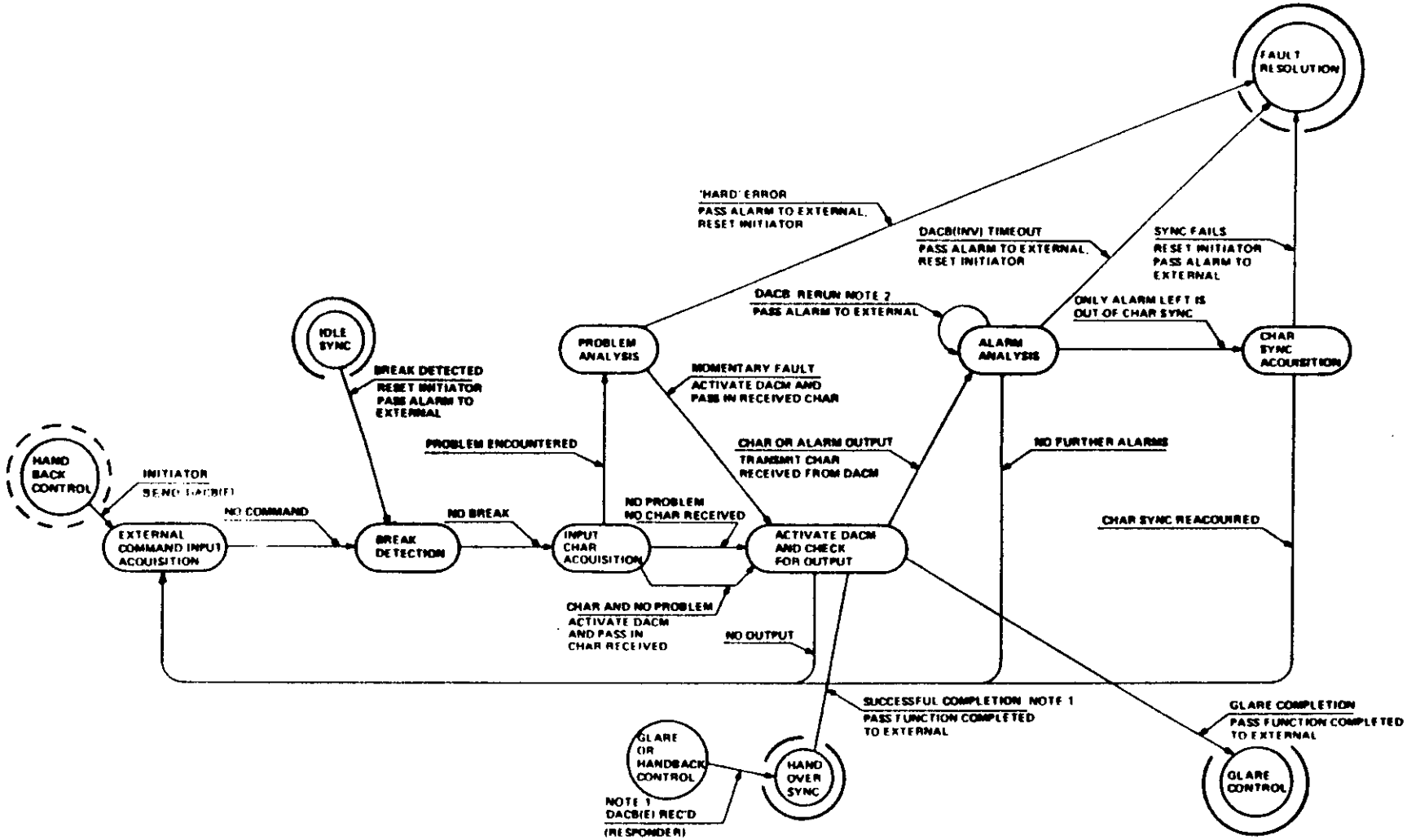


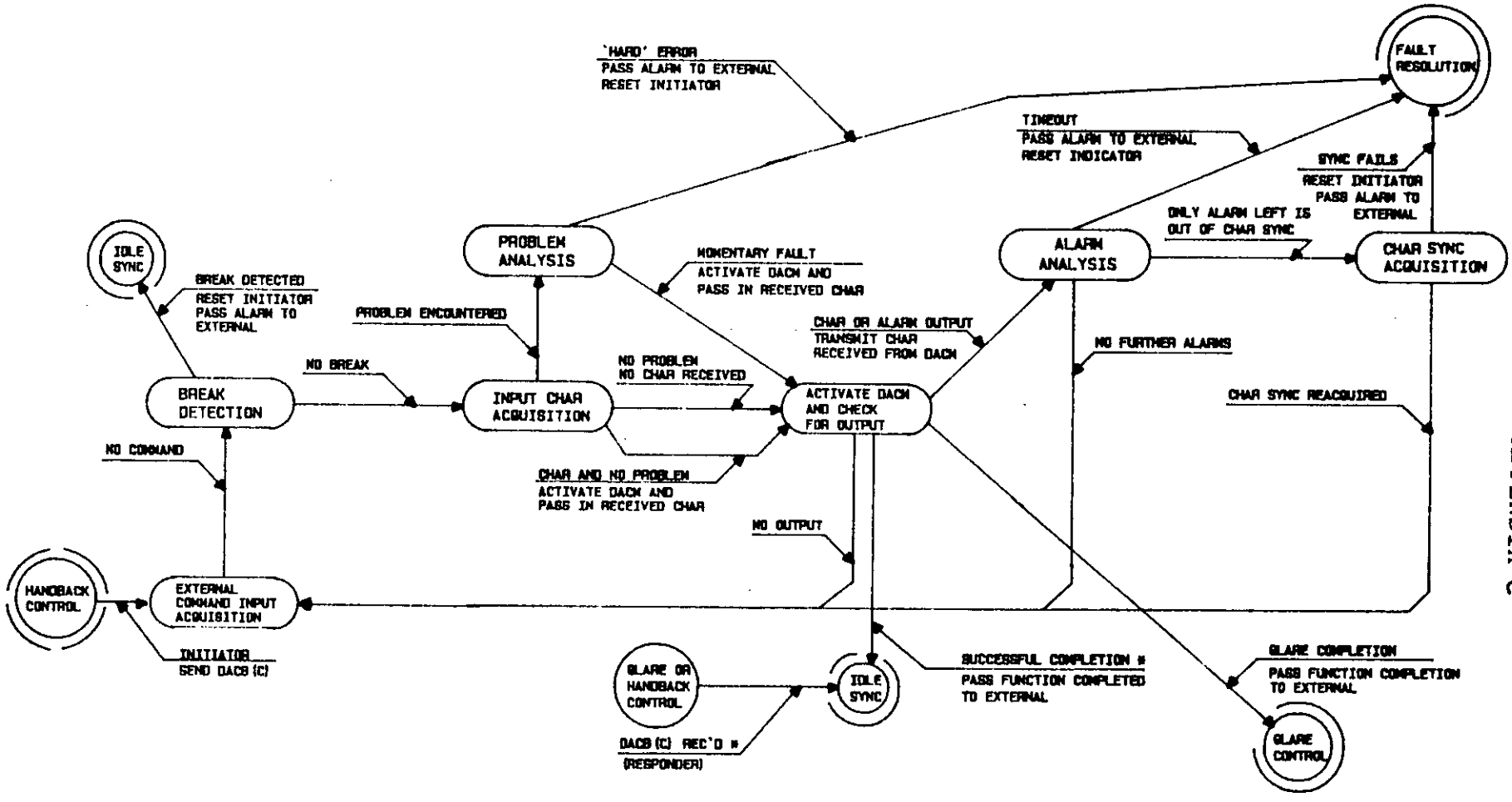
FIGURE 24. Message complete and change characteristic.



