

MIL-STD-188-203-2

23 MARCH 1984

**MILITARY STANDARD**

**SUBSYSTEM DESIGN AND ENGINEERING**

**STANDARDS FOR**

**TACTICAL DIGITAL INFORMATION**

**LINK (TADIL) B**



**TCTS**

**NO DELIVERABLE DATA REQUIRED BY THIS DOCUMENT**

MIL-STD-188-203-2  
23 March 1984

DEPARTMENT OF DEFENSE  
Washington, DC 20301

Subsystem Design and  
Engineering Standards  
for Tactical Digital  
Information Link (TADIL) B  
MIL-STD-188-203-2

1. This Military Standard is approved and mandatory for use by all Departments and Agencies of the Department of Defense, in accordance with the Memorandum of the Office of the Under Secretary of Defense for Research and Engineering, dated 16 August 1983. (See Appendix A.)
2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to:

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

## FOREWORD

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

2. 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).

3. As a result of a Joint Chiefs of Staff (JCS) action, standards for all military communications are now being published in a MIL-STD-188 series of documents. Military communications system technical standards are subdivided into common long haul/tactical standards (MIL-STD-188-100 series), tactical standards (MIL-STD-188-200 series) and long haul standards (MIL-STD-188-300 series).

4. This document is the result of another JCS action requiring that the technical characteristics of the TADIL A, B and C, previously contained in JCS Publication (PUB) 10, be updated and published in the MIL-STD-188 series of standards. The MIL-STD-188 series will not contain TADIL message standards and related information. These requirements will continue to be contained in revisions of JCS PUB 10.

5. The technical characteristics of the TADIL A, B and C are published in the MIL-STD-188-203 series, subdivided as follows:

MIL-STD-188-203-1 containing TADIL A,  
MIL-STD-188-203-2 containing TADIL B, and  
MIL-STD-188-203-3 containing TADIL C.

It is intended that the technical characteristics of other TADIL currently under development, such as the Joint Tactical Information Distribution System (JTIDS), will be included in the MIL-STD-188-203 series.

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## IDENTIFICATION OF INTERNATIONAL STANDARDIZATION AGREEMENT

Certain provisions of this document (see 4.1) are the subject of international standardization agreement STANAG 5501. When a change notice, revision, or cancellation of this document is proposed which will affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels, including departmental standardization offices, if required.

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## 1. SCOPE

1.1 Purpose. The purpose of this document is to establish technical standards and design objectives that are necessary to ensure interoperability and to promote commonality for communications equipment and subsystems used in TADIL B. Also, this document establishes acceptable overall subsystem performance and maximum flexibility of subsystem layout in order to satisfy diverse user requirements without the restrictions caused by interface and incompatibility problems.

1.2 Application. This document is applicable to the design and development of new equipment, assemblages and subsystems used in TADIL B. This document is applicable also to the engineering and installation of existing TADIL B facilities. It is not intended that existing TADIL B facilities be immediately converted to comply with the standards contained in this document. New TADIL B facilities and those undergoing major modification or rehabilitation shall comply with the standards contained in this document subject to the applicable requirements of current procurement regulations.

1.3 Objectives. The main objectives of this document are to ensure interoperation of equipment and subsystems consistent with military requirements, to provide a degree of subsystem performance acceptable to the majority of TADIL B users, and to achieve the necessary degree of performance and interoperation in the most economical way. This document provides for:

- a. Standardizing user-to-user performance characteristics.
- b. Standardizing the type of signals at various interface points in a TADIL B subsystem.
- c. Specifying maximum permissible degradation of a signal in the process of transmission, and allocating the permissible degradation among various parts of a subsystem.
- d. Establishing performance parameters and operating features of equipment, not of detail design, but of other factors which govern the interface characteristics with subsystems and systems in which the TADIL B equipment will be used.
- e. Defining performance parameters without specifying the technology that should be used to obtain the required performance.

An additional objective of this document is to prevent proliferation of equipment serving the same or 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.

1.4 System standards and design objectives. 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. Nonmandatory design objectives are indicated by parentheses after a standardized parameter value or by the word "should" in connection with the parameter value or requirement under consideration. For a definition of the terms "System Standard" and "Design Objective" see Federal Standard (FED-STD) 1037.

## 2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

### 2.1.1 Federal standard.

FED-STD 1037      Glossary of Telecommunication Terms

### 2.1.2 Military standards.

#### 2.1.2.1 Department of Defense (DoD) standards.

MIL-STD-188-110	Equipment Technical Design Standards for Common Long Haul/Tactical Data Modems
MIL-STD-188-114	Electrical Characteristics of Digital Interface Circuits
MIL-STD-188-124	Grounding, Bonding and Shielding for Common Long Haul/Tactical Communication Systems
MIL-STD-188-200	System Design and Engineering Standards for Tactical Communications
MIL-STD-461	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of

#### 2.1.2.2 North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG).

STANAG 5501	Point-to-Point Digital Data Link - Link 1 (U)
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### 2.1.3 Military handbooks.

MIL-HDBK-232	RED/BLACK Engineering-Installation Guidelines (U)
MIL-HDBK-237	Electromagnetic Compatibility/Interference Program Requirements
MIL-HDBK-241	Design Guide for EMI Reduction in Power Supplies

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2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids or requests for proposal shall apply.

2.2.1 DoD publications.

Joint Chiefs of Staff Publication (JCS PUB) 10, Tactical Command and Control, and Communications Systems Standards (U)

DCAC 300-175-9, DCS Operating-Maintenance Electrical Performance Standards

DoDD 4630.5, Compatibility and Commonality of Equipment for Tactical Command and Control, and Communications

NACSIM 5100, Compromising Emanations Laboratory Test Requirements, Electromagnetics (U)

NACSEM 5201, TEMPEST Guidelines for Equipment/System Design (U)

TACS/TADS TIDP, Tactical Air Control System/Tactical Air Defense System Technical Interface Design Plan

(Copies of standards and publications listed in 2.1.1 through 2.2.1 above, and required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

### 3. DEFINITIONS

3.1 Definition of terms. Definition of terms used in this document shall be as specified in FED-STD-1037 which incorporates and supersedes MIL-STD-188-120.

3.2 Abbreviations and acronyms. The abbreviations and acronyms used in this document are listed in Appendix B.

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#### 4. GENERAL REQUIREMENTS

4.1 NATO interoperability. The interchange of information among NATO member nations using NATO Link 1 shall comply with the applicable requirements of the current edition of STANAG 5501.

4.2 Communications security equipment. Communications security equipment normally employed in a TADIL B system may be part of either the transmission subsystem or the terminal subsystem (see Figure 1) depending on the implementing military services. Communications security equipment employed in any TADIL B system shall be transparent and not change the standard TADIL B transmission frame format. (See 5.2.1.) Also, any function incorporated in a TADIL B system for the purpose of equipment interoperability shall be transparent to the standard TADIL B transmission frame format.

4.3 Compromising emanations (TEMPEST). All communications equipment, subsystems and systems shall comply with the applicable TEMPEST criteria of the current edition of the NACSIM 5100 series.

NOTE: NACSEM 5201 provides design guidance and MIL-HDBK-232 provides installation guidelines for compromising emanations.

