MIL-STD-461C
4 AUGUST 1986

SUPERSEDING
MIL-STD-461B
1 APRIL 1980

MILITARY STANDARD

ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY REQUIREMENTS FOR THE CONTROL OF ELECTROMAGNETIC INTERFERENCE

AMSC No. AREA EMCS

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DEPARTMENT OF DEFENSE
WASHINGTON, DC 20402

Electromagnetic Emissions and Susceptibility Requirements
for the Control of Electromagnetic Interference

1. This military standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Space and Naval Warfare Systems Command, Attn: SPAWAR 003-121, Washington, DC 20363-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FOREWORD

1. This standard is established to:

   (a) Ensure that interference control is considered and incorporated into the design of equipment and subsystems; and

   (b) Provide a basis for evaluating the electromagnetic characteristics of equipment and subsystems, as well as for inputs to analyses of the electromagnetic compatibility and effectiveness of systems in a complex electromagnetic environment.

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ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY REQUIREMENTS FOR THE CONTROL OF ELECTROMAGNETIC INTERFERENCE

TO ALL HOLDERS OF MIL-STD-461C:

1. THE FOLLOWING PAGES CONSTITUTE PART 2 OF MIL-STD-461C FOR AIR FORCE ACQUISITIONS:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
2-i through 2-iv	15 October 1987	2-i through 2-iv	4 August 1986
2-1 through 2-24	15 October 1987	2-1 through 2-24	4 August 1986
2-25 through 2-32	15 October 1987		

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Preparing activity:
Air Force - 11

Project No. EMCS-F122

Review activities:
Air Force - 13, 14, 15, 17, 18, 19, 70, 71, 80, 82, 84, 90, 99

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MILITARY STANDARD

ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY REQUIREMENTS
FOR THE CONTROL OF ELECTROMAGNETIC INTERFERENCE

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1. MAKE THE FOLLOWING PEN AND INK CHANGE:

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Custodians:
Army - CR
Navy - EC
Air Force - 11

Review activities:
Army - MI, AV
Navy - SH, OS, AS, YD, MC, CG, TD
Air Force - 13, 15, 17, 19, 68, 69, 79, 99
NSA
DCA
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User activities:
Army - AT, ME, GL, CE, MD

Preparing activity:
NAVY - EC

(Project No. EMCS-0121)

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Part 1. General Requirements

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1. SCOPE

1.1 Purpose. This standard establishes the documentation and design requirements for the control of the electromagnetic emission and susceptibility characteristics of electronic, electrical, and electromechanical equipment and subsystems (as defined herein) designed or procured for use by activities and agencies of the Department of Defense. Such equipment and subsystems may be used independently or as an integral part of other subsystems or systems.

1.2 Application. The requirements of this standard are applicable to the extent specified in the individual equipment or subsystem specification, contract or order. The applicability of the emission and susceptibility requirements are dependent upon the type of equipment or subsystem and its mission and intended installation. When engineering analyses on equipment or subsystems being procured for use in specific systems or platforms reveal that the requirements in this standard are not adequate for that procurement, they may be tailored by the procuring activity and incorporated into the request-for-proposal, specification, contract or order. In cases where a system or integrating contractor is required to prepare a detailed equipment or subsystem specification containing requirements for electromagnetic compatibility (EMC), including electromagnetic interference (EMI), electromagnetic pulse (EMP), electromagnetic (EM) radiation hazards, and so forth, the requirements of this standard shall be tailored as needed to achieve overall required system or platform performance. For equipment and subsystems in feasibility or advanced development stages of the acquisition process, this standard shall be used as a guide in formulating the appropriate requirements. Those requirements shall be enumerated in the individual equipment development or purchase description.

1.3 Units. Symbols, units, and physical constants used in this standard are in accordance with the International System of Units (SI), as described in MIL-STD-463.

1.4 Emission and susceptibility designations. The emission and susceptibility requirements in this standard and corresponding test methods of MIL-STD-462 are designated in accordance with an alpha-numeric coding system where:

C = Conducted
R = Radiated
E = Emission
S = Susceptibility
UM = Unique requirement(s) intended for a miscellaneous, general-purpose equipment or subsystem

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks 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.

SPECIFICATIONS

MILITARY

MIL-E-6051	Electromagnetic Compatibility Requirements, Systems

STANDARDS

MILITARY

MIL-STD-285	Attenuation Measurements For Enclosure, EM Shielding, For Electronic Test Purposes, Method Of
MIL-STD-462	Electromagnetic Emission And Susceptibility, Test Methods For
MIL-STD-463	Definitions And System Of Units, Electromagnetic Interference And Electromagnetic Compatibility

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MIL-STD-480	Configuration Control - Engineering Changes, Deviations And Waivers
MIL-STD-704	Aircraft Electric Power Characteristics
MIL-STD-1377 (NAVY)	Effectiveness Of Cable, Connector And Weapon Enclosure Shielding And Filters In Precluding Hazards Of Electromagnetic Radiation To Ordnance, Measurement Of
MIL-STD-1385 (NAVY)	Preclusion Of Ordnance Hazards In Electromagnetic Fields; General Requirements For
MIL-STD-1512 (USAF)	Electro-explosive Subsystems, Electrically Initiated, Test Methods And Design Requirements
MIL-STD-1541 (USAF)	Electromagnetic Compatibility Requirements For Space Systems
MIL-STD-1542 (USAF)	Electromagnetic Compatibility (EMC) And Grounding Requirements For Space System Facilities

NATO STANAGS

NAT-STD-3516	EMC Test Methods For Aerospace Electrical and Electronic Equipment
NAT-STD-3614	EMC Of Installed Equipment In Aircraft
NAT-STD-3659	Bonding And In-Flight Lightning

HANDBOOKS

MILITARY

MIL-HDBK-235	Electromagnetic (Radiated) Environment Considerations For Design And Procurement Of Electrical and Electronic Equipment
MIL-HDBK-237	Electromagnetic Compatibility Management Guide For Platforms, Systems And Equipment
MIL-HDBK-241	Design Guide For EMI Reduction In Power Supplies
MIL-HDBK-253	Guidance For The Design And Test Of Systems Protected Against The Effects Of Electromagnetic Energy

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.

PUBLICATIONS

AIR FORCE SYSTEMS COMMAND (AFSC)

AFSC DH 1-4	Air Force Systems Command Design Handbook, EMC
AFSC DH 2-5	Air Force Systems Command Design Handbook, Armament
AFSC DH 2-7	Air Force Systems Command Design Handbook, System Survivability

US ARMY AMC MATERIEL READINESS SUPPORT ACTIVITY

AMC Pamphlet 706-235	Hardening Weapon Systems Against RF Energy
AMC Pamphlet 706-410	Engineering Design Handbook, EMC

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SPACE AND NAVAL WARFARE SYSTEMS COMMAND (SPAWAR)

NAVELEX 0101, 106	Naval Shore Electronics Criteria, EMC/EMR Hazards

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSEA OD 30393	Design Principles And Practices For Controlling Hazards Of Electromagnetic Radiation To Ordnance

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

2.2 Other publications. The following document(s) form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DoDISS.

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J551	Measurement Of Electromagnetic Radiation From Motor Vehicles
SAE AIR 1423	Electromagnetic Compatibility On Gas Turbine Engines For Aircraft Propulsion
SAE AIR 1425	Methods Of Achieving Electromagnetic Compatibility Of Gas Turbine Engines Accessories, For Self-Propelled Vehicles

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.)

(Nongovernment standards are generally available for reference from libraries. They are also distributed among nongovernment standards bodies and using Federal agencies.)

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

The terms used in this standard are defined in MIL-STD-463. In addition, the following definitions are applicable for the purpose of this standard:

3.1 Critical area. A location on a platform or installation containing equipment or subsystems which, if malfunctioning due to unwanted electromagnetic energy, could degrade the overall system performance and result in failure or abortion of a primary mission. All locations on a submarine and surface ship are considered critical areas.

3.2 Equipment. Any electrical, electronic, or electromechanical device, or collection of items, intended to operate as an individual unit and perform a singular function. As used herein equipment include, but are not limited to, the following: receivers, transmitters, transceivers, transponders, power supplies, electrical office machines, hand tools, processors, test apparatus and instruments, and material handling equipment.

3.3 Interconnecting leads. Control and signal lines which interface with equipment or subsystems not being supplied under the same contract. Control leads use AC or DC power for control of such devices as relays, solenoids, valves, machinery control sensors, and synchros; whereas signal leads send or receive such signals as clock, IF, audio, digital, and RF.

3.4 Non-critical area. A location in a ground installation where EMI will not result in failure or abortion of a mission or degradation of the overall system performance. Examples of areas which may be considered non-critical are office buildings, recreational areas, laundry areas, food servicing areas, drafting rooms, and woodworking shops.

3.5 Sheltered subsystem. Equipment or components designed specifically for installation in standard military shelters, which comply with MIL-STD-285 and which are not intended to meet the natural environments, such as humidity, temperature, and so forth.

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3.6 Subsystem. For the purpose of this standard, the definition in 3.6a or 3.6b shall be considered as a subsystem. In either case, the devices or equipment may be physically separated when in operation and will be installed in fixed or mobile stations, vehicles, or systems.

a. A collection of devices or equipment designed and integrated to function as a single entry, but wherein any device or equipment is not required to function as an individual equipment, as defined in 3.2.

b. A collection of equipment and subsystems, as defined in 3.6a, designed and integrated to function as a major subdivision of a system and to perform an operational function, or functions, therein.

3.7 System. A composite of equipment, subsystems, skills, and techniques capable of performing or supporting an operational role. A complete system includes related facilities, equipment, subsystems, materials, services, and personnel required for its operation to the degree that it can be considered self-sufficient within its operational or support environment. (EMC requirements for systems are not included in this standard, but rather in such documents as MIL-E-6051, MIL-STD-1541, and MIL-STD-1542.)

3.8 Tailoring. The process by which the requirements of this standard are adapted (that is, modified, deleted, or supplemented) to the peculiarities, characteristics, or operational requirements of the material in an individual equipment or subsystem specification. The tailoring process does not constitute a waiver or deviation. The latter terms are defined in MIL-STD-480.

3.9 Telecommunications equipment. Any equipment which transmits, emits, or receives signs, signals, writing, images, sounds, or information of any nature by wire, radio, visual, or other electromagnetic means.

4. GENERAL REQUIREMENTS

Electronic, electrical, and electromechanical equipment and subsystems shall comply with the applicable requirements in 4.1 through 4.9. These requirements are in addition to the applicable emission and susceptibility requirements and limits defined in other portions of this standard.

4.1 Joint procurements. Equipment or subsystems procured by one DoD activity for multi-agency use shall comply with the requirements of the user agencies.

4.2 North Atlantic Treaty Organization (NATO) procurements. Equipment or subsystems procured by a DoD activity in support of NATO shall comply with the applicable requirements of this standard and any applicable NATO standardization agreement (STANAG), such as NAT-STDs -3516, -3614, and -3659. The NATO STANAGs are not to be waived, deviated from, or tailored unless specific authority has been granted by the procuring activity.

4.3 Design requirements. Equipment and subsystems shall be designed in accordance with the criteria and guidance contained in the following documents, as applicable: MIL-HDBK-235, MIL-HDBK-237, MIL-HDBK-241, MIL-HDBK-253, AFSC DH 1-4, AFSC DH 2-5 and AFSC DH 2-7, AMC Pamphlets 706-235 and 706-410, and NAVELEX 0101, 106.

4.3.1 Filtering (Navy only). The use of line-to-ground filters for EMI control shall be minimized. Such filters establish low impedance paths for structure (common-mode) currents through the ground plane and can be a major cause of interference in systems, platforms, or installations because the currents can couple into other equipment using the same ground plane. If such a filter must be employed, the total line-to-ground capacitance shall not exceed 0.1 microfarads (μF) for 60 hertz (Hz) equipment or 0.02 μF for 400 Hz equipment. The filtering employed shall be fully described in the equipment or subsystem technical manual, as well as the EMI Test Report. The procuring activity shall determine the applicability of this requirement for class A1 equipment and subsystems.

4.3.2 Equipment or subsystems employing electro-explosive devices (EEDs). When EEDs are employed in, or are an integral part of, equipment or subsystems required to meet the requirements of this standard, the EED and associated wiring shall meet the requirements in 4.3.2.1, 4.3.2.2, or 4.3.2.3, as applicable.

4.3.2.1 Air Force procurements. AFSC DH 2-5 shall be used as a design guide, and compliance with MIL-STD-1512 shall be accomplished.

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4.3.2.2 Navy procurements. Compliance with MIL-STD-1385 shall be accomplished, and OD 30393 shall be used as a design guide in implementing the principles outlined in MIL-STD-1385. In addition, MIL-STD-1377 shall be used to determine the effectiveness of cable, connector, and weapon enclosure shielding and filtering. For air weapons, all circuits shall be isolated from the equipment or subsystem case, and the case bonded to the airframe.

4.3.2.3 Army procurements. The requirements of 4.3.2.1 and 4.3.2.2 shall be used as specified in the procurement documentation.

4.4 Self-compatibility. The operational performance of an equipment or subsystem shall not be degraded, nor shall it malfunction when all of the units or devices in the equipment or subsystem are operating together at their designed levels of efficiency or their nominal design capability.

4.5 Commercial off-the-shelf equipment.

4.5.1 Used in equipment or subsystems.

4.5.1.1 Selected by contractor. When it is demonstrated by the contractor that a commercial item selected by the contractor is responsible for an equipment or subsystem failing to meet its contractual EMI requirements, either the commercial item shall be modified or replaced or interference suppression measures shall be employed, so that the equipment or subsystem can meet its contractual EMI requirements.

4.5.1.2 Specified by procuring activity. When it is demonstrated by the contractor that a commercial item specified by the procuring activity for use in an equipment or subsystem is responsible for failure of the equipment or subsystem to meet its contractual EMI requirements, the data indicating such failure shall be included in the EMI Test Report. No modification nor replacement shall be made unless authorized by the procuring activity.

4.5.2 Used as an individual equipment. Commercial equipment without any previous EMI certification shall meet the applicable requirements in Parts 2 through 10 of this standard.

4.6 Government furnished equipment (GFE). When it is demonstrated by the contractor that a GFE is responsible for failure of an equipment or subsystem to meet its contractual EMI requirements, the data indicating such failure, along with descriptions of possible modifications to the GFE, shall be included in the EMI Test Report. No modification shall be made unless authorized by the procuring activity.

4.7 Short-duration emissions. Radiated and conducted transient emissions, resulting from automatic cycling of electronic or electrical switching circuitry and manually controlled operational mode switching functions required for normal operation of the equipment or subsystem, shall meet all applicable requirements of this standard.

4.8 Procurements of equipment or subsystems having met other EMI requirements. Procurements of production-type equipment and subsystems electrically and mechanically identical to those previously procured by activities of DoD or other Federal agencies, or their contractors, shall meet the EMI requirements and associated limits, as applicable in the earlier procurement, unless otherwise specified by the Command or agency concerned. For Navy procurements, production-type equipment shall be tested to all the applicable limits of this standard, but shall meet the EMI requirements and associated limits as applicable in the earlier procurement, unless otherwise specified by the Command or agency concerned. All data shall be provided in the EMI Test Report.

4.9 Testing requirements. The testing requirements and procedures of MIL-STD-462, as implemented by a Government approved EMI Test Plan (See 6.2), shall be used to determine compliance with the applicable emission and susceptibility requirements of Section 5 and Parts 2 through 10 of this standard. When performing susceptibility testing, the thresholds of susceptibility shall be determined and reported in the EMI Test Report, whether below the contractual EMI requirement or above, within the maximum capability of the test equipment used. Data gathered as a result of performing tests in one electromagnetic discipline may be sufficient to satisfy requirements in another. Therefore, to avoid unnecessary duplication, a single test program should be established with similar tests conducted concurrently whenever possible. Equipment that are intended to be operated as a subsystem shall be tested, as such, to the applicable emission and susceptibility requirements and limits whenever practical. Formal testing is not to commence without approval of the test plan by the Command or agency concerned.

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5. EMISSION AND SUSCEPTIBILITY REQUIREMENTS AND LIMITS

5.1 General. Table 1-I is a list of emission and susceptibility requirements established by this standard. General test procedures for these requirements are contained in MIL-STD-462. All results of tests performed to demonstrate compliance with these requirements are to be documented in the EMI Test Report (See 6.2) and forwarded to the Command or agency concerned for evaluation prior to acceptance of the equipment or subsystem. Design procedures and techniques for the control of EMI shall be described in the EMI Control Plan (See 6.2). Approval of design procedures and techniques described in the EMI Control Plan does not relieve the supplier of the responsibility of meeting the contractual emission, susceptibility, and design requirements. The test report shall be required by the contract and is to be forwarded to the Command or agency concerned for evaluation prior to acceptance of the equipment or subsystem.

5.2 Equipment and subsystem classes. Table 1-II defines equipment or subsystem classes in accordance with their intended installation, platform, and mission. In addition, Table 1-II denotes the applicable part of this standard wherein emission and susceptibility requirements and limits are specified. When an equipment or subsystem falls into more than one class, it shall comply with the most stringent of the applicable requirements and limits.

6. NOTES

6.1 Intended use. This standard is intended for use in the acquisition cycle of equipment and subsystems to specify the electromagnetic emission and susceptibility requirements for the control of EMI.

6.2 Data requirements list and cross reference. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of the DOD FAR Supplement 27.410-6 are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this standard is cited in the following subparagraphs.

Applicable Para.	Data requirement	Applicable DID
5.1	Electromagnetic Interference Control Plan	DI-EMCS-80199
4.9	Electromagnetic Interference Test Plan	DI-EMCS-80201
5.1	Electromagnetic Interference Test Report	DI-EMCS-80200

(Data item descriptions related to this standard, and identified in section 6 will be approved and listed as such in DoD 5000.19-L., Vol. II, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 Subject term (key word) listing.

EMC
EMI
EMP
Electromagnetic compatibility
Electromagnetic emission
Electromagnetic interference
Electromagnetic pulse
Electromagnetic susceptibility
Filters, line-to-ground capacitance
Test Limits, EMI
Test Methods, EMI

6.4 International standardization agreements. Certain provisions of this standard (See 4.2) are the subject of international standardization agreements (NAT-STD -3516, -3614, and -3659). 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 accommodation.

6.5 Changes from previous issue. Asterisks or vertical lines are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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TABLE 1-I. EMISSION AND SUSCEPTIBILITY REQUIREMENTS.

Requirement	Description
CE01	Conducted Emissions, Power and Interconnecting Leads, Low Frequency (up to 15 kHz)
CE03	Conducted Emissions, Power and Interconnecting Leads, 0.015 to 50 MHz
CE06	Conducted Emissions, Antenna Terminals 10 kHz to 26 GHz
CE07	Conducted Emissions, Power Leads, Spikes, Time Domain
CS01	Conducted Susceptibility, Power Leads, 30 Hz to 50 kHz
CS02	Conducted Susceptibility, Power and Interconnecting Control Leads, 0.05 to 400 MHz
CS03	Intermodulation, 15 kHz to 10 GHz
CS04	Rejection of Undesired Signals, 30 Hz to 20 GHz
CS05	Cross-modulation, 30 Hz to 20 GHz
CS06	Conducted Susceptibility, Spikes, Power Leads
CS07	Conducted Susceptibility, Squelch Circuits
CS09	Conducted Susceptibility, Structure (Common Mode) Current, 60 Hz to 100 kHz
CS10	Conducted Susceptibility, Damped Sinusoidal Transients, Pins and Terminals, 10 kHz to 100 MHz
CS11	Conducted Susceptibility, Damped Sinusoidal Transients, Cables, 10 kHz to 100 MHz
RE01	Radiated Emissions, Magnetic Field, 0.03 to 50 kHz
RE02	Radiated Emissions, Electric Field, 14 kHz to 10 GHz
RE03	Radiated Emissions, Spurious and Harmonics, Radiated Technique
RS01	Radiated Susceptibility, Magnetic Field, 0.03 to 50 kHz
RS02	Radiated Susceptibility, Magnetic and Electric Fields, Spikes and Power Frequencies
RS03	Radiated Susceptibility, Electric Field, 14 kHz to 40 GHz
RS05	Radiated Susceptibility, Electromagnetic Pulse Field Transient
UM03	Radiated Emissions and Susceptibility, Tactical and Special Purpose Vehicles and Engine-Driven Equipment
UM04	Conducted Emissions and Radiated Emissions and Susceptibility, Engine Generators and Associated Components UPS and MEP Equipment
UM05	Conducted and Radiated Emissions, Commercial Electrical and Electromechanical Equipment

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TABLE 1-II. EQUIPMENT AND SUBSYSTEM CLASSES VS. APPLICABLE PART OF MIL-STD-461 FOR EMISSION AND SUSCEPTIBILITY REQUIREMENTS AND LIMITS.

Class	Description	Applicable Part
A	Equipment and subsystems which must operate compatibly when installed in critical areas, such as the following platforms and installations:	-
A1	Aircraft (including associated ground support equipment)	2
A2	Spacecraft and launch vehicles (including associated ground support equipment)	3
A3	Ground facilities (fixed and mobile, including tracked and wheeled vehicles)	4
A4	Surface ships	5
A5	Submarines	6
B	Equipment and subsystems which support the Class A equipment and subsystems, but which will not be physically located in critical ground areas. Examples are electronic shop maintenance and test equipment used in non-critical areas, theodolites, navaids, and similar equipment used in isolated areas.	7
C	Miscellaneous, general purpose equipment and subsystems not usually associated with a specific platform or installation. Specific items in this class are:	-
C1	Tactical and special purpose vehicles and engine-driven equipment	8
C2	Engine generators and associated components, uninterruptible power sets (UPS) and mobile electric power (MEP) equipment supplying power to or used in critical areas	9
C3	Commercial electrical and electromechanical equipment	10

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Custodians
Army - CR
Navy - EC
Air Force - 11

Review Activities
Army - MI, AV
Navy - SH, OS, AS, YD, MC, CG, TD
Air Force - 13, 15, 17, 19, 68, 69, 79, 99
NSA
DCA
DoDECAC

User Activities:
Army - AT, ME, GL, CE, MD

Preparing Activity:
Navy -EC
(Project EMCS-0112)

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Part 2. Equipment and Systems Installed Aboard Aircraft, Including Associated Ground Support Equipment (Class A1)

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1. SCOPE

This part of MIL-STD-461 supplements Part 1 of the standard by defining emission and susceptibility requirements and limits for equipment and subsystems intended for use aboard aircraft (class A1), including associated non-shipboard ground support equipment and for class A3 equipment and subsystems procured for the Air Force.

1.1 Determining requirements

1.1.1 Air Force and Navy procurements. Table 2-I defines categories of class A1 equipment and subsystems. Table 2-II shall be used to determine the requirements applicable for equipment and subsystems procured for Air Force or Navy use. The table also denotes the paragraphs where in the requirements and limits are defined. A "Y" entry in the table means the requirement is applicable, and the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "Y_L" entry means the applicability of the requirement is limited and is specified in the appropriate corresponding paragraph. The limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "T" entry means that the applicability of the requirement must be determined on a case-by-case basis and, if the requirement is to be imposed, it must so specified in the appropriate procurement document. When required, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. Absence of an entry means the requirement is not applicable.

TABLE 2-I. Categories of class A1 equipment and subsystems.
(For Air Force and Navy use)

Category	Description
A1a	Air launched missiles
A1b	Equipment installed on aircraft (internal or external to airframe)
A1c	Aerospace ground equipment required for the checkout and launch of the aircraft, including electronic test and support equipment
A1d	Trainers and simulators
A1e	Portable medical equipment used for aeromedical airlift
A1f	Aerospace ground equipment used away from the flightline, such as engine test stands and hydraulic test fixtures
A1g	Jet engine accessories
A1h	Class A3 equipment procured for Air Force use

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TABLE 2-II. Emission and susceptibility requirements for class A1 equipment and subsystems (For Air Force and Navy Use).

Requirement	Categories of class A1 equipment and subsystems								Applicable	
	A1a	A1b	A1c	A1d	A1e	A1f	A1g	A1h	Paragraph	Limit Curve
CE01		Y_L					Y_L		2	2-1
CE03	Y	Y	Y	Y	Y	Y	Y	Y	3	2-2, 2-3
CE06	Y_L	Y_L	Y_L					Y_L	4	
CE07	Y	Y	Y	Y	T			Y	5	
CS01	Y	Y	T	Y	T		Y	Y	6	2-4
CS02	Y	Y	Y	Y	T	T	Y	Y	7	
CS03	Y_L	Y_L	Y_L					Y_L	8	
CS04	Y_L	Y_L	Y_L			Y_L		Y_L	9	2-5
CS05	Y_L	Y_L	Y_L			Y_L		Y_L	10	
CS06	Y	Y	Y	Y	Y		Y	Y	11	2-6
CS07		Y_L	Y_L					Y_L	12	
CS09		Y_L							13	2-7
CS10	T	T	T	T	T	T	T		14	2-8
CS11	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		15	2-9
CS12	Y	Y					Y		16	2-15, 2-16
CS13	Y	Y					Y		17	2-17, 2-18
RE01		Y_L							18	2-10
RE02	Y	Y	Y	Y	Y	Y	Y	Y	19	2-11, 2-12
RE03	T	T	T					T	20	
RS01	T	Y_L							21	2-13
RS02	Y	Y	Y	Y	Y	T	Y	Y	22	2-6
RS03	Y	Y	Y	Y	Y	T	Y	Y	23	
RS05	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		24	2-14
RS06	Y	Y					Y		25	

1/ SEE SAE AIR 1423 AND 1425 FOR ADDITIONAL GUIDANCE ON TAILORING.

2/ CATEGORY A1c AND A1f EQUIPMENT PROCURED FOR NAVY SHIPBOARD USE SHALL MEET THE APPLICABLE CLA[illegible] IN PART 5 OF THIS STANDARD.

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1.1.2 Army procurements. Table 2-III shall be used to determine the specific requirements for class A1 equipment and subsystems procured for Army use. The table also denotes the paragraphs wherein the requirements and limits are defined. A "Y" entry in the table means the requirement is applicable, and the limit shall be met using the procedures in MIL-STD-462 or the approved EMI test plan. A Y entry means the applicability of the requirement is limited and is specified in the appropriate corresponding paragraphs. When applicable the limit shall be met using the procedures in MIL-STD-462 or the approved EMI test plan. A "T" entry means that the applicability must be determined on a case-by-case basis and, if the requirement is to be imposed, it must be specified in the appropriate procurement document. When required, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. Absence of an entry means the requirement is not applicable. For procurements of subsystems, such as radar, EW, surveillance, navigation, and the like, comprised of individual equipment listed in table 2-III, the applicable emission and susceptibility requirements for the subsystem shall be tailored by the procuring activity based on the requirements of the individual equipment.

2. CE01 (limited applicability)

2.1 CE01 applicability. This requirement is applicable for equipment and subsystems installed on aircraft having an anti-submarine warfare (ASW) capability and for Navy equipment and subsystems intended for use on aircraft and having Very Low Frequency (VLF) subsystems and equipment. When required, CE01 is applicable only for narrowband emissions between 30 Hz and 15 kilohertz (kHz) on alernating current (AC) and direct current (DC) leads, which obtain power from other sources or provide power to other equipment or subsystems; grounds or neutrals, which are not grounded internally to the subsystem or equipment being measured; and, for Army and Navy procurements, interconnecting control leads which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as clock, IF, audio, firing, digital, RF, and the like, unless otherwise specified by the Command or agency concerned.

2.2 CE01 limits

2.2.1 AC, DC, and interconnecting control leads. Electromagnetic emissions shall not appear on AC, DC, and, where required, interconnecting control leads in excess of the values as shown on figure 2-1. The limits shall be met when measured with an effective bandwidth not exceeding the primary power frequency plus 20% of the power frequency for AC power leads or 75 Hz for DC power leads.

2.2.2 Interconnecting signal leads. If compliance with this requirement is required for signal leads, limits shall developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwith, and pulse rise time. Such limits must be approved by the Command or agency concerned.

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TABLE 2-III. EMISSION AND SUSCEPTIBILITY REQUIREMENTS FOR CLASS A1 EQUIPMENT AND SUBSYSTEMS (FOR ARMY USE).

Requirement / Specific Equipment/Subsystem	Receivers	Transmitters	Antenna Multicouplers	Amplifier, Tuned, RF	Amplifier, Untuned, RF	Intercom/Interphone	Modem	Repeater	Amplifier, Power/Audio	Modulators	Multiplexers	Laser Devices	IR Devices	Transponders	Beacons	Power Supplies	Sensors/Antennas	Inertial Guidance	Teletypewriters	Recorders	Visual Displays	Digital Equipment	Data Annotation	Camera Data	Telephone SWBD	Servo/Synchro	Test Equipment	Time/Frequency STDS	Ultrasonic Devices	Telephones	Transducers/Simulators	Commercial Eq.	All Others Not Listed Herein	Applicable Paragraph
CE01	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T				2
CE03	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	3
CE06	Y	Y												Y	Y																	Y	Y	4
CE07	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T			5
CS01	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	6
CS02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	7
CS03	T			T										T																				8
CS04	T			T										T																				9
CS05	T			T										T																				10
CS06	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	11
CS07	T																																	12
RE02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
RE03		Y												Y	Y																	Y	Y	16
RS01																	T	T																17
RS02						T			T							T	T	T	T	T		T			T	T				T				18
RS03	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	19

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3. CE03

3.1 CE03 applicability. This requirement is applicable for the following types of leads: AC and DC leads, which obtain power from other sources or provide power to other equipment, distribution panels, or subsystems; ground or neutrals, which are not grounded internally to the subsystem or equipment being measured; and, for Army and Navy procurements, interconnecting control leads which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as a clock, IF, audio, firing, digital, radio frequency (RF), and the like, unless otherwise specified by the Command or agency concerned. For Army procurements, the requirement is applicable using the Line Impedance Stabilization Network, as described in MIL-STD-462.

3.2 CE03 limits

3.2.1 AC, DC, and interconnecting control leads. Electromagnetic emissions shall not appear on AC, DC, and, where required, interconnecting control leads in excess of the values shown on figures 2-2 and 2-3 for narrowband and broadband emissions, respectively. For Navy and Air Force procurements, conducted switching spike emissions (including ON/OFF switching) on AC and DC power leads shall meet the requirements of CE07.

3.2.2 Interconnecting signal leads. If compliance with this requirement is required for signal leads, limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

4. CE06 (limited applicability)

4.1 CE06 applicability. This requirement is applicable for those equipment and subsystems with antenna leads or those designed to be connected to antennas. The transmitter (key-down mode), harmonic, and spurious emission portions of this requirement are not applicable for equipment and subsystems procured solely for Army use, when any of the following conditions exist: (a) transmitter power exceeds 5 kilowatts (kW) average, (b) the fundamental frequency of the test sample exceeds 1.24 gigahertz (GHz), (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by suitable dummy load, or (d) for equipment and subsystems with waveguide transmission lines and operating below 1.24 GHz. For cases (a) through (d) use RE03. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The transmitter (key-down) portion of this requirement is not applicable within either the test sample's necessary bandwidth or ±5 percent of the fundamental frequency.

4.2 CE06 limits. Conducted emissions in excess of the values given 4.2.1 through 4.2.3 shall not appear at the test sample's antenna terminals.

4.2.1 Receivers

a. Narrowband emissions: 34 decibels above 1 microvolt (dBμ V)

b. Broadband emissions: 40 dBμ V/megahertz (MHz)

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4.2.2 Transmitters (key-up and standby)

a. Narrowband emissions: 34 dBμ V

b. Broadband emissions: 40 dBμ V/MHz

4.2.3 Transmitters (key-down mode). Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 decibels (dB) down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

5. CE07

5.1 CE07 applicability. This requirement is applicable for Air Force and Navy procurements for the following types of leads: AC and DC leads which obtain power from or provide power to other equipment or subsystems.

5.2 CE07 limits. Conducted switching spikes of less than 50 microseconds in duration shall not exceed the following, as applicable:

a. AC leads: ±50 percent of nominal rms voltage.

b. DC leads: +50 percent, -150 percent of nominal line voltage.

Conducted switching spikes equal to or greater than 50 microseconds in duration shall meet the transient requirements of MIL-STD-704. Spike duration is the time interval between the 50% amplitude point on the transient leading edge and the 50% amplitude point on the transient trailing edge; high frequency ringing superimposed on the pulse leading or trailing edges should be ignored.

6. CS01 (limited applicability)

6.1 CS01 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem. This requirement is not applicable within ±5 percent of the power frequency(ies). For Navy procurements, this requirement may be deleted for AC leads, with the approval of the command or agency concerned, if no circuit within the equipment or system is more sensitive than 100 millivolts (mV). For equipment and subsystems procured solely for Army use, this requirement is applicable for DC leads only.

6.2 CS01 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to electromagnetic energy injected onto its power leads equal to the values on figure 2-4. The requirement is also met when the power source specified in CS01 of MIL-STD-462, adjusted to dissipate 50 watts in a 0.5 ohm load, cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

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7. CS02

7.1 CS02 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

7.2 CS02 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to 1-volt from a 50 ohm source. The test signal shall be applied directly to the equipment input terminals, not through the test sample's power line cord. The requirement is also met when a 1-watt source of 50 ohms impedance cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

8. CS03 (limited applicability)

8.1 CS03 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample as specified in MIL-STD-462.

8.2 CS03 limits. The test sample shall not exhibit any intermodulation products from two signals, beyond those permitted in the individual equipment or subsystem specification, when:

a. Signal generator #1 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462; except that when f_1 is in the frequency range of either 200 to 400 MHz or 2 to 25 MHz, the generator output shall be 80 dB above the reference level, but the output of signal generator #1 shall not exceed 10 dBm.

b. Signal generator #2 is set 66 dB above the level required to obtain the standard references output, as specified in MIL-STD-462, but the generator output level shall not exceed a power level of 10 dBm.

9. CS04 (limited applicability)

9.1 CS04 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

9.2 CS04 limits. The test sample shall not exhibit any undesired response when subjected to the test signal shown on figure 2-5.

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10. CS05 (limited applicability)

10.1 CS05 applicability. This requirement is applicable to receiving equipment and subsystems such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

10.2 CS05 limits. The test sample shall not exhibit, due to cross modulation, any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystems specification, when subjected to the following from signal generator #2: a signal 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but not to exceed a power output level of 10 dBm.

11. CS06

11.1 CS06 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

11.2 CS06 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when the test spikes having the waveform shown on figure 2-6 are applied to the AC and DC power input leads for a period of not less than 1 minute at each phase position, and for a total test period not exceeding 15 minutes in duration (in lieu of the values in MIL-STD-462). The values of $E_{(\ )}$ and $t_{(\ )}$ are given below. Each spike shall be superimposed on the powerline voltage waveform.

a. Spike #1 (All Services) E_1 = 200 Volts; t_1 = 10 microseconds 20%

b. Spike #2 (Air Force and Navy) E_2 = 200 Volts; t_2 = 0.15 microseconds 20%

12. CS07 (limited applicability)

12.1 CS07 applicability. This requirement is applicable for receiving equipments and subsystems which utilize squelch circuits.

