MIL-STD-188-146
15 JUNE 1988

MILITARY STANDARD

INTEROPERABILITY AND PERFORMANCE STANDARDS FOR SATELLITE COMMUNICATIONS

AMSC N/A

AREA SLHC/TCTS

DEPARTMENT OF DEFENSE
WASHINGTON, D.C. 20301

Interoperability and Performance Standards for
Satellite Communications

MIL-STD-188-146

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.)

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

Commander
U.S. Army Communications-Electronics Command
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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 technical standards for tactical and long-haul communications, but later evolved through revisions (MIL-STD-188A, MIL-STD-188B) into a document applicable to tactical communications only (MIL-STD-188C).

2. The Defense Communications Agency (DCA) published DCA Circulars (DCACs) 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. 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-D-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 to be published in the MIL-STD-188-100 series.

4. This document contains technical standards and design objectives for single and multichannel communications circuits that traverse both long-haul and tactical satellite communications systems. The standards contained herein are common to both systems unless stated otherwise. The standards and design objectives have been based upon or make reference to corresponding parameters contained in other appropriate volumes of the MIL-STD-188 series. This document differs, however, in that it covers in more detail those areas applicable to satellite communications.

IDENTIFICATION OF
INTERNATIONAL STANDARDIZATION AGREEMENT

Certain provisions of this standard (see 4.3) are the subject of international standardization agreement STANAG 4232. When amendment, revision, or cancellation of this standard is proposed, which will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

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FIGURES

APPENDIX

1. SCOPE

1.1 Purpose. The purpose of this document is to promulgate technical and engineering parameters in the form of mandatory system standards and optional design objectives that are considered necessary to ensure interoperability and promote compatibility and commonality among Satellite Communications (SATCOM) systems. It is also the purpose of this document to establish a level of performance for SATCOM systems considered necessary to satisfy the requirements of a majority of users. The technical parameters promulgated by this document represent, in general, minimum interoperability and performance characteristics, which may be exceeded as required in order to satisfy specific requirements.

It is not the purpose of this document to serve as a stand-alone, comprehensive reference containing all requirements and technical details required for the design of new equipment. Therefore, parameters for such items as size and weight limitations, connectors, cable assemblies, or power supplies are not contained in this document. Such parameters and other design details are to be established, based on specific requirements, and should be carefully tailored in accordance with the policies of Department of Defense (DOD) Directive (DODD) 4120.21.

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

This document is not intended to be an engineering textbook or a reference handbook for SATCOM systems. It is assumed that the users of this document have a basic technical background in the design and engineering of SATCOM systems.

1.2 Application. This document applies to the design and development of long-haul and tactical SATCOM systems. It does not consider the baseband components of a SATCOM system, as these are covered by other standards. In addition, this standard is applicable, but not mandatory, for the upgrade of existing facilities. Standards for parameters applicable to non-Government owned facilities, leased services, or services provided under published tariffs are outside the scope of this standard. Additional standards for longhaul and tactical systems appear in MIL-STD-188-100 and MIL-STD-188-200.

1.3 Objectives. The main objectives of this document are to ensure interoperability between and among long-haul and tactical SATCOM systems consistent with military requirements; to provide a degree of system performance acceptable to a majority of users of SATCOM systems; and to achieve the necessary degree of interoperability, performance, and compatibility in the most economical way.

1.4 System standards and design objectives. The parameters and other requirements specified in this document are mandatory system standards (see Appendix) if the word "shall" is used in connection with the parameter value or requirement under consideration. Non-mandatory 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 1037A (FED-STD-1037A).

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Standards. Unless otherwise specified, the following standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DODISS) specified in the solicitation form a part of this standard to the extent specified herein.

FEDERAL

FED-STD-1037A	Glossary of Telecommunications Terms

MILITARY

MIL-STD-188-200	System Design and Engineering Standards for Tactical Communications

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

North Atlantic Treaty Organization (NATO) Standardization Agreements (STANAG).

STANAG 4232	Digital Interoperability Between SHF Tactical Satellite Communications Terminals

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

2.2 Other publications. The following document forms a part of this standard to the extent specified herein. Unless otherwise specified, the issue of the document, which is DOD adopted, shall be as those listed in the issue of the DODISS specified in the solicitation. The issues of the documents that have not been adopted shall be as those in effect on the date of the cited DODISS.

International Telecommunication Union (ITU), Radio Regulations

(Copies of the above regulation may be purchased from the International Telecommunication Union, Place des Nations, CH-1211 Geneva 20, Switzerland.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Definition of terms. Definitions of terms used in this document shall be as specified in FED-STD-1037A.