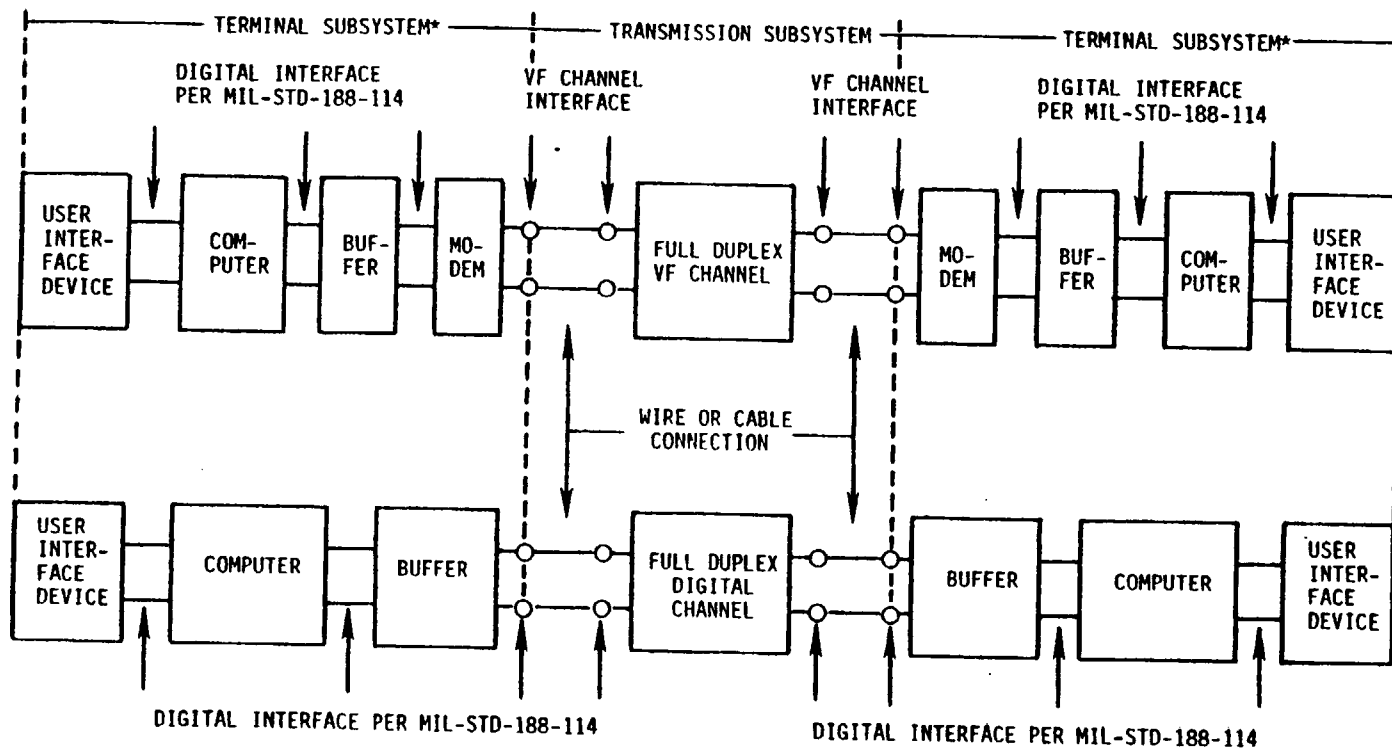
4.4 Electromagnetic interference (EMI) and electromagnetic compatibility (EMC).

4.4.1 Equipment. Any item including subassemblies and parts, serving functionally in an electromagnetic environment in the broadest sense, shall comply with the applicable requirements of the current edition of MIL-STD-461. Techniques used for the measurement and determination of EMI characteristics shall comply with the applicable requirements of the current edition of MIL-STD-462.

NOTE: MIL-HDBK-241 provides guidance for EMI reductions in equipment power supplies.

4.4.2 Subsystems and systems. Communications systems and associated subsystems shall be designed to achieve intra- and inter-system electromagnetic compatibility. There shall be neither unacceptable responses nor malfunctions of any item of the system or subsystem beyond the tolerances established by the applicable requirements of the current edition of MIL-STD-461.

NOTE: MIL-HDBK-237 provides guidance for implementing an EMC program.



\*ANY OR ALL FUNCTIONAL BLOCKS SHOWN IN THE TERMINAL SUBSYSTEM MAY BE INTEGRATED AND COMBINED IN A SINGLE PIECE OF EQUIPMENT.

FIGURE 1. Block diagram of TADIL B system.



4.5 Electronic warfare (EW) requirements. Based on the EW threat, admissible reduced data signaling rates together with degraded bit error rates (BER) shall be specified as a design requirement by the user.

NOTE: Admissible reduced data signaling rates are dependent on applicable interoperability requirements.

4.6 Grounding, bonding and shielding. Methods and practices for grounding, bonding and shielding of ground-based telecommunications equipment and facilities, including buildings and structures supporting tactical communications, shall comply with the applicable requirements of the current edition of MIL-STD-188-124.

4.7 Clock equipment, timing, control and alarm. The electrical characteristics of clock equipment, timing, control and alarm circuits shall comply with the applicable requirements of the current edition of MIL-STD-188-114. Additionally, clock equipment, control and timing shall comply with the applicable requirements of subparagraph 5.3.6 of MIL-STD-188-200.

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current edition of MIL-STD-188-124.

4.7 Clock equipment, timing, control and alarm. The electrical characteristics of clock equipment, timing, control and alarm circuits shall comply with the applicable requirements of the current edition of MIL-STD-188-114. Additionally, clock equipment, control and timing shall comply with the applicable requirements of subparagraph 5.3.6 of MIL-STD-188-200.

## 5. DETAILED REQUIREMENTS

5.1 General. The TADIL B system normally interconnects tactical air defense and aircraft control units of the implementing military services. TADIL B employs a dedicated, point-to-point, full duplex digital data link utilizing serial transmission frame characteristics and standard message formats transmitted by individual signal elements or binary digits (bits) on a time sequential basis. Signals may be transmitted in direct current (dc) digital form or the signals may be converted to quasi-analog form depending on the type of transmission subsystem employed. Typical system configurations for TADIL B systems using voice frequency (VF) channels or digital channels are shown in Figure 1. The TADIL B system consists of two terminal subsystems and the transmission subsystem. The terminal subsystem may consist of user interface devices and a computer which converts data to a usable format, a buffer to compensate for any difference in the data signaling rate between the computer and transmission subsystem, and a signal converter such as a modulator/demodulator (modem) which converts the digital signals into quasi-analog signals for transmission over VF channels and reconverts incoming quasi-analog signals into digital signals. The arrangement of components may be modified by combining the buffer and modem in one unit or the buffer can be combined with the computer. It is not the intent of this standard to stipulate the format of the data transfer within composite components; however, the data transferred to the transmission subsystem will be in serial form and in the standard TADIL B transmission frame format. The transmission subsystem is composed of the transmission lines or interconnecting cables and a full duplex channel employing radio links, satellite links or cable links. Also included in the transmission subsystem is the multiplex equipment (frequency division multiplex (FDM) or time division multiplex (TDM)) normally associated with multichannel radio subsystems.

5.2 Terminal subsystem characteristics. The terminal subsystem provides the capability to superimpose the TADIL B message formats onto the TADIL B transmission frame and buffer the messages to accommodate differences between the processing rate of the system and the data signaling rate. The terminal subsystem will also provide, when needed, signal conversion capabilities, such as modulation/demodulation, for interfacing with the transmission subsystem. The terminal subsystem also provides the interface with the user devices, such as keyboards and display devices. The requirements of 5.2.1 through 5.2.8.3.2 apply to all TADIL B terminal subsystems, regardless of the specific arrangements of equipment within the terminal subsystem and modulation or data signaling rates employed, except where stated otherwise in the applicable subparagraph.