12.2 CS07 limits

12.2.1 Requirement 1. Squelch circuits shall not open when the output of a 50-ohm impedance impulse generator, set at 90 dBμV/MHz, is applied and matched to the input terminals of the test sample.

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12.2.2 Requirement 2. The squelch circuit shall not open when two signals are applied at the input of the test sample. One signal shall be an unmodulated RF signal at the receiver tuned frequency, whose amplitude is two-thirds of the RF voltage used to adjust the squelch threshold. The second signal shall be an impulse signal of 50 dBμV/MHz.

13. CS09 (limited applicability)

13.1 CS09 applicability. This requirement is applicable to Navy equipment and subsystems that have an operating frequency range of 100 kHz or less and an operating sensitivity of 1μV or less, such as 0.5μV.

13.2 CS09 limits. The test sample shall not exhibit any malfunction, degradation of performance or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to the levels shown on figure 2-7 across the applicable test points.

14. CS10 (limited applicability)

14.1 CS10 applicability. This electromagnetic pulse (EMP) requirement is applicable to Navy equipment and subsystem interface pins and terminals of power leads, control leads, signal leads, and grounds and neutrals which are not grounded internally to the equipment or subsystem. Applications of requirement are to be determined on a case-by-case basis. It should be noted that if the equipment is to be installed in an intentionally unhardened aircraft, the equipment will not be adequately protected against the specified EMP.

14.2 CS10 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the individual equipment or subsystem specification, after being subjected to a test signal having either the waveform and common mode current level shown on figure 2-8, as determined in accordance with MIL-STD-462.

15. CS11 (limited applicability)

15.1 CS11 applicability. This EMP requirement is applicable to Navy equipment and subsystems having interconnecting or intraconnecting control, signal, or power cables. This requirement is not applicable for equipment intended solely for use on non-metallic aircraft, unless otherwise specified by the procuring activity. It should be noted that if the requirement is to be installed in an intentionally unhardened aircraft, the equipment will not be adequately protected against the specified electromagnetic pulse (EMP). Actual cable types, sizes and configurations subjected to the specified RS05 levels are exempt from meeting this requirement.

15.2 CS11 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the equipment or subsystem specification, after being subjected to a test signal having the waveform shown in figure 2-9 and having a maximum bulk common mode cable current of 10 amps, as determined in accordance with MIL-STD-462.

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16. CS12

16.1 CS12 applicability. This requirement is applicable to equipment and subsystems procured for Air Force use.

16.2 CS12 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances allowed by the individual equipment or subsystems specification, when the current waveform of figure 2-15 is induced at 10 kHz, 100 kHz, 1 MHz, 10 MHz, and 100 MHz in each interconnecting and power cable at the peak current level specified on figure 2-16. Additional test frequencies(particularily between 1 and 50 MHz) shall apply when required by system design considerations or when required by the procuring activity. When a 1500 volt level is reached between any pin and its lowest impedance return the requirement of this test shall be considered to be met.

17. CS13

17.1 CS13 applicability. This requirement is applicable to equipment and subsystem procured for Air Force use.

17.2 CS13 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances allowed by the individual equipment or subsystem specification, when a pulse signal is applied to each single wire or multiple wire unit (twisted pair, triax, etc.) of the interconnecting and power leads. The pulse signal shall produce the current and voltage waveform of figure 2-17 at the levels shown on figure 2-18 when applied to calibration loops. Test frequencies shall be 10 kHz, 100 kHz, 1 MHz, 10 MHz and 100 MHz. Additional test frequencies (particularily between 1 MHz and 50 MHz) shall when required by system design considerations or when required by the procuring activity.

18. RE01 (limited applicability)

18.1 RE01 applicability. This requirement is applicable only for equipments and subsystems installed in aircraft having an ASW capability and for Navy equipment and subsystems intended for use on aircraft having Very Low Frequency (VLF) equipment and subsystems. When required, RE01 is applicable for radiated emissions from equipments and subsystems, cables (including control, pulse, intermediate frequency (IF), power antennas transmission lines) and interconnecting wiring of the test sample. The requirement applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply for radiation from antennas.

18.2 RE01 limit. Magnetic field emissions shall not be radiated in excess of the levels shown on figure 2-10.

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19. RE02

19.1 RE02 applicability. This requirement is applicable for radiated emissions from equipments and subsystems, cables (including control, pulse IF, power and antennas transmission lines) and interconnecting wiring of the test sample; for narrowband, it applies at the fundamental frequencies, and all spurious emissions including harmonics, but does not apply for radiation from antennas. This requirement is applicable for broadband emissions from 14 kHz to 1 GHz and for narrowband emissions from 14 kHz to 10 GHz.

19.2 RE02 limits. E-field emissions shall not be radiated in excess of those given in 19.2.1 and 19.2.2. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves.

19.2.1 Narrowband electric field emissions. Narrowband E-field emissions shall not be radiated in excess of the applicable limit curve shown on figure 2-11 at the required test distance, as specified in MIL-STD-462.

19.2.2 Broadband electric field emissions. Broadband E-field emissions from all equipments and subsystems, including radiated switching transients resulting from (1) automatic cycling of electronic or electrical switching circuitry, (2) actuation of push-to-talk mechanisms (that is keying of transmitters), or (3) manual switching shall not be radiated in excess of the applicable limit curve shown on figure 2-12 at the required test distances, as specified in MIL-STD-462.

20. RE03 (limited applicability

20.1 RE03 applicability. This requirement is applicable for transmitting equipments and subsystems with antenna leads or those designed to be connected to antennas. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The requirement is not applicable within either the test sample's necessary bandwidth or 5 percent of the fundamental frequency.

20.1.1 Army procurements. This requirement is applicable for transmitting equipments and subsystems procured solely for Army use when any of the following conditions exist: (a) transmitter power exceeds 5 kW average; (b) the fundamental frequency of the test sample exceeds 1.24 GHz; (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable dummy load; or (d) for equipments and subsystems with waveguide transmission lines and operating below 1.24 GHz.

20.1.2 Air Force and Navy procurements. This requirement is applicable, with the approval of the procuring activity, when the transmitter spurious emissions and harmonics cannot be determined using the procedures in CE06.

20.2 RE03 limit. Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB whichever requires less suppression.

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21. RS01 (limited applicability)

21.1 RS01 applicability. This requirement is applicable only for equipments and subsystems installed in aircraft having an ASW capability, and for Navy equipment and subsystems intended for use on aircraft having Very Low Frequency (VLF) equipment and subsystems. When required, RS01 is applicable to equipments and subsystems, and their associated cabling and connectors.

21.2 RS01 limit. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to magnetic fields equal to the levels shown on figure 2-13.

22. RS02

22.1 RS02 applicability. This requirement is applicable to equipment and systems as indicated in 22.1.1 and 22.1.2.

22.1.1 Part I - spikes. This portion of RS02 is applicable for all Department of Defense (DoD) activities.

22.1.2 Part II - power frequency. This requirement is applicable for equipments and subsystems procured for Air Force and Navy use.

22.2 RS02 limits

22.2.1 Part I - spikes. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the test spikes having the waveform shown on figure 2-6. The values of $E_{(\ )}$ and $t_{(\ )}$ are given below:

a. Spike #1 (All Services) — E_1 = 200 Volts; t_1 = 10 microseconds ±20%

b. Spike #2 (Air Force and Navy) — E_2 = 200 Volts; t_2 = 0.15 microseconds ±20%

22.2.2 Part II - power frequency. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when 20 amperes are applied to the test wire at the power frequency(ies) of the test sample.

23. RS03

23.1 RS03 applicability. This requirement is applicable for all equipment and subsystem between 14 kHz and 10 GHz. Above 10 GHz, this requirement applies only at all intentionally generated frequencies of known intentional emitters on the aircraft, and for Navy procurements, the aircraft's host ship. For Air Force procurements, this requirement is not applicable above 10 GHz, unless otherwise required by the procuring activity.

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23.2 RS03 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to the radiated electric fields (E) specified herein. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circurlarly polerized waves are also acceptable. Appropriate consideration shall be given to the operational radiated electromagnetic environment from both friendly and hostile emitters which an equipment or subsystem may encounter during its life cycle. Applicable portions of MIL-HDBK-235 shall be used to determine the anticipated environment. As a minimum, the following levels apply. If levels substantially higher than those given herein are specified, modifications to the procedure in MIL-STD-462 may be required or desirable. Such modifications are to be described in the EMI Test Plan.

Frequency Range	E-Field (Volts/Meter (V/m))
14 kHz to 2 MHz	20, except that for Army procurements the level is 1 V/m
2 to 10 GHz	20
Above 10 GHz	20

23.2.1 Air Force and Navy equipments and subsystems installed in non-metallic aircraft, non-metallic structures on metallic aircraft or externally mounted on metallic aircraft. Such equipments shall not malfunction when subjected to a radiated E-field of 200 V/m over the required frequency range.

23.2.2 Air Force flight critical equipment and subsystems. Equipment and subsystems which are flight critical shall not malfunction when subjected to a radiated E-field of 200 V/m from 14 kHz to 10 GHz.

24. RS05 (limited applicability)

24.1 RS05 applicability). This requirement is intended for Navy equipment and subsystems and is applicable whenf both of the following conditions exist: (a) operation of the equipment or subsystem is essential for safety or the success of a mission and (b) the equipment or subsystem is installed on a non-metallic structure on a metallic aircraft or externally mounted on on a metallic aircraft. This requirement is not applicable for equipment intended solely for use on non-metallic aircraft, unless otherwise required by the procuring activity. Cables that can not be tested in accordance with MIL-STD-462 shall meet the requirements of CS11, and cables subjected to the specified CS11 levels are exempt from meeting this requirement.

24.2 RS05 limit. The test sample shall not exhibit any permanent malfunction degradation of performance, or deviation from specified indications,beyond the tolerances and recovery times indicated in the individual equipment or subsystems specification, after being subjected to a test signal having thewaveform and amplitude shown on figure 2-14.

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25. RS06

25.1 RS06 applicability. This requirement is applicable to equipment and subsystems procured for Air Force use.

25.2 RS06 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances allowed by the individual equipment or subsystem specification while being subjected to a radiated eletromagnetic field generated by fast switching pulses from a relay coil. The peak-to-peak transient voltage across the relay coil shall be a minimum of 600 volts.

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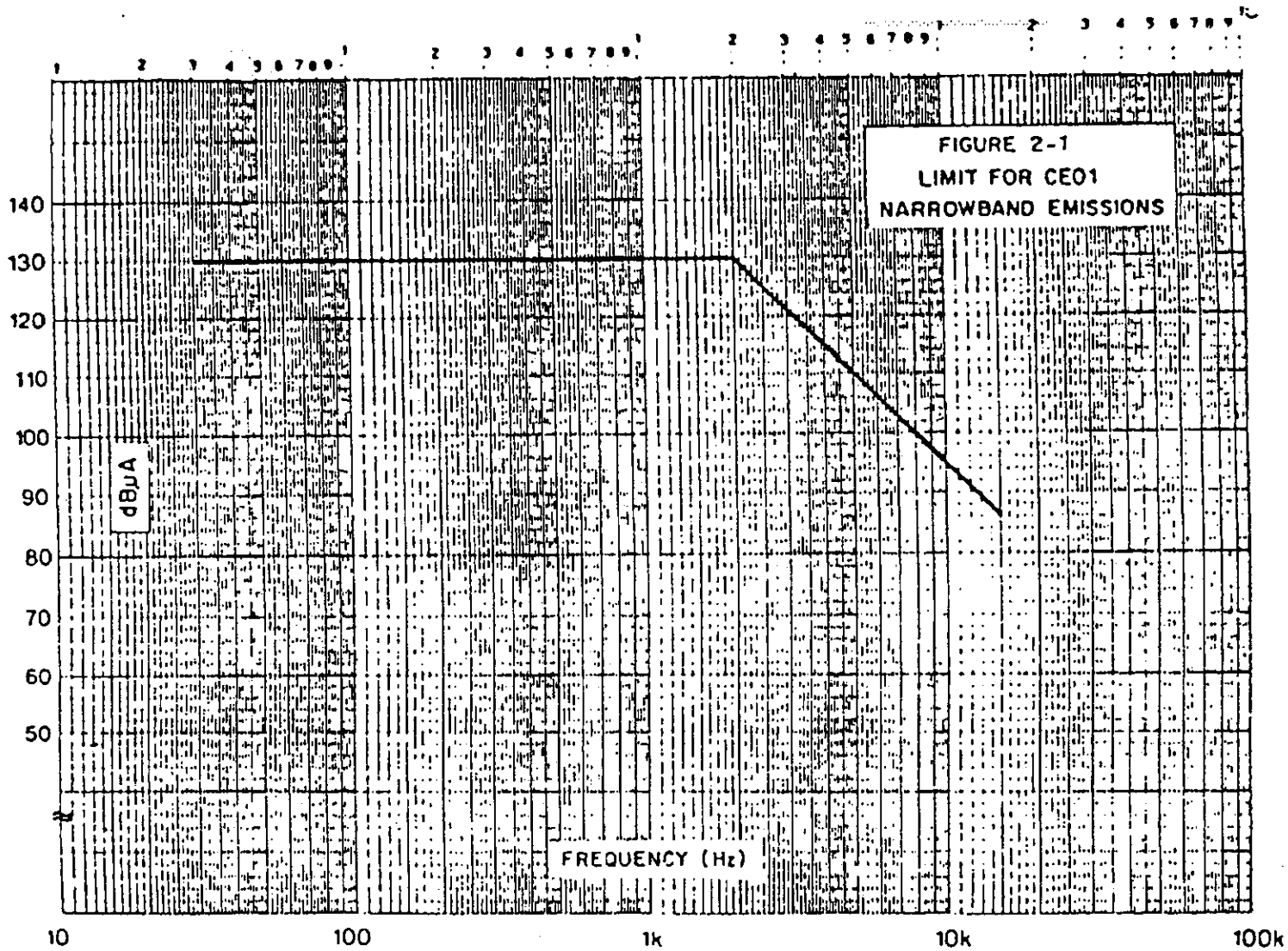

FIGURE 2-1. LIMIT FOR CE01 NARROWBAND EMISSIONS

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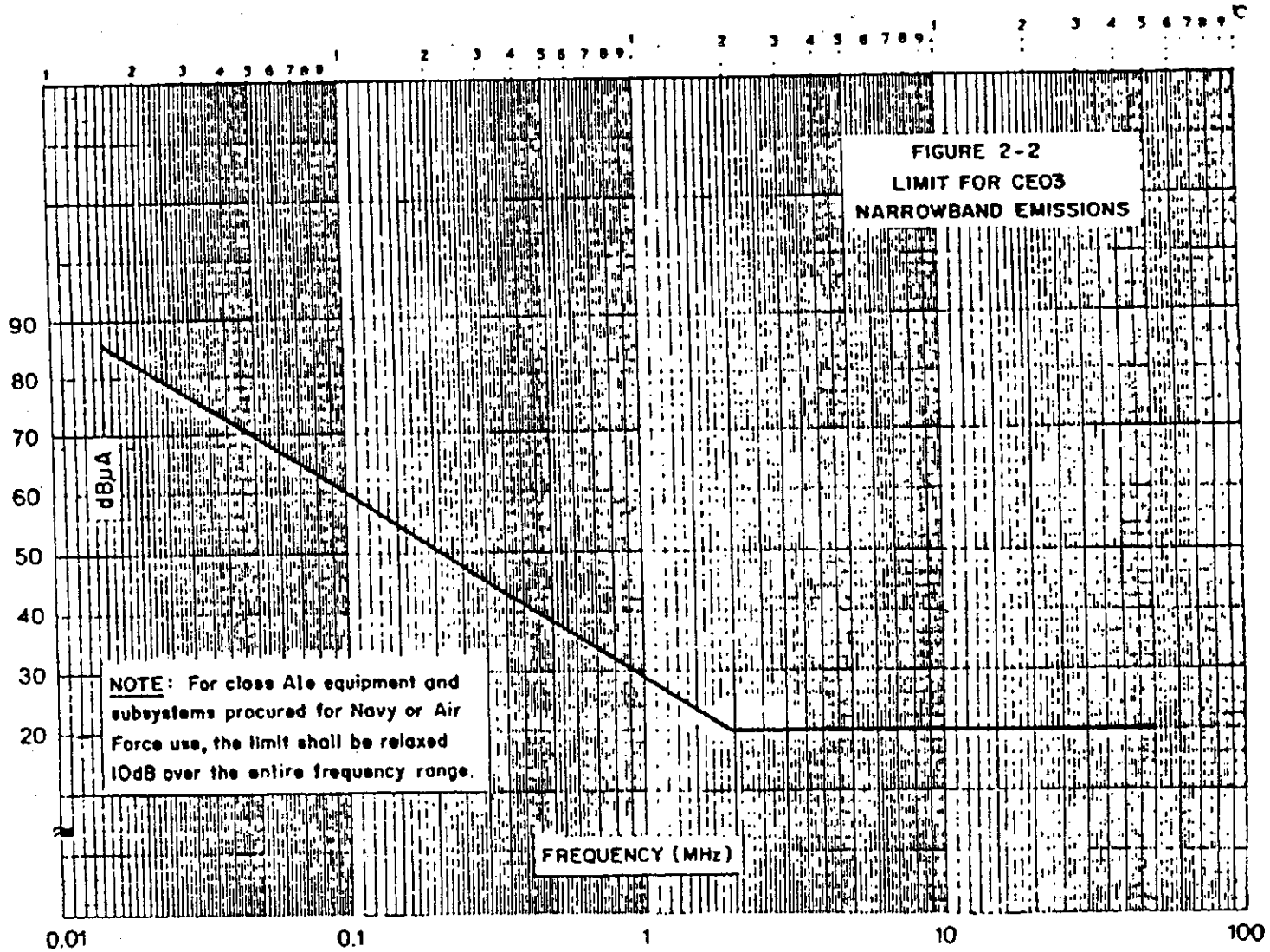

FIGURE 2-2. LIMIT FOR CE03 NARROWBAND EMISSIONS

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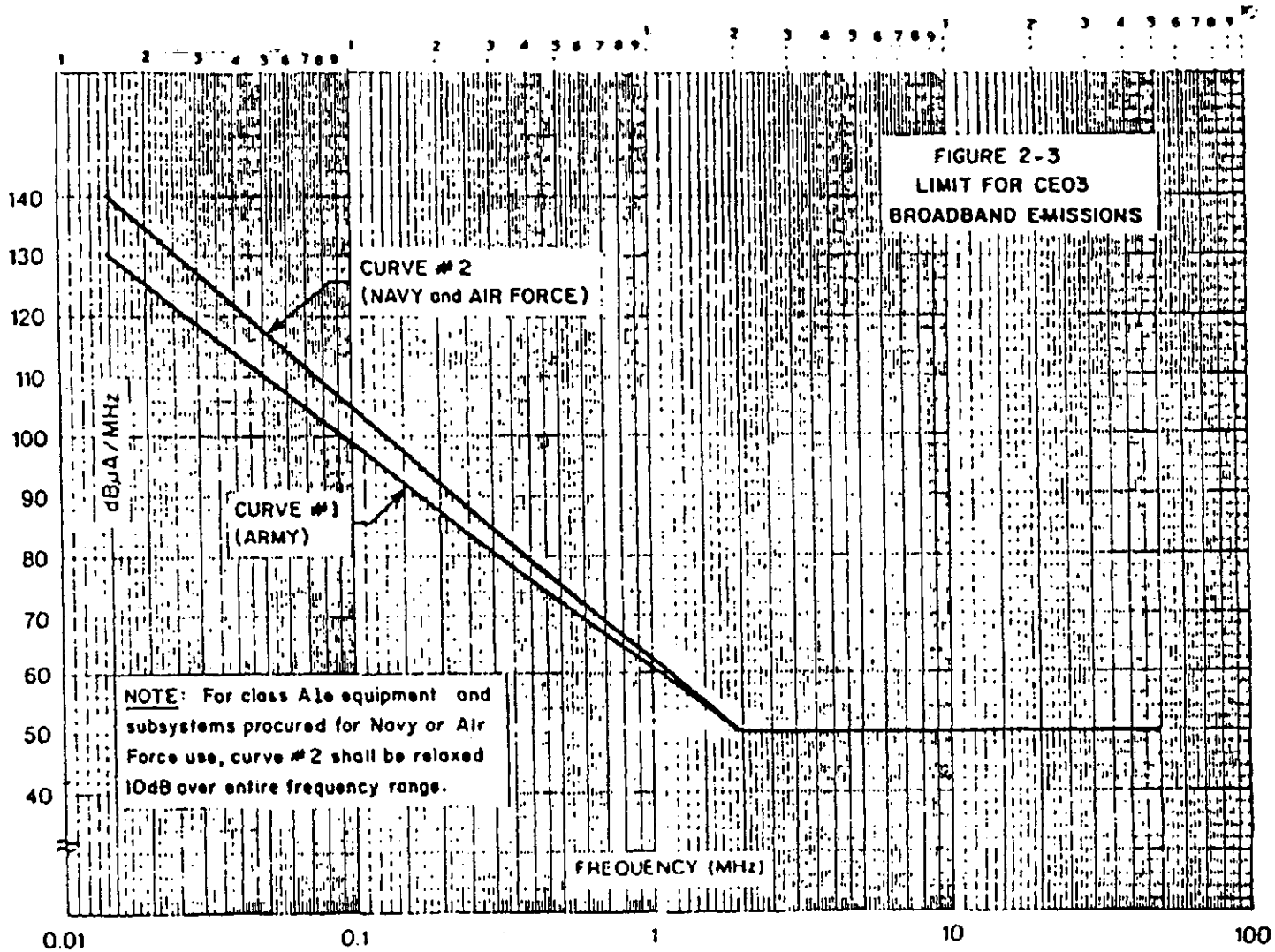

FIGURE 2-3. LIMIT FOR CE03 BROADBAND EMISSIONS

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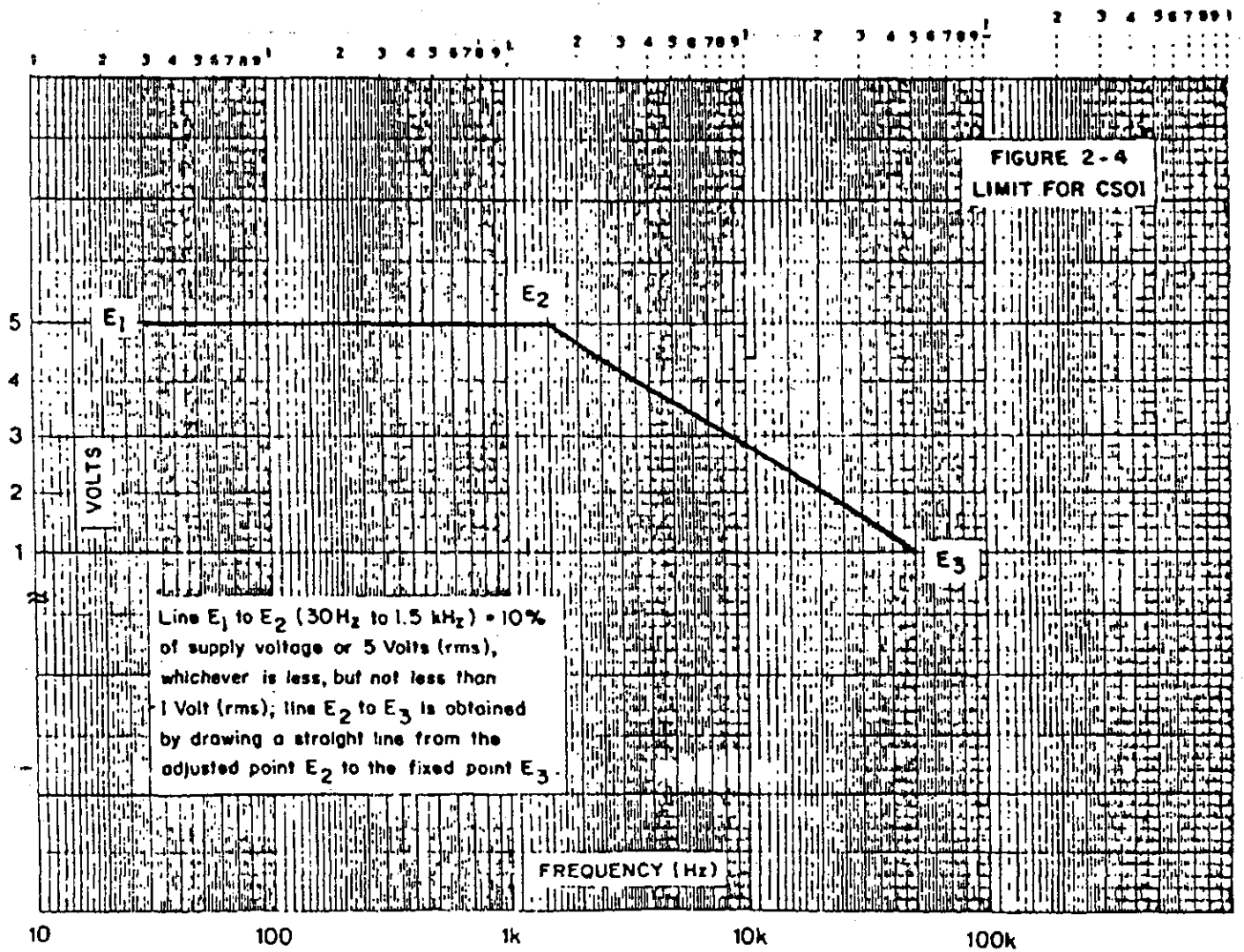

FIGURE 2-4. LIMIT FOR CS01

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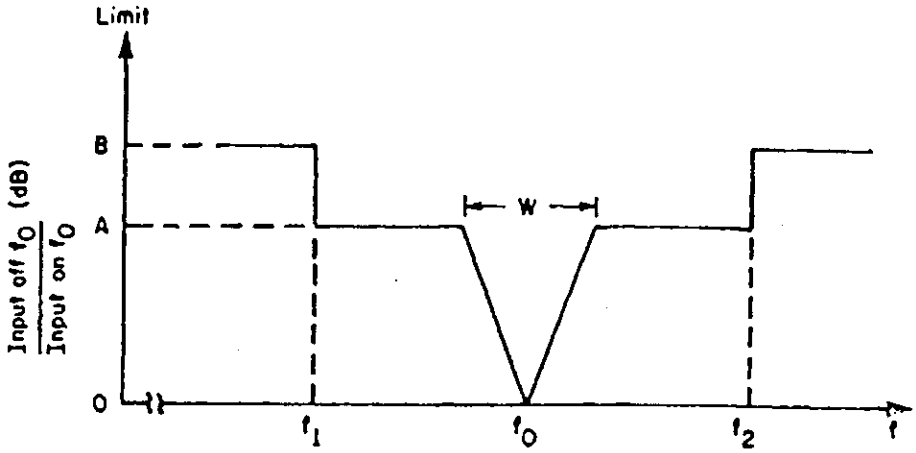

f_0 = Receiver tuned frequency or band center for amplifiers.

f_1 = Lowest tunable frequency of receiver band in use or the lowest frequency of amplifier passband.

f_2 = Highest tunable frequency of receiver band in use or the highest frequency of amplifier passband.

W = Bandwidth between the 80 dB points of the receiver selectivity curve as defined in the test sample's technical requirements or the control plan.

Limits:

1. The limit at A is 80 dB above the input level required to produce the standard reference output. (This limit shall not be used for amplifiers)
2. The limit at B shall be set as follows:
   a. Receivers: 0 dBm applied directly to the receiver input terminals.
   b. Amplifiers: The limit shall be as specified in the test sample's technical requirement or control plan. If no limit is defined in the above documents, the 0 dBm value shall be used.

FIGURE 2-5. LIMIT FOR CS04

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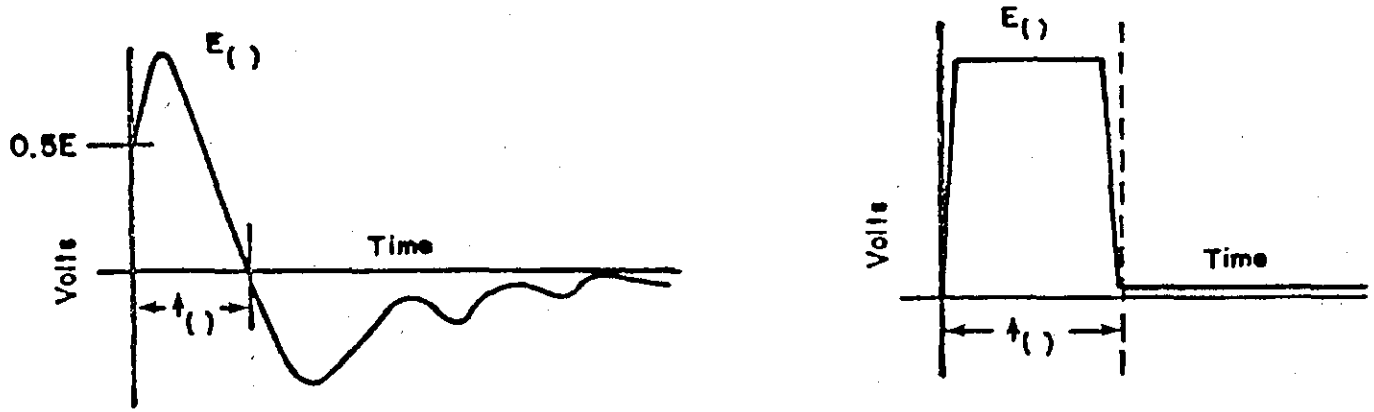

NOTE: The test sample shall be subjected to the spike(s) with the waveform shown and with the specified voltage(s) and pulsewidth(s).