3.2 Abbreviations and acronyms. The abbreviations and acronyms used in this document are defined as follows:

dB	-	decibel(s)
dBc	-	dB, referred to carrier level
dBi	-	dB, referred to isotropic radiator
dBm	-	dB, referred to 1 mW
DCA	-	Defense Communications Agency
DCS	-	Defense Communications System
DOD	-	Department of Defense
DODD	-	DOD directive
DODISS	-	DOD Index of Specifications and Standards
EIRP	-	effective isotropically radiated power
EHF	-	extremely high frequency (30 GHz to 300 GHz)
FCC	-	Federal Communications Commission
GHz	-	gigahertz, (1 GHz = 1000 MHz)
Hz	-	hertz, (1 Hz = 1 cycle per second)
IF	-	intermediate frequency
ITU	-	International Telecommunications Union
JCS	-	Joint Chiefs of Staff
kHz	-	kilohertz, (1 kHz = 1000 Hz)
MCEB	-	Military Communications-Electronics Board
MHz	-	megahertz, (1 MHz = 1000 kHz)
mW	-	milliwatt(s) (1 mW = 1/1000 W)

3. DEFINITIONS (Continued)

NATO	-	North Atlantic Treaty Organization
NMCS	-	National Military Command System
NTIA	-	National Telecommunications and Information Agency
RF	-	radio frequency
SATCOM	-	Satellite Communications
SHF	-	super high frequency (3 GHz to 30 GHz)
SSB	-	single sideband
STANAG	-	Standardization Agreement (NATO)
UHF	-	ultra high frequency (300 MHz to 3000 MHz)
VSWR	-	voltage standing wave ratio
W	-	watt(s)
WARC	-	World Administrative Radio Conference

4. GENERAL REQUIREMENTS

4.1 Basic SATCOM system. The basic elements of a SATCOM system are depicted in Figure 1 and consist of the earth terminal, the satellite, and the system control elements.

4.1.1 Earth terminal. The basic function of the earth terminal is to interface the user with the satellite. Figure 2 is a block diagram that depicts a basic earth terminal consisting of transmitter, receiver, and antenna.

4.1.2 Satellite. The satellite receives uplink signals, optionally processes these signals, translates them in frequency, and amplifies and retransmits these signals to another satellite or to one or more earth terminals.

NOTE: The SATCOM transponder performance characteristics are not defined in this document. However, the contribution of the transponder in areas such as in-band phase and amplitude response, injection source stability, and phase noise, etc., must be budgeted, along with those of the ground elements in order to provide the required total system performance.

4.1.3 System control. Each SATCOM system shall provide a control segment to ensure responsiveness to changing user requirements, environmental and stressed conditions, DOD doctrine, and ITU Radio Regulations. This control system shall provide, as required, various manual and automatic means to supervise all earth terminal accesses and satellite performance and initiate control actions to react to abnormal or non-optimal conditions and optionally allocate system resources.