5.2.1 Transmission frame format. A transmission frame shall consist of 72 bits divided into eight groups consisting of nine bits each as shown in Table 1 and Figure 2. The groups shall be of three different types as stated in 5.2.1.1 through 5.2.1.3.

TABLE I. TADIL B transmission frame format.

	START GROUP	DATA GROUP 1		DATA GROUP 2		DATA GROUP 3		DATA GROUP 4		DATA GROUP 5		DATA GROUP 6		CHECK GROUP	
	ALL SPACE (0) BITS	MARK (1) BIT	INFO BITS	MARK (1) BIT	INFO BITS	MARK (1) BIT	INFO BITS	MARK (1) BIT	INFO BITS	MARK (1) BIT	INFO BITS	MARK (1) BIT	INFO BITS	MARK (1) BIT	PARITY BITS
NUMBER OF TRANSMISSION BITS	0-8	9	10-17	18	19-26	27	28-35	36	37-44	45	46-53	54	55-62	63	64-71
NUMBER OF INFORMATION BITS (MES- SAGE FORMAT)			0-7		8-15		16-23		24-31		32-39		40-47		

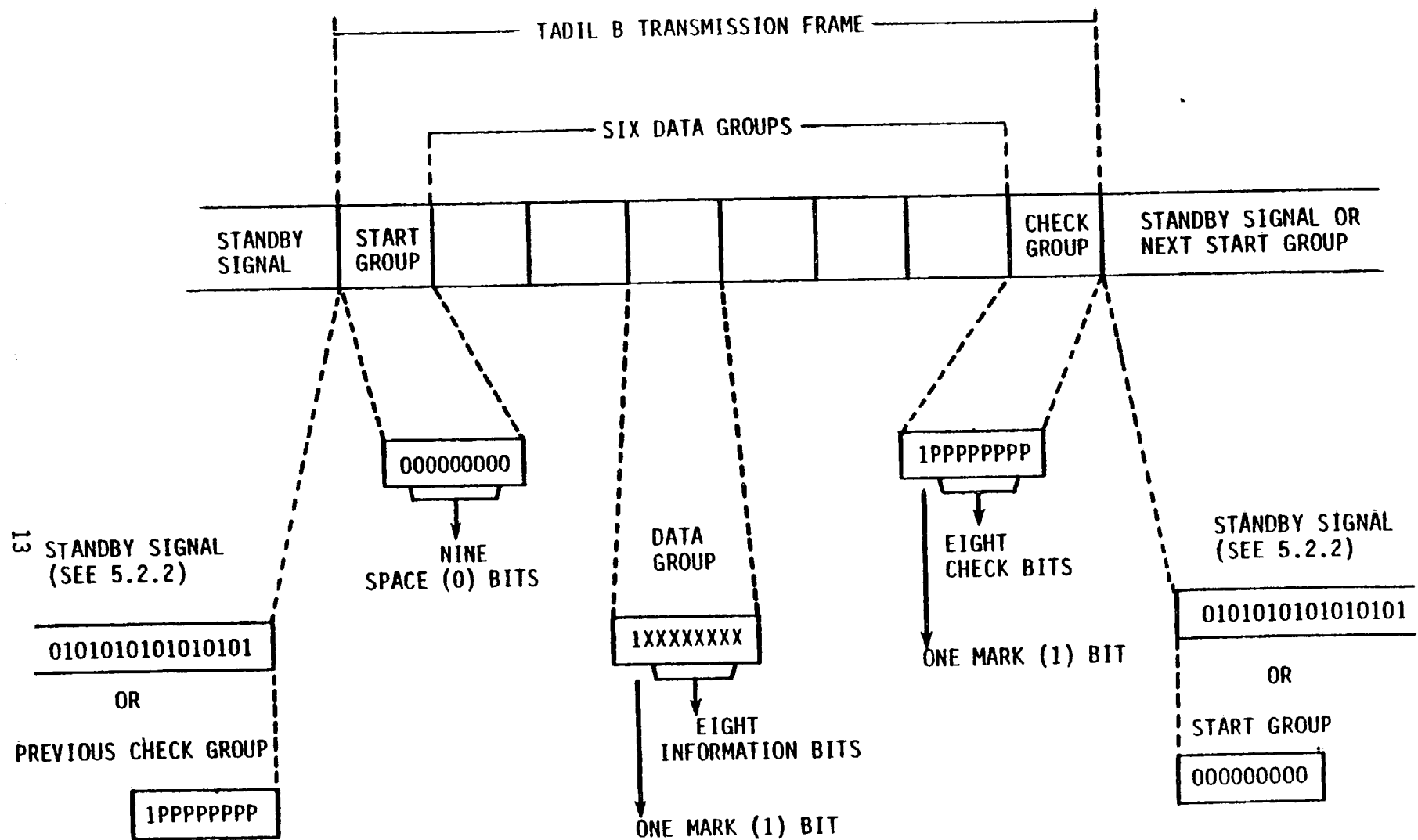


FIGURE 2. TADIL B transmission frame.

5.2.1.1 Start group. Each transmission frame shall begin with a start group. The start group shall consist of nine Space (0) bits, resulting in a unique train of bits to identify the start of a new transmission frame.

5.2.1.2 Data group. Each transmission frame shall contain six data groups. The first bit in each data group shall be a Mark (1) bit followed by eight information bits for a total of 48 information bits.

5.2.1.3 Check group. Each transmission frame shall end with a check group which shall consist of a Mark (1) bit followed by eight check bits. Each of the check bits shall be an odd parity bit for bits of the data groups. The relationship of the check bits to the information bits of the message shall be as shown in Table II.

TABLE II. TADIL B check group/data group relationship.

	Bit Position (See Table I)							
Data Group 1	10	11	12	13	14	15	16	17
Data Group 2	19	20	21	22	23	24	25	26
Data Group 3	28	29	30	31	32	33	34	35
Data Group 4	37	38	39	40	41	42	43	44
Data Group 5	46	47	48	49	50	51	52	53
Data Group 6	55	56	57	58	59	60	61	62
Check Group	64	65	66	67	68	69	70	71

NOTE: Bit 64 is the odd parity of data bits 10, 19, 28, 37, 46, 55 and bit 65 is the odd parity of data bits 11, 20, 29, 38, 47, 56, etc.

5.2.1.4 Message format. The message format shall consist of the 48 information bits contained in the six data groups (see 5.2.1.2) and shall be as specified in the current edition of JCS PUB 10 and the TACS/TADS TIDP.

5.2.2 Standby signal. The standby signal shall be a continuous series of alternating Space (0) bits and Mark (1) bits. The standby signal shall always end with a Mark (1) bit. Whenever a TADIL B link is to be synchronized, the standby signal period shall consist of any integral number of

bits equal to or greater than 16. Between contiguous TADIL B transmission frames, the standby signal shall not be required. Between noncontiguous TADIL B transmission frames, a standby signal consisting of any integral number of bits and ending with a Mark (1) bit may be used.

NOTE: The standby signal is frequently referred to as idle pattern.

5.2.3 Data signaling rates. All TADIL B systems shall be capable of operating at a basic data signaling rate of 1200 bits per second (b/s). As a Design Objective, TADIL B systems should be capable of operating at a data signaling rate of 2400 b/s or at higher standard data signaling rates specified in subparagraph 5.3.5.1 of MIL-STD-188-200.