FIGURE 2-6. ACCEPTABLE WAVESHAPES FOR CS06 AND RS02

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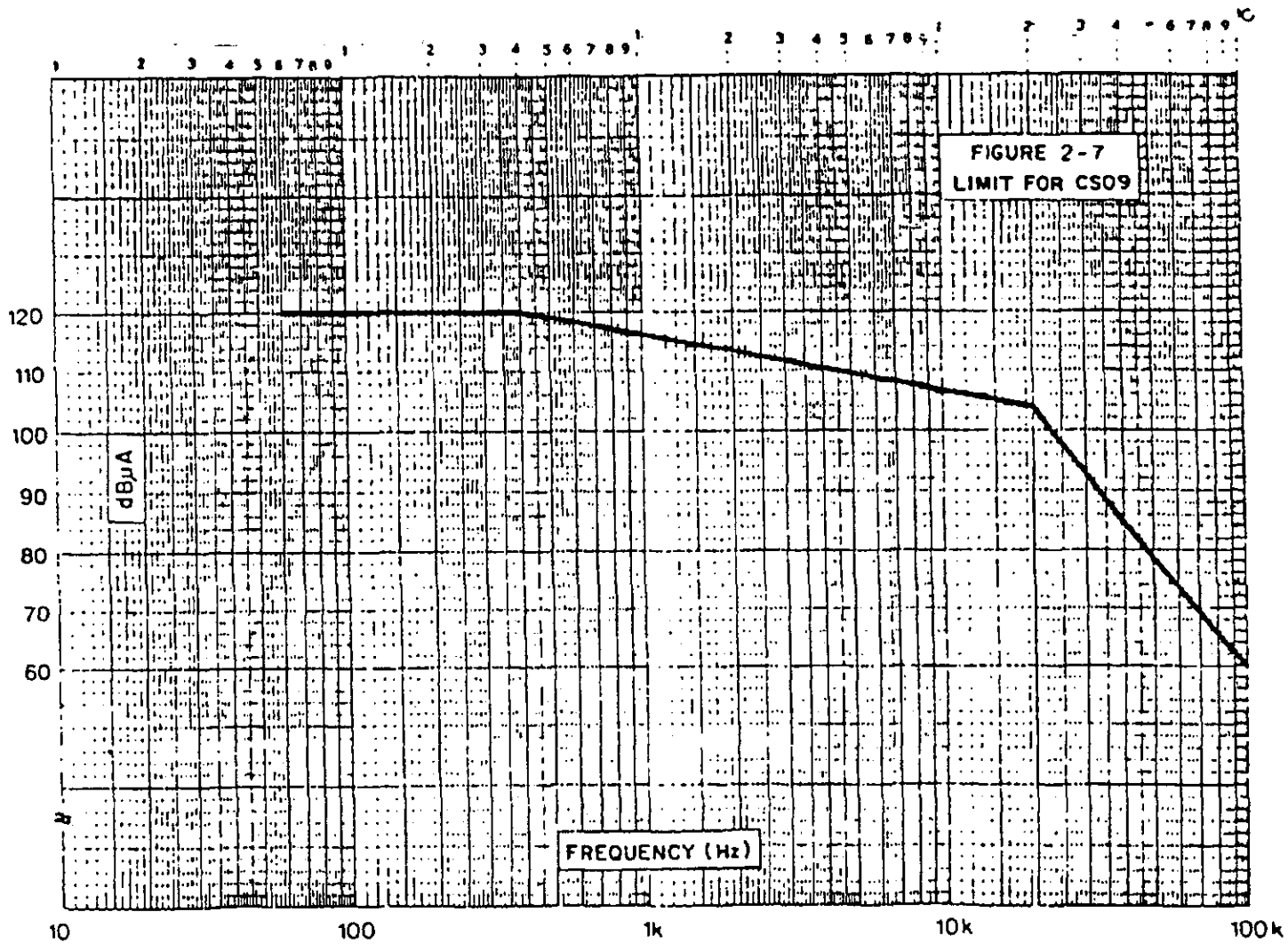

FIGURE 2-7. LIMIT FOR CS09

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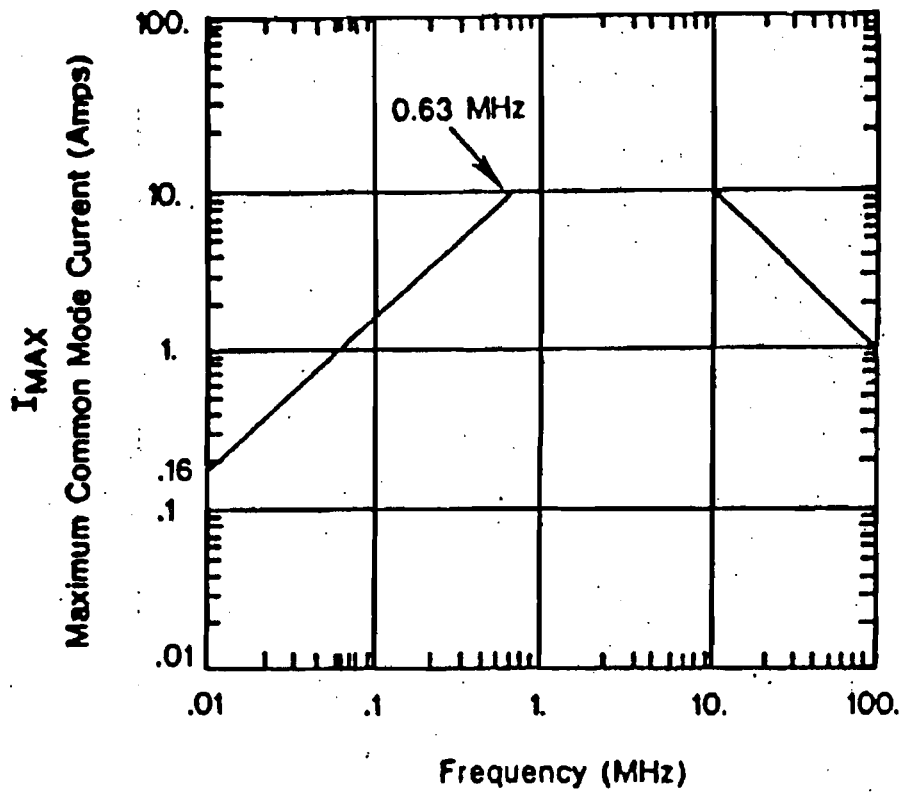

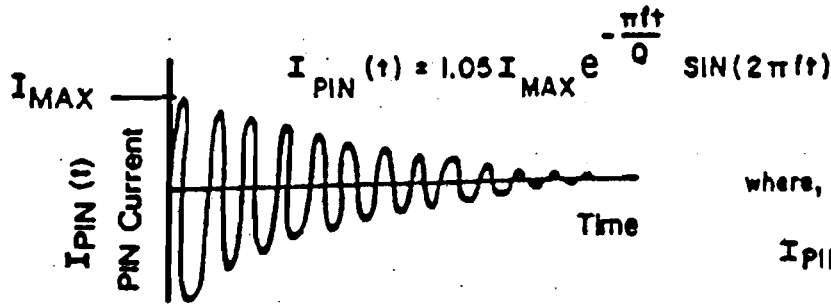

$$I_{PIN}(t) = 1.05\, I_{MAX}\, e^{-\frac{\pi f t}{Q}} \sin(2\pi f t)$$

where,

$I_{PIN}(t)$ = common mode pi current in amps

f = frequency, hertz

t = time, seconds

Q = decay factor

FIGURE 2-8. LIMIT FOR CS10

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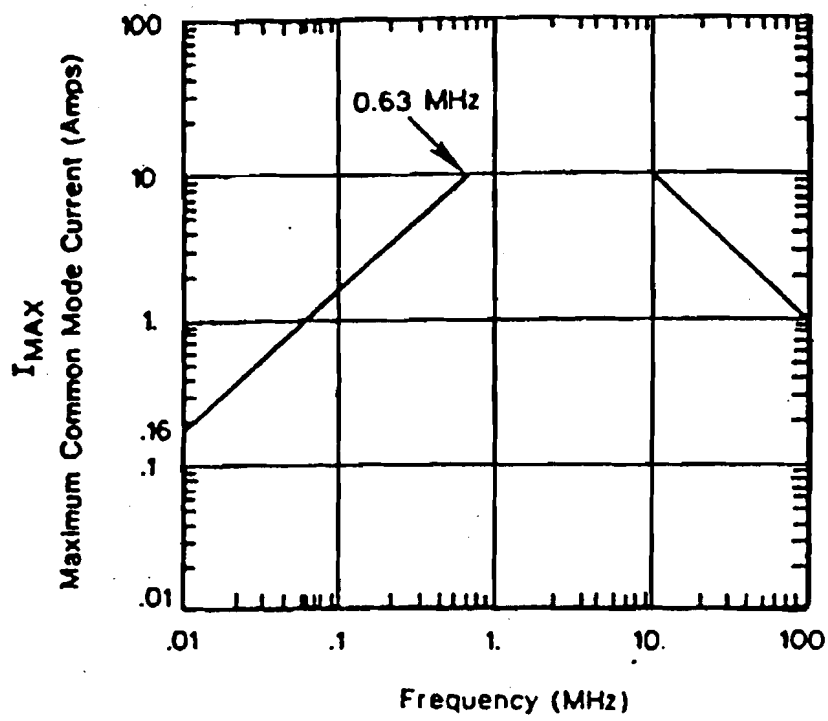
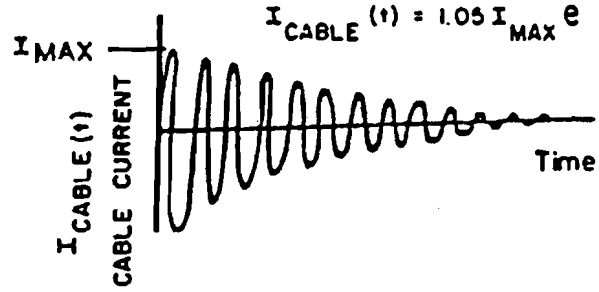


$$I_{CABLE}(t) = 1.05\, I_{MAX}\, e^{-\frac{\pi f t}{Q}} \sin(2\pi f t)$$



where,

$I_{CABLE}(t)$ = common mode cable current in amps

f = frequency, hertz

t = time, seconds

Q = decay factor

FIGURE 2-9. LIMIT FOR CS11

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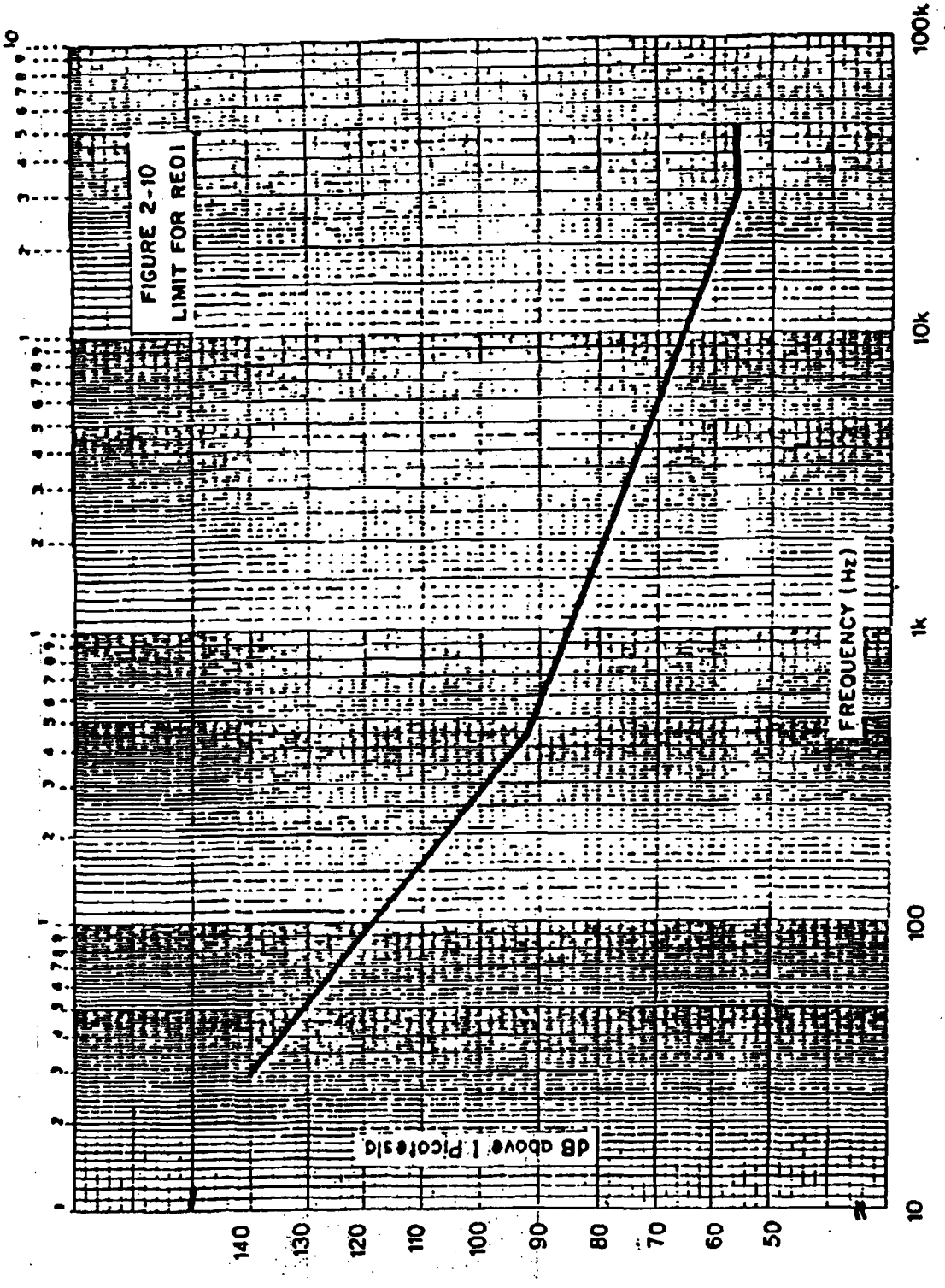

FIGURE 2-10. LIMIT FOR RE01

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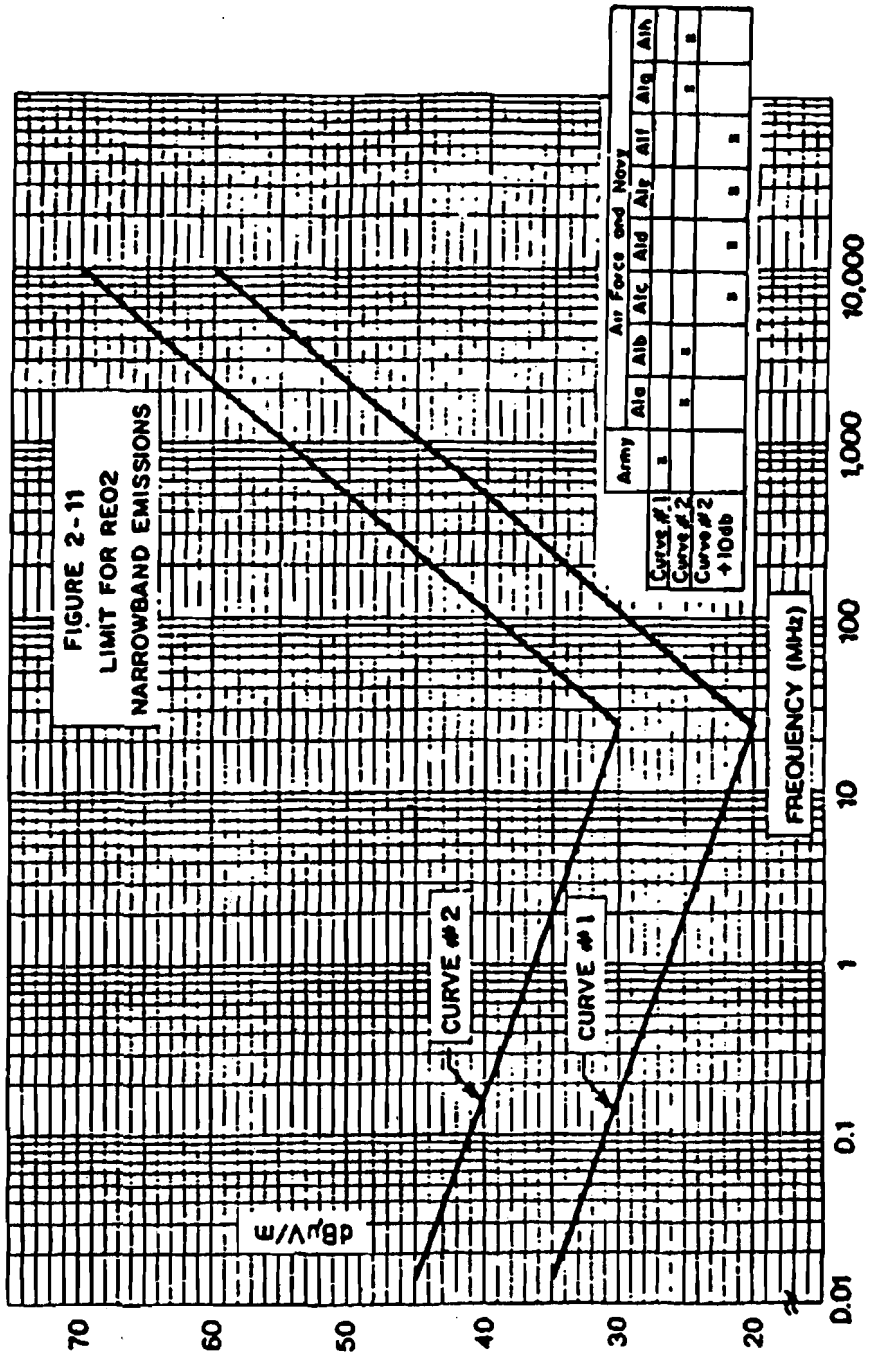

FIGURE 2-11. LIMIT FOR RE02 NARROWBAND EMISSIONS

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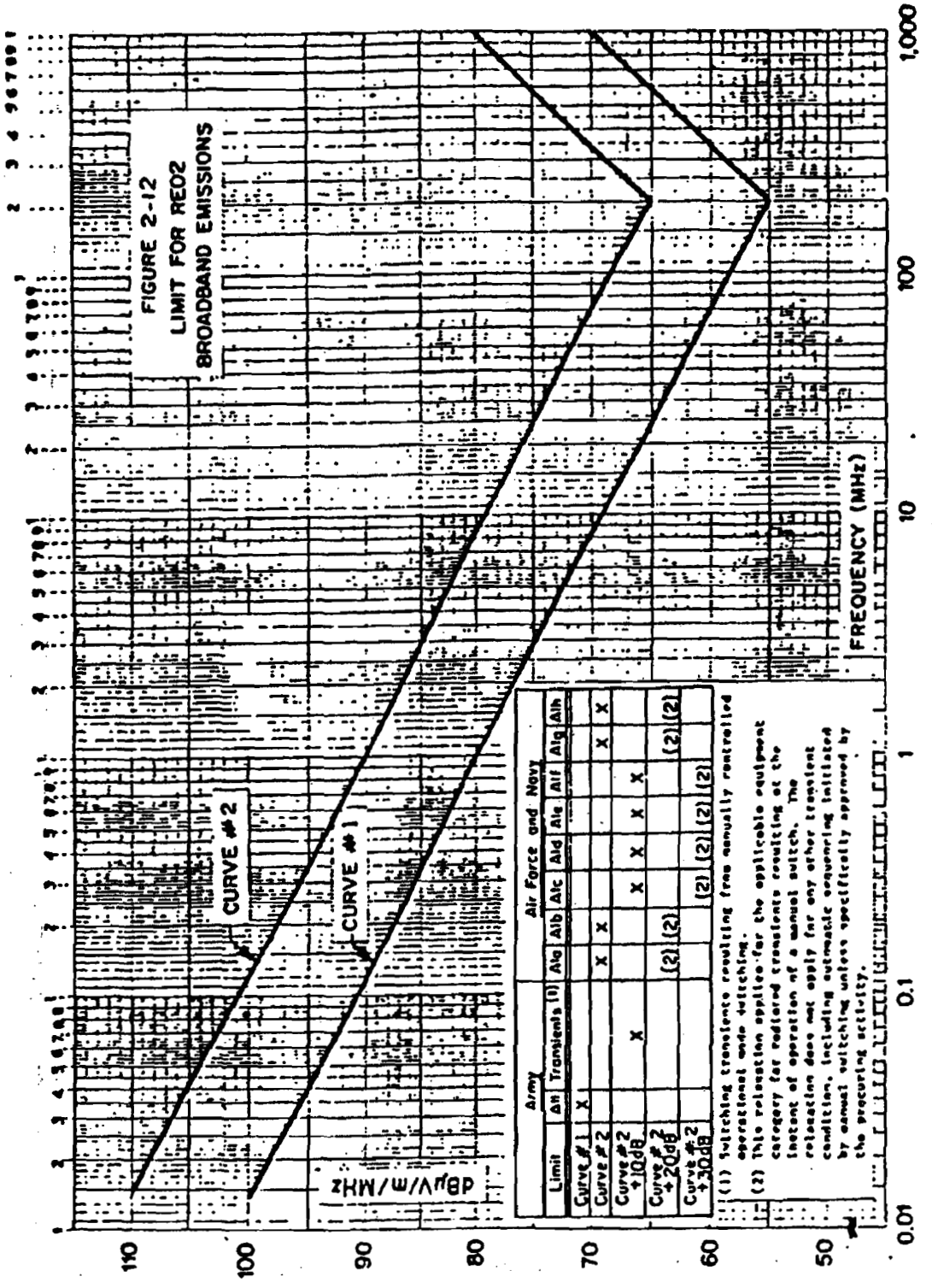

FIGURE 2-12. LIMIT FOR RE02 BROADBAND EMISSIONS

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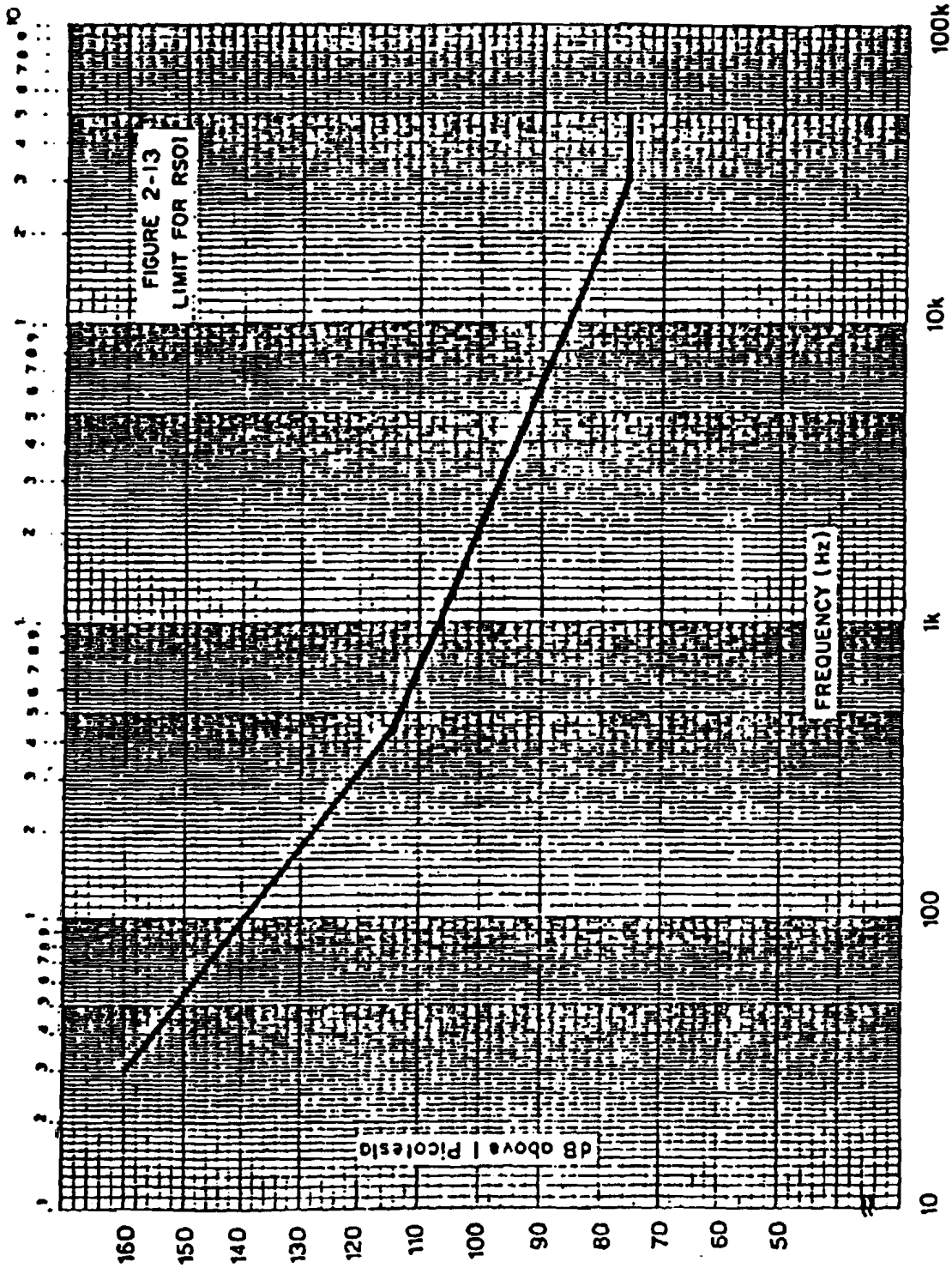

FIGURE 2-13. LIMIT FOR RSO1

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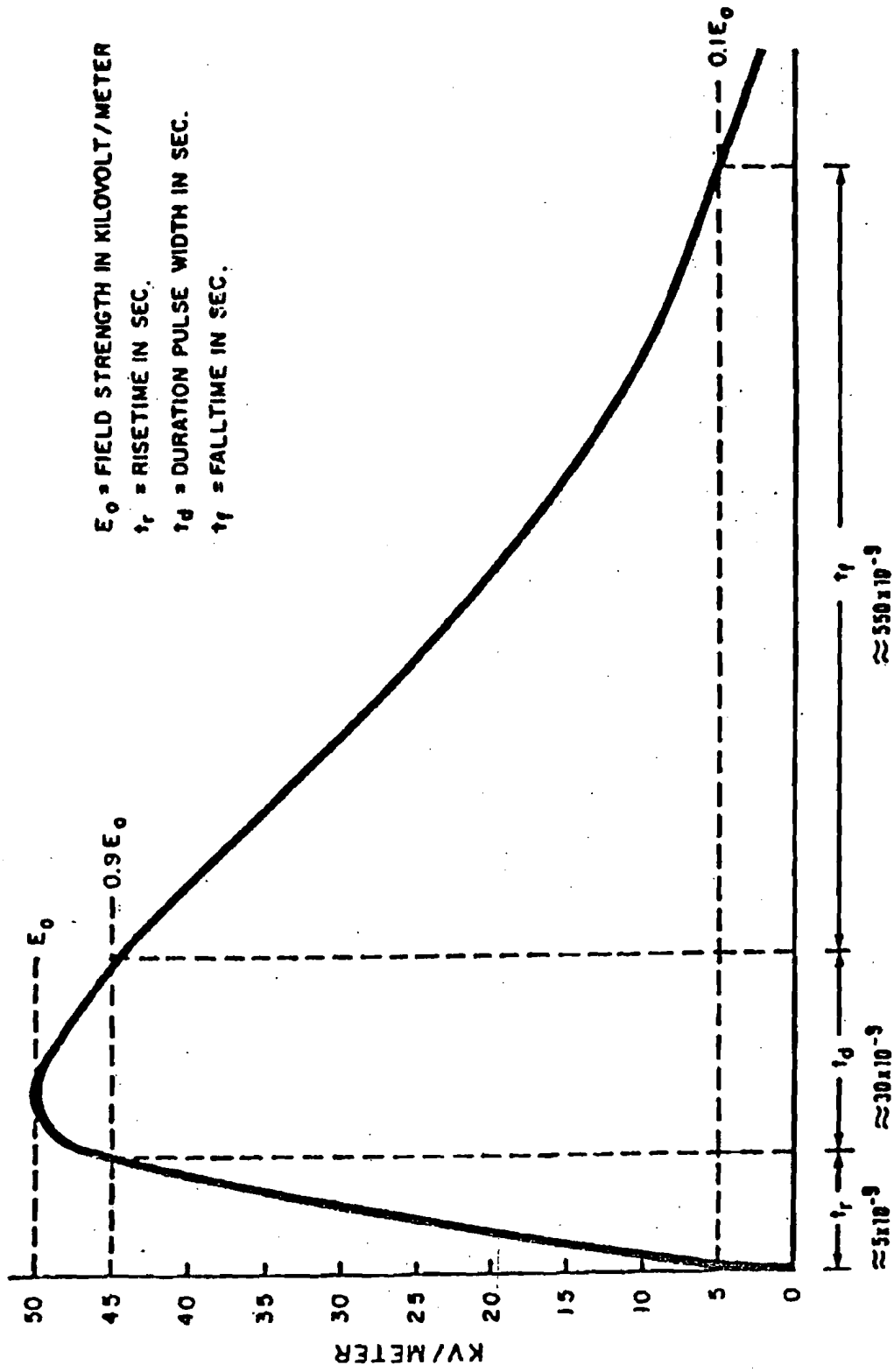

FIGURE 2-14. LIMIT FOR RS05

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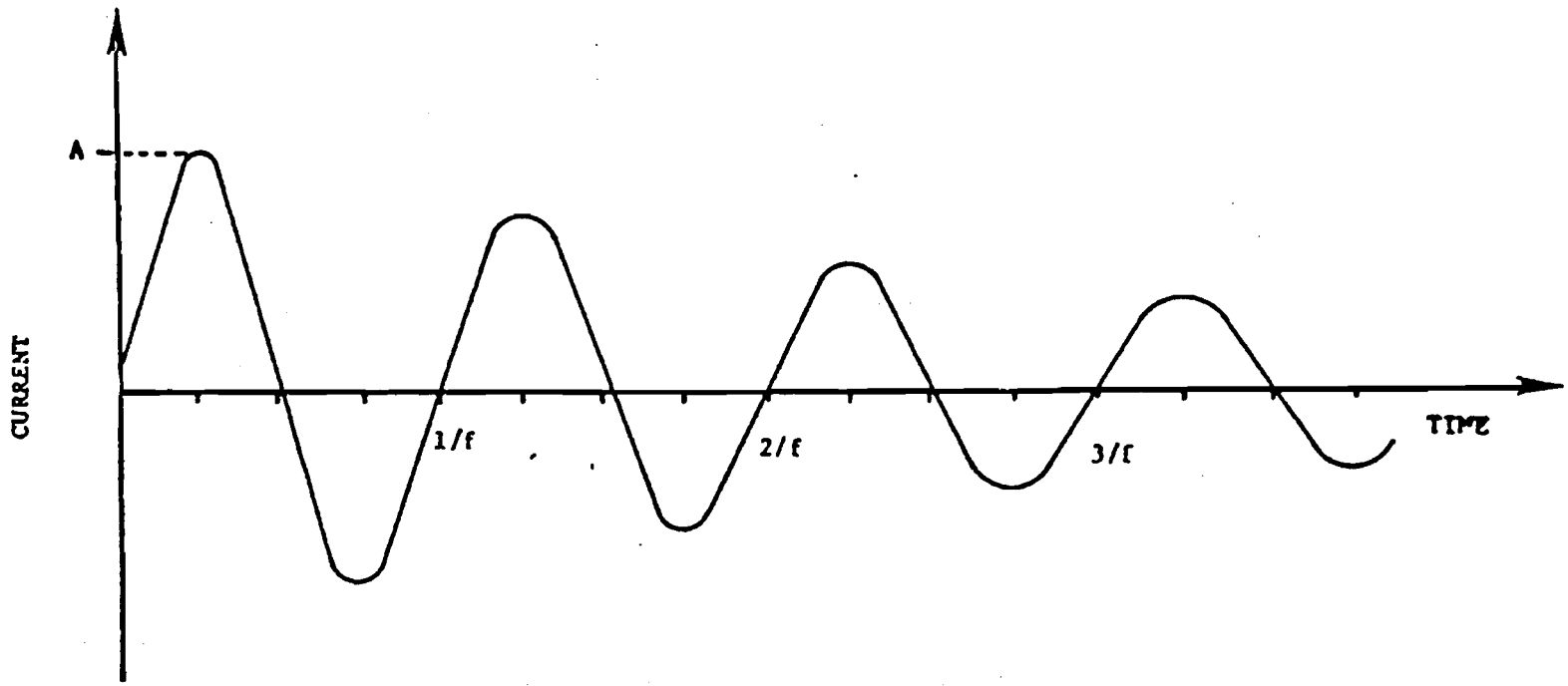

NOTES: 1/ Waveform equation normalized: $e^{-(\pi ft)/Q} \sin 2\pi ft$ where:

f= test frequency (Hz)
t= time (sec)
Q= 20±5 quality factor

2/ "A" is the peak current level shown in Figure 2-16.

FIGURE 2-15. Waveform for CS12.

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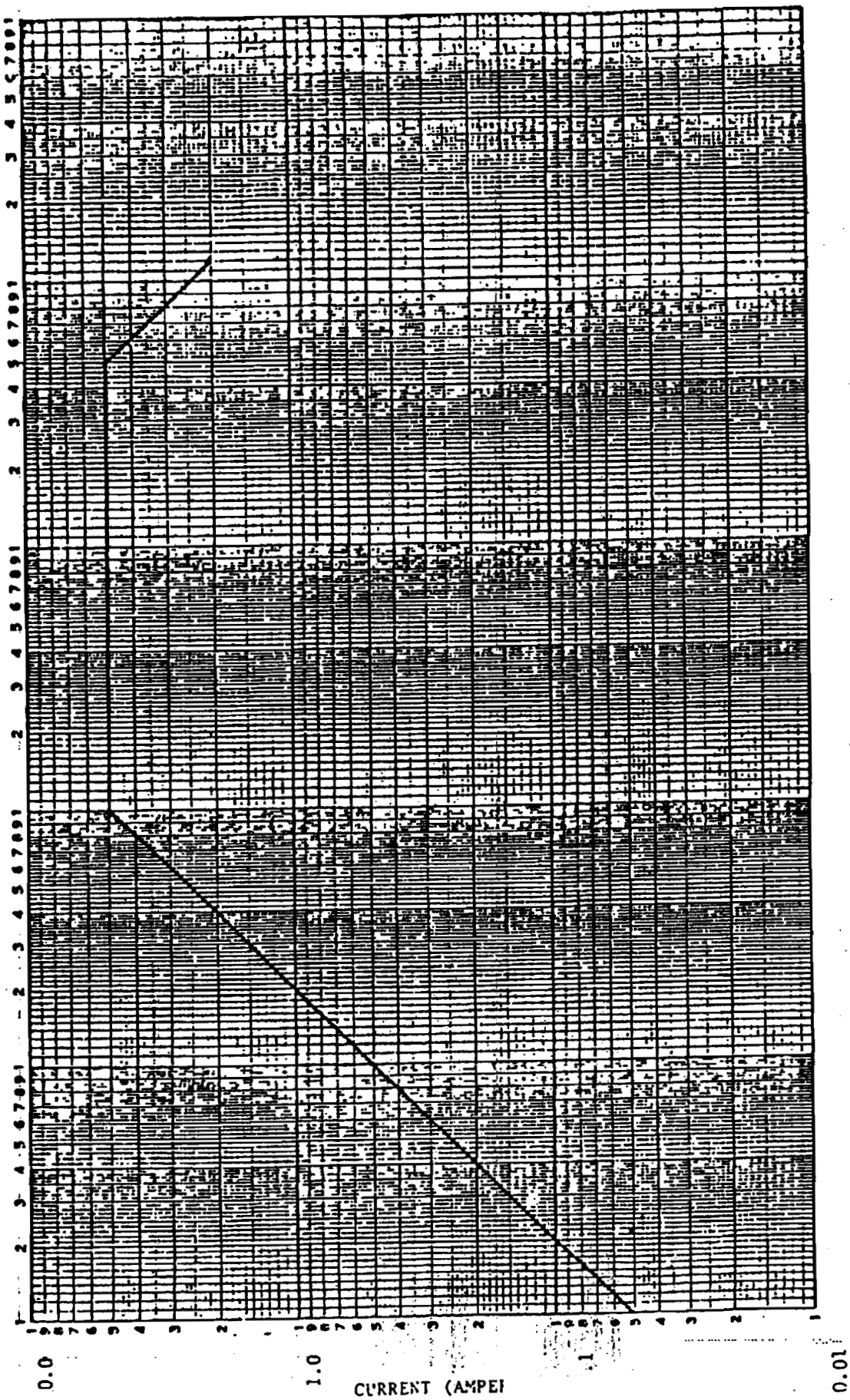

FIGURE 2-16. Limit for CS12.

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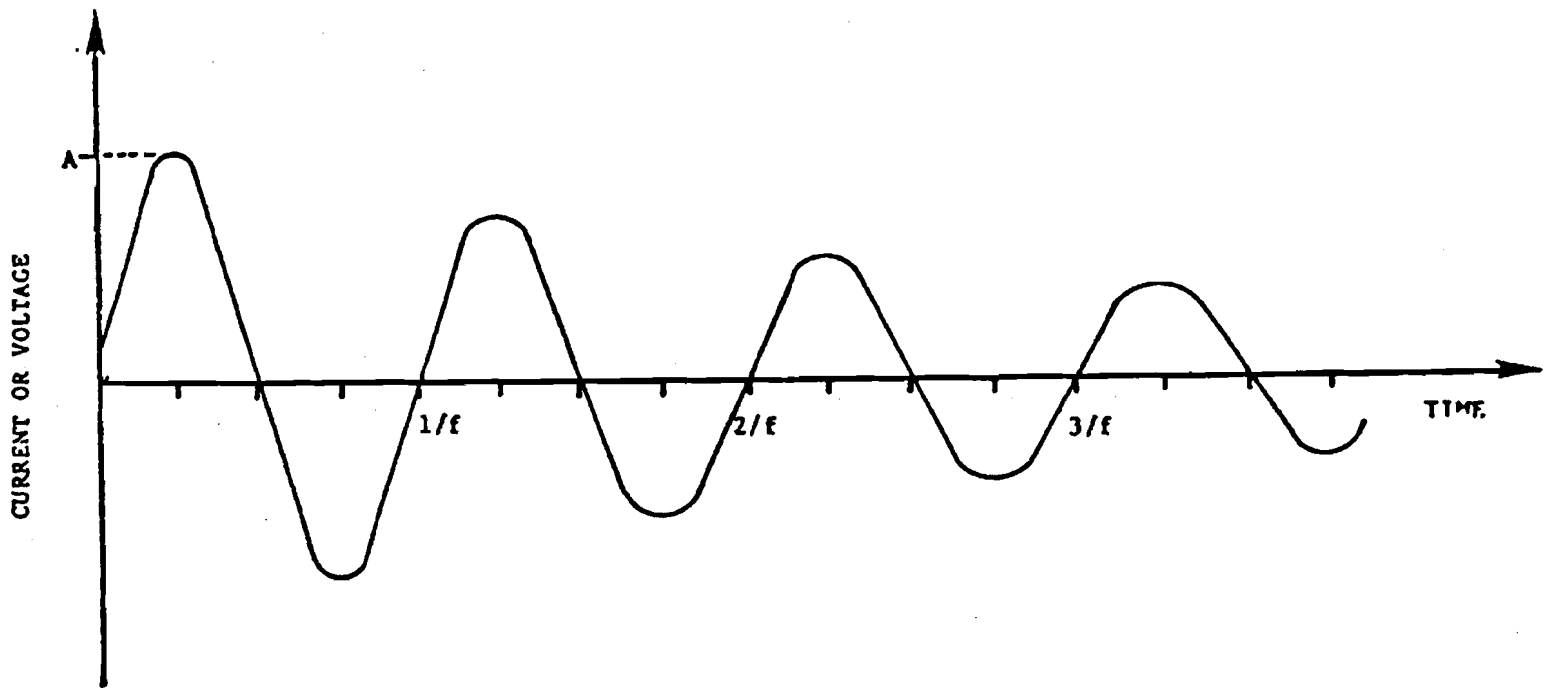

NOTES: 1/ Waveform equation normalized: $e^{-(\pi f t)/Q} \sin 2\pi f t$ where:

f = test frequency (Hz)
t = time (sec)
Q = 20±5 quality factor

2/ "A" is the peak current or voltage level shown in Figure 2-18.