NOTE 1: INCLUDES DACB (E) WITH ACK 31 EXCHANGE AND INITIATOR SENDING MARK INITIATOR AND RESPONDER VERIFY COMPLETION OF DACM SIGNALING BEFORE TRANSITIONING TO HANDOVER SYNC

NOTE 2: TWO DIFFERENT DACB (E) ANSWERED BY DACB (INV)

FIGURE 25. Cancel and continue new call characteristics.



* INCLUDES DACB (C) WITH ACK 31 EXCHANGE AND INITIATOR SENDING MARK INITIATOR AND RESPONDER VERIFY COMPLETION OF DACH SIGNALING BEFORE TRANSITIONING TO IDLE SYNC

FIGURE 26. Return to idle.

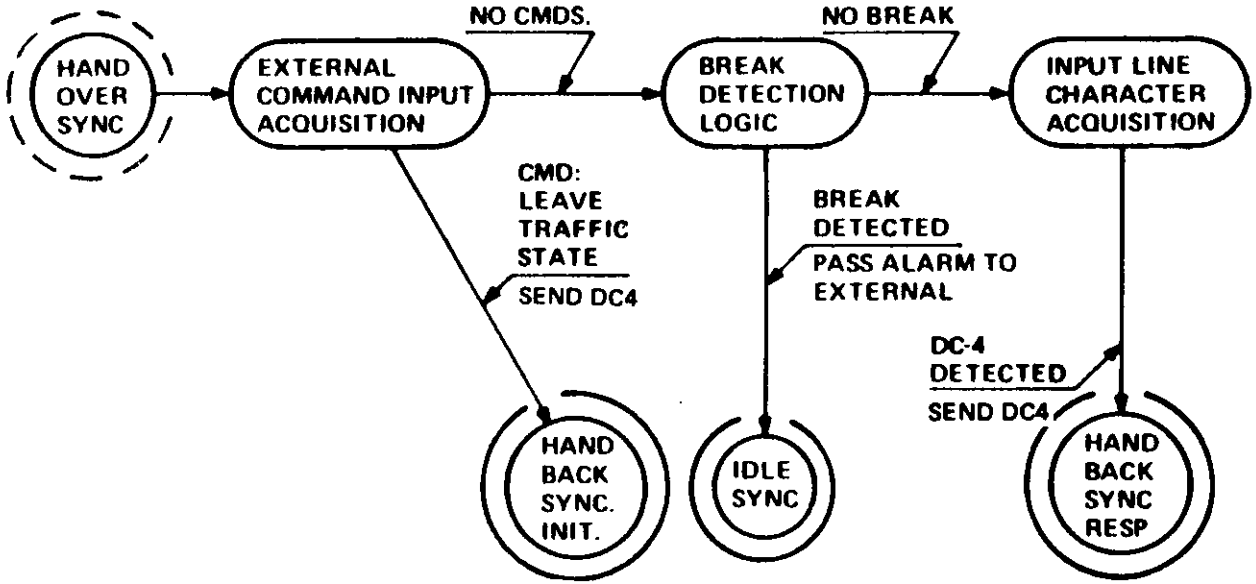


FIGURE 27. Intermediate level diagram traffic state.

APPENDIX C

50.5 Lower-level diagrams.

50.5.1 Data adapter control mode. DACM is a signaling method which translates process requests to output DACBs and input DACBs to process requests. The process requests are those listed under DACM protocol processes (signaling) (see 50.3). Only one may be active at a time because of the nature of these process requests. The majority of the requests require transition to another state. If more than one were processed simultaneously, the next state could be indeterminate. It is the responsibility of the process requestor (an external function) to have only one request outstanding. It is the responsibility of DACM to resolve a process request and an incoming DACB (which signals a request from the distant end). The rules for translating a process request to DACM signaling are referred to as DACM initiator (see figure 10). The rules for translating a DACB received to a process request are called DACM responder (see figure 28). The function of deciding which set of rules applies is called the DACM arbiter.