5.2.4 Data signaling rate tolerance. The tolerance of all data signaling rates of the transmitted signal shall be  $\pm 1$  part in 100,000, measured at the output of the transmitting terminal subsystem, properly terminated. Receiving terminal subsystems shall be capable of accepting data signaling rate variations of up to  $\pm 0.5$  percent.

5.2.5 Modem characteristics. All TADIL B modems shall comply with the applicable requirements of the current edition of MIL-STD-188-110.

5.2.5.1 Basic characteristics for 1200 b/s. For the data signaling rate of 1200 b/s, phase continuous frequency shift keying (FSK) shall be used with a center frequency of 1700 hertz (Hz), a Mark (1) frequency of 1300 Hz and a Space (0) frequency of 2100 Hz in accordance with MIL-STD-188-110.

5.2.5.2 Basic characteristics for 2400 b/s. For the optional data signaling rate of 2400 b/s, if implemented, quadrature phase shift keying (QPSK) shall be used with a carrier frequency of 1800 Hz in accordance with MIL-STD-188-110, resulting in a modulation rate of 1200 bauds (Bd) at the VF channel interface. (See Figure 1.)

5.2.6 Receiver synchronization. The receiving terminal subsystem shall attain bit synchronization in not more than 9 bits. The receiving terminal subsystem shall maintain bit synchronization for a minimum of 200 milliseconds (ms) after interruption of the signal.

5.2.7 Terminal subsystem BER. The BER attributable directly to the terminal subsystem shall not exceed 1 erroneous bit in 10,000,000 bits transmitted at the applicable modulation rate or data signaling rate, when the output of the transmitting terminal subsystem is connected directly to the input of the receiving terminal subsystem. This requirement shall be achieved while employing a test pattern over any continuous 5-hour period. The test pattern for measuring the BER shall be inserted at that point in the transmitting terminal subsystem which superimposes the TADIL B message onto the TADIL B transmission frame format. (See 5.2.1.) The test pattern

shall be measured at that point in the receiving terminal subsystem which samples the TADIL B transmission frame format.

NOTE: The test pattern for measuring the BER is not standardized and will be defined in applicable equipment or subsystem specifications.

#### 5.2.8 Interface characteristics.

##### 5.2.8.1 Digital equipment interface characteristics.

5.2.8.1.1 Electrical characteristics. The electrical characteristics of the interfaces between the equipment of the terminal subsystem shown in Figure 1 shall comply with the applicable requirements of the current edition of MIL-STD-188-114.

NOTE: Any or all of the equipment of the terminal subsystem may be integrated and combined into a single piece of equipment. When combined into a single piece of equipment, MIL-STD-188-114 does not apply to internal equipment connections.

##### 5.2.8.1.2 Data signal connection. Not standardized.

NOTE: Serial data signal connections or parallel data signal connections may be used to interconnect the equipment located in the terminal subsystem. (See Figure 1.)

5.2.8.2 VF channel interface characteristics. As a Design Objective for terminal equipment with an integral modem and a VF channel interface, access to the internal digital signal should be provided with electrical characteristics in accordance with the applicable requirements of the current edition of MIL-STD-188-114.

NOTE: The purpose of the Design Objective of 5.2.8.2 is to facilitate a possible interconnection of the terminal equipment with a digital channel by eliminating the need for reconvertng the quasi-analog signal at the VF channel interface to a digital signal. (See also 5.3.3.)

5.2.8.2.1 Impedance. The impedance at the modulator output and the demodulator input shall each be 600 ohms, balanced to ground, with a minimum return loss of 26 dB against a 600-ohm resistance over the frequency band from 300 Hz to 3400 Hz. The electrical symmetry shall be sufficient to suppress longitudinal currents to a level which is at least 40 dB below reference level (-40 dBm0).

5.2.8.2.2 Quasi-analog signal levels. The transmitted quasi-analog signal level at the modulator output shall be adjusted such that the signal level stated in 5.3.2.1.5 is obtained at the input of the VF channel of the transmission subsystem.



NOTE: The received quasi-analog signal level at the demodulator input is not standardized. This level depends on the quasi-analog signal level at the VF channel output, stated in 5.3.2.1.5, and the attenuation of the wire or cable connection between the output of the VF channel and the input of the terminal subsystem. (See Figure 1.)

5.2.8.2.3 Data signal connection. The exchange of quasi-analog data signals between the terminal subsystems and the transmission subsystem shall be by serial transfer of data bits over a single full duplex VF channel of the transmission subsystem.

NOTE: Timing, control and alarm functions may require additional connections between equipment located in the terminal subsystem and the transmission subsystem. (See 4.7.)

### 5.2.8.3 Digital channel interface characteristics.

5.2.8.3.1 Electrical characteristics. The electrical characteristics of the digital channel interface between the terminal subsystems and the transmission subsystem shall comply with the applicable requirements of the current edition of MIL-STD-188-114.

5.2.8.3.2 Data signal connection. The exchange of digital data signals between the terminal subsystems and the transmission subsystem shall be by serial transfer of data bits over a single full duplex digital channel of the transmission subsystem. (See Note of 5.2.8.2.3.)

5.3 Transmission subsystem characteristics. TADIL B terminal subsystems are interconnected with transmission subsystems (See Figure 1) that provide a nominal 4 kHz full duplex VF channel or a full duplex digital channel. The channels are dedicated (non-switched) connections on a point-to-point basis and have transmission characteristics in accordance with the applicable requirements of MIL-STD-188-200. The transmission subsystem normally employs FDM or time division multiplexing/pulse code modulation (TDM/PCM) wideband transmission facilities using line-of-sight (LOS) or tropospheric scatter radio links, or radio relay links. Cable links with and without repeaters, or satellite links may also be used, provided the channel derived by these links meets the applicable requirements of 5.3.2.1.1 through 5.3.3.4. The transmission subsystem will include the wire or cable connection from/to the terminal subsystem to/from the channel transmission equipment, such as multiplexer/demultiplexer equipment or cable interface converter equipment.

5.3.1 Types of tactical subsystems. Based on various requirements for multichannel trunking networks, different tactical multichannel subsystems and wideband radio transmission equipment have been designed. Multichannel subsystems are classified as tactical subsystems type I, II, III and IV. Table III summarizes the basic characteristics, and 5.3.1.1 through 5.3.1.4 briefly describe these different types of subsystems.

TABLE III. Switched multichannel communications subsystems.

MIL-STD-188-200 Terms	Probable Maximum Distance	Multiplexer Equipment	TLP*	Quasi-Analog Signal Level*	Standard Test Tone Level*	MIL-STD-188-100 Terms
Tactical Sub-system Type I	300 km	FDM	OTLP	-13 dBm0	-10 dBm0	Tactical Highly Maneuverable System
Tactical Sub-system Type II	300 km	TDM/PCM	-4TLP	-6 dBm0	-3 dBm0	
		FDM**	-4TLP	-6 dBm0	-3 dBm0	
Tactical Sub-system Type III	1800 km	FDM	OTLP	-13 dBm0	-10 dBm0	Tactical Less Maneuverable System
Tactical Sub-system Type IV	1200 km	TDM/CVSD	Not appl.	Not appl.	Not appl.	Not applicable

\*See Figure 4.

\*\*There is older FDM equipment still in the inventory. This equipment has been classified as belonging to the tactical subsystem type II.

5.3.1.1 Tactical subsystem type I. This type is a multichannel transmission subsystem using FDM equipment and frequency modulation (FM) wideband LOS or tropospheric scatter radio links or radio relay links to cover distances up to several hundred kilometers (km). The FDM equipment provides nominal 4 kHz VF channels (see Figure 3) and has been designed to operate with a quasi-analog signal level of -13 dBm0 and a test tone level of -10 dBm0 at the 4-wire input and output terminals of each VF channel and with a zero transmission level point (OTLP) at these terminals.