FIGURE 2-17. Waveform for CS13.

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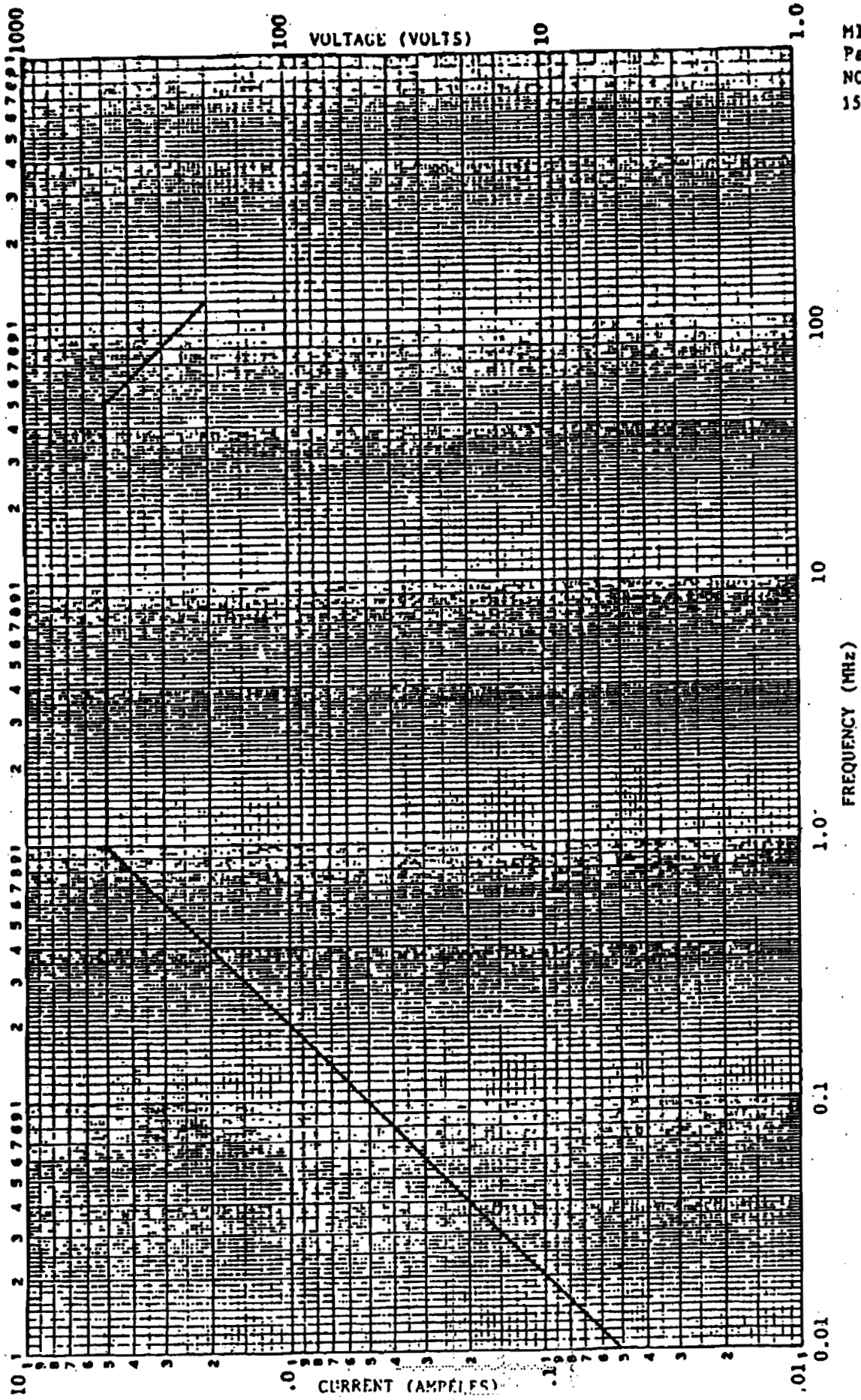

FIGURE 2-18. Limit for CS13.

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Part 3. Equipment and Subsystems Installed Aboard Spacecraft and Launch Vehicles, Including Associated Ground Support Equipment (Class A2)

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1. SCOPE

This part of MIL-STD-461 supplements Part 1 of the standard by defining emission and susceptibility requirements and limits for equipment and subsystems intended for use aboard spacecraft and launch vehicles (class A2), including associated ground support equipment, and for class A3 equipment and subsystems procured for the Air Force.

1.1 Determining requirements. Table 3-I defines categories of class A2 equipment and subsystems. Table 3-II shall be used to determine the requirements applicable to class A2 equipment and subsystems. The table also denotes the paragraphs wherein the requirements and limits are defined. A "Y" entry in the table means the requirement is applicable, and the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "Y_L" entry means the applicability of the requirement is limited and is specified in the corresponding appropriate paragraph. When applicable, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "T" entry means that the applicability of the requirement must be determined on a case-by-case basis and, if the requirement is to be imposed, it must be so specified in the appropriate procurement document. When required, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. Absence of an entry means the requirement is not applicable.

TABLE 3-I. Categories of Class A2 equipment and subsystems.

Category	Description
A2a	Equipment installed on spacecraft or launch vehicle
A2b	Aerospace ground equipment required for the checkout and launch, including electronic test and support equipment
A2c	Trainers and simulators
A2d	Class A3 equipment procured for Air Force use

2. CE01 (limited applicability)

2.1 CE01 applicability. Applications of this requirement are to be determined on a case-by-case basis. When required, CE01 is applicable only for narrowband emissions between 30 Hz and 15 kHz on AC and DC leads, which obtain power from or provide power to other equipment or subsystems. The requirement is not applicable for interconnecting leads unless otherwise specified by the Command or agency concerned.

2.2 CE01 limits.

2.2.1 AC and DC leads. Electromagnetic emissions shall not appear on AC and DC leads in excess of the values as shown on Figure 3-1. The limits shall be met when measured with an effective bandwidth not exceeding the primary power frequency plus 20% of the power frequency for AC power leads or 75 Hz for DC power leads.

2.2.2 Interconnecting leads. If compliance with this requirement is required for interconnecting leads, limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

3. CE03

3.1 CE03 applicability. This requirement is applicable for AC and DC leads, which obtain power from other sources or provide power to other equipment and subsystems. The requirement is not applicable for interconnecting leads, unless otherwise specified by the Command or agency concerned.

3.2 CE03 limits.

3.2.1 AC and DC leads. Electromagnetic emissions shall not appear on AC and DC leads in excess of the values as shown on Figures 3-2 and 3-3 for narrowband and broadband emissions, respectively. Conducted switching spike emissions (including ON/OFF switching) on AC and DC power leads shall meet the requirements of CE07.

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TABLE 3-II. EMISSION AND SUSCEPTIBILITY REQUIREMENTS FOR CLASS A2 EQUIPMENT AND SUBSYSTEMS

	CATEGORIES OF CLASS A2 EQUIPMENT/ SUBSYSTEMS				Applicable	
Requirement	A2a	A2b	A2c	A2d	Paragraph	Limit Curve
CE01	T			T	2	3-1
CE03	Y	Y	Y	Y	3	3-2, 3-3
CE06	Y_L	Y_L		Y_L	4	
CE07	Y	Y	Y	Y	5	
CS01	Y	T	Y	Y	6	3-4
CS02	Y	Y	Y	Y	7	
CS03	Y_L	Y_L		Y_L	8	
CS04	Y_L	Y_L		Y_L	9	3-5
CS05	Y_L	Y_L		Y_L	10	
CS06	Y	Y	Y	Y	11	3-6
CS07	Y_L	Y_L		Y_L	12	
RE01	T			T	13	3-7
RE02	Y	Y	Y	Y	14	3-8, 3-9
RE03	Y_L	Y_L		T	15	
RS02	Y	Y	Y	Y	16	3-6
RS03	Y	Y	Y	Y	17	

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3.2.2 Interconnecting leads. If compliance with this requirement is required for interconnecting leads, limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

4. CE06 (limited applicability)

4.1 CE06 applicability. This requirement is applicable for those equipment and subsystems with antenna leads or those designed to be connected to antennas. The transmitter (key-down mode), harmonic, and spurious emission portions of this requirement are not applicable for equipment and subsystems procured solely for Army use, when any of the following conditions exist: (a) transmitter power exceeds 5 kW average, (b) the fundamental frequency of the test sample exceeds 1.24 GHz, (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable dummy load, or (d) for equipment and subsystems with waveguide transmission lines and operating below 1.24 GHz. For cases (a) through (d) use RE03. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The transmitter (key-down) portion of this requirement is not applicable within either the test sample's necessary bandwidth or ± 5 percent of the fundamental frequency.

4.2 CE06 limits. Conducted emissions in excess of the values given in 4.2.1 through 4.2.3 shall not appear at the test sample's antenna terminals.

4.2.1 Receivers.

a. Narrowband emissions: 34 dB µV

b. Broadband emissions: 40 dB µV/MHz

4.2.2 Transmitters (key-up and standby).

a. Narrowband emissions: 34 dB µV

b. Broadband emissions: 40 dB µV/MHz

4.2.3 Transmitters (key-down mode). Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

5. CE07

5.1 CE07 applicability. This requirement is applicable for the following types of leads: AC or DC leads which obtain power from or provide power to other equipment or subsystems.

5.2 CE07 limits. Conducted switching spikes of less than 50 microseconds in duration shall not exceed the following, as applicable:

a. AC leads: ± 50 percent of nominal root mean square (rms) voltage.

b. DC leads: + 50 percent, -150 percent of nominal line voltage.

Conducted switching spikes equal to or greater than 50 microseconds in duration shall meet the transient requirements as specified in the individual equipment or subsystem specifications. Spike duration is the time interval between the 50% amplitude point on the transient leading edge and the 50% amplitude point on the transient trailing edge; high frequency ringing superimposed on the pulse leading or trailing edges should be ignored.

6. CS01

6.1 CS01 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem. The requirement is not applicable within ± 5 percent of the power frequency(ies). For Navy procurements, this requirement may be deleted for AC leads, with the approval of the Command or agency concerned, if no circuit within the equipment or system is more sensitive than 100 mV.

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6.2 CS01 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to electromagnetic energy injected onto its power leads less than or equal to the values on Figure 3-4. The requirement is also met under the following condition: when the power source specified in MIL-STD-462, adjusted to dissipate 50 watts in a 0.5 ohm load, cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

7. CS02

7.1 CS02 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

7.2 CS02 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to 1 volt from a 50-ohm source. The test signal shall be applied directly to the equipment input terminals, not through the test sample's power line cord. The requirement is also met under the following condition: when a 1-watt source of 50 ohms impedance cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

8. CS03 (limited applicability)

8.1 CS03 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample as specified in MIL-STD-462. For Army equipment and subsystems, the requirement is applicable only when specifically called out in the procurement documentation.

8.2 CS03 limits. The test sample shall not exhibit any intermodulation products from two signals, beyond those permitted in the individual equipment or subsystem specification, when:

a. Signal generator #1 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462; except that when f_1 is in the frequency range of either 200 to 400 MHz or 2 to 25 MHz, the generator output shall be 80 dB above the reference level, but the output of signal generator #1 shall not exceed 10 dBm.

b. Signal generator #2 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but the generator output level shall not exceed a power level of 10 dBm.

9. CS04 (limited applicability)

9.1 CS04 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462. For Army equipment and subsystems, the requirement is applicable only when specifically called out in the procurement documentation.

9.2 CS04 limits. The test sample shall not exhibit any undesired response when subjected to the test signal shown on Figure 3-5.

10. CS05 (limited applicability)

10.1 CS05 applicability. This requirement is applicable to receiving equipment and subsystems such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample as specified in MIL-STD-462. For Army equipment and subsystems, the requirement is appliceble only when specifically called out in the procurement documentation.

10.2 CS05 limits. The test sample shall not exhibit, due to cross modulation, any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the following from signal generator #2: a signal 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but not to exceed a power output level of 10 dBm.

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11. CS06

11.1 CS06 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

11.2 CS06 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when the test spikes having the waveform shown on Figure 3-6 are applied to the AC and DC power input leads for a period of not less than 1 minute at each phase position, and for a total test period not exceeding 15 minutes in duration (in lieu of the values in MIL-STD-462). The values of $E_{()}$ and $t_{()}$ are given below. Each spike shall be superimposed on the powerline voltage waveform.

a. Spike #1 (All Services) E_1 = 200 Volts; t_1 = 10 microseconds ± 20%.

b. Spike #2 (Air Force and Navy) E_2 = 200 Volts; t_2 = 0.15 microseconds ± 20%.

12. CS07 (limited applicability)

12.1 CS07 applicability. This requirement is applicable for receiving equipment and subsystems which utilize squelch circuits.

12.2 CS07 limits.

12.2.1 Requirement 1. The squelch circuits shall not open when the output of a 50-ohm impedance impulse generator, set at 90 dB μV/MHz, is applied and matched to the input terminals of the test sample.

12.2.2 Requirement 2. The squelch circuit shall not open when two signals are applied at the input of the test sample. One signal shall be an unmodulated RF signal at the receiver tuned frequency, whose amplitude is two-thirds of the RF voltage used to adjust the squelch threshold. The second signal shall be an impulse signal of 50 dB μV/MHz.

13. RE01 (limited applicability)

13.1 RE01 applicability. Applications of this requirement are to be determined on a case-by-case basis. When required, RE01 is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample. The requirement applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas.

13.2 RE01 limit. Magnetic field emissions shall not be radiated in excess of the levels shown on Figure 3-7.

14. RE02

14.1 RE02 applicability. This requirement is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample; for narrowband, it applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas. This requirement is applicable for broadband emissions from 14 kHz to 1 GHz and for narrowband emissions from 14 kHz to 10 GHz.

14.2 RE02 limits. E-field emissions shall not be radiated in excess of those given in 14.2.1 and 14.2.2. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves.

14.2.1 Narrowband electric field emissions. Narrowband E-field emissions shall not be radiated in excess of the limit curve shown on Figure 3-8 at the required test distance, as specified in MIL-STD-462.

14.2.2 Broadband electric field emissions. Broadband E-field emissions from all equipment and subsystems, including radiated switching transients resulting from (1) automatic cycling of electronic or electrical switching circuitry, (2) actuation of push-to-talk mechanisms (that is, keying of transmitters), or (3) manual switching shall not be radiated in excess of the applicable limit curve shown on Figure 3-9 at the required test distances, as specified in MIL-STD-462.

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15. RE03 (limited applicability)

15.1 RE03 applicability. This requirement is applicable for those equipment and subsystems with antenna leads or those designed to be connected to antennas. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The requirement is not applicable within either the test sample's necessary bandwidth or ± 5 percent of the fundamental frequency.

15.1.1 Army procurements. This requirement is applicable for transmitting equipment and subsystems procured solely for Army use when any of the following conditions exist: (a) transmitter power exceeds 5 kW average, (b) the fundamental frequency of the test sample exceeds 1.24 GHz, (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable dummy load, or (d) for equipment and subsystems with waveguide transmission lines and operating below 1.24 GHz.

15.1.2 Air Force and Navy procurements. This requirement is applicable, with the approval of the procuring activity, when the spurious emissions and harmonics cannot be determined using the procedures in CE06.

15.2 RE03 limit. Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

16. RS02

16.1 RS02 applicability. Parts I and II are applicable for all DoD activities.

16.2 RS02 limits.

16.2.1 Part I - spikes. The test sample shall not exhibit any malfunction, degradation of performance, or daviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the test spikes having the waveform shown on Figure 3-6. The values of $E_{()}$ and $t_{()}$ are given below:

a. Spike #1 (All Services) E_1 = 200 Volts; t_1 = 10 microseconds ± 20%.

b. Spike #2 (Air Force and Navy) E_2 = 200 Volts; t_2 = 0.15 microseconds ± 20%.

16.2.2 Part II - power frequency. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when 20 amperes are applied to the test wire at the power frequency(ies) of the test sample.

17. RS03

17.1 RS03 applicability. This requirement is applicable for all equipment and subsystems between 14 kHz and 10 GHz. Above 10 GHz, this requirement applies only at all intentionally generated frequencies of any known emitter on the spacecraft or launch vehicle. For Air Force procurements, this requirement is not applicable above 10 GHz, unless otherwise required by the procuring activity.

17.2 RS03 limits. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the radiated electric fields (E) less than or equal to those specified herein. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circular polarized waves are also acceptable. Appropriate consideration shall be given to the operational radiated electromagnetic environment from both friendly and hostile emitters which an equipment or subsystem may encounter during its life cycle. Applicable portions of MIL-HDBK-235 shall be used to determine the anticipated environment. As a minimum, the following levels apply. If levels substantially higher than those given herein are specified, modifications to the procedures in MIL-STD-462 may be required. Such modifications are to be described in the EMI Test Plan.

Frequency Range	E-Field (Volts/meter)
14 kHz to 30 MHz	10
30 MHz to 10 GHz	5
Above 10 GHz	20

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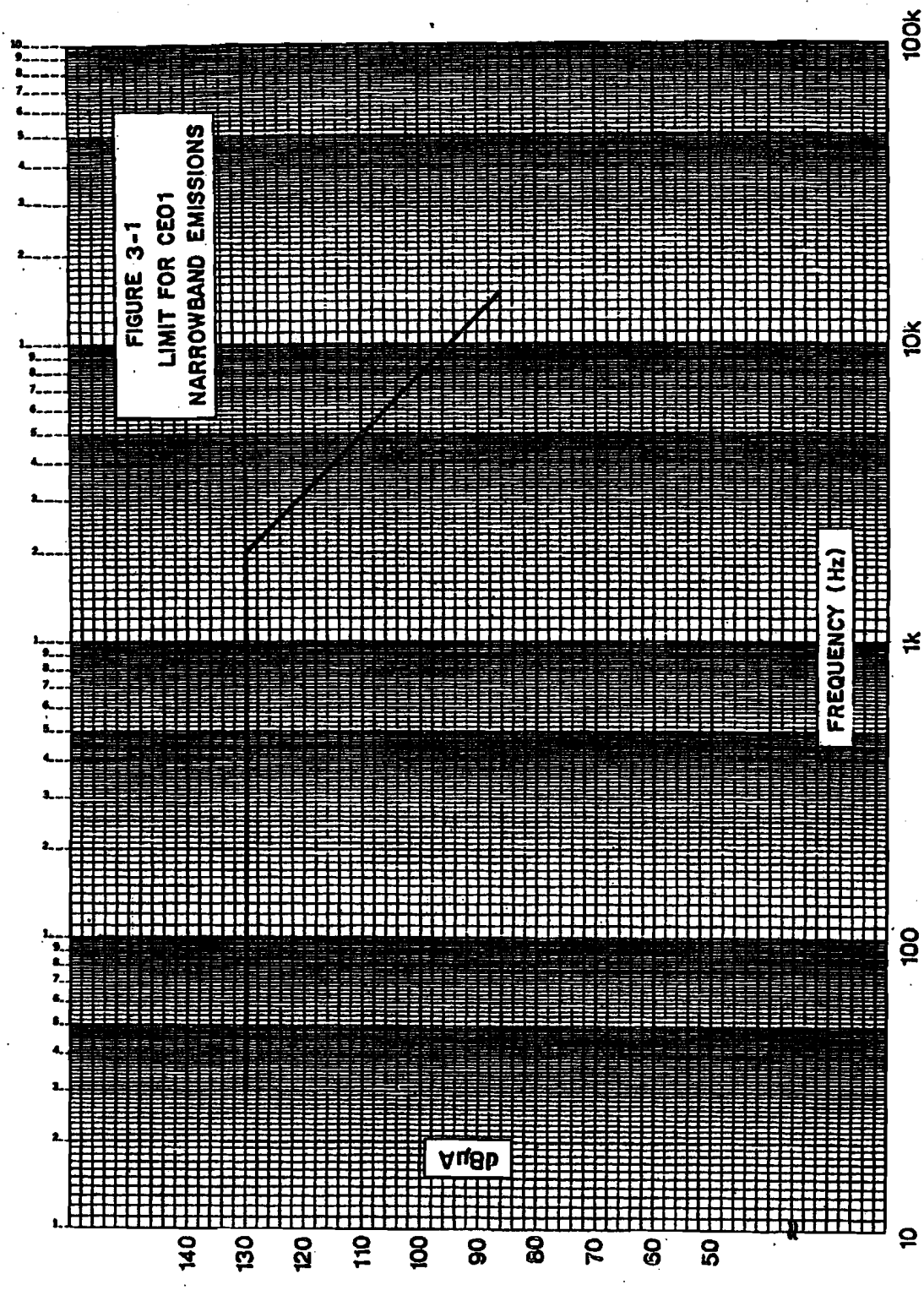

FIGURE 3-1. LIMIT FOR CE01 NARROWBAND EMISSIONS

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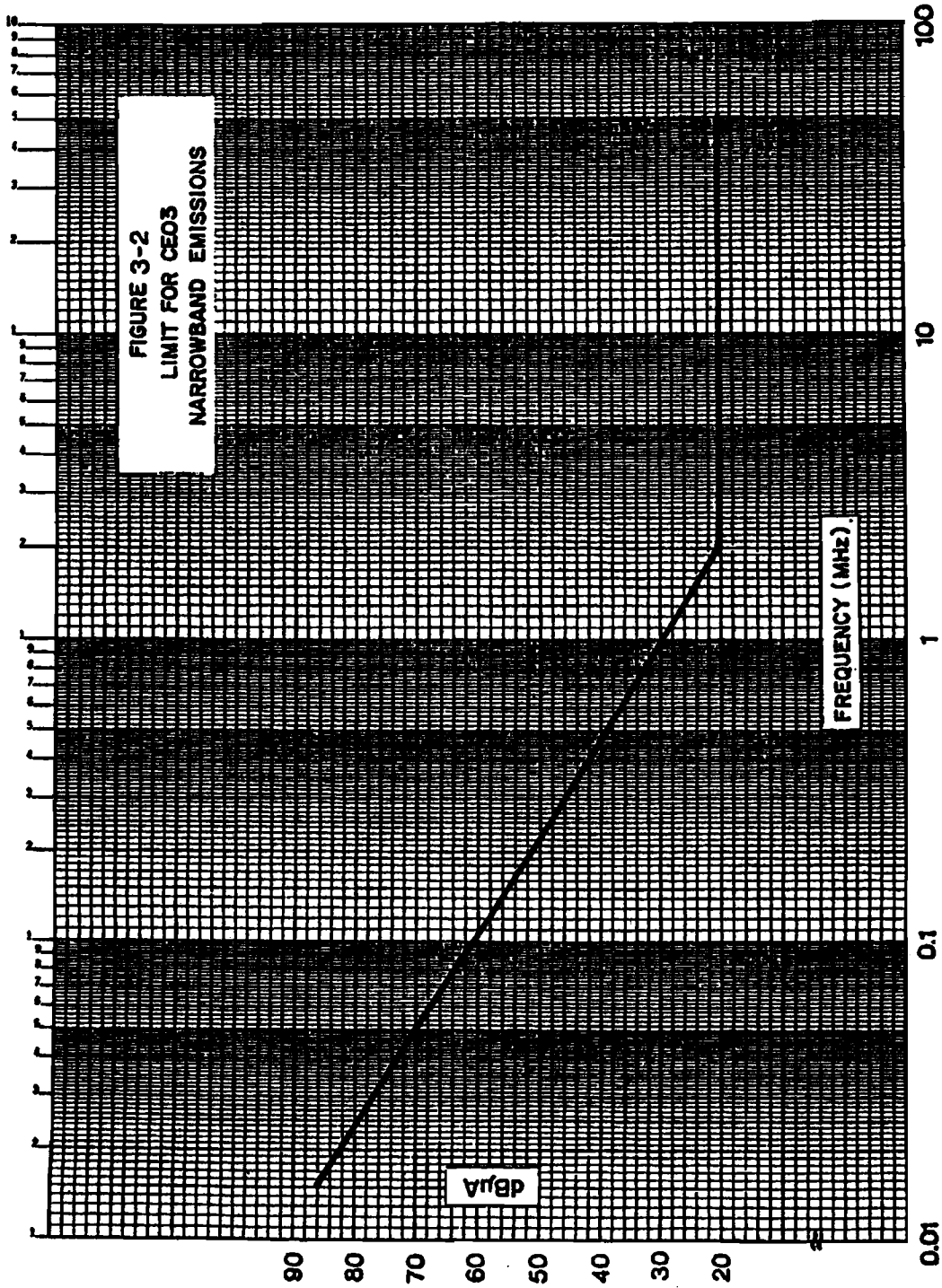

FIGURE 3-2. LIMIT FOR CE03 NARROWBAND EMISSIONS

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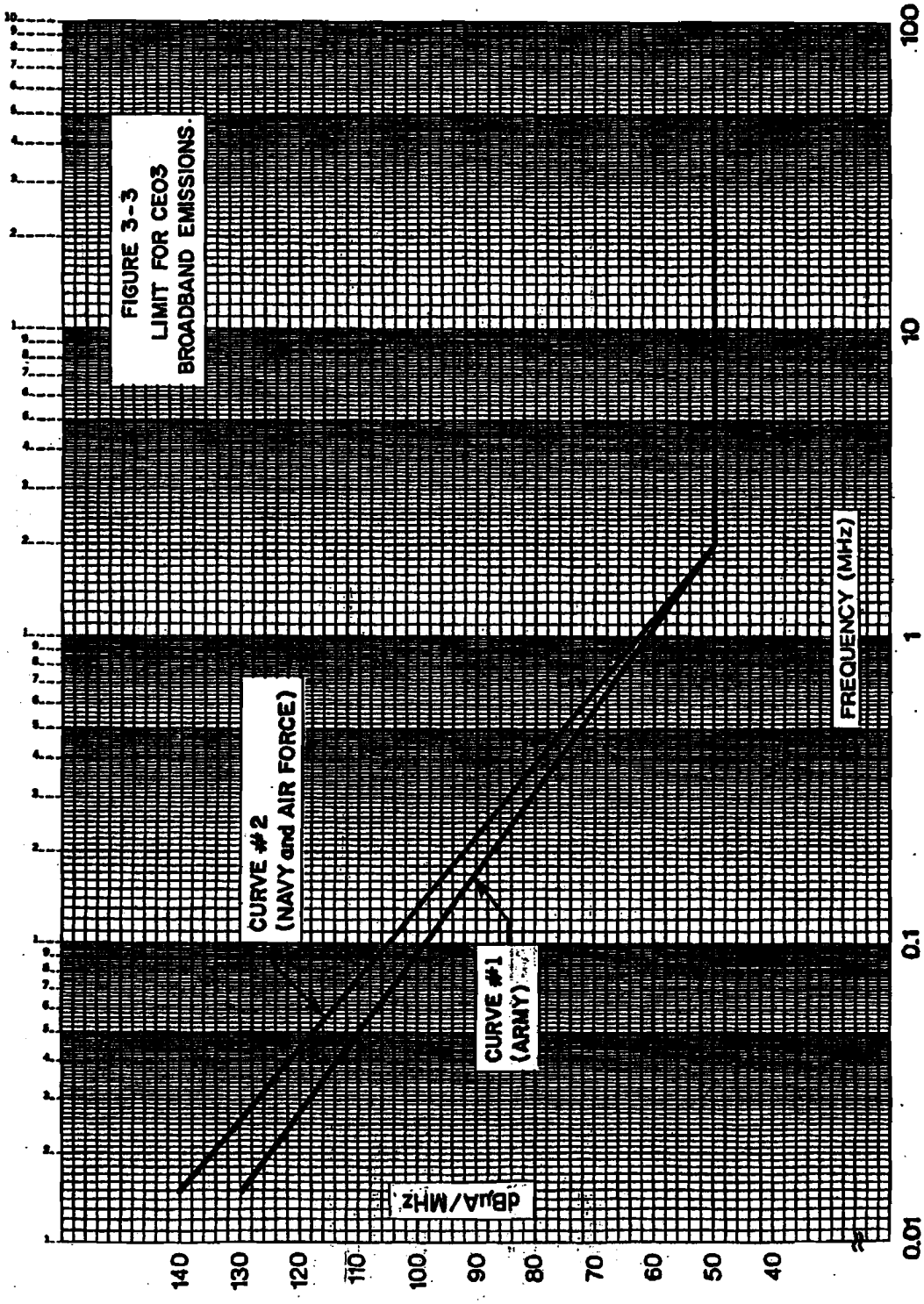

FIGURE 3-3. LIMIT FOR CE03 BROADBAND EMISSIONS

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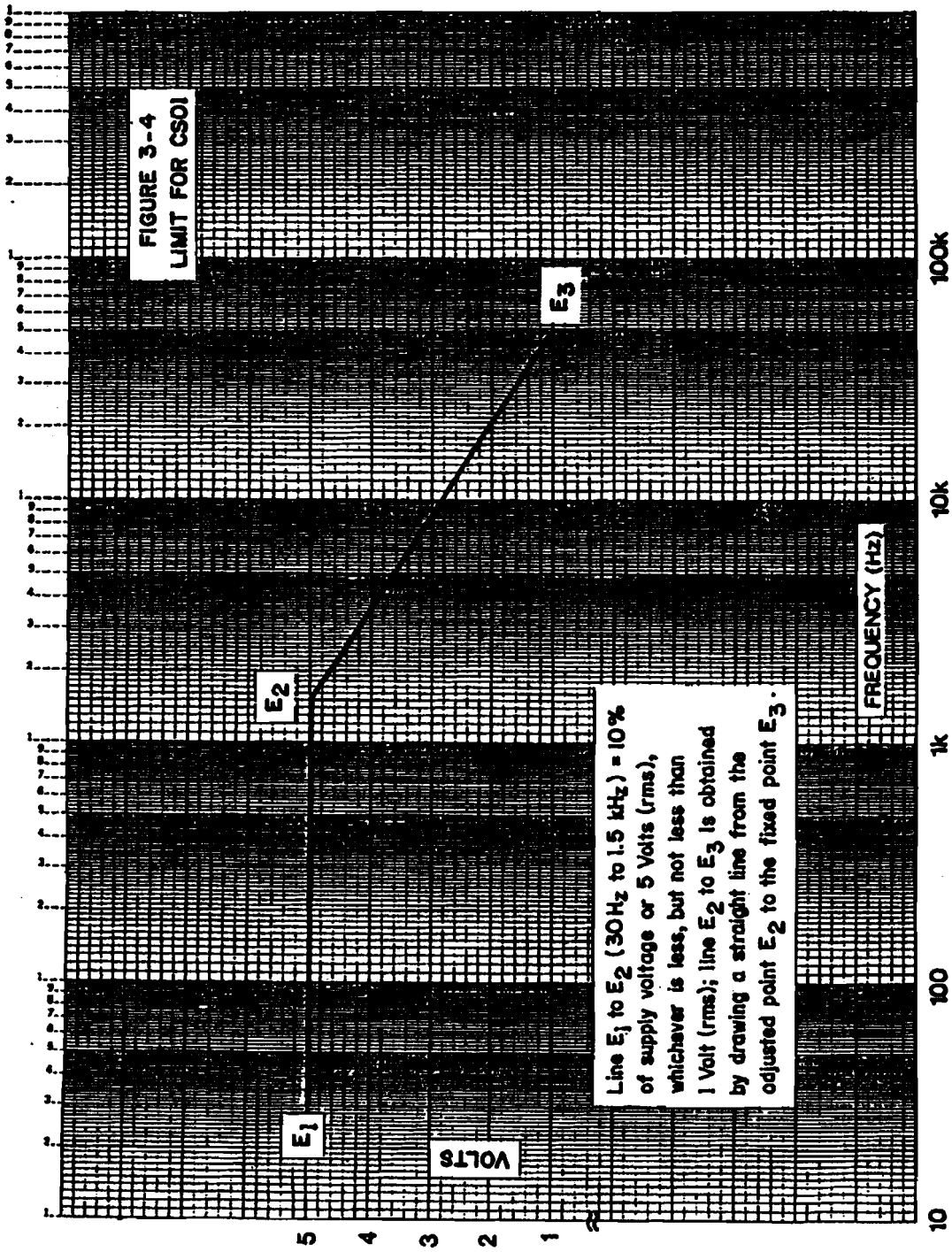

FIGURE 3-4. LIMIT FOR CS01

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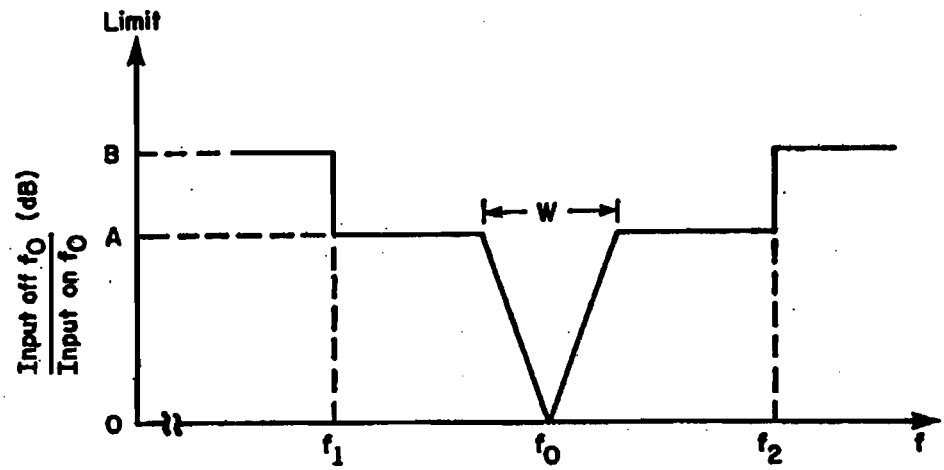

f_0 = Receiver tuned frequency or band center for amplifiers.

f_1 = Lowest tunable frequency of receiver band in use or the lowest frequency of amplifier passband.

f_2 = Highest tunable frequency of receiver band in use or the highest frequency of amplifier passband.