50.5.1.1 DACM arbiter. The rule for the DACM arbiter is simple. If the initiator function is not active, the responder function is active. The initiator function is made active whenever a CMD is received. The initiator function is made inactive (reset) whenever:

a. DACM signaling is successfully completed.

b. DACM signaling backs down because of glare.

c. DACM signaling is not completed due to exit for reasons external to DACM rules, such as break detection or exit for failures covered by DACM rules.

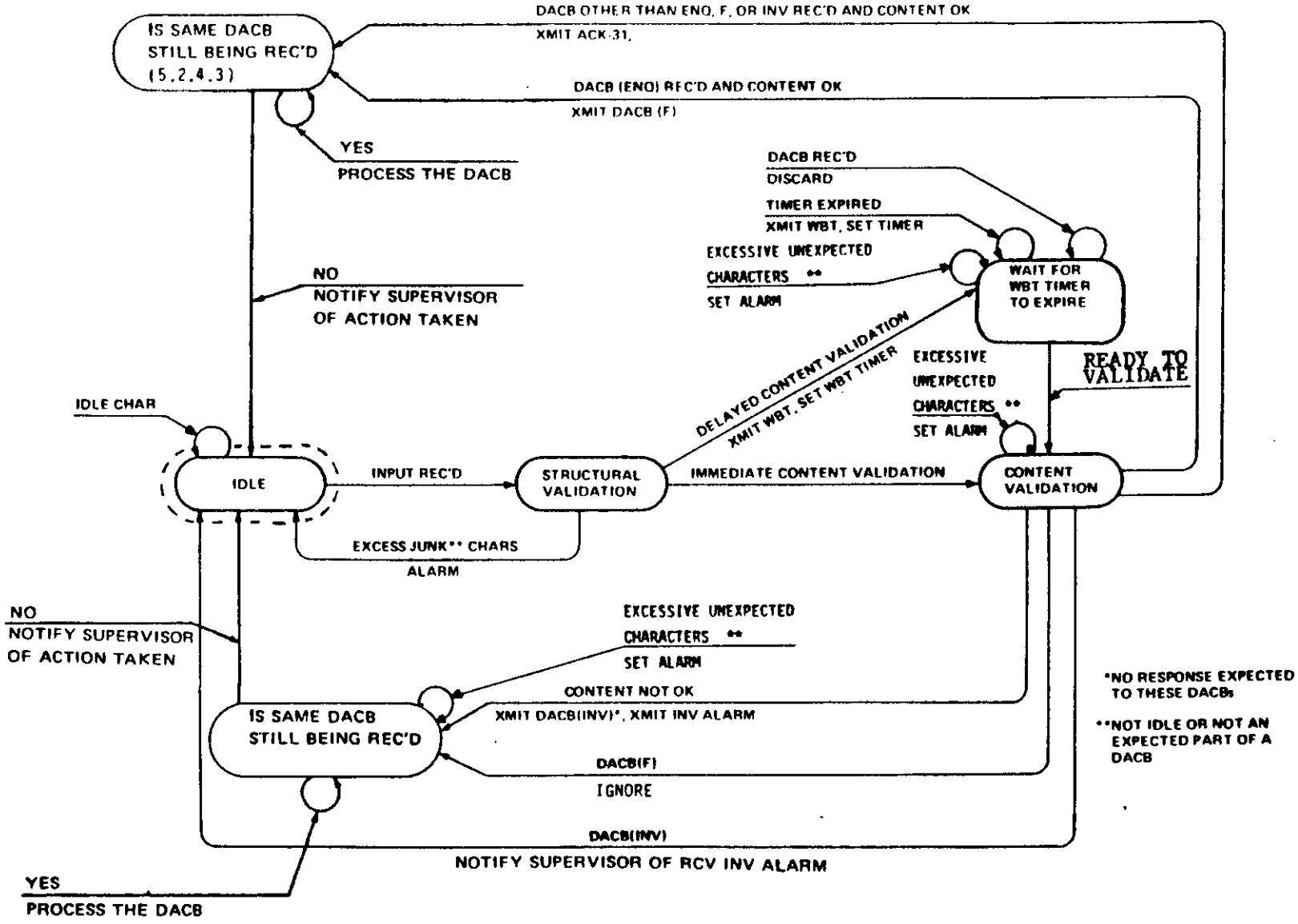


FIGURE 28. DACM responder.