5.3.1.2 Tactical subsystem type II. This type is a multichannel transmission subsystem using TDM/PCM equipment and wideband LOS, tropospheric scatter or satellite radio links or radio relay links, or cable links with repeaters transmitting digital signals over distances of up to several hundred km. The TDM/PCM equipment provides nominal 4 kHz VF channels (see Figure 3) and has been designed to operate with a quasi-analog signal level of -6 dBm0 and a test tone level of -3 dBm0 at the 4-wire input and output terminals of each VF channel and with a -4TLP at these terminals. For transmitting data in digital form over the tactical subsystem type II, see 5.3.3.

5.3.1.3 Tactical subsystem type III. This type is a multichannel transmission subsystem using FDM equipment and FM wideband LOS or tropospheric scatter radio links or radio relay links. The subsystem has been designed for much longer distances (up to 1800 km) than the tactical subsystems type I and type II. The FDM equipment provides nominal 4 kHz VF channels (see Figure 3) and has been designed to operate with a quasi-analog signal level of -13 dBm0 and a test tone level of -10 dBm0 at the 4-wire input and output terminals of each VF channel and with a OTLP at these terminals.

5.3.1.4 Tactical subsystem type IV. This type is a multichannel TDM transmission subsystem under development that will employ continuously variable slope delta (CVSD) modulation as the analog-to-digital conversion method and digital wideband LOS, tropospheric scatter and satellite radio links. The subsystem will have the capability to interface with existing nominal 4 kHz VF channels (see Figure 3) and will also have the capability to interconnect TADIL B terminal subsystems operating with digital signals at 1200 b/s and higher standard data signaling rates, over a digital channel. Access over a digital channel will be the primary and preferred method of transmission in lieu of converting digital signals into quasi-analog signals for transmission over analog channels.

5.3.2 VF channel characteristics. The requirements of 5.3.2.1.1 through 5.3.2.5 apply to VF channels of the transmission subsystem that are used to interconnect with and exchange information between TADIL B terminal subsystems. These requirements apply to all VF channels, regardless of the type of tactical subsystem (see 5.3.1), modulation and data signaling rates, transmission distances and type of radio or cable links employed, except where stated otherwise in the applicable subparagraph.

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### 5.3.2.1 Input/output characteristics.

5.3.2.1.1 Standard test signal. The level of the standard test signal shall be 0 dBm at a OTLP, or 0 dBm0, with a frequency of 1000 Hz,  $\pm 25$  Hz. A test signal frequency of 1004 Hz is preferred for PCM transmission.

NOTE 1: The standard test signal is generally used for testing the peak power transmission capability and for measuring the harmonic distortion of a VF channel. In the tactical subsystem type II (see Table III), the standard test signal is also used for level alignment of links in tandem, providing that the circuit to be aligned does not include links of the tactical subsystems type I or type III or a long haul system. The standard test signal should not be used in the tactical subsystems type I and type III for level alignment of links in tandem since the test signal may overload FDM channels.

NOTE 2: The standard test signal (with a level of 0 dBm0) must not be transmitted across a VF channel interface between the tactical subsystem type II and the tactical subsystems type I or III in either direction. Any TLP of the tactical subsystem type II has to be considered internal to this subsystem and must not be related to a TLP of the tactical subsystems type I and type III in terms of signal levels. For interfacing VF channels of the tactical subsystem type II with VF channels of the tactical subsystems type I or type III, see 5.3.2.5.

5.3.2.1.2 Standard test tone. In the tactical subsystems type I and type III (see Table III), the level of the standard test tone shall be -10 dBm0, that is -10 dBm at a OTLP of these subsystems, with a frequency of 1000 Hz,  $\pm 25$  Hz. In the tactical subsystem type II, the level of the standard test tone shall be -3 dBm0, that is -7 dBm at a -4TLP of that subsystem or -3 dBm at a OTLP of that subsystem, with a frequency of 1000 Hz,  $\pm 25$  Hz. (See Note 3.) A test tone frequency of 1004 Hz is preferred for PCM transmission.

NOTE 1: The difference in test tone levels between the tactical subsystem type II and the tactical subsystems type I and type III, is caused by different traffic signal levels (voice and quasi-analog signals) at the respective OTLP of the subsystem under consideration. The different traffic signal levels are based on different overload characteristics of the communications equipment employed in these subsystems. Therefore, any TLP of the tactical subsystem type II has to be considered internal to this subsystem and must not be related to a TLP of the tactical subsystems type I and type III in terms of signal levels. For interfacing VF channels of the tactical subsystem type II with VF channels of the tactical subsystems type I or type III, see 5.3.2.5.

NOTE 2: The standard test tone is generally used for level alignment of VF channels of single links and of links in tandem in the tactical subsystems type I and type III. It has been found necessary to use, for link alignments, the much lower level of the standard test tone (as compared to the standard test signal) in order to prevent overloading of those multi-channel wideband transmission subsystems that use FDM or radio equipment, or both, designed for voice service with an activity factor as low as 25 percent. This type of equipment is normally employed in tactical subsystems type I and III and in long haul systems.

NOTE 3: In the tactical subsystem type II, the standard test tone should be used only for level alignment of VF channels of those links that interconnect, and form part of a circuit, with the tactical subsystems type I or III or a long haul system. Details of this level alignment across a VF channel interface between the tactical subsystems type I or III and the tactical subsystem type II are stated in 5.3.2.5.

5.3.2.1.3 Data signal connection. Same as 5.2.8.2.3.

5.3.2.1.4 Impedance. The impedance of the transmitting and receiving terminals of a nominal 4 kHz VF channel interface for quasi-analog signals shall each be 600 ohms, balanced to ground, with a minimum return loss of 26 dB against a 600-ohm resistance over the frequency band from 300 Hz to 3400 Hz. The electrical symmetry shall be sufficient to suppress longitudinal currents to a level which is at least 40 dB below reference level (-40 dBm0).

5.3.2.1.5 Quasi-analog signal levels. For the tactical subsystems type I and type III (see Table III), the quasi-analog signal level shall be -13 dBm0 (i.e., -13 dBm at a OTLP) at the input terminals, and shall be -13 dBm0,  $\pm 0.5$  dB, at the output terminals of the FDM equipment of the transmission subsystem. For the tactical subsystem type II, the quasi-analog signal level shall be -6 dBm0 (i.e., -10 dBm at a -4TLP) at the input terminals and shall be -6 dBm0,  $\pm 0.5$  dB, at the output terminals of the TDM/PCM equipment of the transmission subsystem. The interconnection between VF channels of the tactical subsystems type I or type III and VF channels of the tactical subsystem type II shall be in accordance with 5.3.2.5.

5.3.2.1.6 Channel noise power. For the tactical subsystems type I and type III (see Table III), the nonimpulse type of the total channel noise power (consisting of multiplex idle channel noise, multiplex loaded channel noise and transmission media noise) shall not exceed 50,000 pW0 (47.0 dBm0), when measured at or referenced to a OTLP of the VF channel under consideration. For the tactical subsystem type II, the nonimpulse type of the idle channel noise power shall not exceed 40,000 pW0 (46.0 dBm0), when measured at or referenced to a OTLP of the VF channel under consideration. The channel noise power shall be measured with flat weighting over the frequency band from 300 Hz to 3400 Hz.