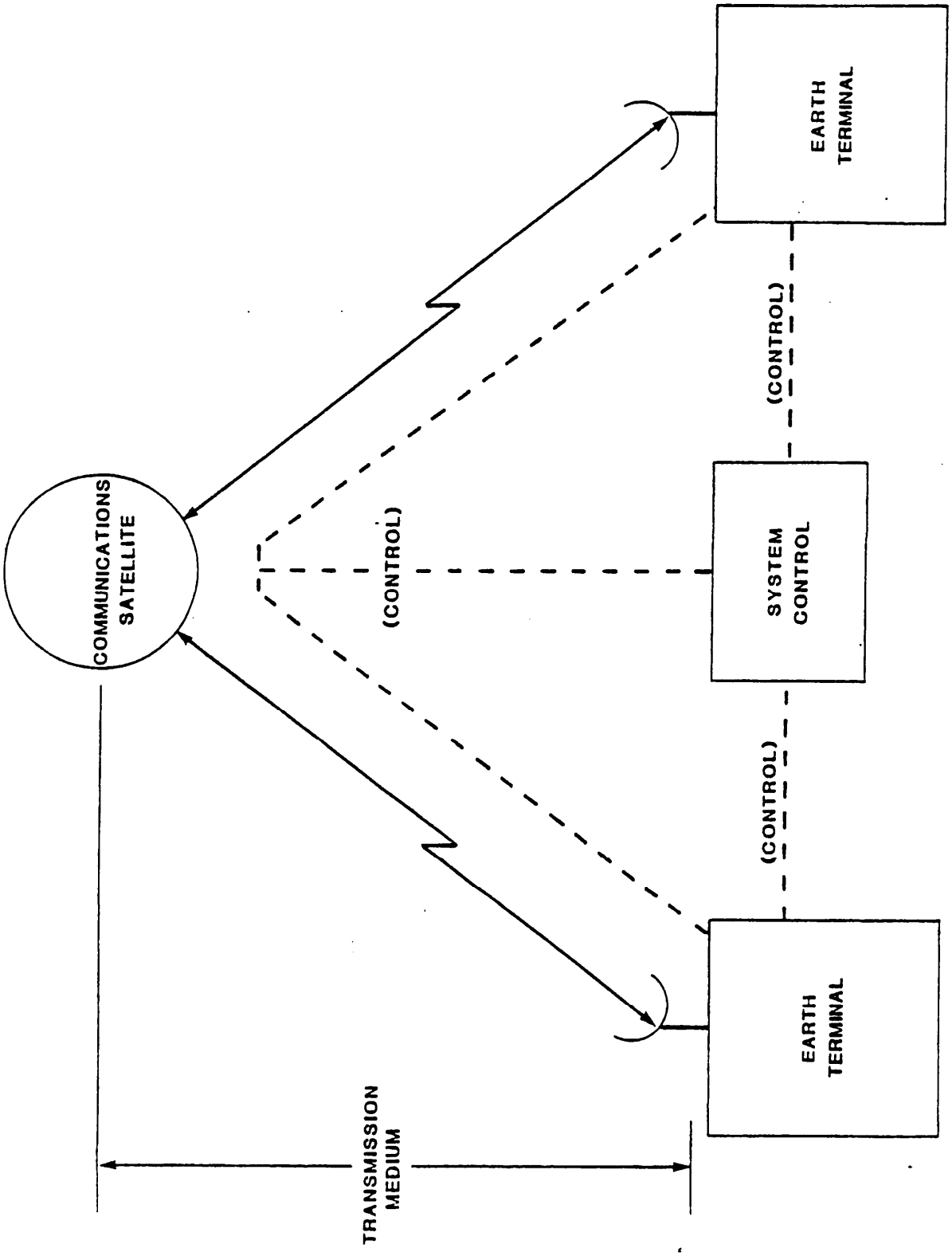

FIGURE 1. Basic SATCOM system.