APPENDIX C

50.5.1.2 DACM initiator. When a CMD is received, transmission of the proper DACB is initiated. The DACB is transmitted continuously until:

a. An answer is received. An answer is defined as:

(1) ACK 31.
(2) WBT 31.
(3) Response DACB. See responder for description of DACB validation.

b. A time-out occurs.

c. A glare is detected.

d. Transmission is terminated.

50.5.1.3 DACM responder. When a valid DACB is received, it is acknowledged and the process it requested is communicated to a higher level.

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APPENDIX D

GOLAY CODING FOR DACM AND MESSAGE TRAFFIC

Appendix D contains specific information in support of MIL-STD-188-216. Appendix D is not a mandatory part of this document.

APPENDIX D

10. GENERAL

10.1 Purpose. The purpose of this appendix is to explain how Golay coding is used for DACM and message traffic.

10.2 Scope. This appendix contains information pertaining to Golay coding that will assist the user in better understanding its relationship with the main body of this document.

20. APPLICABLE DOCUMENTS

Not applicable.

30. DEFINITIONS

For purpose of this appendix, the definitions of section 3 of this document and FED-STD-1037 shall apply.

APPENDIX D

40. GENERAL REQUIREMENTS

40.1 Forward error correction (FEC) capability. FEC is capable of being utilized for data rate transformations listed in table XXVIII. For start-up data, Golay Coding can only be utilized with data which are bit synchronized to the DA clock and have integral bit length start-stop bits.

40.1.1 The 1/2 rate Golay code. The 1/2 rate Golay code is based on use of the 23 12-Golay code, extended to 24 bits total length by addition of a zero bit. The transmitting DA/MS shall use the following generator polynominal.

$$g(x) = X^{11} + X^{10} + X^6 + X^5 + X^4 + X^2 + 1.$$

After deriving the 11 check bits by division of the 12 net information bits by the above polynominal, the twenty-fourth bit is set to zero. Transmission of the resulting 24 bit codeword shall constitute 1/2 rate Golay code transmission (see figures 29 and 30). Bit 1 of the 24 bit FEC codeword is bit 1 (b_1) or bit 5 (b_5) of a DACM character. DACM characters are the ESC, DC4, DACB characters, and DACB acknowledgments. Bit 1 of the 24 bit FEC codeword is bit 1 (b_1) or bit 5 (b_5) of the Mode I or Mode VI characters (data, control, framing, sync, ACKs, CAN, CAK, etc.).

40.1.2 Double codeword transmission. Double codeword transmission (1/4 rate Golay) is the transmission of a 1/2 rate Golay codeword twice contiguously (see figure 31).

40.1.3 Quadruple codeword transmission. Quadruple codeword transmission (1/8 rate Golay) is the transmission of a 1/2 rate Golay codeword four times contiguously (see figure 31).