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5.3.2.1.7 Signal-to-noise ratio (SNR). The rms-signal-to-rms-noise ratio shall be at least 26 dB for data transmission with modulation rates of 2400 Bd or less over VF channels. The parameter shall be measured at the quasi-analog output terminals of the transmission subsystem with flat weighting over the frequency band occupied by the quasi-analog signals.

NOTE: The SNR stated in 5.3.2.1.7 is a necessary but not sufficient requirement for acceptable data transmission since signal discontinuities (see 5.3.2.3) may increase the BER for certain unpredictable periods of time.

5.3.2.1.8 Single tone interference. No interfering single-frequency tone shall exceed 30 dBrn (Design Objective: 24 dBrn), measured at the quasi-analog input terminals of the demodulator in the terminal subsystem with flat weighting over the frequency band from 300 Hz to 3400 Hz.

5.3.2.1.9 Frequency displacement. Any single-frequency signal transmitted over a VF channel shall be reproduced at the output terminals of this channel with a frequency error of not more than  $\pm 1$  Hz for single links and not more than  $\pm 4$  Hz for multiple links in tandem.

#### 5.3.2.2 Transfer function characteristics.

5.3.2.2.1 Transmission subsystem BER. The BER of the transmission subsystem shall not exceed 1 erroneous bit in 100,000 bits transmitted at the applicable modulation rate or data signaling rate, when the transmission subsystem is tested from the output of the transmitting terminal subsystem to the input of the receiving terminal subsystem. (See Figure 1 and Note of 5.2.7.) While this requirement applies to the BER of the received data signal, an acceptable measure of the BER may be obtained by using the standby signal. (See 5.2.2.) If the standby signal is used, three separate test runs shall be performed over the transmission subsystem for a period of at least 300 seconds for each test run.

5.3.2.2.2 Character-count and bit-count integrity. No extraneous characters or bits (see Note) shall be inserted or deleted in message texts. This requirement shall apply to all modulation and data signaling rates. The mean-time-between-losses of character-count and bit-count integrity shall be not less than 24 hours, measured from the data source of the transmitting terminal subsystem to the data sink of the receiving terminal subsystem.

NOTE: Extraneous characters or bits include time differential blanks associated with asynchronous/synchronous transmission equipment. These characters or bits are permissible in the transmission subsystem if they can be recovered prior to forwarding the signal to the user interface device.

5.3.2.2.3 Insertion loss. The insertion loss of a VF channel shall be 0 dB,  $\pm 0.5$  dB, measured at 1000 Hz,  $\pm 25$  Hz.



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5.3.2.2.4 Net loss variation. The net loss variation of a VF channel shall not exceed  $\pm 1$  dB over any 15 consecutive minutes, and  $\pm 5$  dB over any 30 consecutive days.

NOTE: The above values do not account for net loss variations of unprotected field wire. Net losses of unprotected field wire may vary up to 0.7 dB/km between wet and dry weather conditions.

5.3.2.2.5 Insertion loss versus frequency characteristic. For data transmission with modulation rates of 1200 Bd or less over VF channels, the insertion loss versus frequency characteristic, referenced to 1000 Hz, shall not exceed the values given in Table IV over the frequency bands stated. Loss is indicated by a (+) and gain by a (-) sign. (See Figure 3A.)

NOTE: The parameter values listed in Tables IV and V are identical to the values for the D2 circuit parameters which are part of the DCS technical schedule published in DCAC 300-175-9. The DCS technical schedule is based on corresponding parameter values used by commercial carriers. The parameter values of the DCS technical schedule are considered to be the best information available to specify VF channel characteristics necessary for acceptable data transmission. However, experience has shown that VF channels may provide acceptable data service when the measured parameters are close to, but not exactly within the limits of the values listed in Tables IV and V. Therefore, the parameter values listed in these tables should not be used exclusively to determine the need for regenerating data signals and conditioning data channels.

TABLE IV. Insertion loss versus frequency characteristic of VF channels for data transmission with modulation rates of 1200 Bd or less.

Frequency in Hz	Insertion Loss in dB (Referenced to 1000 Hz)
$f < 300$	$\geq -2$
$300 \leq f < 1000$	-2 to +6
$1000 \leq f < 2400$	-1 to +3
$2400 \leq f < 2700$	-2 to +6
$2700 \leq f < 3000$	-3 to +12
$3000 \leq f$	$\geq -3$

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5.3.2.2.6 Envelope delay distortion. For data transmission with modulation rates of 1200 Bd or less over VF channels, the envelope delay distortion, measured between 800 Hz and 2600 Hz, shall not exceed the values given in Table V over the frequency bands stated. (See Figure 3B and Note of 5.3.2.2.5.)

TABLE V. Envelope delay distortion of VF channels for data transmission with modulation rates of 1200 Bd or less.

Frequency in Hz	Maximum Envelope Delay Distortion in microseconds
$800 \leq f < 1000$	1750
$1000 \leq f < 2400$	1000
$2400 \leq f \leq 2600$	1750

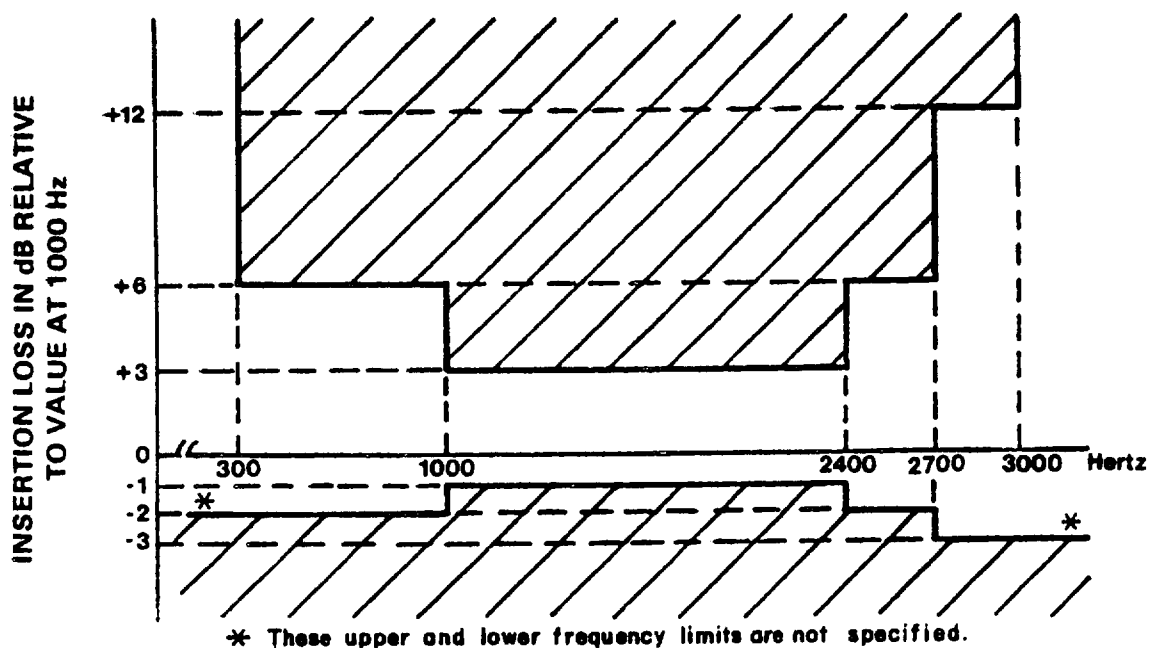
5.3.2.2.7 Total harmonic distortion. For data transmission with modulation rates of 2400 Bd or less over VF channels, the total harmonic distortion produced by any single-frequency test signal within the frequency band between 300 Hz and 3000 Hz shall be at a level which is at least 30 dB below reference level (-30 dBm0) with a Design Objective of -40 dBm0. The total harmonic distortion shall be measured with a standard test signal in accordance with 5.3.2.1.1.