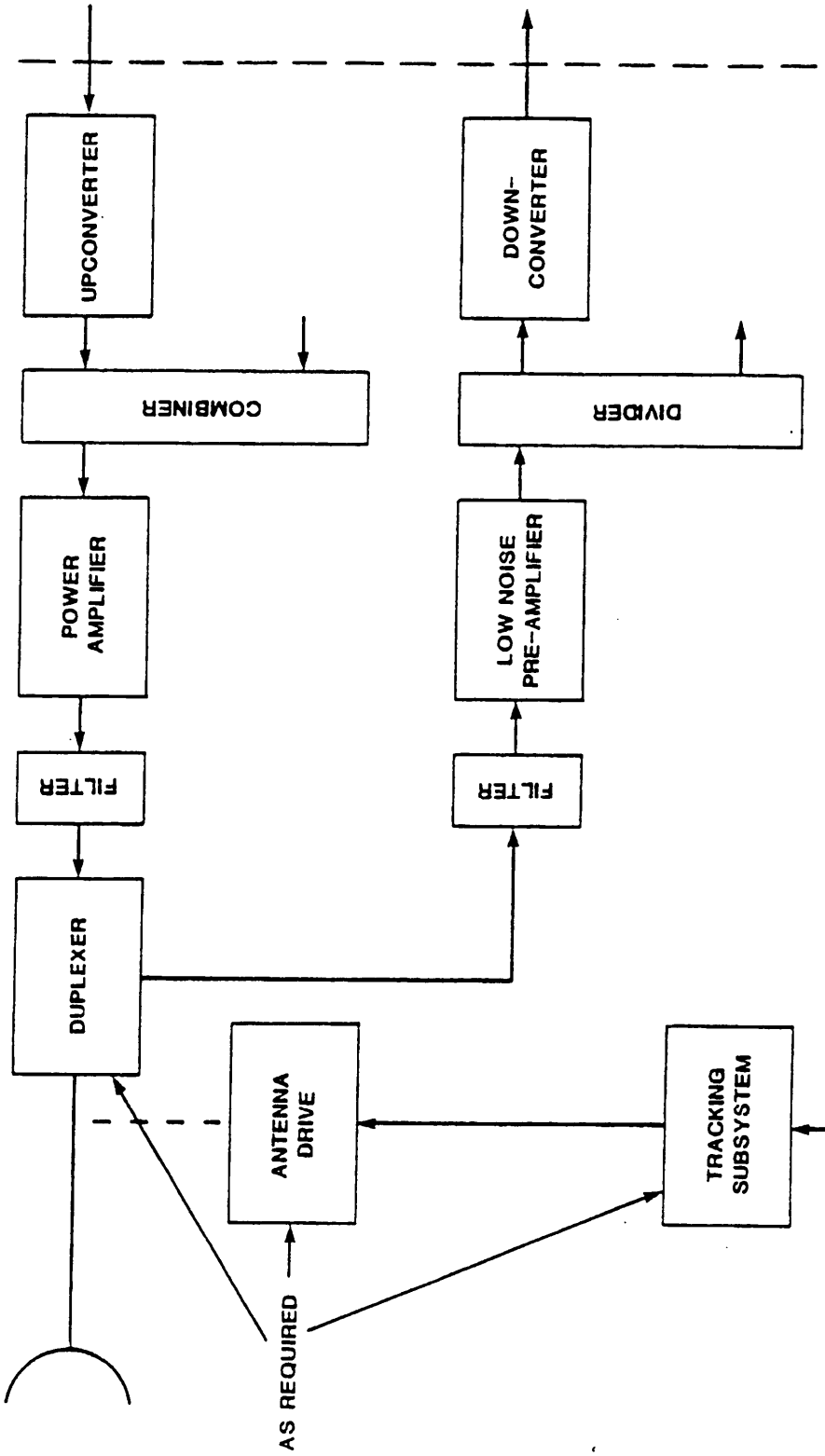

FIGURE 2. Basic earth terminal functional diagram.

4.2 Radio regulations. The use of the frequency spectrum in SATCOM systems is regulated by international agreements embodied in the Radio Regulations, published by the General Secretariat of the ITU, Geneva, Switzerland, and modified periodically by World Administrative Radio Conferences (WARC). These regulations are further qualified at the national level through Federal Government agencies, such as the National Telecommunications and Information Agency (NTIA) and the Federal Communications Commission (FCC); and through military agencies, such as the Joint Chiefs of Staff (JCS) and the Military Communications-Electronics Board (MCEB). Military frequency planning, including joint functional frequency allocation tables, is established as a joint action area under the MCEB.

The equipment design and the choice and performance of the equipment, as well as the spectrum support, which includes both spectrum allocation power limits and specific frequency assignments, must satisfy the provision of these regulations. Adequate familiarity with these regulations is, therefore, required of designers and users of SATCOM equipment. Final approval of frequency bands, operating modes, and equipment characteristics within the DOD rests with the MCEB.

Appendix J of MIL-STD-188-200 contains information based on the ITU Radio Regulations concerning the classification and designation of emissions and necessary bandwidths for radio transmission.

4.3 NATO interoperability. For interoperation with NATO member nations the technical characteristics of SATCOM shall comply with the applicable requirements of the current edition of STANAG 4232.

NOTE: STANAG 4232 defines the requirements for tactical satellite interoperability for super high frequency (SHF) systems.

4.4 General design requirements. SATCOM equipment subsystems and control systems shall meet the applicable requirements of Paragraph 5.1.2 of MIL-STD-188-200.

5. DETAILED REQUIREMENTS

5.1 Interface to earth terminal. Figure 3 depicts the radio frequency (RF) and intermediate frequency (IF) interfaces for user signal access to the earth terminal.

5.1.1 RF interface parameters. Where the earth terminals provide for user signal access at an RF port, including the system control segment, the interface shall meet the requirements of 5.1.1.1 through 5.1.1.3.

5.1.1.1 Input signal level. For SHF earth terminals, the input signal level required at the transmit RF interface (combiner) to produce full rated effective isotropically radiated power (EIRP) from the earth terminal shall not exceed -8 dBm for long-haul terminals and shall be a design objective for tactical terminals.

5.1.1.2 Output signal level. For SHF earth terminals, the RF gain from the antenna output to the receive RF interface (divider) shall be sufficient to maintain the design system noise temperature when interfaced with a device exhibiting a noise figure of 16 dB.

5.1.1.3 Impedance. The RF interface ports shall be nominal 50 ohms, unbalanced to ground. The voltage standing wave ratio (VSWR) shall not exceed 1.25:1 for SHF earth terminals.