W = Bandwidth between the 80 dB points of the receiver selectivity curve as defined in the test sample's technical requirements or the control plan.

Limits:

1. The limit at A is 80 dB above the input level required to produce the standard reference output. (This limit shall not be used for amplifiers)
2. The limit at B shall be set as follows:
   a. Receivers: 0 dBm applied directly to the receiver input terminals.
   b. Amplifiers: The limit shall be as specified in the test sample's technical requirement or control plan. If no limit is defined in the above documents, the 0 dBm value shall be used.

FIGURE 3-5. LIMIT FOR CS04

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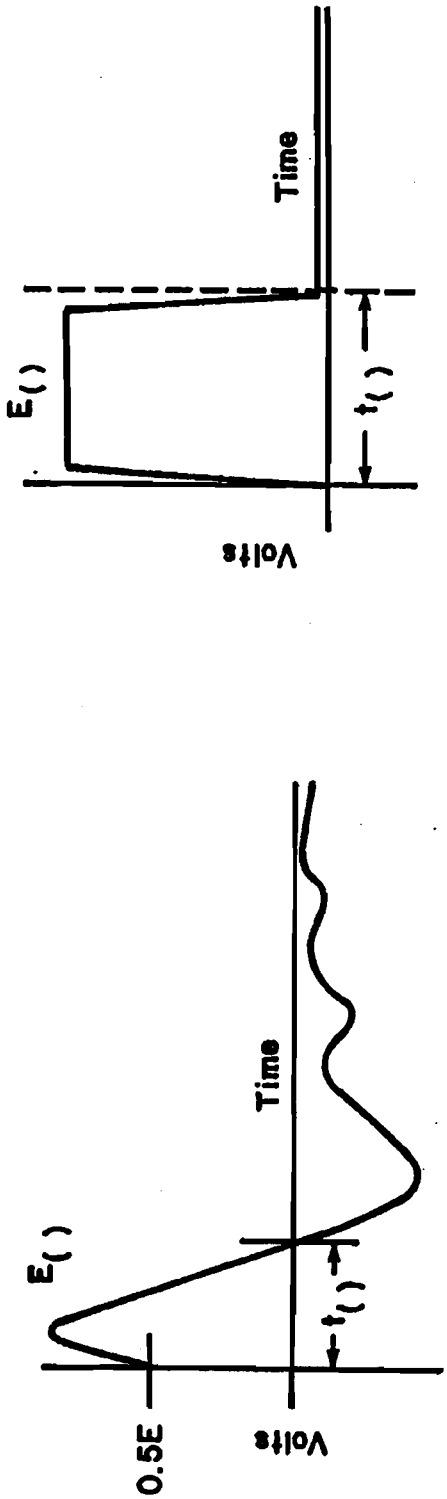

NOTE: The test sample shall be subjected to the spike(s) with the waveform shown and with the specified voltage(s) and pulsewidth(s).

FIGURE 3-6. ACCEPTABLE WAVESHAPES FOR CSO6 AND RSO2

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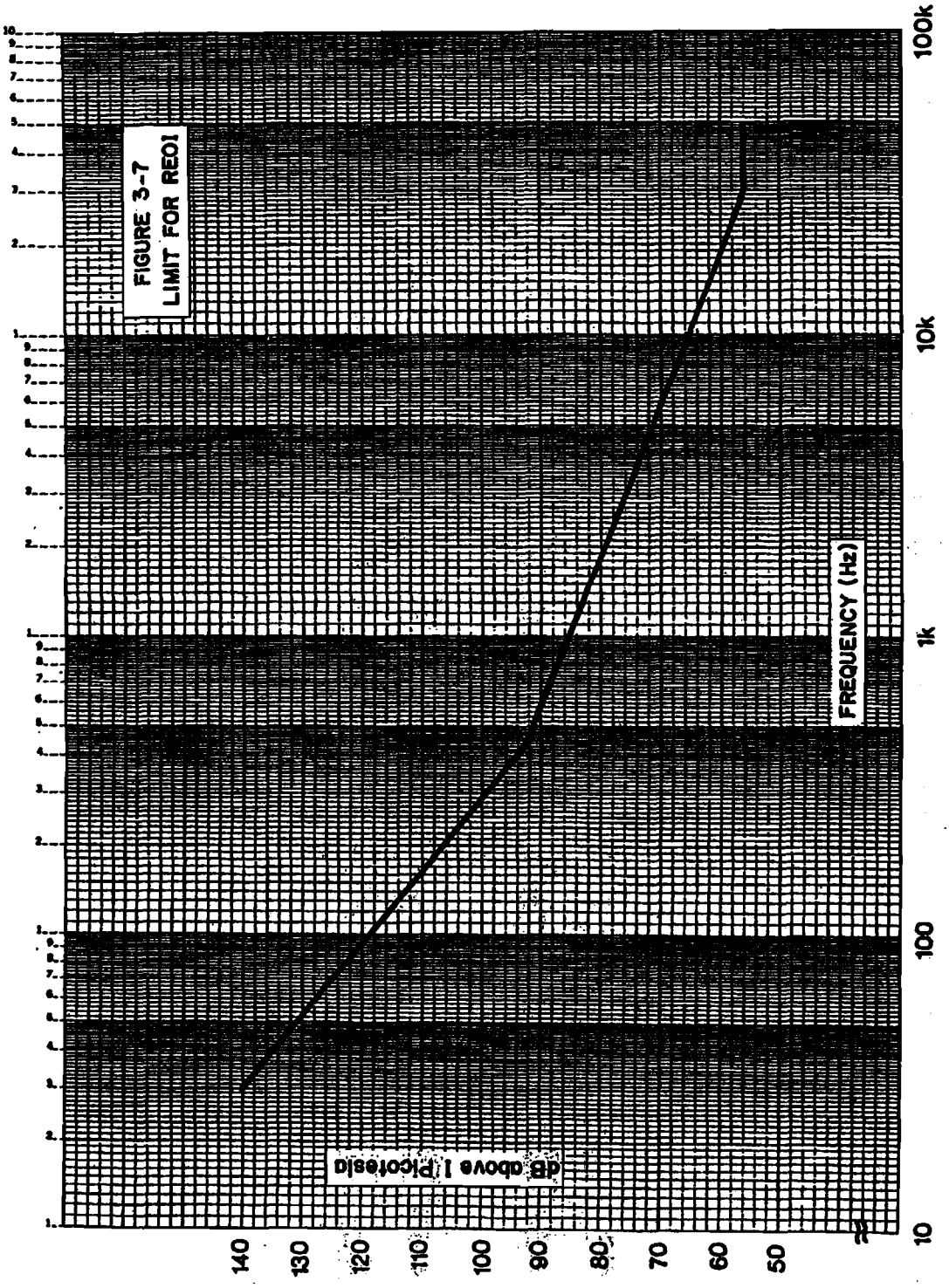

FIGURE 3-7. LIMIT FOR RE01

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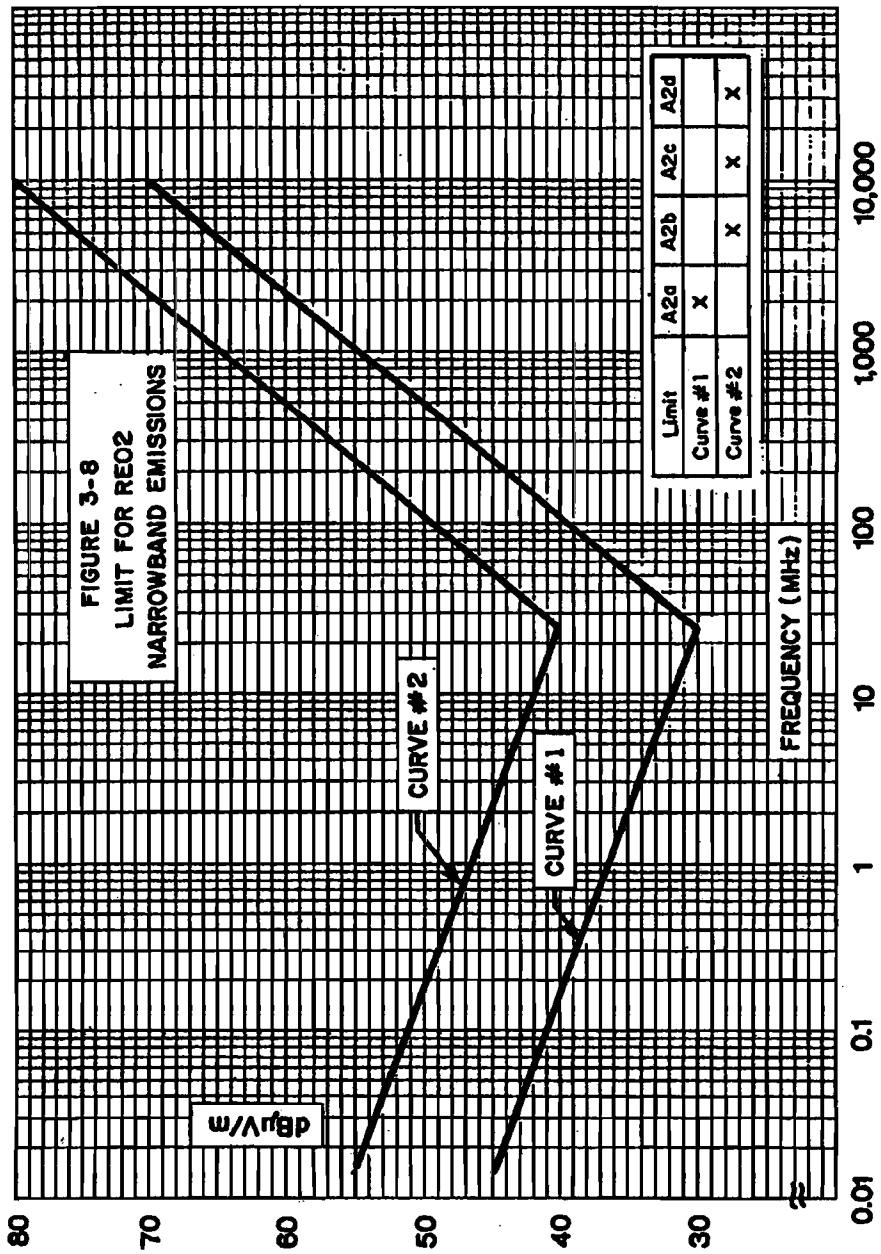

FIGURE 3-8. LIMIT FOR RE02 NARROWBAND EMISSIONS

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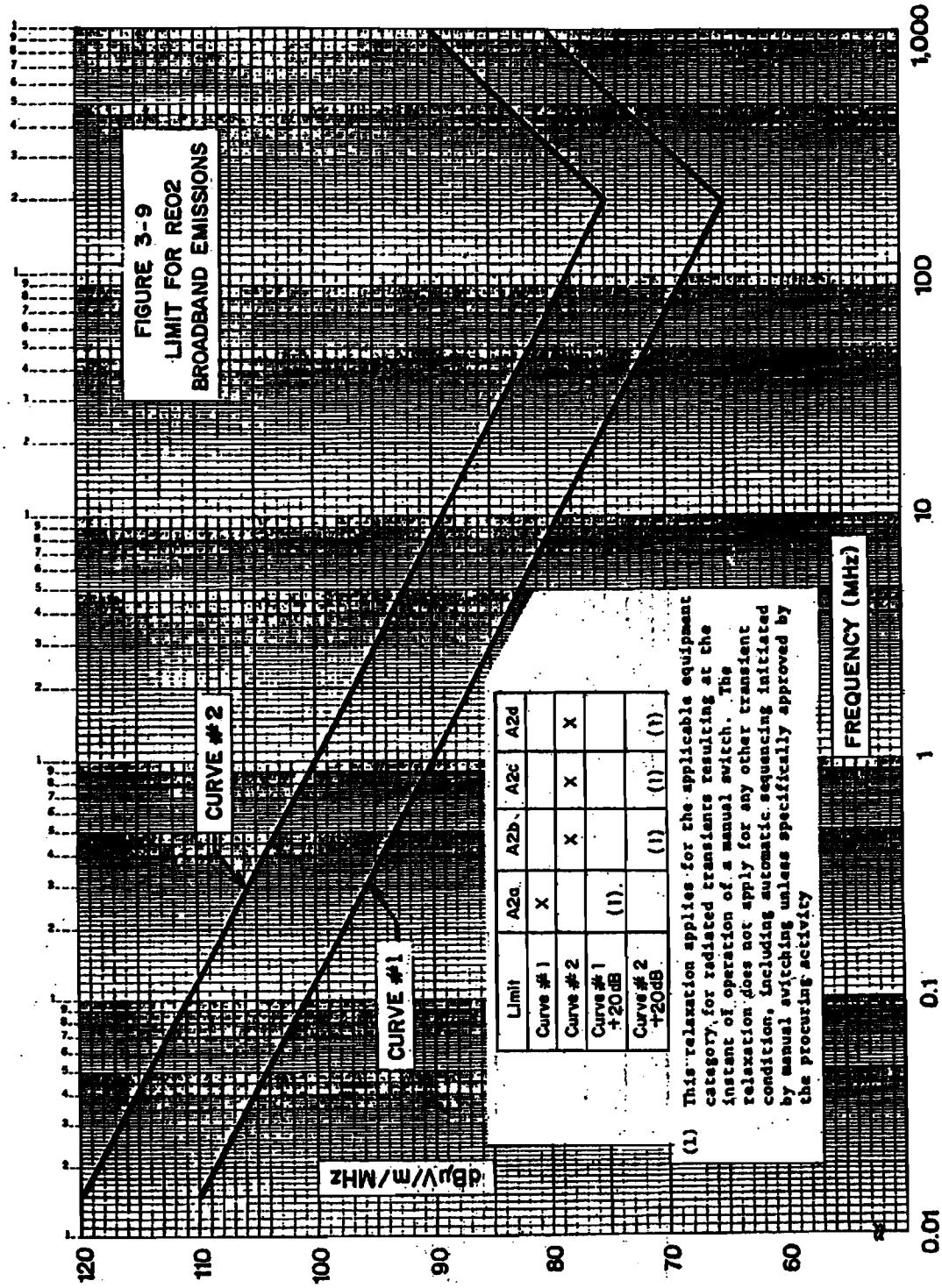

FIGURE 3-9. LIMIT FOR RE02 BROADBAND EMISSIONS

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Part 4. Equipment and Subsystems Installed in Ground Facilities (Fixed and Mobile, Including Tracked and Wheeled Vehicles) (Class A3)

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1. SCOPE

This part of MIL-STD-461 supplements Part 1 of the standard by defining emission and susceptibility requirements and limits for equipment and subsystems intended for use in ground fixed and mobile facilities, including tracked and wheeled vehicles (Class A3). Navy requirements for ground support equipment used for checkout and launch of aircraft, spacecraft, and launch vehicles are contained in Parts 2 and 3 of MIL-STD-461 and should be tailored as necessary. Part 4 is not applicable for Air Force procurements; refer to Parts 2 and 3.

1.1 Determining requirements. Table 4-I shall be used to determine the specific requirements for class A3 equipment and subsystems. The table also denotes the paragraphs wherein the requirements and limits are defined. A "Y" entry in the table means the requirement is applicable, and the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "Y_L" entry means the applicability of the requirement is limited and is specified in the appropriate corresponding paragraph. When applicable, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "T" entry means that the applicability of the requirement must be determined on a case-by-case basis and, if the requirement is to be imposed, it must be so specified in the appropriate procurement document. When required, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. Absence of an entry means the requirement is not applicable. For procurements of subsystems, such as radar, EW surveillance, and the like, comprised of individual equipment listed in Table 4-1, the applicable emission and susceptibility requirements for the subsystem shall be tailored by the procuring activity based on the requirements of the individual equipment.

2. CE01 (limited applicability)

2.1 CE01 applicability. This requirement is applicable for alternating current (AC) and direct current (DC) leads, which obtain power from other sources or provide power to other equipment or subsystems; grounds or neutrals, which are not grounded internally to the subsystem or equipment being measured; and interconnecting control leads, which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as clock, IF, audio, firing, digital, RF, and the like, unless otherwise specified by the Command or agency concerned. For Army equipment or subsystems the requirement is applicable only when specifically called out in the procurement documentation.

2.1.1 DC and interconnecting leads. This requirement is applicable for narrowband emissions from 30 Hz and 15 kHz.

2.1.2 AC leads. The requirement is applicable for equipment and subsystems procured for Navy use. This requirement is applicable for narrowband emissions from the power frequency(ies) of the test sample to 15 kHz. Other applications and limits for this requirement are to be determined and specified on a case-by-case basis.

2.2 CE01 limits.

2.2.1 DC leads. Electromagnetic emissions shall not appear on DC leads in excess of the values shown on the applicable curve on Figure 4-1. The limits shall be met when measured with an effective bandwidth not exceeding 75 Hz.

2.2.2 AC leads. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on the applicable limit line on Figure 4-2. The limits shall be met when measured with an effective bandwidth not exceeding the primary power frequency plus 20% of the primary power frequency.

2.2.3 Interconnecting leads.

2.2.3.1 Army procurements.

2.2.3.1.1 Interconnecting control leads. Electromagnetic emissions shall not appear on interconnecting control leads in excess of the values shown on the applicable curve on Figure 4-1. The limits shall be met when measured with an effective bandwidth not exceeding the primary power frequency plus 20% of the primary power frequency for AC leads or 75 Hz for DC leads.

2.2.3.1.2 Interconnecting signal leads. If compliance with this requirement is required for signal leads, limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

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TABLE 4-I. EMISSION AND SUSCEPTIBILITY REQUIREMENTS FOR CLASS A3 EQUIPMENT AND SUBSYSTEMS

Requirement / Specific Equipment/Subsystem	Receivers	Transmitters	Antenna Multicouplers	Amplifier, Tuned, RF	Amplifier, Untuned, RF	Intercom/Interphone	Modem	Repeater	Amplifier, Power/Audio	Modulators	Multiplexers	Laser Devices	IR Devices	Transponders	Beacons	Power Supplies	Sensors/Antennas	Inertial Guidance	Teletypewriters	Recorders	Visual Displays	Digital Equipment	Photographic Equipment	Trainers/Simulators	Telephone SWBD	Servo/Synchro	Test Equipment	Time/Frequency STDS	Ultrasonic Devices	Telephones	Surface Launched Missiles	Commercial Equipment (Army Only)	All Others Not Listed Herein	Applicable Paragraph
CE01	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		Y_L	2
CE03	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	3
CE06	Y_L	Y_L	T	Y_L	Y_L									Y_L	Y_L																Y_L	Y_L	Y_L	4
CE07	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	5
CS01	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	6
CS02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	7
CS03	Y_L		T	T	T	Y_L			Y_L					Y_L			T			Y_L											Y_L		Y_L	8
CS04	Y_L		T	T	T	T			T					T																	Y_L			9
CS05	Y_L		T	T	T	Y_L			Y_L					Y_L			T			Y_L											Y_L		Y_L	10
CS06	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	11
CS07	Y_L																																	12
CS09	Y_L	T	Y_L	Y_L	Y_L				Y_L					Y_L			Y_L	T				Y_L						Y_L					Y_L	13
CS10	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T		T	14
CS11	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	T	Y_L	T	Y_L	Y_L		Y_L	15
RE01	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L			Y_L	16
RE02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	17
RE03		Y_L												Y_L	Y_L																	Y_L	Y_L	18
RS01	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L			Y_L	19
RS02	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L			Y_L	20
RS03	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	21
RS06	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	[illegible]	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		Y_L	22

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2.2.3.2 Navy procurements.

2.2.3.2.1 Connected outer shields and twisted pairs together. For interconnecting control and signal leads having the outer shield connected, and for twisted pairs with the pairs together, electromagnetic emissions shall not appear on the leads in excess of the values shown on the applicable curve on Figure 4-1.

2.2.3.2.2 Disconnected outer shield and twisted pairs separated. For interconnecting control and signal leads having the outer shield disconnected, and for twisted pairs having the pairs separated, the limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

3. CE03

3.1 CE03 applicability. This requirement is applicable for the following types of leads: AC and DC leads, which obtain power from other sources or provide power to other equipment, distribution panels, or subsystems; grounds or neutrals, which are not grounded internally to the subsystem or equipment being measured; and interconnecting control leads, which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as a clock, IF, audio, firing, digital, RF, and the like, unless otherwise specified by the Command or agency concerned. For Army procurements, the requirement is applicable using the Line Impedance Stabilization Network, as described in MIL-STD-462.

3.2 CE03 limits.

3.2.1 DC leads. Electromagnetic emissions shall not appear on DC leads in excess of the values shown on the applicable curve on Figures 4-3 and 4-4 for narrowband and broadband emissions, respectively.

3.2.2 AC leads.

3.2.2.1 Army procurements. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on Figures 4-3 and 4-4 for narrowband and broadband emissions, respectively.

3.2.2.2 Navy procurements. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on Figures 4-5 and 4-6 for narrowband and broadband emissions, respectively.

3.2.3 Interconnecting leads.

3.2.3.1 Army procurements.

3.2.3.1.1 Interconnecting control leads. Electromagnetic emissions shall not appear on interconnecting control leads in excess of the values shown on the applicable curve on Figures 4-3 and 4-4 for narrowband and broadband emissions, respectively.

3.2.3.1.2 Interconnecting signal leads. If compliance with this requirement is required for signal leads, limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

3.2.3.2 Navy procurements.

3.2.3.2.1 Connected outer shields and twisted pairs together. For interconnecting control and signal leads having the outer shield connected, and for twisted pairs with the pairs together, electromagnetic emissions shall not appear on the leads in excess of the values shown on the applicable curve on Figures 4-3 and 4-4 for narrowband and broadband emissions, respectively.

3.2.3.2.2 Disconnected outer shield and twisted pairs separated. For interconnecting control and signal leads having the outer shield disconnected, and for twisted pairs having the pairs separated, the limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

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4. CE06 (limited applicability)

4.1 CE06 applicability. This requirement is applicable for those equipment and subsystems with antenna leads or those designed to be connected to antennas. The transmitter (key-down mode), harmonic and spurious emission portions of this requirement are not applicable for equipment and subsystems procured solely for Army use, when any of the following conditions exist: (a) transmitter power exceeds 5 kW average, (b) the fundamental frequency of the test sample exceeds 1.24 GHz, (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable dummy load, or (d) for equipment and subsystems with waveguide transmission lines and operating below 1.24 GHz. For cases (a) through (d) use RE03. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The transmitter (key-down) portion of this requirement is not applicable within either the test sample's necessary bandwidth or ± 5 percent of the fundamental frequency.

4.2 CE06 limits. Conducted emissions in excess of the values given below shall not appear at the test sample's antenna terminals.

4.2.1 Receivers.

a. Narrowband emissions: 34 dB µV

b. Broadband emissions: 40 dB µV/MHz

4.2.2 Transmitters (key-up and standby).

a. Narrowband emissions: 34 dB µV

b. Broadband emissions: 40 dB µV/MHz

4.2.3 Transmitters (key-down mode). Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

5. CE07

5.1 CE07 applicability. Applications of this requirement are to be determined on a case-by-case basis for Navy procurements for the following types of leads: AC or DC leads which obtain power from or provide power to other equipment or subsystems.

5.2 CE07 limits. Conducted switching spikes of less than 50 microseconds in duration shall not exceed the following, as applicable:

a. AC leads: ± 50 percent of nominal rms voltage.

b. DC leads: + 50 percent, -150 percent of nominal line voltage.

Conducted switching spikes equal to or greater than 50 microseconds in duration shall meet the transient requirements as specified in the individual equipment or subsystem specifications. Spike duration is the time interval between the 50% amplitude point on the transient leading edge and the 50% amplitude point on the transient trailing edge; high frequency ringing superimposed on the pulse leading or trailing edges should be ignored.

6. CS01 (limited applicability)

6.1 CS01 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals, which are not grounded internally to the equipment or subsystem. The requirement is not applicable within ± 5 percent of the power frequency(ies). For Navy procurements, this requirement may be deleted for AC leads, with the approval of the Command or agency concerned, if no circuit within the equipment or system is more sensitive than 100 mV or better.

6.2 CS01 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to electromagnetic energy injected onto its power leads less than or equal to the values on Figure 4-7. The requirement is also met under the following condition: when the power source specified in MIL-STD-462, adjusted to dissipate 50 watts in a 0.5 ohm load, cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

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7. CS02

7.1 CS02 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

7.2 CS02 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to 1-volt from a 50 ohm source. The test signal shall be applied directly to the equipment input terminals, not through the test sample's power line cord. The requirement is also met under the following condition: when a 1-watt source of 50 ohms impedance cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

8. CS03 (limited applicability)

8.1 CS03 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462. For Army equipment and subsystems the requirement is applicable only when specifically called out in the procurement documentation.

8.2 CS03 limits. The test sample shall not exhibit any intermodulation products from two signals, beyond those permitted in the individual equipment or subsystem specification, when:

a. Signal generator #1 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, except that when f_1 is in the frequency range of either 200 to 400 MHz or 2 to 25 MHz, the generator output shall be 80 dB above the reference level, but the output of signal generator #1 shall not exceed 10 dBm.

b. Signal generator #2 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but the generator output level shall not exceed a power level of 10 dBm.

9. CS04 (limited applicability)

9.1 CS04 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462. For Army equipment and subsystems the requirement is applicable only when specifically called out in the procurement documentation.

9.2 CS04 limits. The test sample shall not exhibit any undesired response when subjected to the test signal shown on Figure 4-8.

10. CS05 (limited applicability)

10.1 CS05 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462. For Army equipment and subsystems the requirement is applicable only when specifically called out in the procurement documentation.

10.2 CS05 limits. The test sample shall not exhibit, due to cross modulation, any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the following from signal generator #2: a signal 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but not to exceed a power output level of 10 dBm.

11. CS06

11.1 CS06 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals, which are not grounded internally to the equipment or subsystem.

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11.2 CS06 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when the test spikes having the waveform shown on Figure 4-9 are applied to the AC and DC power input leads for a period of not less than 1 minute at each phase position, and for a total test period not exceeding 15 minutes in duration (in lieu of the values in MIL-STD-462). The values of $E_{()}$ and $t_{()}$ are given below. The spike shall be superimposed on the powerline voltage waveform.

a. Spike #1 (Army) E_1 = 100 Volts; t_1 = 10 microseconds ± 20%.

b. Spike #2 (Navy) E_2 = 400 Volts; t_2 = 5 microseconds ± 20%.

12. CS07 (limited applicability)

12.1 CS07 applicability. This requirement is applicable for receiving equipment and subsystems which utilize squelch circuits.

12.2 CS07 limits.

12.2.1 Requirement 1. The squelch circuits shall not open when the output of a 50-ohm impedance impulse generator, set at 90 dB µV/MHz, is applied and matched to the input terminals of the test sample.

12.2.2 Requirement 2. The squelch circuit shall not open when two signals are applied at the input of the test sample. One signal shall be an unmodulated RF signal at the receiver tuned frequency, whose amplitude is two-thirds of the RF voltage used to adjust the squelch threshold. The second signal shall be an impulse signal of 50 dB µV/MHz.

13. CS09 (limited applicability)

13.1 CS09 applicability. This requirement is applicable to Navy equipment and subsystems that have an operating frequency range of 100 kHz or less and an operating sensitivity of 1 µV or less, such as 0.5 µV. Other applications of this requirement are to be determined on a case-by-case basis.

13.2 CS09 limit. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the levels shown on Figure 4-10 across the applicable test points.

14. CS10 (limited applicability)

14.1 CS10 applicability. This electromagnetic pulse (EMP) requirement is applicable to Navy equipment and subsystem interface pins and terminals of power leads, control leads, signal leads, and grounds and neutrals which are not grounded internally to the equipment or subsystem. Applications of this requirement are to be determined on a case-by-case basis. It should be noted that if the equipment is to be installed in an intentionally unhardened (unshielded) area, the equipment will not be adequately protected against the specified EMP.

14.2 CS10 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the individual equipment or subsystem specification, after being subjected to a test signal having either the waveform and common mode current level shown on Figure 4-11, as determined in accordance with MIL-STD-462.

15. CS11 (limited applicability)

15.1 CS11 applicability. This EMP requirement is applicable to Navy equipment and subsystems having interconnecting or intraconnecting control, signal, or power cables. It should be noted that if the equipment is to be installed in an intentionally unhardened (unshielded) area, the equipment will not be adequately protected against the specified EMP. Actual cable types, sizes and configurations subjected to the specified RS05 levels are exempt from meeting this requirement.

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15.2 CS11 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the equipment or subsystem specification, after being subjected to a test signal having the waveform shown in Figure 4-12 and having a maximum bulk common mode cable current of 10 amps, as determined in accordance with MIL-STD-462.

16. RE01 (limited applicability)

16.1 RE01 applicability. This requirement is applicable for Navy equipment and subsystems installed in fixed or mobile ground facilities. Other applications of this requirement are to be determined on a case-by-case basis. When required, RE01 is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample. The requirement applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas.

16.2 RE01 limit. Magnetic field emissions shall not be radiated in excess of the levels shown on Figure 4-13.

17. RE02

17.1 RE02 applicability. This requirement is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample. For narrowband, it applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas. This requirement is applicable for broadband emissions from 14 kHz to 1 GHz and for narrowband emissions from 14 kHz to 10 GHz.

17.2 RE02 limits. E-field emissions shall not be radiated in excess of those given in 17.2.1 and 17.2.2. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves.

17.2.1 Narrowband electric field emissions. Narrowband E-field emissions shall not be radiated in excess of the applicable limit curve shown on Figure 4-14 at the required test distance, as specified in MIL-STD-462.

17.2.2 Broadband electric field emissions. Broadband E-field emissions from all equipment and subsystems, including radiated switching transients resulting from (1) automatic cycling of electronic or electrical switching circuitry, (2) actuation of push-to-talk mechanisms (that is, keying of transmitters), or (3) manual switching shall not be radiated in excess of the limit curve shown on Figure 4-15 at the required test distances, as specified in MIL-STD-462.

18. RE03 (limited applicability)

18.1 RE03 applicability. This requirement is applicable for those equipment and subsystems with antenna leads or those designed to be connected to antennas. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The requirement is not applicable within either the test sample's necessary bandwidth or $\pm$ 5 percent of the fundamental frequency.

18.1.1 Army procurements. This requirement is applicable for transmitting equipment and subsystems procured solely for Army use, when any of the following conditions exist: (a) transmitter power exceeds 5 kW average, (b) the fundamental frequency of the test sample exceeds 1.24 GHz, (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable dummy load, or (d) for equipment or subsystems with waveguide transmission lines and operating below 1.24 GHz.

18.1.2 Navy procurements. This requirement is applicable, with the approval of the procuring activity, when the spurious emissions and harmonics cannot be determined using the procedures in CE06.

18.2 RE03 limit. Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: $50 + 10 \log P$ (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

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19. RS01 (limited applicability)

19.1 RS01 applicability. This requirement is applicable for Navy equipment and subsystems installed in fixed or mobile ground facilities. Other applications of this requirement are to be determined on a case-by-case basis. When required, RS01 is applicable to equipment and subsystems and their associated cabling and connectors.

19.2 RS01 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to magnetic fields less than or equal to the levels shown on Figure 4-16.

20. RS02

20.1 RS02 applicability. This requirement is applicable to equipment and systems as indicated in 20.1.1 and 20.1.2.

20.1.1 Part I - spikes. This portion of RS02 is applicable for all DoD activities.

20.1.2 Part II - power frequency. This requirement is applicable for equipment and subsystems procured for Navy use. For Army equipment and subsystems, the requirement is applicable only when specifically called out in the procurement documentation.

20.2 RS02 limits.

20.2.1 Part I - spikes. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the test spikes having the waveform shown on Figure 4-9. The values of $E_{()}$ and $t_{()}$ are given below:

a. Spike #1 (Army) E_1 = 100 Volts; t_1 = 10 microseconds $\pm$ 20%.

b. Spike #2 (Navy) E_2 = 400 Volts; t_2 = 5 microseconds $\pm$ 20%.

20.2.2 Part II - power frequency. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when 20 amperes are applied to the test wire at the power frequency(ies) of the test sample.

21. RS03

21.1 RS03 applicability. This requirement is applicable for all equipment and subsystems between 14 kHz and 10 GHz. Above 10 GHz this requirement is not mandatory unless otherwise required by the procuring activity.

21.2 RS03 limits. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the radiated electric fields (E) specified herein. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circular polarized waves are also acceptable. Appropriate consideration shall be given to the operational radiated electromagnetic environment from both friendly and hostile emitters which an equipment or subsystem may encounter during its life cycle. Applicable portions of MIL-HDBK-235 shall be used to determine the anticipated environment. As a minimum, the following levels apply. If levels substantially higher than those given herein are specified, modifications to the procedure in MIL-STD-462 may be required or desirable. Such modifications are to be described in the EMI Test Plan.

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Frequency Range	E-Field (Volts/meter) Army	Navy RCVR sites	All other Navy sites
14 kHz to 2 MHz	1	1	10
2 to 30 MHz	10	1	10
30 to 2000 MHz	5	1	10
2 to 10 GHz	5	1	40
Above 10 GHz	20	1	40

22. RS05 (limited applicability)

22.1 RS05 applicability. This requirement is intended for Navy equipment and subsystems and is applicable when both of the following conditions exist: (a) operation of the equipment or subsystem is essential for the success of a mission and (b) the equipment or subsystem is to be located outside of an intentionally hardened (shielded) area. This requirement is not applicable for equipment intended solely for use in non-metallic ground facilities, unless otherwise required by the procuring activity. Cables that can not be tested in accordance with MIL-STD-462 shall meet the requirements of CS11, and cables subjected to the specified CS11 levels are exempt from meeting this requirement.

22.2 RS05 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the individual equipment or subsystem specification, after being subjected to a test signal having the waveform and amplitude shown on Figure 4-17.