5.3.2.2.8 Intermodulation distortion (IMD). As a Design Objective for data transmission with modulation rates of 2400 Bd or less over VF channels, the individual IMD products, produced by any two equal level single-frequency signals between 300 Hz and 3000 Hz, should be at a level which is at least 30 dB below reference level (-30 dBm0). The level of the composite two-frequency test signal for IMD measurements shall be -3 dBm0, that is -3 dBm at a OTLP of the subsystem under consideration, and each single-frequency signal level shall be -6 dBm0.

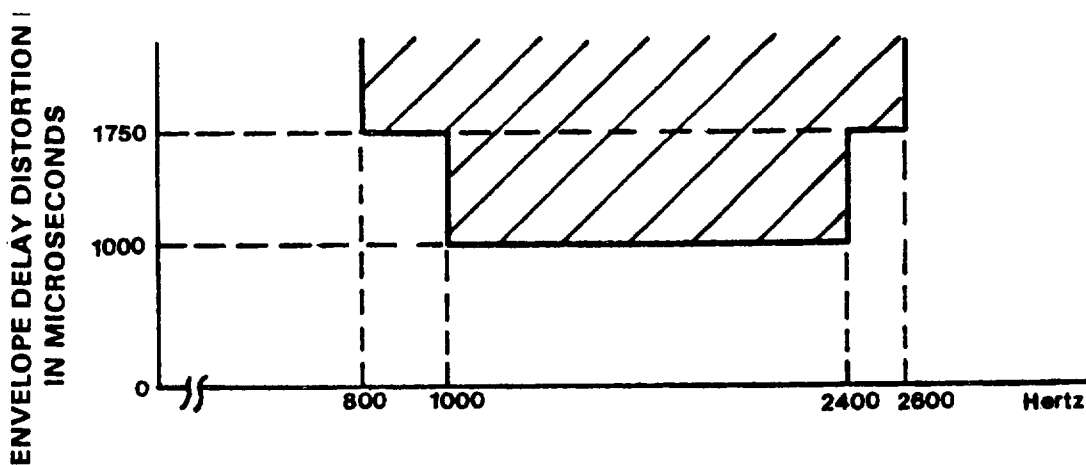
NOTE 1: The level of -3 dBm0 of the composite signal for IMD measurements results in comparable peak loading of VF channels for quasi-analog signals.

NOTE 2: The frequencies of the two equal level signals should be selected so that at least the third order harmonic products fall within the specified frequency band.





**A. INSERTION LOSS VERSUS FREQUENCY CHARACTERISTIC**



**B. ENVELOPE DELAY DISTORTION**

FIGURE 3. VF channel parameters for data transmission with modulation rates of 1200 Bd or less.

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### 5.3.2.3 Signal discontinuities.

5.3.2.3.1 Impulse noise. For data transmission over VF channels, the impulse noise shall not exceed 15 counts above a level of 71 dBm over any continuous 15-minute period. The impulse noise shall be measured at the quasi-analog input terminals of the demodulator of the receiving terminal subsystem with flat weighting over the frequency bandwidth occupied by the quasi-analog signals. The test instrument shall be capable of counting rates of up to 7.5 counts per second.

5.3.2.3.2 Signal level dropouts. As a Design Objective for data transmission over VF channels, the number of signal level dropouts equal to or greater than 12 dB and exceeding a period of 10 ms should be less than 2 dropouts over any continuous 15-minute period.

5.3.2.3.3 Signal level change. Under consideration.

5.3.2.3.4 Phase jitter. The total peak-to-peak phase jitter, imparted to a test tone traversing a VF channel at any frequency between 300 Hz and 3000 Hz, shall not exceed 15 degrees (Design Objective: 10 degrees).

5.3.2.3.5 Phase hits. For data transmission over VF channels, the number of phase hits of greater than  $\pm 20$  degrees shall not exceed 15 hits over any continuous 15-minute period.

5.3.2.3.6 Amplitude (or gain) hits. Under consideration.

5.3.2.4 Equalization and regeneration. Not standardized.

NOTE: Equalization of VF channels and regeneration of data signals have to be determined by circuit engineering on a case-by-case basis. (See also Note of 5.3.2.2.5.)

5.3.2.5 Special method for interconnecting VF channels of the tactical subsystems type I or III with type II. VF channels of the tactical subsystems type I or type III (see Table III) shall be interconnected with VF channels of the tactical subsystem type II on the basis of the standard test tone levels in accordance with 5.3.2.1.2, and not on the basis of the TLP of these subsystems. (See Figure 4.)

NOTE: The special method for interconnecting VF channels in accordance with the requirement of 5.3.2.5 results in a gain of 3 dB at the interface point for quasi-analog signals traversing from the tactical subsystems type I or type III to the tactical subsystem type II, and in an attenuation of 3 dB at the interface point for signals traversing in the opposite direction, as shown in Figure 4.

5.3.3 Digital channel characteristics. Two types of equipment, a time division digital multiplexer (TDDM) and a high speed serial data buffer

(HSSDB), have been developed and are being introduced in the tactical subsystem type II. (See 5.3.1.2.) The TDDM is capable of accepting up to 24 digital telegraph or data signals and combining these signals into a 32 kb/s bit stream which is fed into the HSSDB. For digital signals, the HSSDB automatically bypasses the analog-to-digital/digital-to-analog converters in the TDM/PCM equipment and provides direct access into the digital bit stream of the TDM/PCM link. As this equipment becomes available, it is recommended that digital telegraph and data signals not be converted into quasi-analog signals and transmitted through a TDM/PCM VF channel but, rather, be transmitted as digital signals through the TDM link. A better utilization of available channel capacity and better signal quality can be achieved if a digital signal is transmitted through the tactical subsystem type II without converting this signal into a quasi-analog signal. The tactical subsystem type IV (see 5.3.1.4) will also provide the capability to transmit digital signals without conversion to quasi-analog signals.

The requirements of 5.3.3.1 through 5.3.3.4 apply to digital channels of the transmission subsystem that are used to interconnect with and exchange information between TADIL B terminal subsystems. These requirements apply to all digital channels regardless of the type of tactical subsystem (see 5.3.1), modulation and data signaling rates, transmission distances and types of radio or cable links employed. Additional requirements for digital channels will be established when sufficient data based on measured performance are available for installed digital systems operating under various conditions.

5.3.3.1 Transmission subsystem BER. Same as 5.3.2.2.1.

5.3.3.2 Character-count and bit-count integrity. Same as 5.3.2.2.2.

5.3.3.3 Electrical characteristics. Same as 5.2.8.3.1.

5.3.3.4 Data signal connection. Same as 5.2.8.3.2.

5.3.3.5 Regeneration. Not standardized.

NOTE: Regeneration points for data transmission over digital channels have to be determined by circuit engineering on a case-by-case basis. (See also Note of 5.3.2.2.5.)