5.1.2 IF interface parameters. All single or multichannel terminals shall provide IF transmit and receive interface ports at 700 MHz or 70 MHz or both. These interface ports shall meet the requirements of 5.1.2.1 through 5.1.2.3.

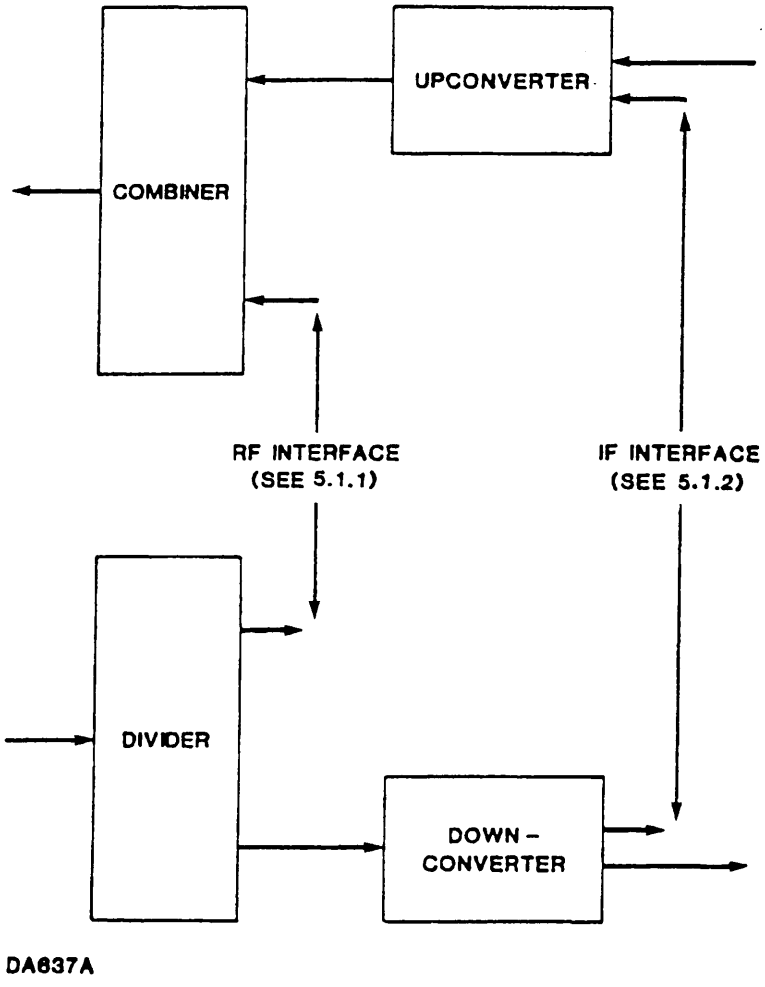

FIGURE 3. Interfaces to earth terminal.

5.1.2.1 Input signal level. The input signal level provided to the upconverters shall be within the range of -10 dBm to +10 dBm.

5.1.2.2 Output signal level. The output signal level provided from the downconverters shall not exceed +10 dBm.

5.1.2.3 Impedance. The IF interface ports shall be a nominal 50 ohms, unbalanced to ground. The VSWR shall not exceed 1.25:1.

5.2 Earth terminal.

5.2.1 Transmit power. The specific EIRP for each terminal is mission dependent. The maximum EIRP, based upon the angle of elevation of the earth terminal antenna, shall be limited to the maximum EIRP specified in Article 28 of the ITU Radio Regulations.

NOTE: ITU Radio Regulations place restrictions on the maximum transmitted EIRP for frequencies greater than 1 GHz. These restrictions are imposed to reduce interference between satellite and terrestrial systems.

5.2.2 UHF earth terminal. The UHF earth terminal shall be configured to include the antenna, the transmitter, and the receiver; however, the transmitter requirement may be waived for valid receive-only applications.

5.2.2.1 UHF transmitter. The UHF transmitter shall meet the requirements of 5.2.2.1.1 through 5.2.2.1.7.

5.2.2.1.1 UHF transmitter power control. Means shall be provided to control the earth terminal EIRP. Control of the EIRP shall be settable to within an accuracy of 1 dB from minimum to maximum power. This requirement is waived for small mobile platforms.

5.2.2.1.2 UHF phase linearity. When operated in a back-to-back configuration through a transparent translator, the departure from linear phase of the transmitter and receiver combination shall not exceed $\pm$0.1 radian over 80 percent of the 1-dB IF bandwidth.