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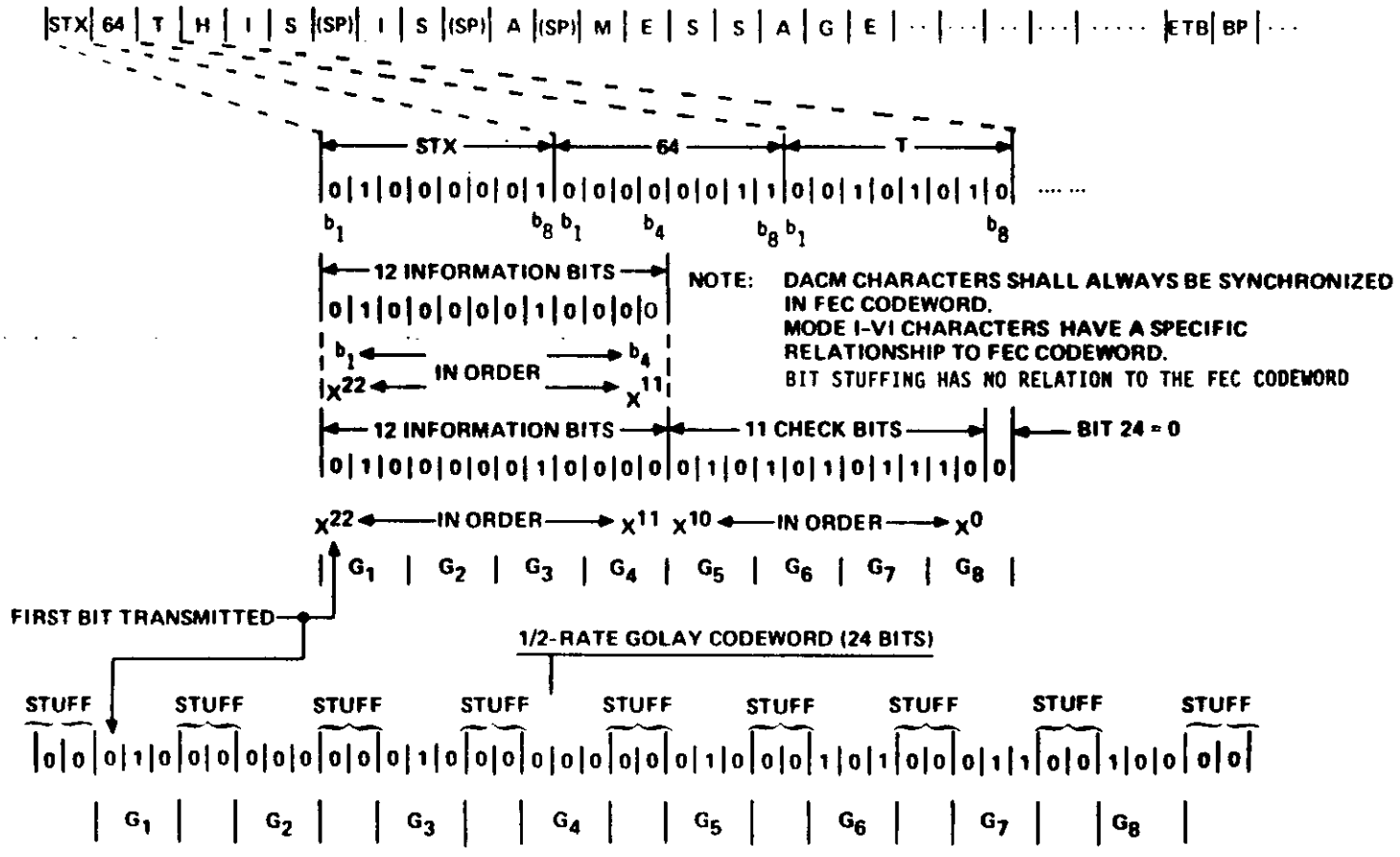
TABLE XXVIII. Forward error correcting technique.

Loop Transmission Rate (b/s)	Information Rate (Bauds) (Bit Synchronous)	FEC TECHNIQUE Golay Code
2400	300 600 1200	Quadruple Codeword (1/8 Rate) Double Codeword (1/4 Rate) Half Rate (1/2 Rate)
4800	600 1200 2400	1/8 Rate 1/4 Rate 1/2 Rate
9600	1200 2400 4800	1/8 Rate 1/4 Rate 1/2 Rate
16000	1200 2400 4800 2000 4000 8000	1/8 Rate, Stuffed to 16000 1/4 Rate, Stuffed to 16000 1/2 Rate, Stuffed to 16000 1/8 Rate 1/4 Rate 1/2 Rate
32000	2400 4800 9600 4000 8000 16000	1/8 Rate, Stuffed to 32000 1/4 Rate, Stuffed to 32000 1/2 Rate, Stuffed to 32000 1/8 Rate 1/4 Rate 1/2 Rate

[1] Error-Correcting Codes, by W. Wesley Peterson and E.J. Weldon, Jr., The MIT Press, Second Edition, 1972.