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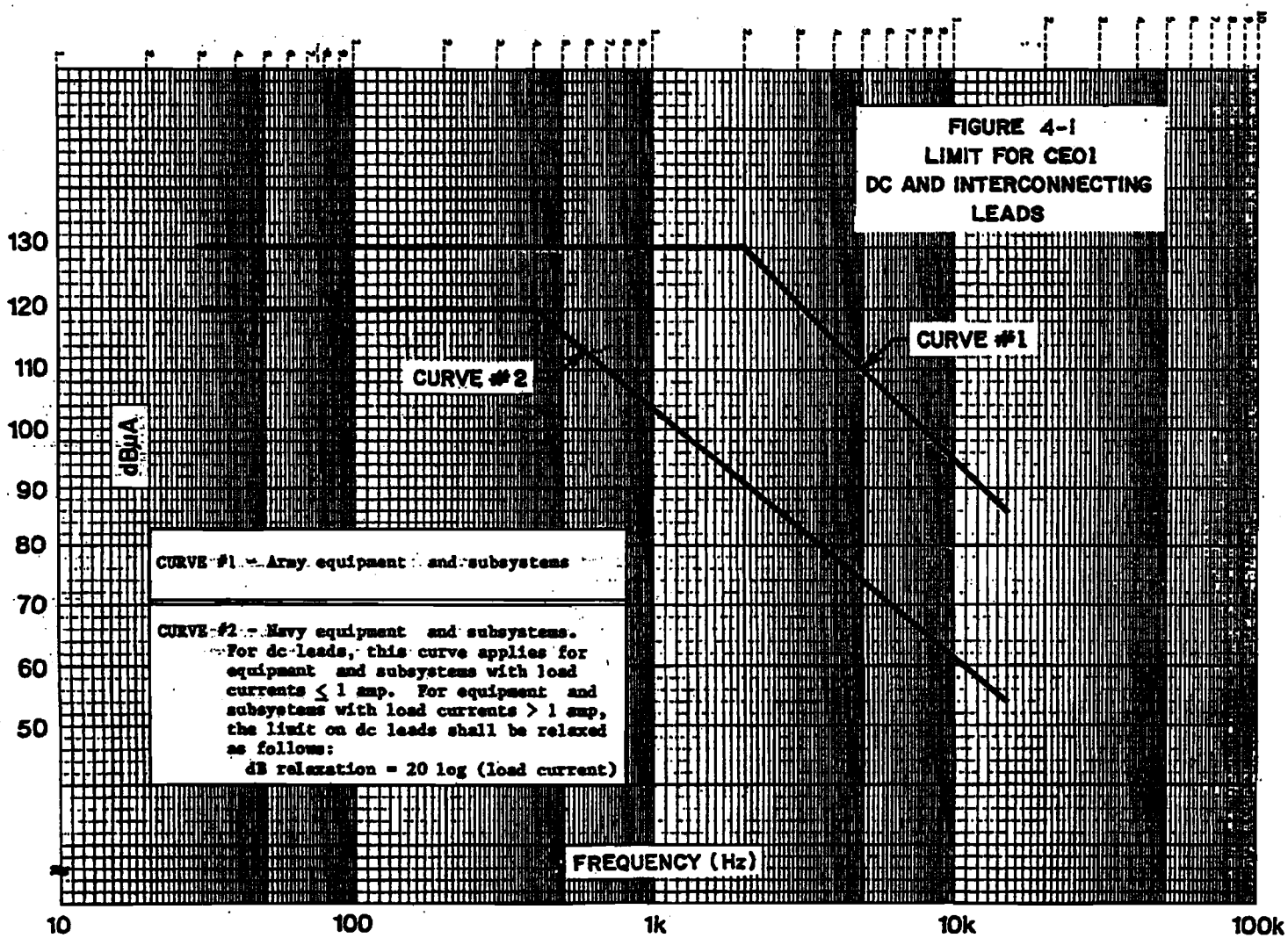

FIGURE 4-1. LIMIT FOR CE01 DC AND INTERCONNECTING LEADS

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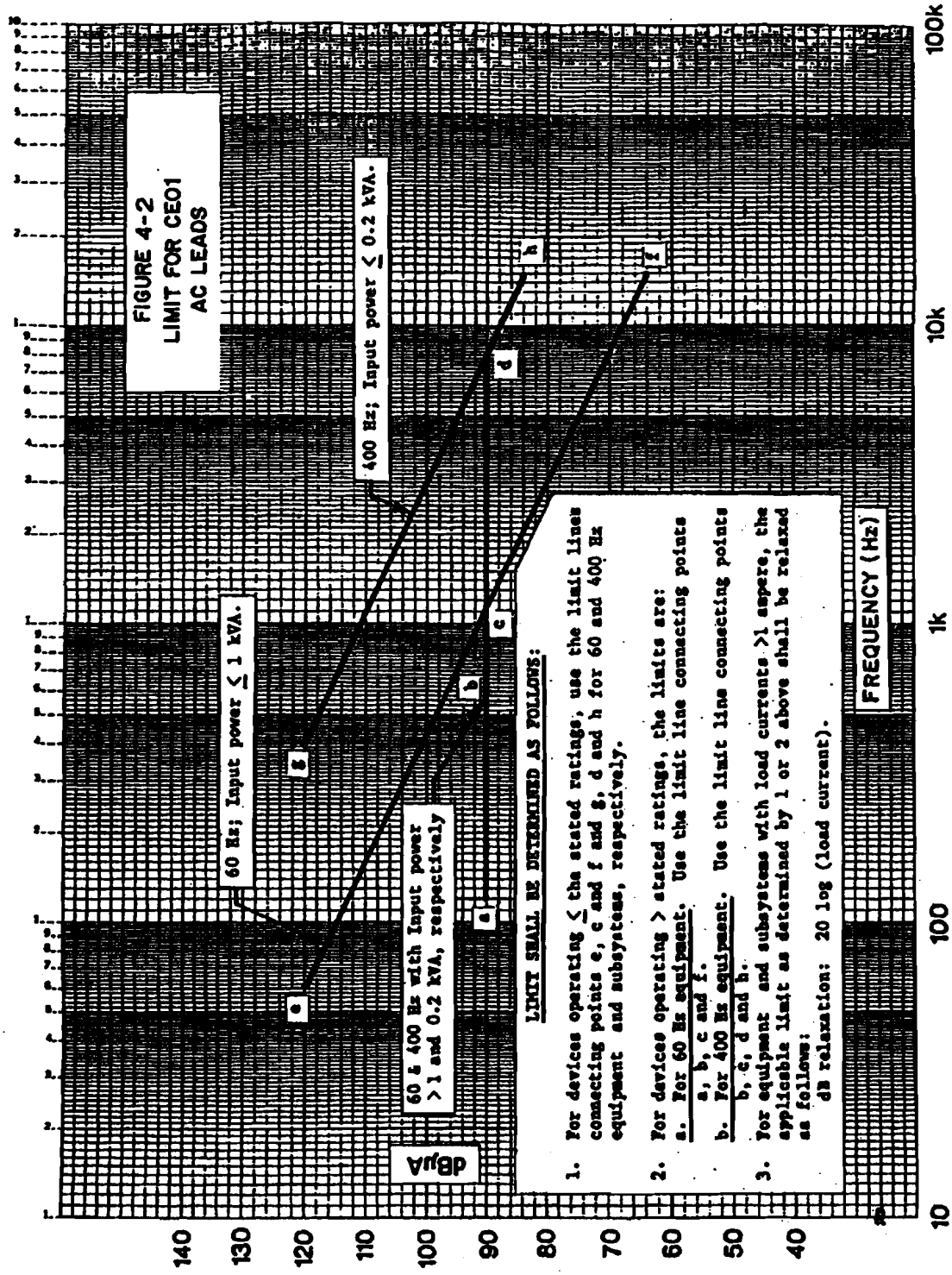

FIGURE 4-2. LIMIT FOR CE01 AC LEADS

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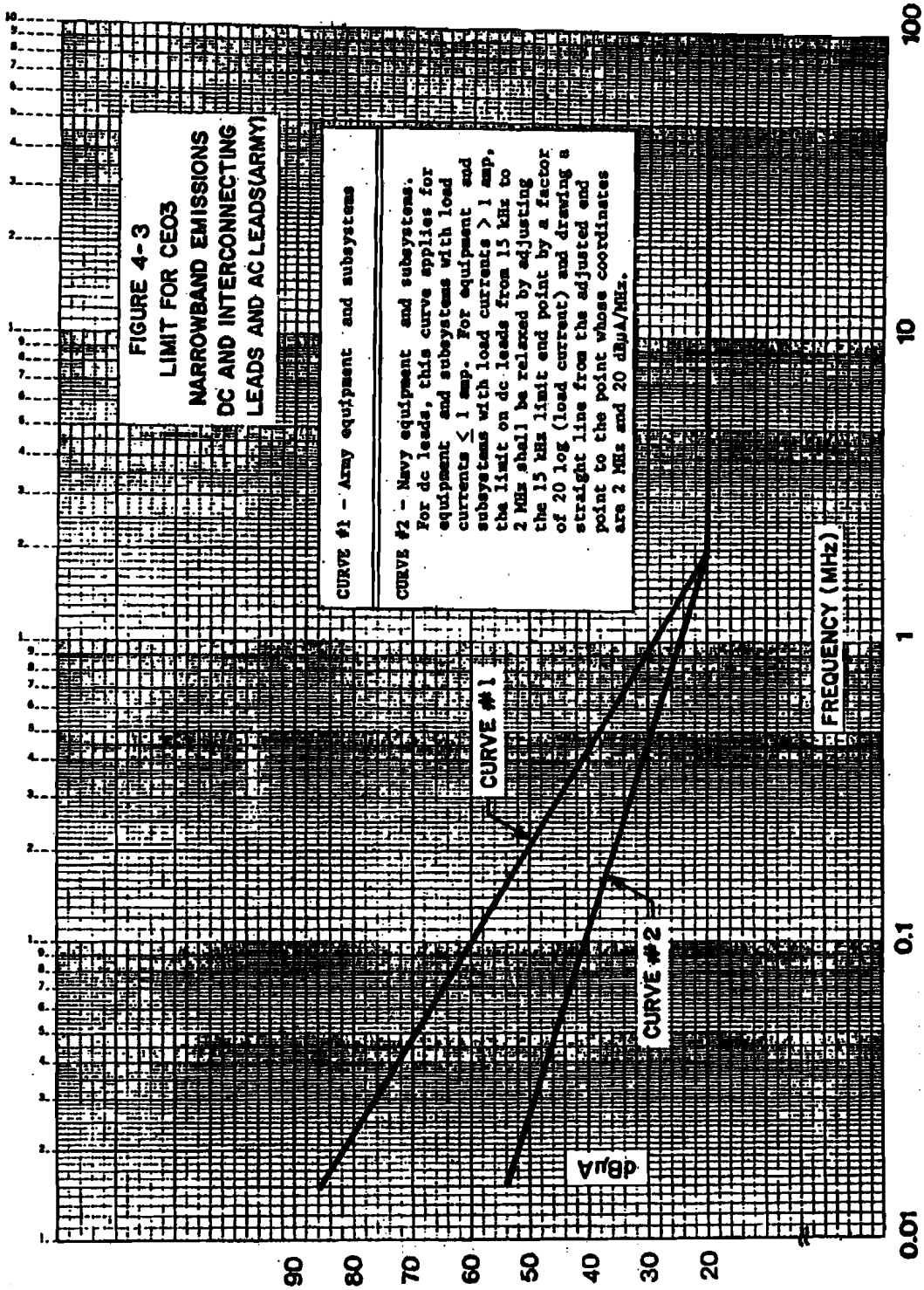

FIGURE 4-3. LIMIT FOR CE03 NARROWBAND EMISSIONS DC AND INTERCONNECTING LEADS AND AC LEADS (ARMY)

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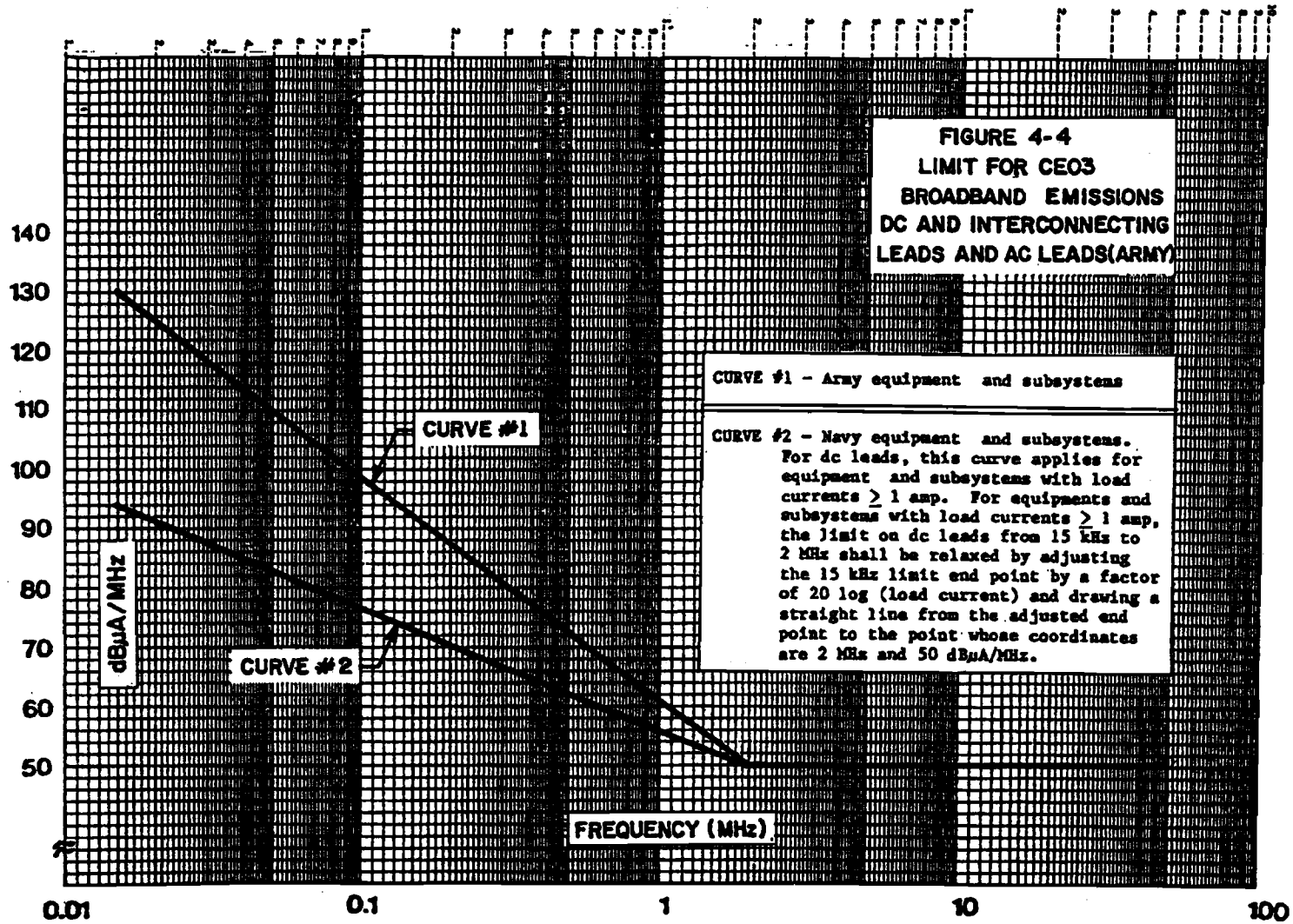

FIGURE 4-4. LIMIT FOR CE03 BROADBAND EMISSIONS DC AND INTERCONNECTING LEADS AND AC LEADS (ARMY)

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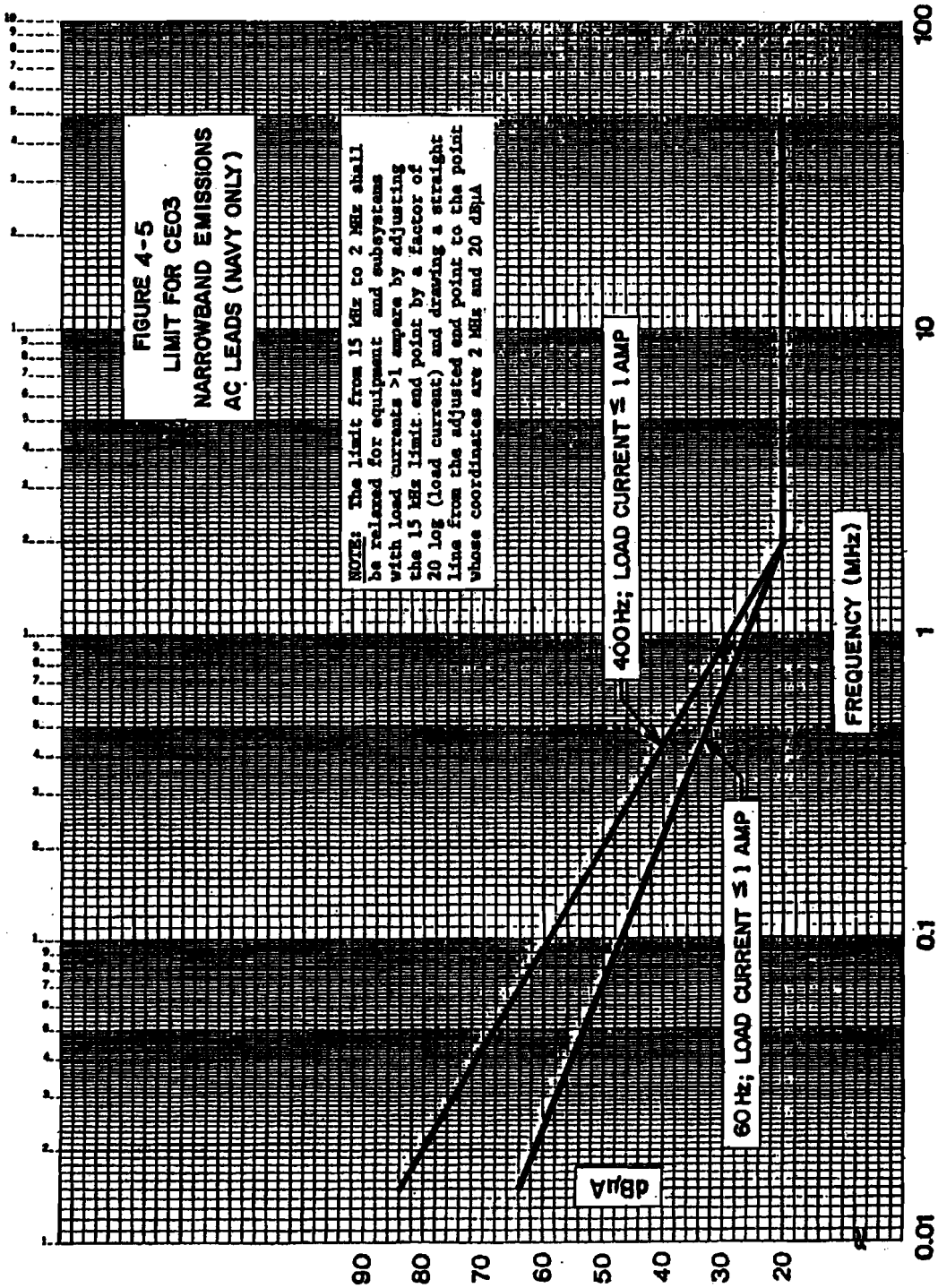

FIGURE 4-5. LIMIT FOR CE03 NARROWBAND EMISSIONS AC LEADS (NAVY ONLY)

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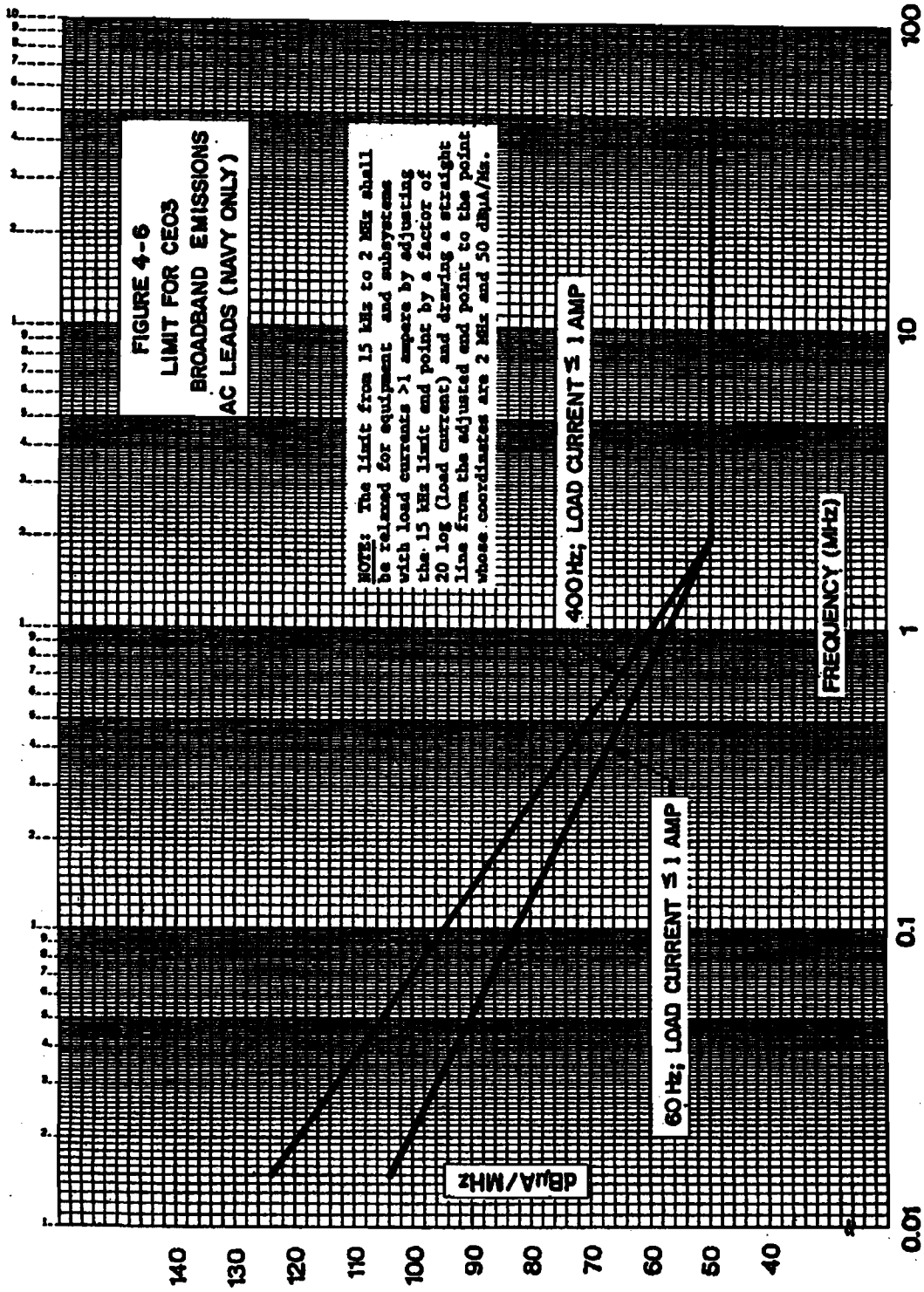

FIGURE 4-6. LIMIT FOR CE03 BROADBAND EMISSIONS AC LEADS (NAVY ONLY)

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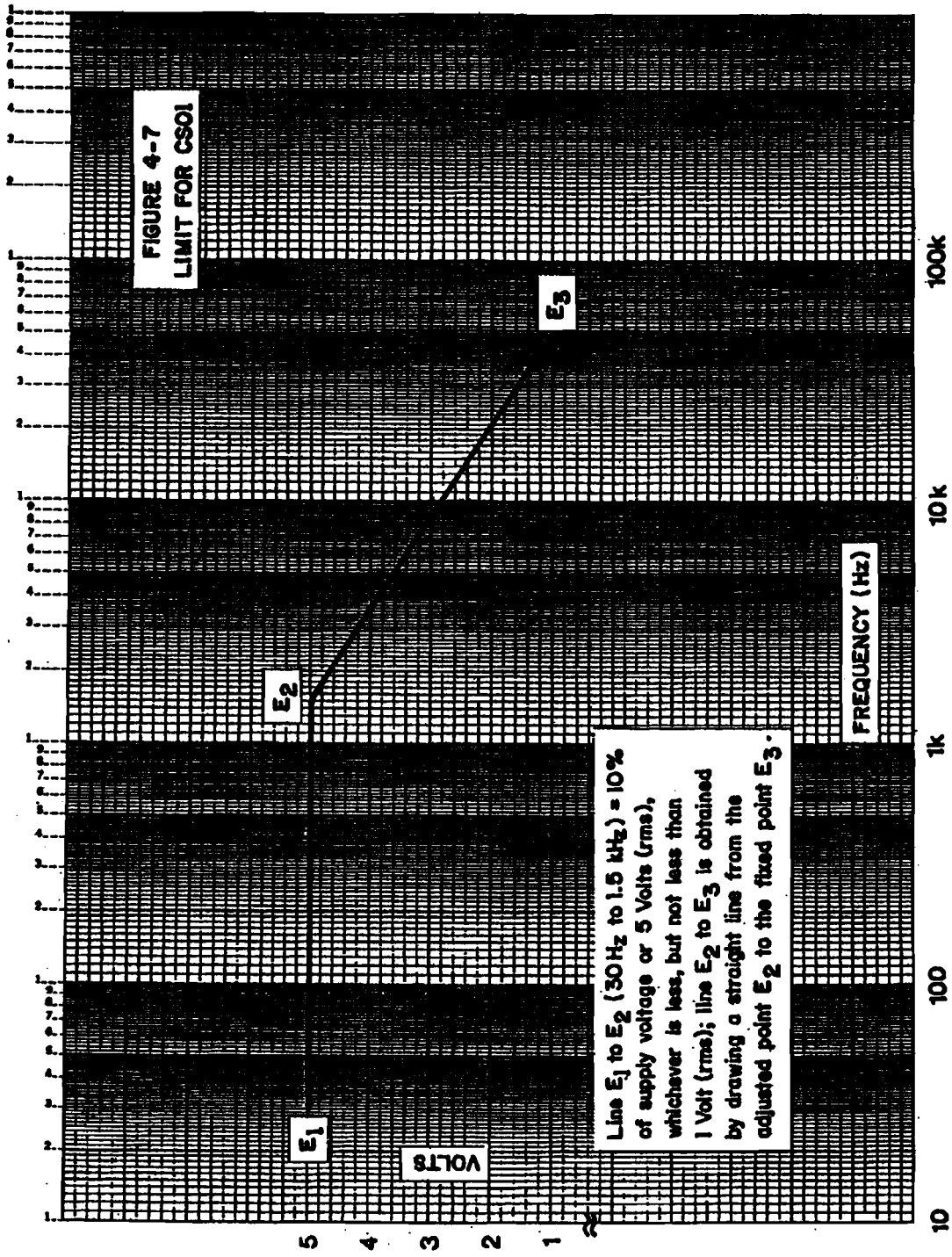

FIGURE 4-7. LIMIT FOR CS01

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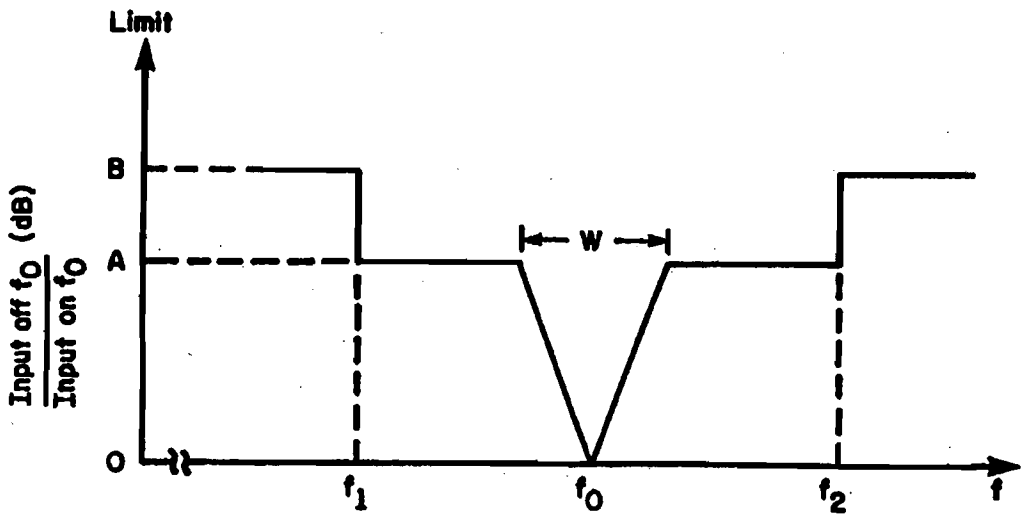

f_0 = Receiver tuned frequency or band center for amplifiers.

f_1 = Lowest tunable frequency of receiver band in use or the lowest frequency of amplifier passband.

f_2 = Highest tunable frequency of receiver band in use or the highest frequency of amplifier passband.

W = Bandwidth between the 80 dB points of the receiver selectivity curve as defined in the test sample's technical requirements or the control plan.

Limits:

1. The limit at A is 80 dB above the input level required to produce the standard reference output. (This limit shall not be used for amplifiers)
2. The limit at B shall be set as follows:
   a. Receivers: 0 dBm applied directly to the receiver input terminals.
   b. Amplifiers: The limit shall be as specified in the test sample's technical requirement or control plan. If no limit is defined in the above documents, the 0 dBm value shall be used.

FIGURE 4-8. LIMIT FOR CS04

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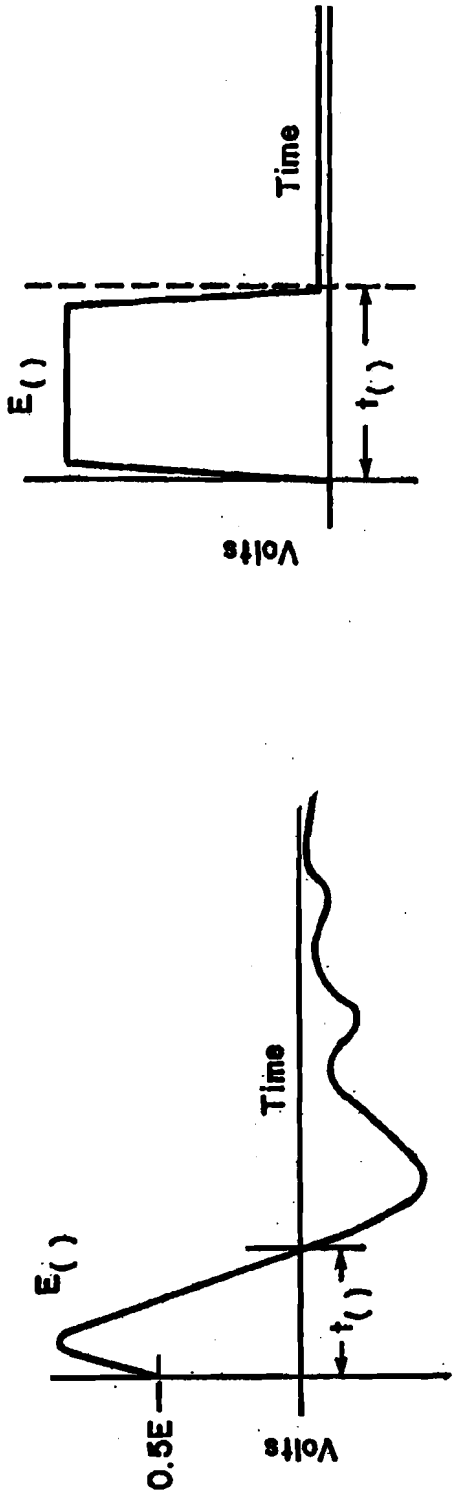

NOTE: The test sample shall be subjected to the spike(s) with the waveform shown and with the specified voltage(s) and pulsewidth(s).