5.2.2.1.3 Ultra high frequency (UHF) amplitude response. When operated in a back-to-back configuration through a transparent translator, the amplitude variation shall not exceed $\pm$0.4 dB over any 5-kHz bandwidth within the 1-dB IF bandwidth and shall not exceed $\pm$1.0 dB over 80 percent of the 1-dB IF bandwidth.

5.2.2.1.4 UHF transmit spectral purity. When operated in a back-to-back configuration through a transparent translator, the total spurious content of the carrier, including phase noise and discrete spurious signals, shall not exceed an envelope defined by the following points [single sideband (SSB)].

$\leq$-55 dBc/Hz offset 10 Hz from carrier
$\leq$-75 dBc/Hz offset 100 Hz from carrier
$\leq$-85 dBc/Hz offset 1 kHz from carrier
$\leq$-90 dBc/Hz offset 10 kHz to 10 MHz from carrier
$\leq$-120 dBc/Hz offset > 10 MHz from carrier

5.2.2.1.5 UHF transmit extraneous outputs. The EIRP of extraneous or spurious emissions, excluding harmonics or intermodulation products, shall be at least 60 dB below the rated normal EIRP. The EIRP of any single harmonic of the fundamental shall be at least 60 dB below the normal EIRP of the fundamental.

5.2.2.1.6 UHF transmit intermodulation products. The third and higher order intermodulation products resulting from two equal carriers simultaneously passing through the transmitter shall not exceed -20 dB when measured relative to the total output power level (rated EIRP) of the two carriers. This requirement is waived for single channel systems.

5.2.2.1.7 UHF transmit spectrum inversion. There shall be no inversion of spectrum between any IF input and the antenna output. Frequency translation shall be accomplished without inverting the logic or signal sense of the data stream.

5.2.2.2 UHF receiver. The UHF receiver shall meet the requirements of 5.2.2.2.1 through 5.2.2.2.5.

5.2.2.2.1 UHF phase linearity. See 5.2.2.1.2.

5.2.2.2.2 UHF amplitude response. See 5.2.2.1.3.

5.2.2.2.3 UHF receiver spectral purity. See 5.2.2.1.4.

5.2.2.2.4 UHF receiver spurious output. All spurious frequencies shall be suppressed at least 80 dB below any desired signal response.

5.2.2.2.5 UHF receiver spectrum inversion. There shall be no inversion of spectrum between the downlink antenna interface and any IF output. Frequency translation shall be accomplished without inverting the logic or signal sense of the data stream.

5.2.2.3 UHF antenna polarization. The UHF antenna shall be right-hand (clockwise) circularly polarized except for antennas used in small mobile platforms, which may use linearly polarized elements.

NOTE: For an observer looking in the direction of propagation, the rotation of the electric field vector in a stationary transverse plane is clockwise for right-hand polarization. Similarly, the rotation is counterclockwise for left-hand polarization.

5.2.3 SHF earth terminal. The earth terminal shall be configured to include the antenna, the transmitter, and the receiver; however, the transmitter requirement may be waived for valid receive-only application.

5.2.3.1 SHF transmitter. The SHF transmitter shall meet the requirements of 5.2.3.1.1 through 5.2.3.1.8.

5.2.3.1.1 SHF transmit power control. Means shall be provided to control the earth terminal EIRP. Control of the EIRP shall be settable to within an accuracy of 1.0 dB from minimum to maximum power.

5.2.3.1.2 SHF transmit stability. For any setting of the transmit gain and for a constant IF input level, the EIRP shall not vary more than ±1.0 dB in any 24-hour period within the operating environment specified for the equipment.

5.2.3.1.3 SHF transmit phase linearity. The departure from linearity at the 70-MHz input shall not exceed ±0.1 radian over the central 20 MHz of a channel and shall not exceed ±0.25 radian over 80 percent of the 1-dB IF bandwidth. The departure from linearity at the 700-MHz input shall not exceed ±0.15 radian over the central 50 percent of the 1-dB IF bandwidth and shall not exceed ±0.4 radian over 80 percent of the 1-dB IF bandwidth.

5.2.3.1.4 SHF transmit amplitude response. The amplitude variation at the 70-MHz input shall not exceed ±1.0 dB at the central 20 MHz of a channel and shall not exceed ±2.0 dB over 80 percent of the 1-dB IF bandwidth. The amplitude variation at the 700-MHz input shall not exceed ±1.0 dB at the central 50 percent of the 1-dB IF bandwidth and shall not exceed ±2.0 dB over 80 percent of the 1-dB IF bandwidth.