1/2 - RATE GOLAY BIT STUFFED CODEWORD (40 BITS)*

* - BIT STUFFING PERFORMED AFTER FEC ENCODING
BIT DESTUFFING PERFORMED PRIOR TO DECODING

FIGURE 29. 1/2 rate Golay codeword generation.

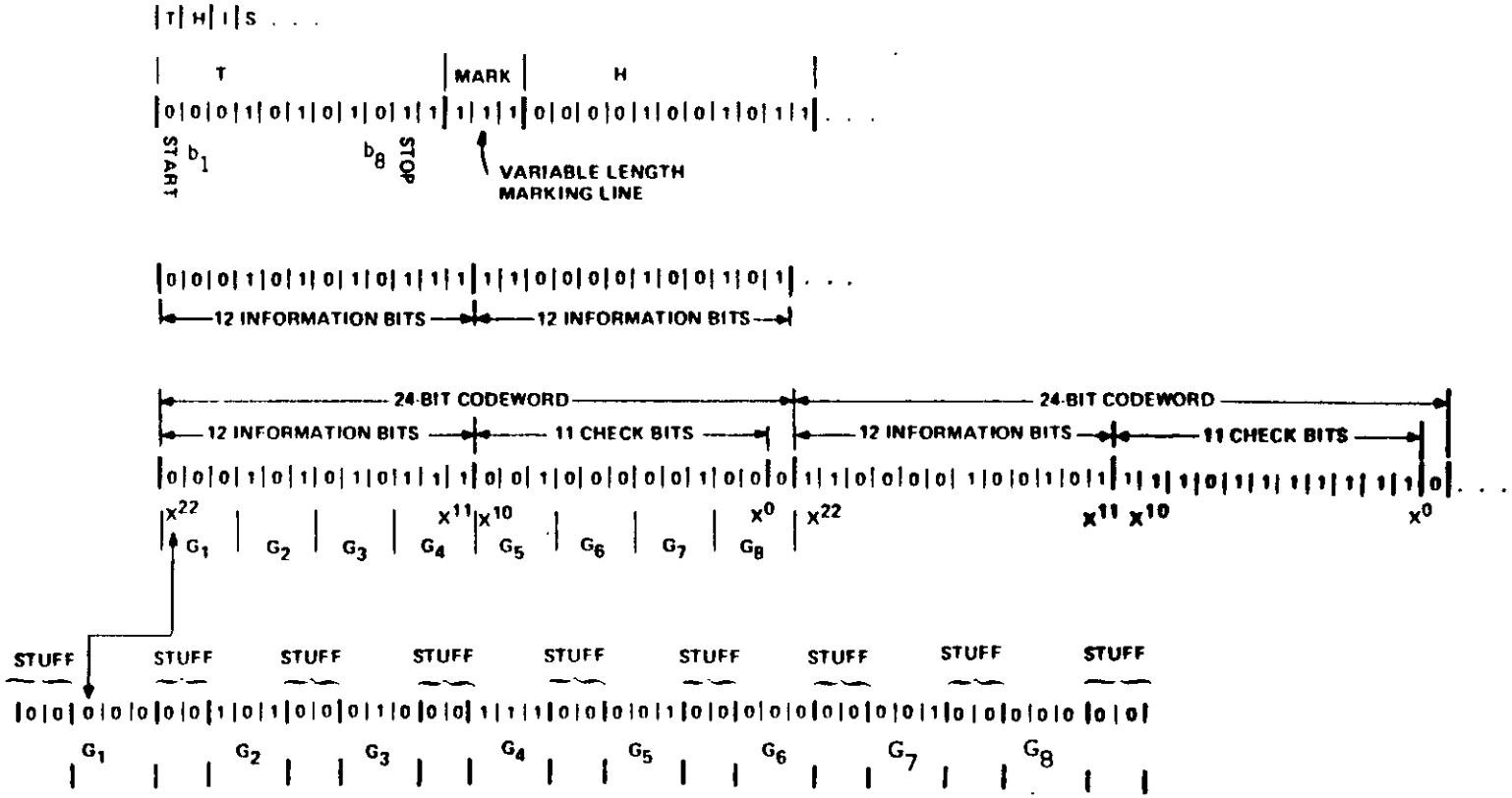
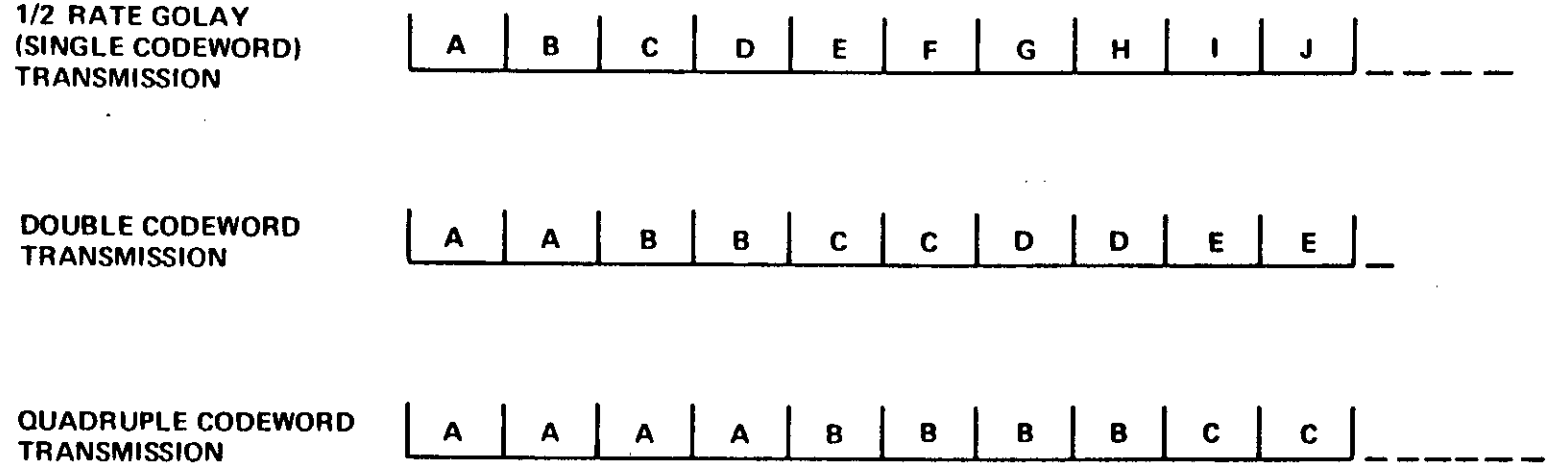


FIGURE 30. Start-stop example 1/2 rate Golay codeword generation (ASCII, 2 stop bits).



A,B,C,. . . . . ARE 1/2 RATE GOLAY CODEWORDS.

CODEWORDS ARE EITHER NOT STUFFED (24 BIT) OR STUFFED (40 BIT) AS REQUIRED FOR DTE TO LOOP TRANSFORMATION (SEE TABLE I).

CODEWORD BITS ARE SINGULARLY SAMPLED AT LOOP BIT RATE.

FIGURE 31. Types of codeword transmission.

CONCLUDING MATERIAL

Custodians:

Army - SC

Navy - EC

Air Force - 90

DCA - DC

Review Activities:

Army - AC

Navy - NC, TD, OM

Air Force - 02, 17

DCA

DODECAC

User Activities:

Army - CR

Navy - MC

Air Force - 13

DCA

Preparing Activity:
DLA - JT
JTC^{3}A-JT
(Project TCTS-2610)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-188-116	Interoperability Standards for Information and Record Traffic E

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*:

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

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