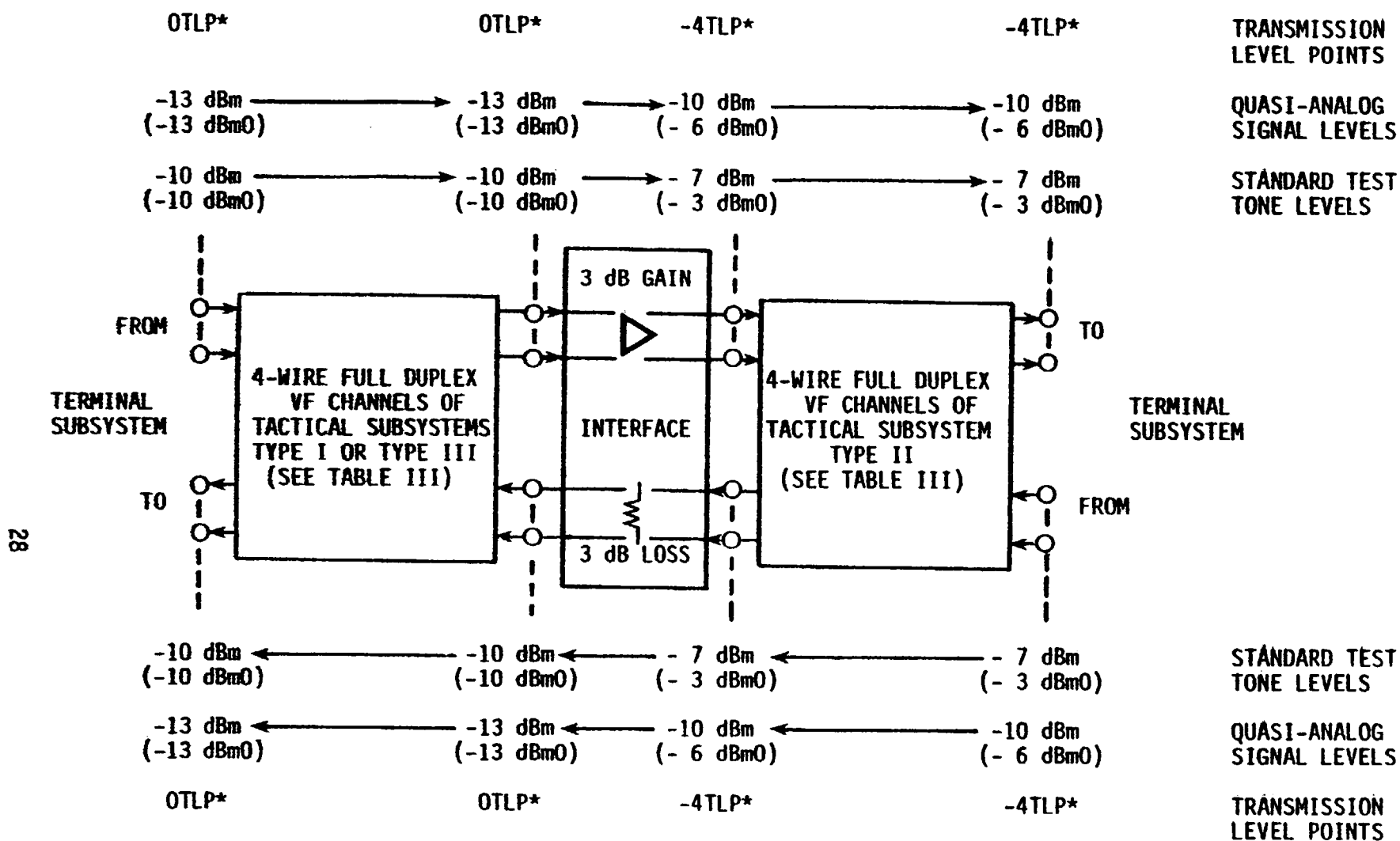


FIGURE 4. Signal level and interface diagram for connecting VF channels of tactical subsystems type I or type III with type II.

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CUSTODIANS:

ARMY - CR  
NAVY - EC  
AIR FORCE - 90

PREPARING ACTIVITY:

ARMY - CR

REVIEW ACTIVITIES:

ARMY - CR, MI, SC  
NAVY - AS, EC, MC, NC, OM, YD,  
AIR FORCE - 02, 90  
DCA - DC  
NSA - NS  
TRI-TAC - TT

USER ACTIVITIES:

ARMY  
NAVY  
AIR FORCE

OTHER INTEREST:

JCS

PROJECT NO.:

TCTS-2030-2

INTERNATIONAL INTEREST

NATO

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## 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-188-203-2. Appendix A is a mandatory  
part of this standard.



RESEARCH AND  
ENGINEERING

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

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 (C3) 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 function 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.

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A handwritten signature in dark ink, appearing to read "Z. D. Dinneen", written over the typed name of the Assistant Secretary of Defense.



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## APPENDIX B

### LIST OF ABBREVIATIONS AND ACRONYMS USED IN MIL-STD-188-203-2.

This Appendix contains general information  
in support of MIL-STD-188-203-2. Appendix B is  
not a mandatory part of this standard.

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## 20 List of abbreviations and acronyms used in MIL-STD-188-203-2

Bd	baud(s)
b/s	bit(s) per second
BER	bit error rate(s)
bit	binary digit
CVSD	continuously variable slope delta
dB	decibel(s)
dBm	decibel(s) referred to one milliwatt
dBm0	decibel(s) referred to one milliwatt, and referenced to zero transmission level point
dBrn	decibel(s) above reference noise
dBrn0	decibel(s) above reference noise, referenced to zero transmission level point
dc	direct current
DCA	Defense Communications Agency
DCAC	DCA Circular(s)
DCS	Defense Communications System
DoD	Department of Defense
DoDD	DoD Directive(s)
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EW	electronic warfare
FDM	frequency division multiplex(ing)
FED-STD	Federal Standard(s)
FM	frequency modulation
FSK	frequency shift keying (or keyed)
HSSDB	high speed serial data buffer
Hz	hertz, (1 Hz = 1 cycle per second)
IMD	intermodulation distortion
JCS	Joint Chiefs of Staff
JCS PUB	JCS Publication(s)
JTIDS	Joint Tactical Information Distribution System
kb/s	kilobit(s) per second, (1 kb/s = 1000 b/s)
kHz	kilohertz, (1 kHz = 1000 hertz)
km	kilometer(s), (1 km = 1000 meters)
LOS	line-of-sight
MIL-HDBK	Military Handbook(s)
MIL-STD	Military Standard(s)
modem	modulator/demodulator
ms	millisecond(s)
NATO	North Atlantic Treaty Organization
NMCS	National Military Command System
PCM	pulse code modulation
pW	picowatt(s), (1 pW = 10 <sup>-12</sup> watt)
pW0	picowatt(s), referenced to zero transmission level point
QPSK	quadrature phase shift keying
rms	root-mean-square
SNR	signal-to-noise ratio

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STANAG	standardization agreement(s) (of the NATO)
TACS/TADS	Tactical Air Control System/Tactical Air Defense System
TADIL	Tactical Digital Information Link(s)
TDDM	time division digital multiplexer
TDM	time division multiplex(ing)
TEMPEST	unclassified short name for investigations and studies of compromising emanations
TIDP	Technical Interface Design Plan
TLP	transmission level point(s)
VF	voice frequency
OTLP	zero transmission level point(s)



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## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER MIL-STD-188-203-2		2. DOCUMENT TITLE Subsystem Design and Engineering Standards for Tactical Digital Information Link (TADIL) B	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)  <input type="checkbox"/> VENDOR  <input type="checkbox"/> USER  <input type="checkbox"/> MANUFACTURER  <input type="checkbox"/> OTHER (Specify): _____	
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