5.2.3.1.5 SHF transmit spectral purity. The total spurious content of any translated carrier, including phase noise and discrete spurious signals, shall not exceed an envelope defined by the following points (SSB).

≤-60 dBc/Hz offset 10 Hz from carrier
≤-75 dBc/Hz offset 100 Hz from carrier
≤-95 dBc/Hz offset 1 kHz from carrier
≤-110 dBc/Hz offset 10 kHz from carrier
≤-120 dBc/Hz offset 100 kHz from carrier
≤-130 dBc/Hz offset ≥ 1 MHz from carrier

5.2.3.1.6 SHF transmit extraneous outputs. The EIRP of extraneous or spurious emissions excluding harmonics or intermodulation products, shall be at least 80 dB below the rated normal EIRP. The EIRP of any single harmonic of the fundamental shall be at least 60 dB below the normal EIRP of the fundamental.

5.2.3.1.7 SHF transmit intermodulation products. The intermodulation products resulting from two equal carriers simultaneously passing through the transmitter shall not exceed the following values when measured relative to the total output power level of the two carriers.

OUTPUT POWER LEVEL	MAXIMUM INTERMODULATION PRODUCT
Rated EIRP	-14 dB
Rated EIRP -3 dB	-19 dB
Rated EIRP -6 dB	-25 dB

For each additional 1-dB decrease in rated EIRP the intermodulation products shall decrease 3 dB.

5.2.3.1.8 SHF transmit spectrum inversion. There shall be no inversion of spectrum between any IF input and the antenna output. Frequency translation shall be accomplished without inverting the logic or signal sense of the data stream.

5.2.3.2 SHF receiver. The SHF receiver shall meet the requirements of 5.2.3.2.1 through 5.2.3.2.6.

5.2.3.2.1 SHF receiver phase linearity. The departure from linearity at the 70-MHz output shall not exceed ±0.1 radian over the central 20 MHz of a channel and shall not exceed ±0.25 radian over 80 percent of the 1-dB IF bandwidth. The departure from linearity at the 700-MHz output shall not exceed ±0.15 radian over the central 50 percent of the 1-dB IF bandwidth and shall not exceed ±0.4 radian over 80 percent of the 1-dB IF bandwidth.

5.2.3.2.2 SHF receiver amplitude response. The amplitude variation at the 70-MHz output shall not exceed ±1 dB at the central 20 MHz of a channel and shall not exceed ±2 dB over 80 percent of the 1-dB IF bandwidth. The amplitude variation at the 700-MHz output shall not exceed ±1.0 dB at the central 50 percent of the 1-dB IF bandwidth and shall not exceed ±2.0 dB over 80 percent of the 1-dB IF bandwidth.

5.2.3.2.3 SHF receiver spectral purity. The spectral purity of any translated carrier shall be defined in 5.2.3.1.5.

5.2.3.2.4 SHF receiver spurious output. The sum total of spurious signal power measured at the 70-MHz or 700-MHz IF output shall be at least 20 dB below the thermal noise power measured in the required operating bandwidth with maximum signal into the low noise amplifier. No one spurious signal shall be greater than an equivalent signal 10 dB below the noise level in

the narrowest bandwidth of interest at the low noise amplifier input. The requirements of this paragraph shall be met with multiple carriers being transmitted at rated EIRP and simultaneously receiving two carriers, at the maximum expected signal level, at the input to the low noise amplifier.

5.2.3.2.5 SHF receiver spectrum inversion. There shall be no inversion of spectrum between the downlink antenna interface and any IF output. Frequency translation shall be accomplished without inverting the logic or signal sense of the data stream.

5.2.3.2.6 SHF receiver gain stability. The SHF receive gain shall not vary more than ± 2.0 dB in any 24-hour period within the operating environment specified for the equipment.

5.2.3.3 SHF antenna. The SHF antenna shall meet the requirements of 5.2.3.3.1 through 5.2.3.3.3.

5.2.3.3.1 SHF antenna sidelobe levels. The sidelobe pattern of the SHF antenna shall be bounded by the limit of the following expressions:

$$G = 32 - 25 \log_{10} \theta, \text{ dBi}, \quad 1^{o*} \leq \theta \leq 48^{o}$$

$$G = -10 \text{ dBi} \qquad \theta > 48^{o}$$

*For $D/\lambda < 100$ this angle becomes $100\lambda/D$ degrees

where: G is the gain of the sidelobe envelope relative to an isotropic antenna in the direction of the geostationary orbit in dBi.