FIGURE 4-9. ACCEPTABLE WAVESHAPES FOR CS06 AND RS02

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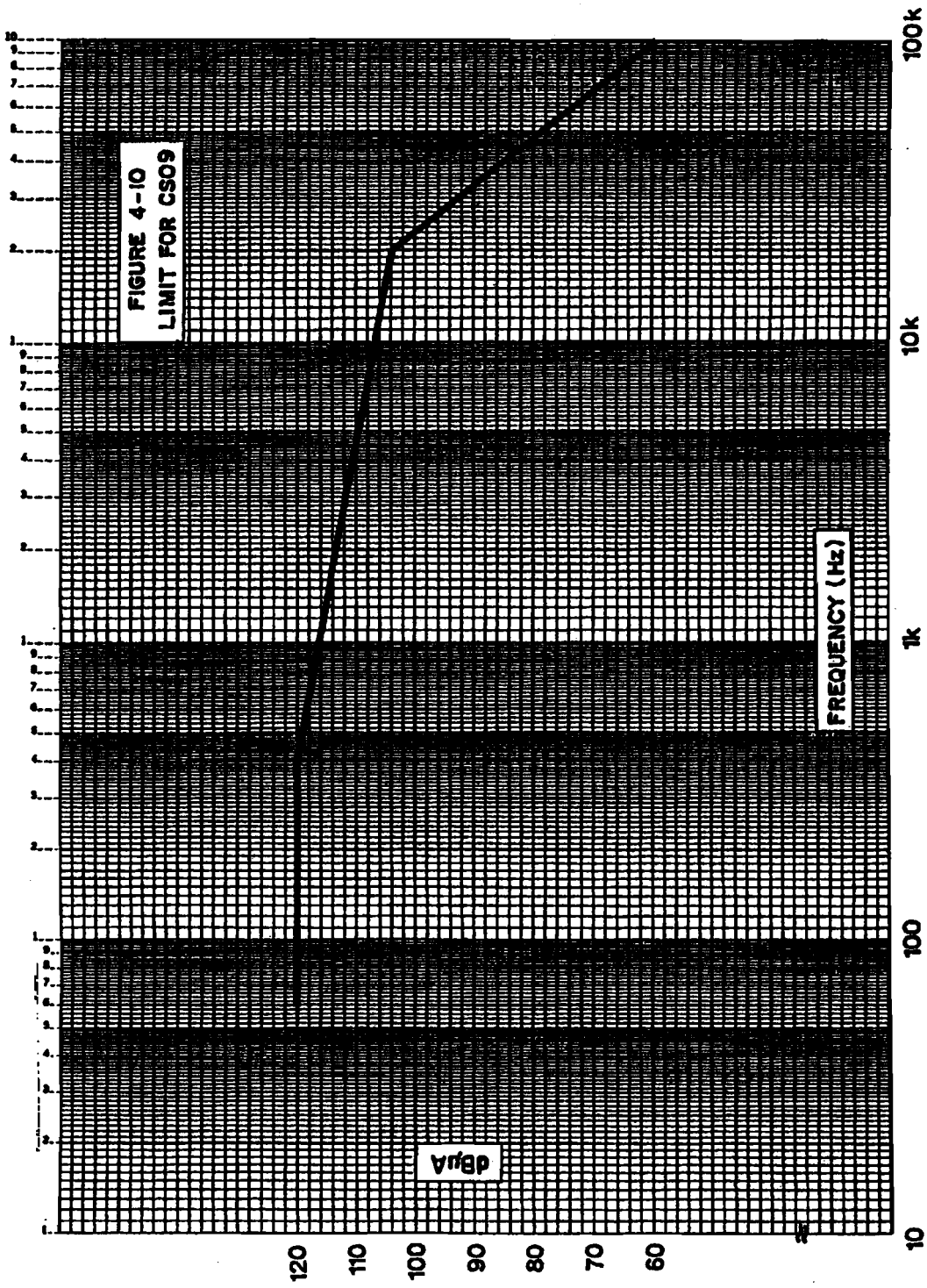

FIGURE 4-10. LIMIT FOR CS09

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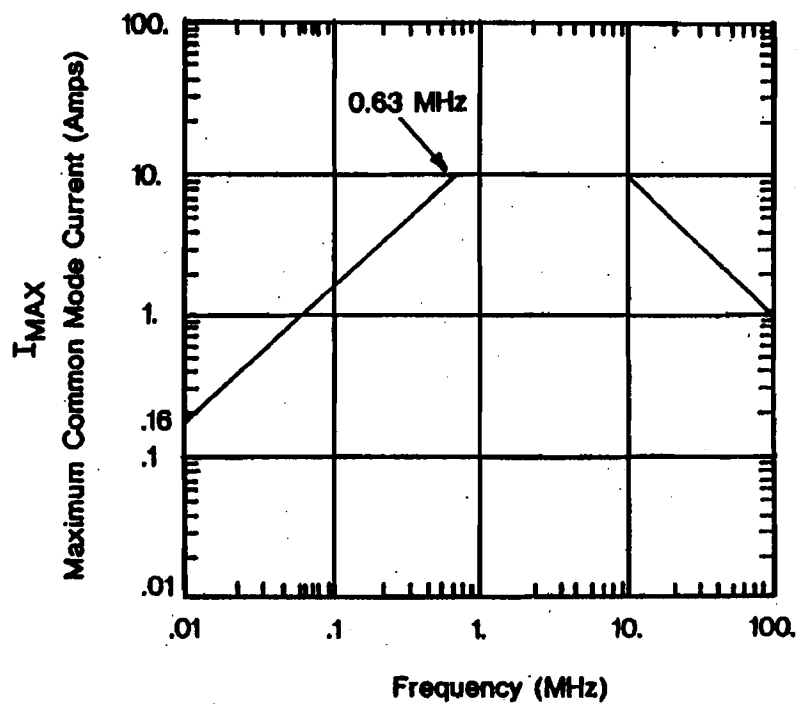

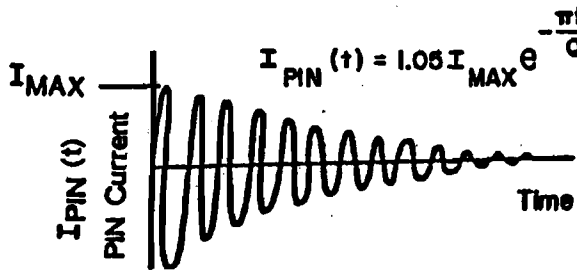

$$I_{PIN}(t) = 1.05 I_{MAX} e^{-\frac{\pi f t}{Q}} \sin(2\pi f t)$$

where,

$I_{PIN}(t)$ = common mode pin current in amps

f = frequency, hertz

t = time, seconds

Q = decay factor

FIGURE 4-11. LIMIT FOR CS10

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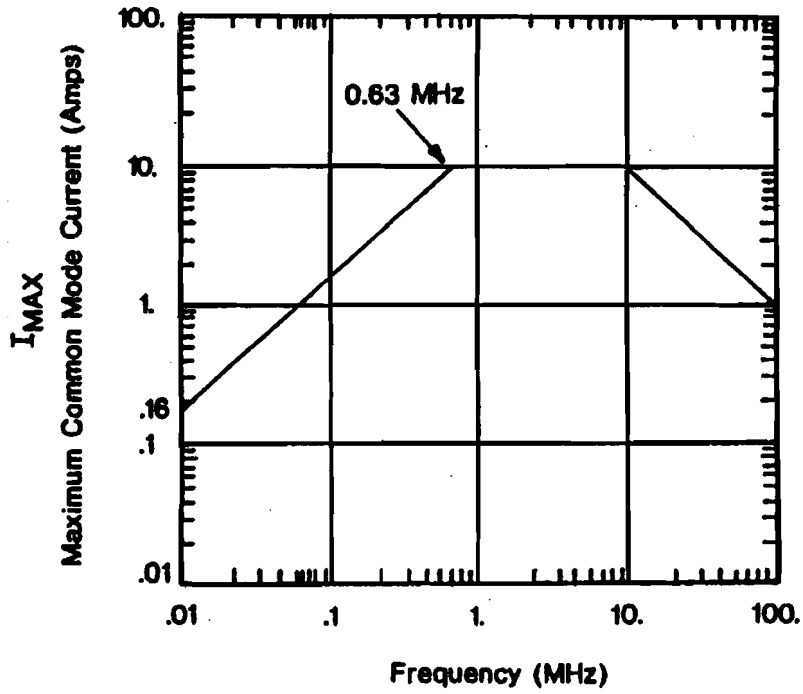

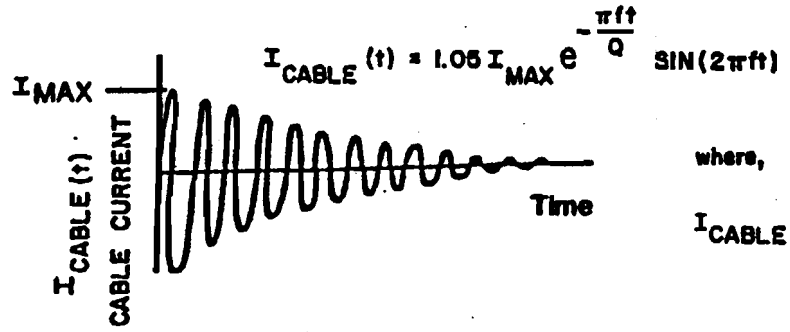

where,

$I_{CABLE}(t)$ = common mode cable current in amps

f = frequency, hertz

t = time, seconds

Q = decay factor

FIGURE 4-12. LIMIT FOR CS11

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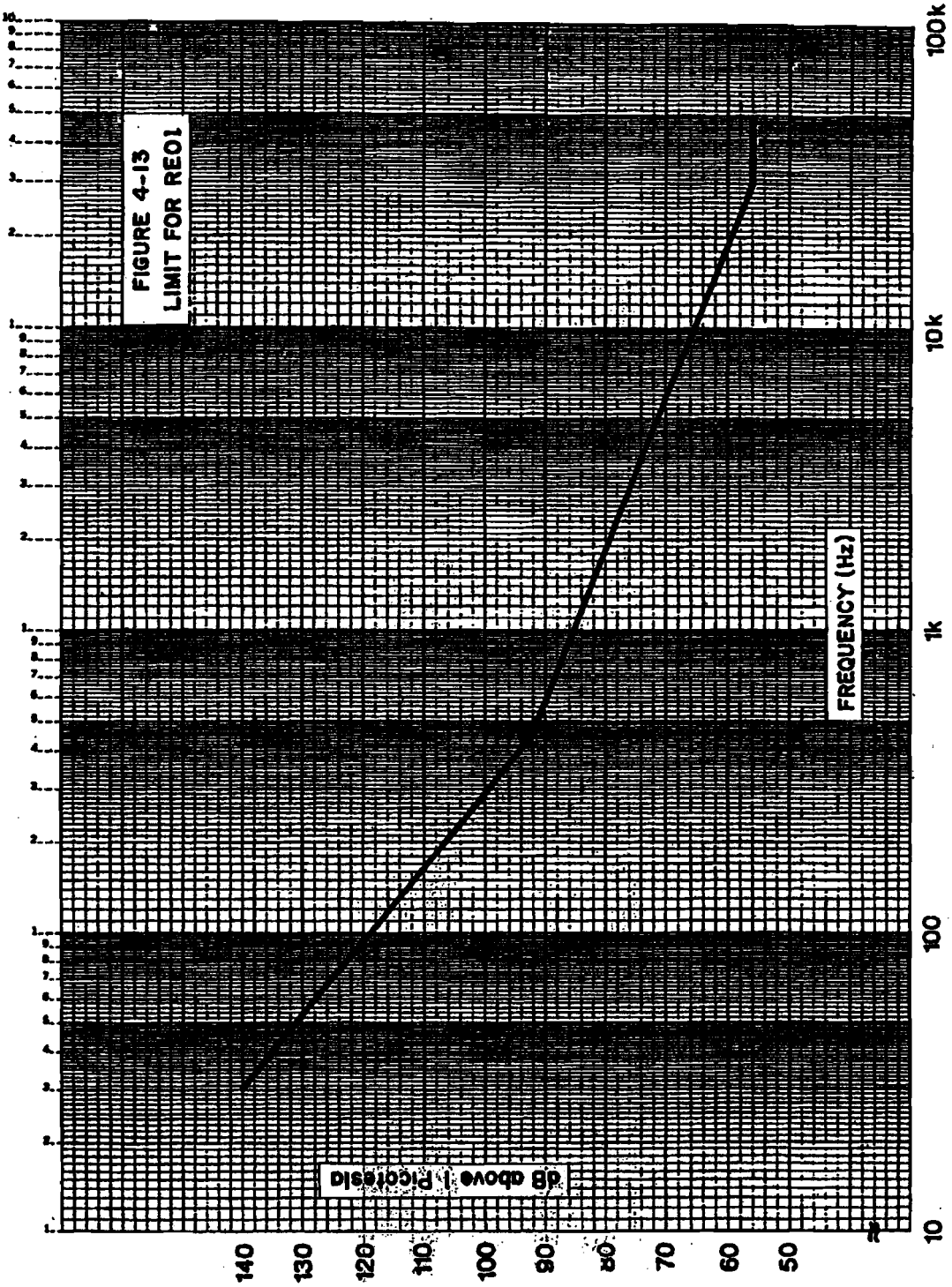

FIGURE 4-13. LIMIT FOR REO1

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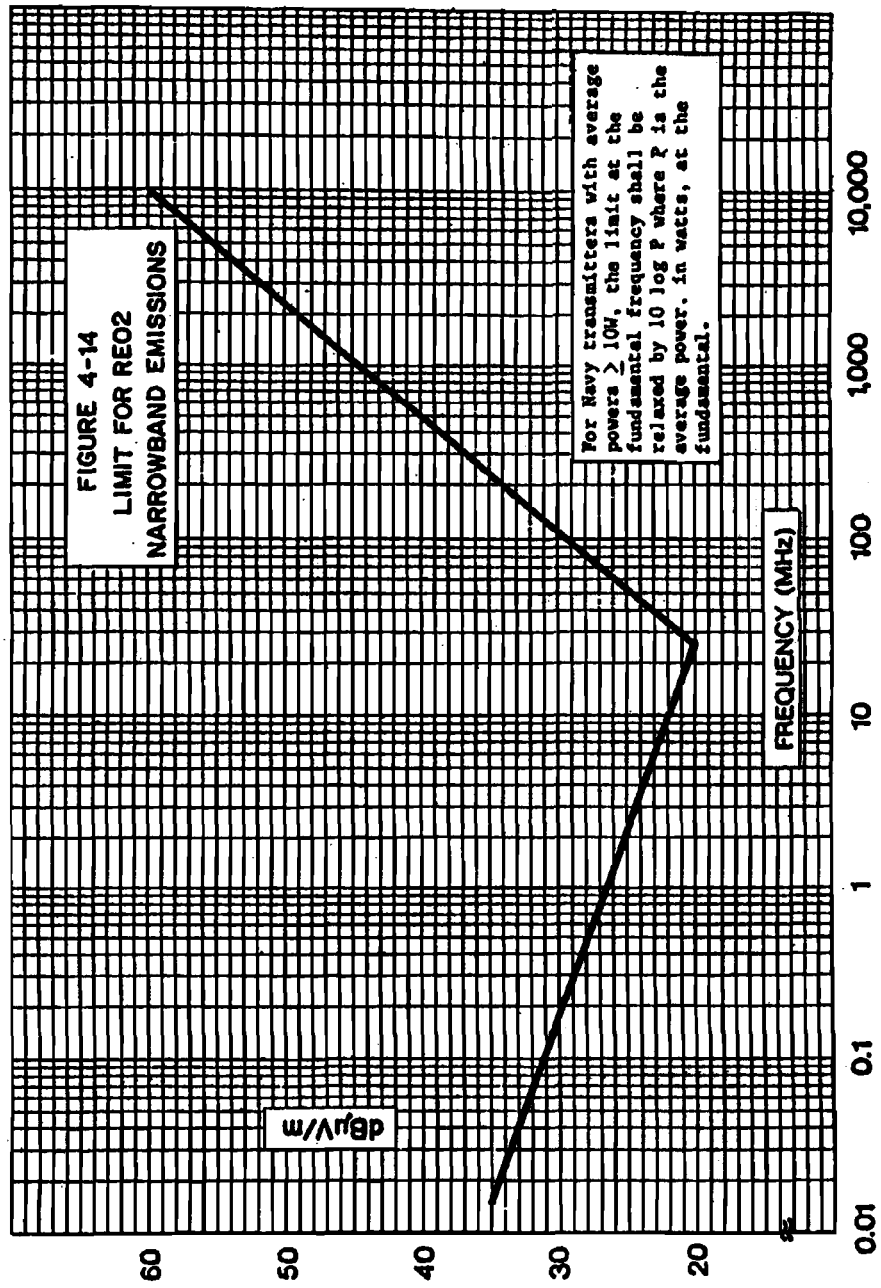

FIGURE 4-14. LIMIT FOR RE02 NARROWBAND EMISSIONS

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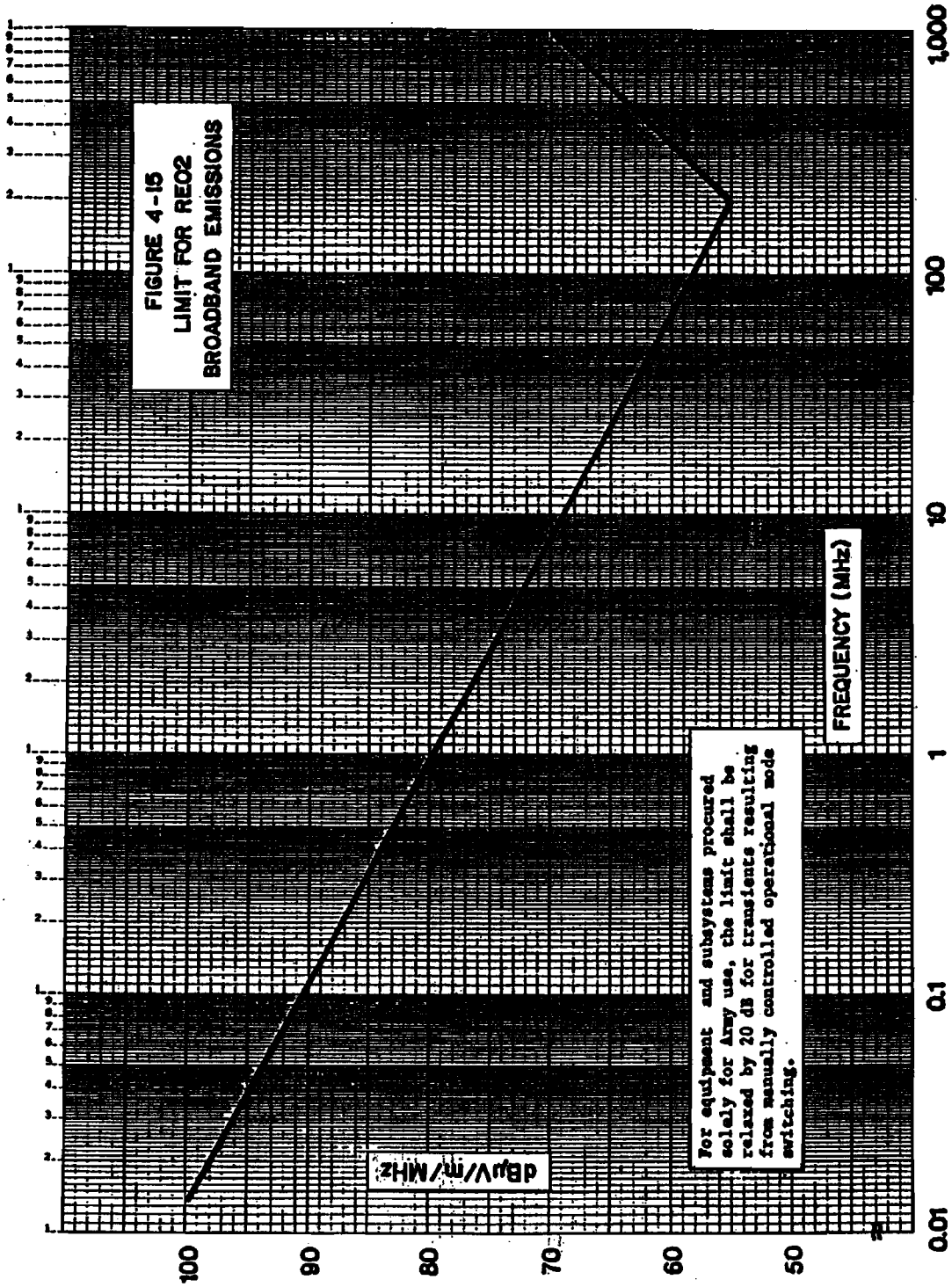

FIGURE 4-15. LIMIT FOR RE02 BROADBAND EMISSIONS

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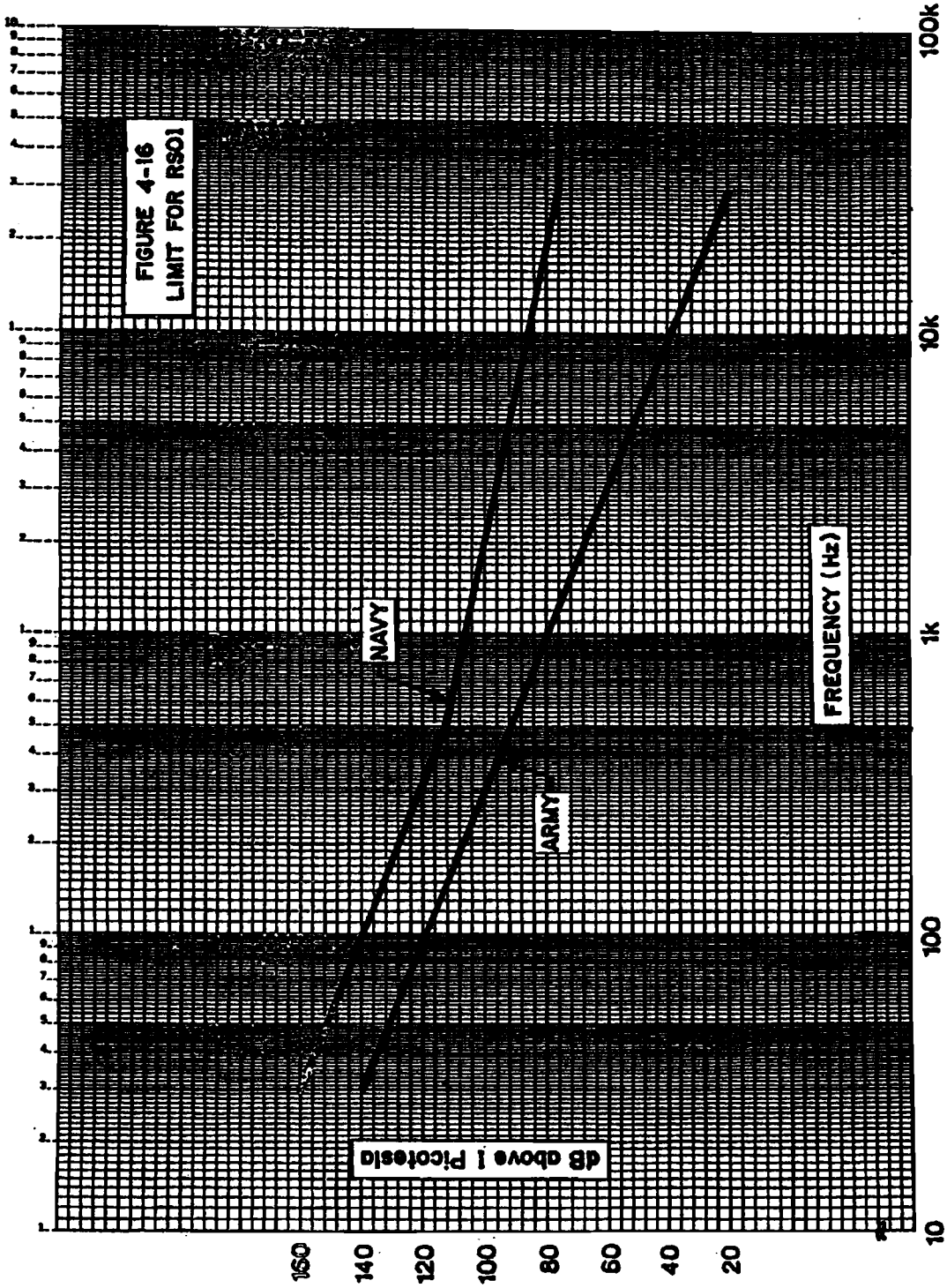

FIGURE 4-16. LIMIT FOR RSO1

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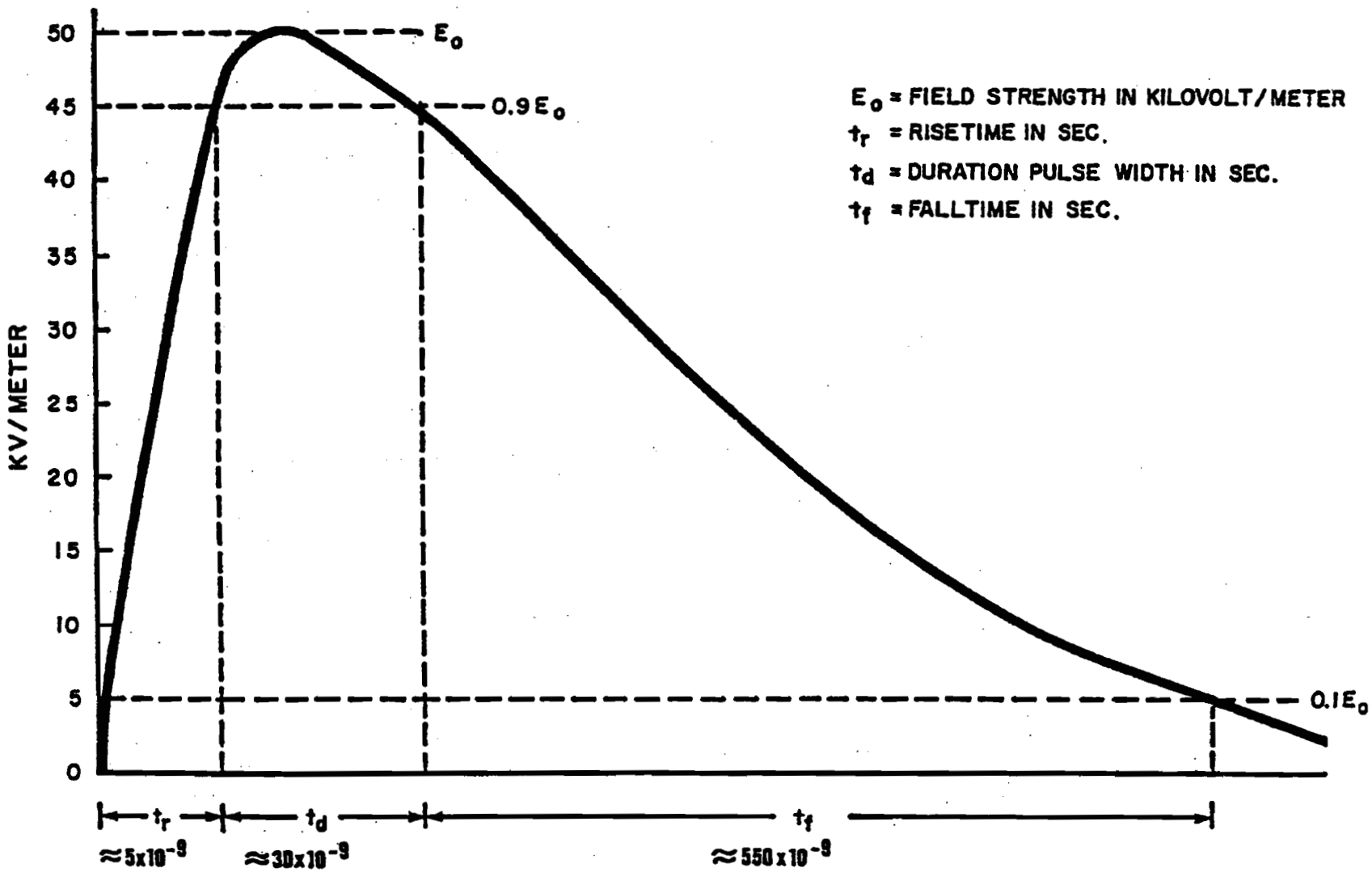

FIGURE 4-17. LIMIT FOR RS05

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Part 5. Equipment and Subsystems Installed in Surface Ships (Class A4)

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1. SCOPE

This part of MIL-STD-461 supplements Part 1 of the standard by defining emission and susceptibility requirements and limits for equipment and subsystems intended for use in surface ships (Class A4).

1.1 Determining requirements. Table 5-I shall be used to determine the specific requirements for Class A4 equipment and subsystems. The table also denotes the paragraphs wherein the requirements and limits are defined. A "Y" entry in the table means the requirement is applicable, and the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "Y_L" entry means the applicability of the requirement is limited and is specified in the appropriate corresponding paragraph. The limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "T" entry means that the applicability must be determined on a case-by-case basis and, if the requirement is to be imposed, it must be so specified in the appropriate procurement document. When required, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. Absence of an entry means the requirement is not applicable. For procurements of subsystems, such as radar, EW surveillance, and the like, comprised of individual equipment listed in Table 5-I, the applicable emission and susceptibility requirements for the subsystem shall be tailored by the procuring activity based on the requirements of the individual equipment.

1.2 Exceptions for interference free electrical and electromechanical equipment. There are electrical and electromechanical equipment which are usually interference free and for which written approval to forego emission testing may be obtained when procured as individual equipment. As a means of establishing whether an equipment will require testing, the equipment manufacturer shall forward to the Command or agency concerned a complete electrical description of the equipment and the justification to forego testing. Written approval to forego testing must be obtained obtained from the Command or agency concerned and shall be requested as early in the procurement cycle as possible.

1.3 Exceptions for nonessential electrical and electromechanical equipment. The following electrical and electromechanical equipment are considered nonessential and need not meet the susceptibility requirements specified herein.

- Recreational equipment, such as electrical games
- Vending machines

2. CE01

2.1 CE01 applicability. This requirement is applicable for alternating current (AC) and direct current (DC) leads, which obtain power from other sources or provide power to other equipment or subsystems; grounds or neutrals, which are not grounded internally to the subsystem or equipment being measured; and interconnecting control leads, which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as clock, IF, audio, firing, digital, RF, and the like, unless otherwise specified by the Command or agency concerned.

2.1.1 DC and interconnecting leads. This requirement is applicable for narrowband emissions from 30 Hz to 15 kHz.

2.1.2 AC leads. This requirement is applicable for narrowband emissions from the power frequency(ies) of the test sample to 15 kHz.

2.2 CE01 limits.

2.2.1 DC leads. Electromagnetic emissions shall not appear on DC leads in excess of the values shown on Figure 5-1. The limits shall be met when measured with an effective bandwidth not exceeding 75 Hz.

2.2.2 AC leads. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on the applicable limit line on Figure 5-2. The limits shall be met when measured with an effective bandwidth not exceeding the primary power frequency plus 20% of the primary power frequency.

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TABLE 5-I. EMISSION AND SUSCEPTIBILITY REQUIREMENTS FOR CLASS A4 EQUIPMENT AND SUBSYSTEMS

Requirement / Specific Equipment/Subsystem	Receivers	Transmitters	Antenna Multicouplers	Amplifier, Tuned, RF	Amplifier, Untuned, RF	Intercom/Interphone	Modem	Repeater	Amplifier, Power/Audio	Modulators	Shiftphones	Laser Devices	IR Devices	Transponders	Beacons	Power Supplies	Sensors	Inertial Guidance	Teletypewriters	Recorders	Visual Displays	Digital Equipment	Photographic Equipment	Routing Signal Junction Switching Connection Boxes	Telephone SWBD	Servo/Synchro	Test Equipment	Time/Frequency STDS	Ultrasonic Devices	Telephones	Surface Launched Missiles	Sonar Devices	Manpack or Helmet with Self-Contained Battery	Manpack or Helmet Using Ship Power	Controlled Control And Monitoring Eqpt And Sensors	Electrical Equipment Without Solid State	Electrical Equipment With Solid State	Portable Electric Hand Tools	All Others Not Listed Herein	Applicable Paragraph
CE01	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y		Y	2
CE03	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	3
CE06	Y_L	Y_L	T	Y_L	Y_L									Y_L	Y_L																Y_L		Y_L		Y_L					Y_L	4
CS01	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y		Y	5
CS02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y		Y	6
CS03	Y		T	T	T	Y			Y					Y			T			Y											Y_L		Y	Y						7
CS04	Y		T	T	T	T			T					T										Y_L							Y_L		Y	Y						8
CS05	Y		T	T	T	Y			Y					Y			T			Y											Y_L		Y	Y						9
CS06	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y		Y	10
CS07	Y_L																																							11
CS08	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		Y_L	Y_L		Y_L	Y_L	Y_L	Y_L	Y_L		Y_L	Y_L				Y_L	12
CS10	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T			T			T	T	13
CS11	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	T	Y_L	Y_L	T	Y_L	T	Y_L	Y_L	Y_L			Y_L			Y_L	Y_L	14
RE01	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y			Y		Y	Y	15
RE02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	16
RE03		Y_L												Y_L	Y_L																		Y_L	Y_L					Y_L	17
RS01	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y			Y		Y	Y	18
RS02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y			Y		Y	Y	19
RS03	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	20
RS05	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		Y_L	Y_L	Y_L	Y_L	T	Y_L	Y_L	T	Y_L	T	Y_L	Y_L	Y_L	T	T	T		Y_L		Y_L	21

COMPLY WITH THE REQUIREMENTS OF PART 10

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2.2.3 Interconnecting leads.

2.2.3.1 Connected outer shields and twisted pairs together. For interconnecting control and signal leads having the outer shield connected, and for twisted pairs with the pairs together, electromagnetic emissions shall not appear on the leads in excess of the values shown on Figure 5-1. The limits shall be met when measured with an effective bandwidth not exceeding the primary power frequency plus 20% of the primary power frequency for AC leads or 75 Hz for DC leads.

2.2.3.2 Disconnected outer shield and twisted pairs separated. For interconnecting control and signal leads having the outer shield disconnected, and for twisted pairs with the pairs separated, the limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

3. CE03

3.1 CE03 applicability. This requirement is applicable for alternating current (AC) and direct current (DC) leads, which obtain power from other sources or provide power to other equipment or subsystems; grounds or neutrals, which are not grounded internally to the subsystem or equipment being measured; and interconnecting control leads, which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as clock, IF, audio, firing, digital, RF, and the like, unless otherwise specified by the Command or agency concerned.

3.2 CE03 limits.

3.2.1 DC leads. Electromagnetic emissions shall not appear on DC leads in excess of the values shown on Figures 5-3 and 5-4 for narrowband and broadband emissions, respectively.

3.2.2 AC leads. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on the applicable limit lines on Figures 5-5 and 5-6 for narrowband and broadband emissions, respectively.

3.2.3 Interconnecting leads.

3.2.3.1 Connected outer shield and twisted pairs together. For interconnecting control and signal leads having the outer shield connected, and for twisted pairs with the pairs together, electromagnetic emissions shall not appear on the leads in excess of the values shown on Figures 5-3 and 5-4 for narrowband and broadband emissions, respectively.

3.2.3.2 Disconnected outer shield and twisted pairs separated. For interconnecting control and signal leads having the outer shield disconnected, and for twisted pairs having the pairs separated, the limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

4. CE06 (limited applicability)

4.1 CE06 applicability. This requirement is applicable for those equipment and subsystems with antenna leads or those designed to be connected to antennas. The transmitter key-down harmonic and spurious emission portions of this requirement may be measured using the procedures in RE03 (in lieu of those of CE06) with the approval of the Command or agency concerned, when any of the following conditions exist: (a) transmitter power exceeds 5 kW average, (b) the fundamental frequency of the test sample exceeds 1.24 GHz, (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable dummy load, or (d) for equipment and subsystems with waveguide transmission lines and operating below 1.24 GHz. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The transmitter (key-down) portion of this requirement is not applicable within either the test sample's necessary bandwidth or ± 5 percent of the fundamental frequency.

4.2 CE06 limits. Conducted emissions in excess of the values given below shall not appear at the test sample's antenna terminals.

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4.2.1 Receivers.

a. Narrowband emissions: 34 dB μV

b. Broadband emissions: 40 dB μV/MHz

4.2.2 Transmitters (key-up and standby).

a. Narrowband emissions: 34 dB μV

b. Broadband emissions: 40 dB μV/MHz

4.2.3 Transmitters (key-down mode). Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

5. CS01

5.1 CS01 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem. The requirement is not applicable within ± 5 percent of the power frequency(ies). For Navy procurements, this requirement may be deleted for AC leads, with the approval of the Command or agency concerned, if no circuit within the equipment or system has a sensitivity of 100 mV or better.

5.2 CS01 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to electromagnetic energy injected onto its power leads less than or equal to the values shown on Figure 5-7. The requirement is also met under the following condition: when the power source specified in MIL-STD-462, adjusted to dissipate 50 watts in a 0.5 ohm load, cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

6. CS02

6.1 CS02 applicability. This requirement is applicable as follows: (1) equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem and (2) for Navy procurements, interconnecting control leads which provide AC or DC power from or to the test sample.

6.2 CS02 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to 1 volt from a 50 ohm source. The test signal shall be applied directly to the equipment input terminals, not through the test sample's power line cord. The requirement is also met under the following condition: when a 1-watt source of 50 ohms impedance cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source. When required by the Command or agency concerned, the Centralized Control and Monitoring Equipment or Sensors shall meet the requirements from 2 to 30 MHz, when subjected by common mode coupling to 12.25 volts or 3 watts from a 50 ohm source; this requirement is applicable for unshielded cables and cables with shields grounded only at one end.

7. CS03 (limited applicability)

7.1 CS03 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample as specified in MIL-STD-462.

7.2 CS03 limits. The test sample shall not exhibit any intermodulation products from two signals, beyond those permitted in the individual equipment or subsystem specification, when:

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a. Signal generator #1 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462; except that when f_1 is in the frequency range of either 200 to 400 MHz or 2 to 25 MHz, the generator output shall be 80 dB above the reference level, but the output of signal generator #1 shall not exceed 10 dBm.

b. Signal generator #2 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but the generator output level shall not exceed a power level of 10 dBm.