θ is the angle in degrees between the main beam axis and the direction considered.

D = antenna diameter
λ = wavelength
} expressed in the same units

5.2.3.3.2 SHF antenna polarization. Earth terminal antennas shall be right-hand (clockwise) circularly polarized for transmission, and left-hand (counterclockwise) circularly polarized for reception. (See note of 5.2.2.3.)

NOTE: Frequency reuse applications require that earth terminal antennas shall be left-hand (counterclockwise) circularly polarized for transmission and right-hand (clockwise) circularly polarized for reception.

5.2.3.3.3 SHF antenna axial ratio. The axial ratio shall be no greater than 2.0 dB over the receive and transmit bands. Frequency reuse plans require improved axial ratios with a Design Objective of 0.5 dB.

5.2.4 EHF earth terminal. Requirements are not presently defined.

5.3 Satellite parameters.

5.3.1 Power output. The EIRP from a satellite is mission dependent. Satellite systems, however, shall be designed so that maximum EIRP from any satellite shall not exceed the power density at the earth's surface specified in Article 28 of the ITU Radio Regulations.

5.3.2 Station-keeping capabilities. All geostationary satellites shall have the capability of maintaining their position within the tolerance established by the provisions of the current issue of the ITU Radio Regulations.

5.3.3 Antenna pointing accuracy. Geostationary satellites shall provide the means to maintain the pointing direction of maximum radiation of earthward beams within the limits established by the provisions of the current issue of the ITU Radio Regulations.

5.3.4 Antenna polarization.

5.3.4.1 UHF. The UHF satellite antenna shall be right-hand (clockwise) circularly polarized. (See note of 5.2.2.3.)

5.3.4.2 SHF. The SHF satellite antenna shall be left-hand (counterclockwise) circularly polarized for transmission and right-hand (clockwise) circularly polarized for reception. (See note of 5.2.2.3.)

NOTE: Frequency reuse applications require that satellite antennas shall be right-hand (clockwise) circularly polarized for transmission and left-hand (counterclockwise) circularly polarized for reception.

5.3.4.2.1 SHF axial ratio. The axial ratio shall be no greater than 2.0 dB over the receive and transmit bands. Frequency reuse plans require improved axial ratios with a Design Objective of 0.75 dB.

5.3.4.3 Extremely high frequency (EHF). Requirements are not presently defined.

5.4 System control requirements.

5.4.1 Spacecraft control. All control systems shall provide the means to determine the satellite position in relation to the earth. The control systems shall also provide the means for adjustments through uplink commands to maintain satellite position within limits established by operational requirements or the ITU Radio Regulations.

NOTE: The accuracy of the control systems in determining satellite position must be compatible with the requirements of the ITU Radio Regulations.

5.4.2 Antenna pointing accuracy maintenance. The control systems shall provide the means to determine the pointing direction of maximum radiation of any satellite downlink antenna on geostationary satellites. The control systems shall also provide the means to effect adjustments through uplink commands to maintain pointing accuracy within the limits established by ITU Radio Regulations.

5.4.3 Satellite power output. All control systems shall provide the means to control the satellite EIRP to ensure that the ITU Radio Regulation requirements of maximum power flux density at the earth's surface are not exceeded.

5.4.4 Cessation of emissions. All control systems shall provide the means through uplink commands to cease emissions of any or all transponder and beacon transmitters.

5.4.5 Earth terminal. The control systems shall encompass control of bandwidth, frequency, and power of all earth terminal accesses. Control systems shall also provide the means to determine earth terminal required

antenna pointing directions to permit satellite signal acquisition. The prediction accuracy shall be one tenth of the earth terminal antenna beamwidth in both elevation and azimuth.

5.4.6 SATCOM payload. The control systems shall, where design features are inherent to satellite design, provide control of amplifier gain states, antenna connectivity, and antenna nulling operations.

6. NOTES

6.1 Subject term (key word) listing

Communications satellite
Control system
Downlink signals
Earth terminal
EIRP
Geostationary satellite
SATCOM
Uplink signals

Custodians:

Army - CR
Navy - EC
Air Force - 90

Review activities:

Army - SC
Navy - EC, MC
Air Force - 90
DCA - DC
NSA - NS
JTC^{3}A

User activities:

Army
Navy
Air Force

Preparing activity:

Army - CR
(Project SLHC-1460)

International interest:

NATO

APPENDIX

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

The Appendix contains information related to MIL-STD-188-146 and is a mandatory part of this standard.

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.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-188-146	Interoperability and Performance Standards for Satellite Communications

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)*

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

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