8. CS04 (limited applicability)

8.1 CS04 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

8.2 CS04 limits. The test sample shall not exhibit any undesired response when subjected to the test signal shown on Figure 5-8.

9. CS05 (limited applicability)

9.1 CS05 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

9.2 CS05 limits. The test sample shall not exhibit, due to cross modulation, any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the following from signal generator #2: a signal 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but not to exceed a power output level of 10 dBm.

10. CS06

10.1 CS06 applicability. This requirement is applicable as follows: (1) equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem and (2) for Navy procurements, interconnecting control leads which provide AC or DC power from or to the test sample.

10.2 CS06 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when the test spike having the waveform shown on Figure 5-9 is applied to the AC and DC power input leads for a period of not less than 1 minute at each phase position, and for a total test period not exceeding 15 minutes in duration (in lieu of the values in MIL-STD-462). The values of $E_{()}$ and $t_{()}$ are given below. The spike shall be superimposed on the powerline voltage waveform.

a. Spike #1 E_1 = 400 Volts; t_1 = 5 microseconds $\pm$ 20%.

11. CS07 (limited applicability)

11.1 CS07 applicability. This requirement is applicable for receiving equipment and subsystems which utilize squelch circuits.

11.2 CS07 limits.

11.2.1 Requirement 1. The squelch circuits shall not open when the output of a 50-ohm impedance impulse generator, set at 90 dB µV/MHz, is applied and matched to the input terminals of the test sample.

11.2.2 Requirement 2. The squelch circuit shall not open when two signals are applied at the input of the test sample. One signal shall be an unmodulated RF signal at the receiver tuned frequency, whose amplitude is two-thirds of the RF voltage used to adjust the squelch threshold. The second signal shall be an impulse signal of 50 dB µV/MHz.

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12. CS09 (limited applicability)

12.1 CS09 applicability. This requirement is applicable to equipment and subsystems that have an operating frequency range of 100 kHz or less and an operating sensitivity of 1 μV or less, such as 0.5 μV.

12.2 CS09 limit. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the levels less than or equal to those on Figure 5-10 across the applicable test points.

13. CS10 (limited applicability)

13.1 CS10 applicability. This electromagnetic pulse (EMP) requirement is applicable to Navy equipment and subsystem interface pins and terminals of power leads, control leads, signal leads, and grounds and neutrals which are not grounded internally to the equipment or subsystem. Applications of this requirement are to be determined on a case-by-case basis. It should be noted that if the equipment is to be installed on an intentionally unhardened (unshielded) ship, the equipment will not be adequately protected against the specified EMP.

13.2 CS10 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the individual equipment or subsystem specification, after being subjected to a test signal having either the waveform and common mode current level shown on Figure 5-11, as determined in accordance with MIL-STD-462.

14. CS11 (limited applicability)

14.1 CS11 applicability. This EMP requirement is applicable to Navy equipment and subsystems having interconnecting or intraconnecting control, signal, or power cables. This requirement is not applicable for equipment intended solely for use on wooden hull ships, unless otherwise specified by the procuring activity. It should be noted that if the equipment is to be installed on an unhardened (unshielded) ship, the equipment will not be adequately protected against the specified EMP. Actual cable types, sizes and configurations subjected to the specified RS05 levels are exempt from meeting this requirement.

14.2 CS11 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the equipment or subsystem specification, after being subjected to a test signal having the waveform shown in Figure 5-12 and having a maximum bulk common mode cable current of 10 amps, as determined in accordance with MIL-STD-462.

15. RE01

15.1 RE01 applicability. This requirement is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample. The requirement applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas.

15.2 RE01 limit. Magnetic field emissions shall not be radiated in excess of the levels shown on Figure 5-13. If the requirement cannot be met even with equipment modifications, the magnetic field level-versus-distance falloffs shall be determined, and the data submitted in the EMI Test Report.

16. RE02

16.1 RE02 applicability. This requirement is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample. For narrowband, it applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas. This requirement is applicable for broadband emissions from 14 kHz to 1 GHz and for narrowband emissions from 14 kHz to 10 GHz, except as noted below:

a. For sonar equipment, narrowband and broadband emission requirements are applicable up to 75 MHz.

b. For electrical equipment, narrowband and broadband emission requirements are applicable up to 400 MHz.

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16.2 RE02 limits. E-field emissions shall not be radiated in excess of those given in 16.2.1 and 16.2.2. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves.

16.2.1 Narrowband electric field emissions. Narrowband E-field emissions shall not be radiated in excess of the applicable limit curve shown on Figure 5-14 at the required test distance, as specified in MIL-STD-462.

16.2.2 Broadband electric field emissions. Broadband E-field emissions from all equipment and subsystems, including radiated switching transients resulting from (a) automatic cycling of electronic or electrical switching circuitry, (b) actuation of push-to-talk mechanisms (that is, keying of transmitters), or (c) manual switching shall not be radiated in excess of the applicable limit curve shown on Figure 5-15 at the required test distances, as specified in MIL-STD-462.

17. RE03 (limited applicability)

17.1 RE03 applicability. This requirement is applicable, with the approval of the procuring activity, when the spurious emissions and harmonics cannot be determined using the procedures of CE06. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The requirement is not applicable within either the test sample's necessary bandwidth or $\pm$ 5 percent of the fundamental frequency.

17.2 RE03 limit. Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

18. RS01

18.1 RS01 applicability. This requirement applies to equipment and subsystems and their associated cabling and connectors.

18.2 RS01 limits. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to magnetic fields less than or equal to the limit curve shown on Figure 5-16.

19. RS02

19.1 RS02 applicability. Parts I and II of this requirement are applicable to equipment and subsystems procured for use on surface ships.

19.2 RS02 limits.

19.2.1 Part I - spikes. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the test spikes having the waveform shown on Figure 5-9. The values of $E_{()}$ and $t_{()}$ are given below:

a. Spike #1 E_1 = 400 Volts; t_1 = 5 microseconds $\pm$ 20%.

19.2.2 Part II - power frequency. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when 20 amperes are applied to the test wire at the power frequency(ies) of the test sample.

20. RS03

20.1 RS03 applicability. This requirement is applicable from 14 kHz and 10 GHz, plus at all intentionally generated frequencies between 10 and 40 GHz of any known intentional emitter located on the ship.

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20.2 RS03 limits. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the radiated electric fields (E) less than or equal to those specified herein. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circular polarized waves are also acceptable. Appropriate consideration shall be given to the operational radiated electromagnetic environment from both friendly and hostile emitters which an equipment or subsystem may encounter during its life cycle. Applicable portions of MIL-HDBK-235 shall be used to determine the anticipated environment. As a minimum, the following levels apply. If levels substantially higher than those given herein are specified, modifications to the procedure in MIL-STD-462 may be required. Such modifications are to be described in the EMI Test Plan.

Frequency	E-field level (Volts/meter at anticipated location of equipment or subsystem)		
	BELOW DECKS		ABOVE DECKS
	METALLIC HULLS	NON-METALLIC HULLS	Areas exposed to the weather, all surface ships
14 kHz to 10 GHz	10	50	200
Above 10 GHz	10	50	200

21. RS05 (limited applicability)

21.1 RS05 applicability. This requirement is intended for Navy equipment and subsystems and is applicable when both of the following conditions exist: (a) operation of the equipment or subsystem is essential for the success of a mission and (b) the equipment or subsystem is to be located in areas exposed to the weather; i.e., above decks on intentionally hardened (shielded) ships. This requirement is not applicable for equipment intended solely for use on wooden hull ships, unless otherwise specified by the procuring activity. Cables that can not be tested in accordance with MIL-STD-462 shall meet the requirements of CS11 and cables subjected to the specified CS11 levels are exempt from meeting this requirement.

21.2 RS05 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the individual equipment or subsystem specification, after being subjected to a test signal having the waveform and amplitude shown on Figure 5-17.

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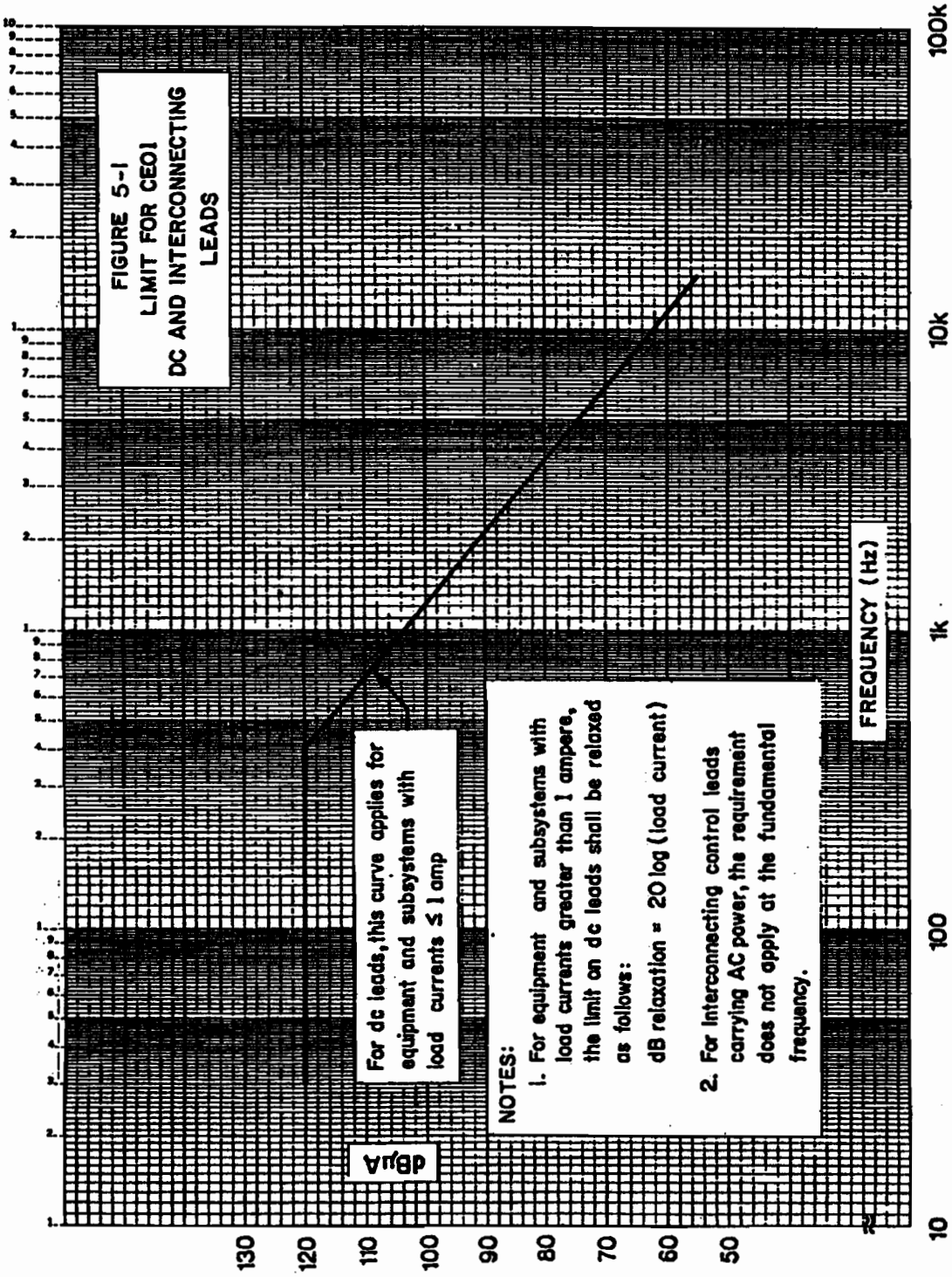

FIGURE 5-1. LIMIT FOR CE01 DC AND INTERCONNECTING LEADS

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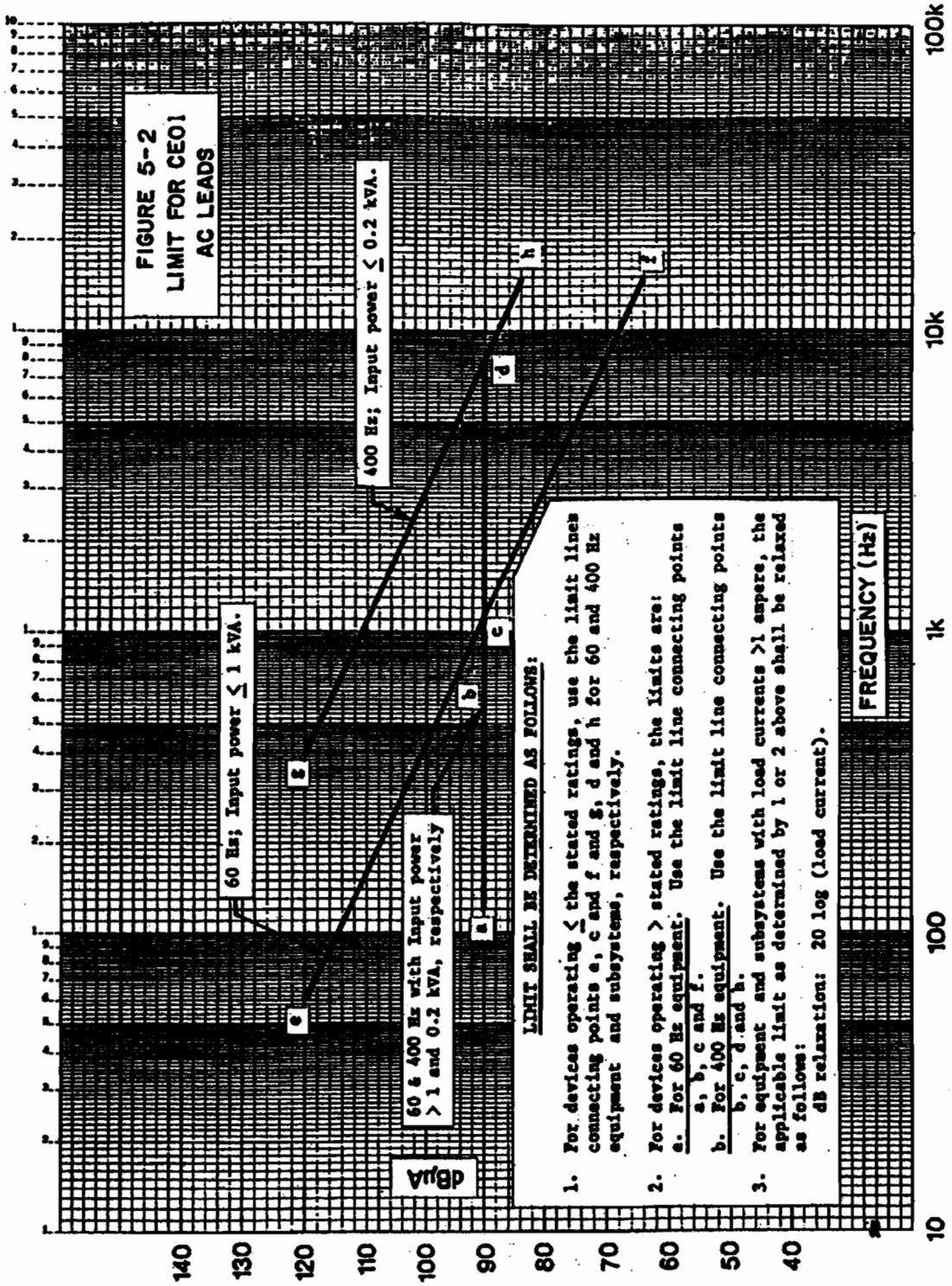

FIGURE 5-2. LIMIT FOR CE01 AC LEADS

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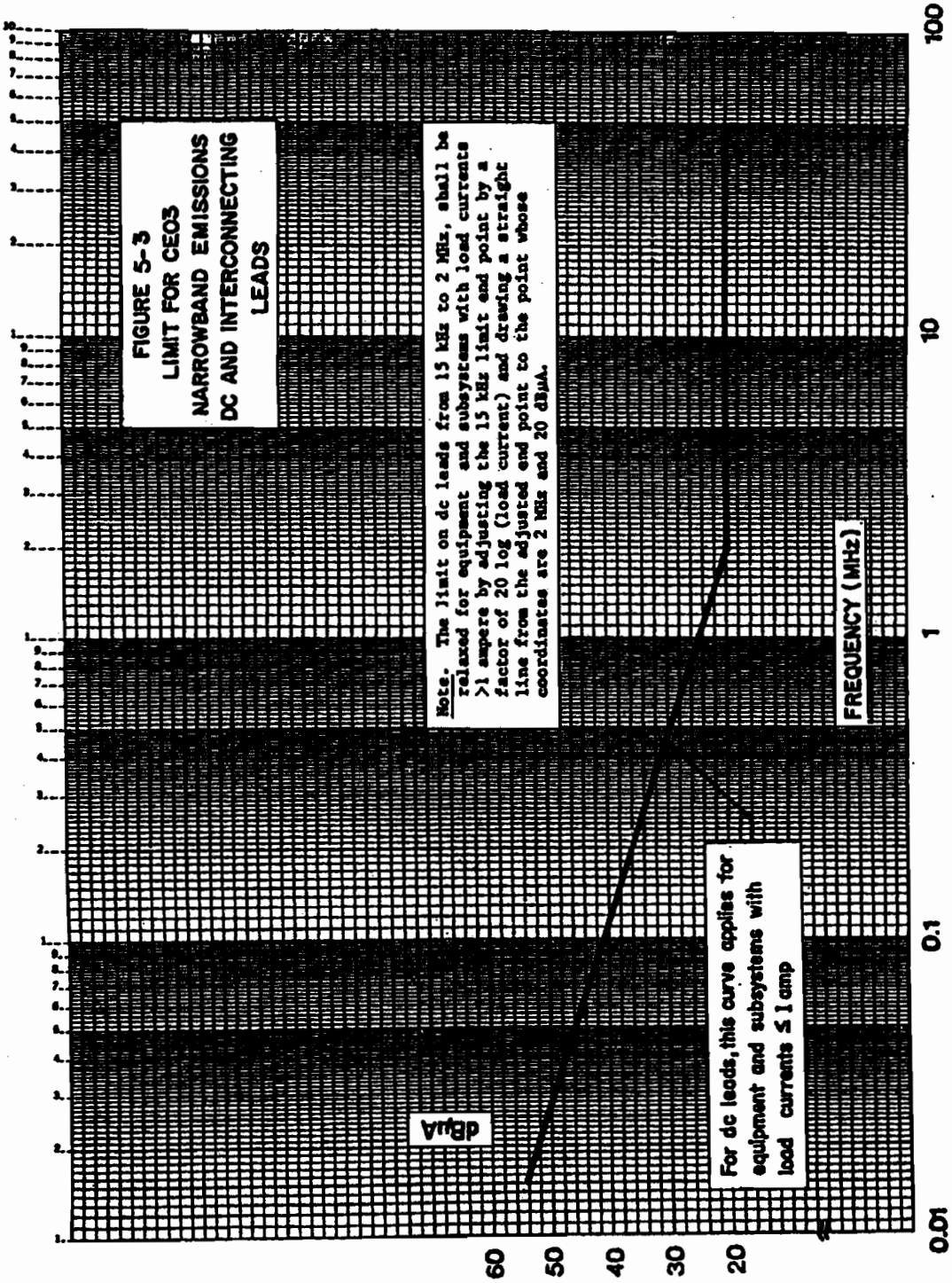

FIGURE 5-3. LIMIT FOR CE03 NARROWBAND EMISSIONS DC AND INTERCONNECTING LEADS

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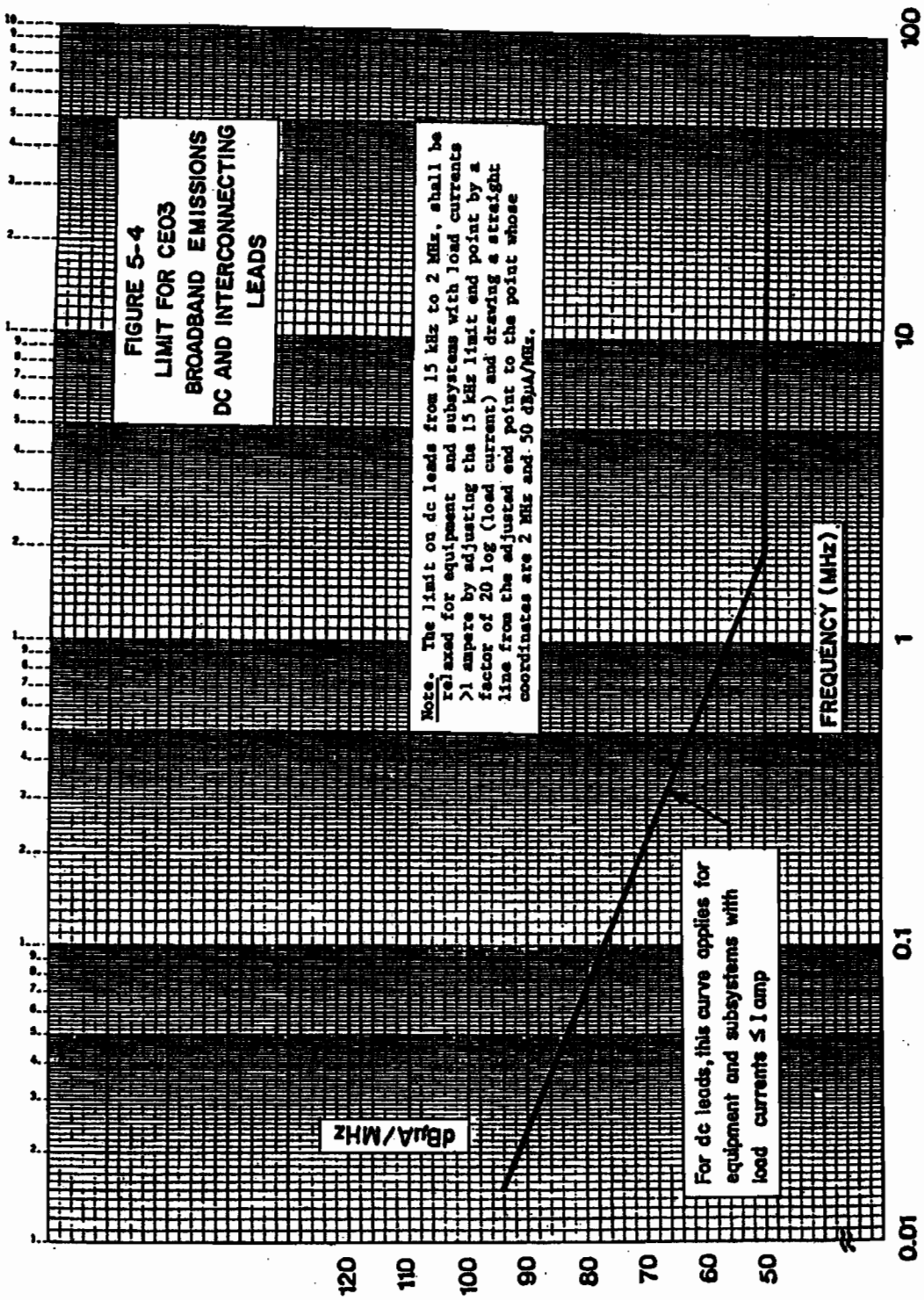

FIGURE 5-4. LIMIT FOR CE03 BROADBAND EMISSIONS DC AND INTERCONNECTING LEADS

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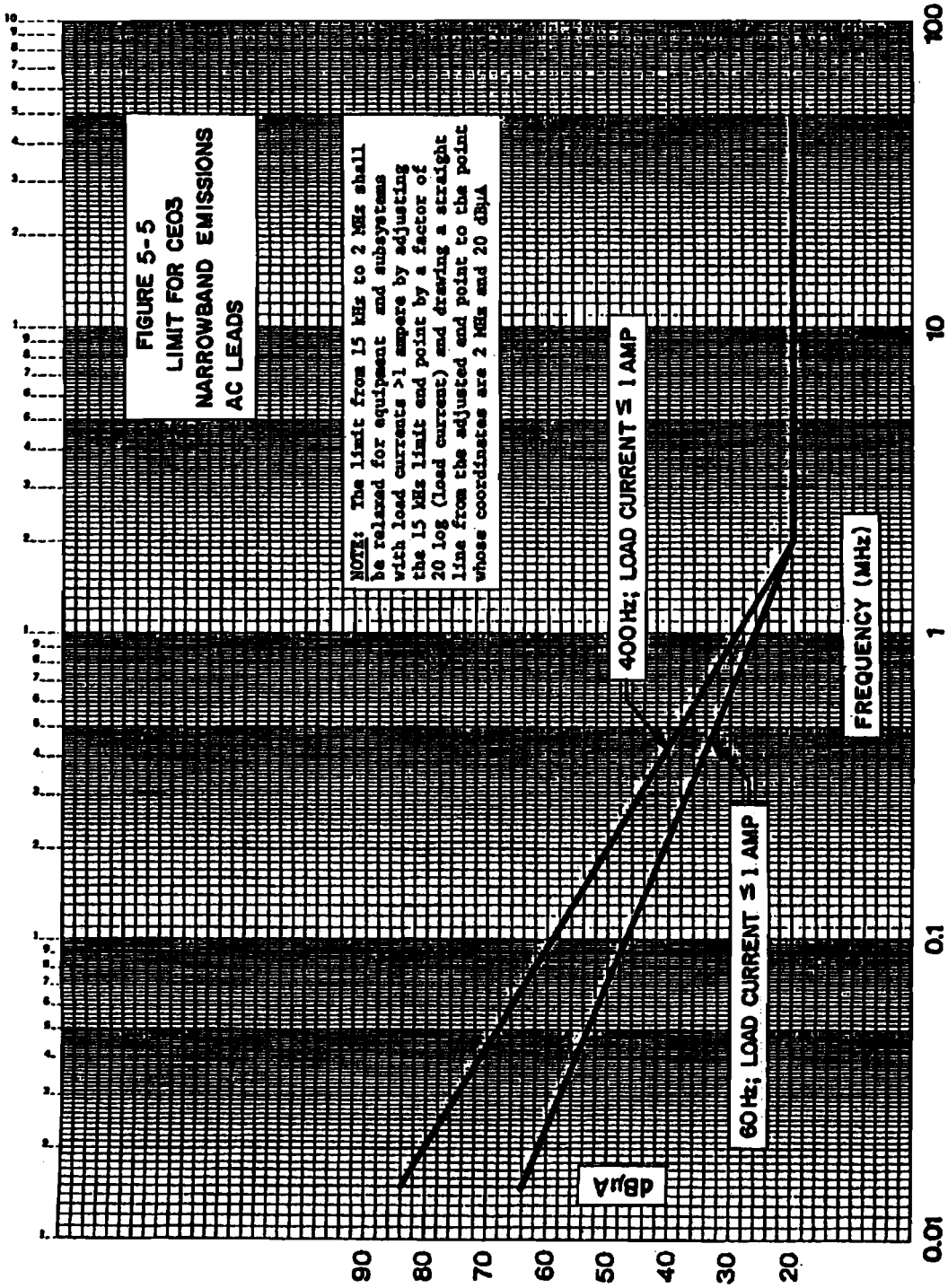

FIGURE 5-5. LIMIT FOR CE03 NARROWBAND EMISSIONS AC LEADS

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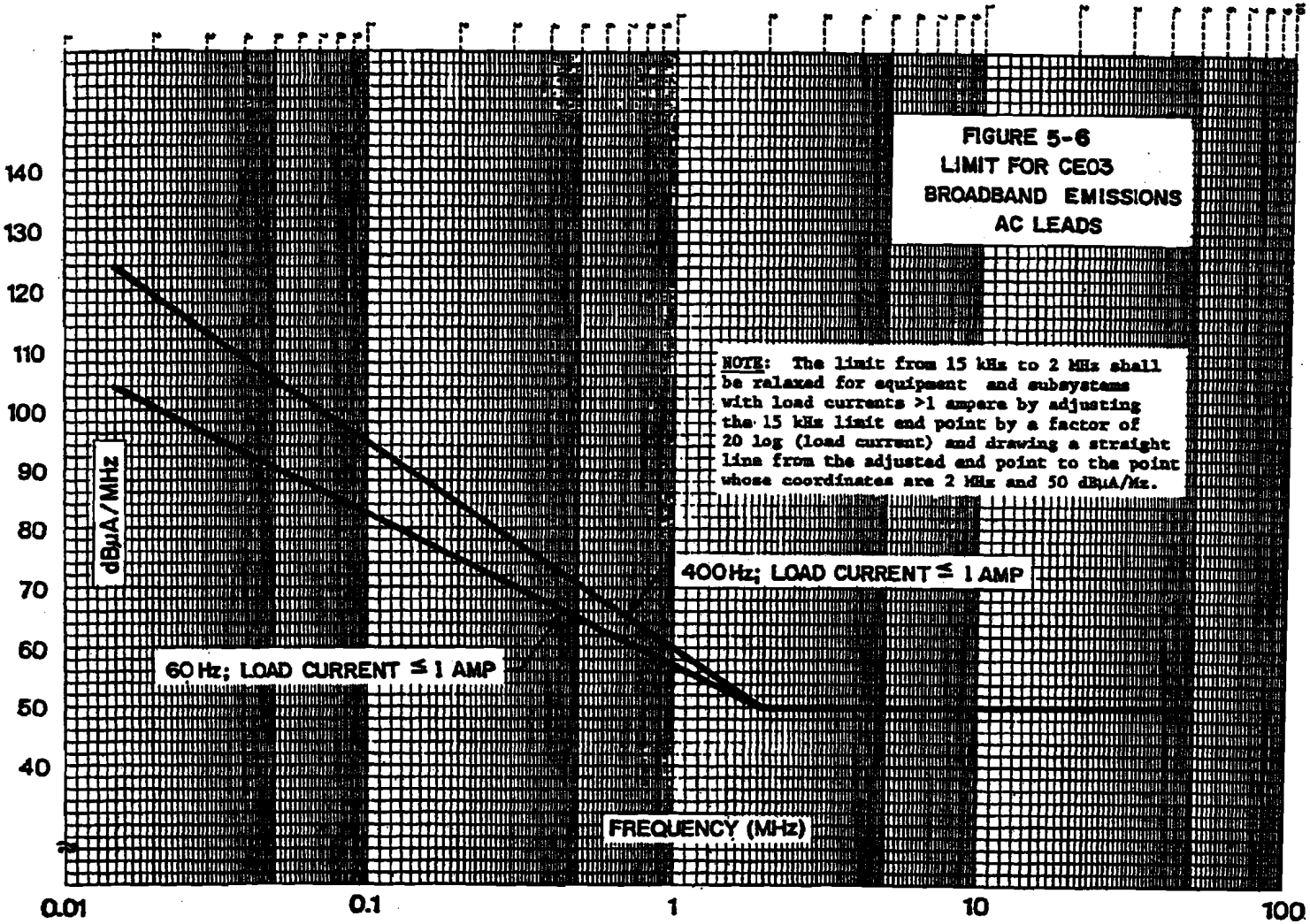

FIGURE 5-6. LIMIT FOR CE03 BROADBAND EMISSIONS AC LEADS

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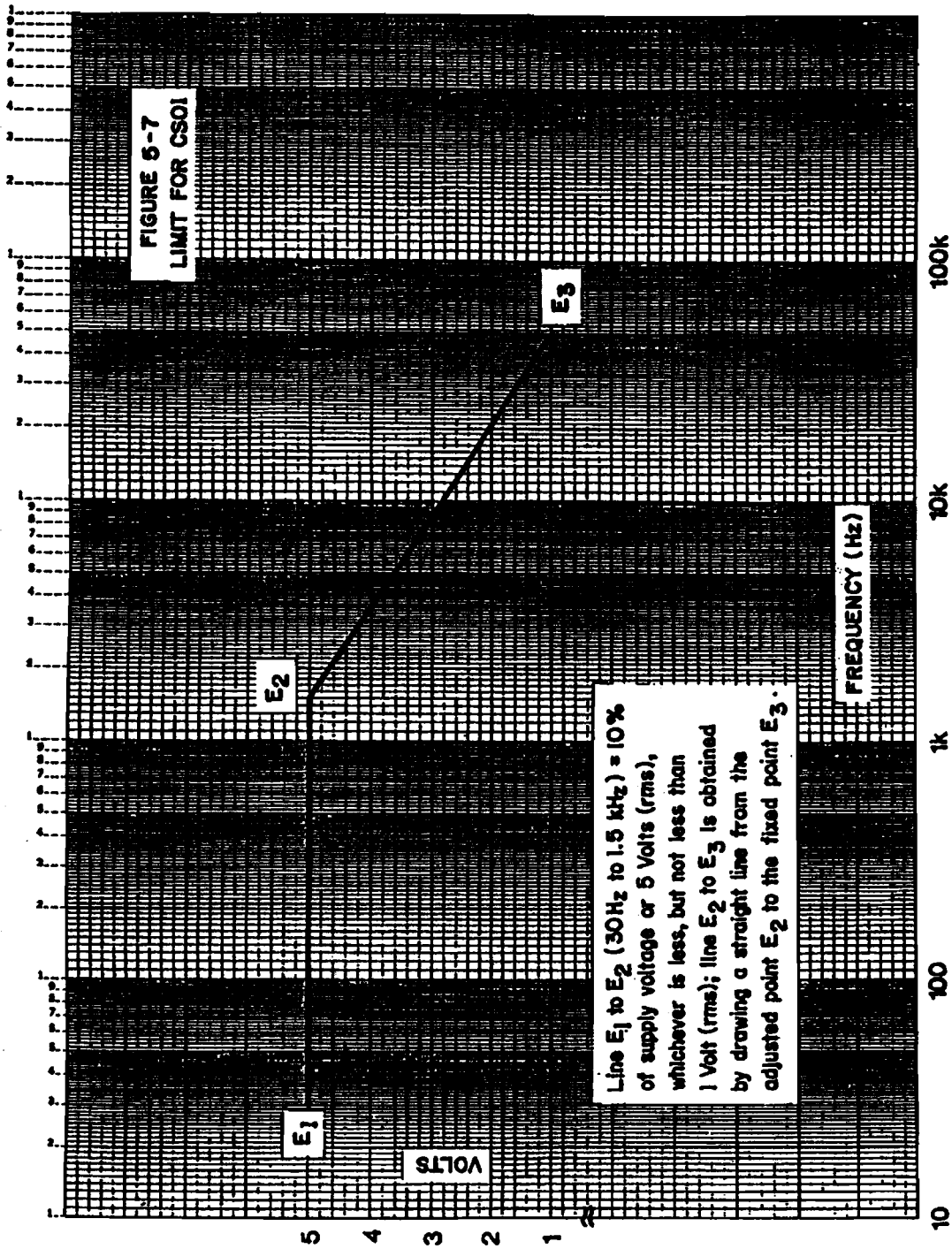

FIGURE 5-7. LIMIT FOR CS01

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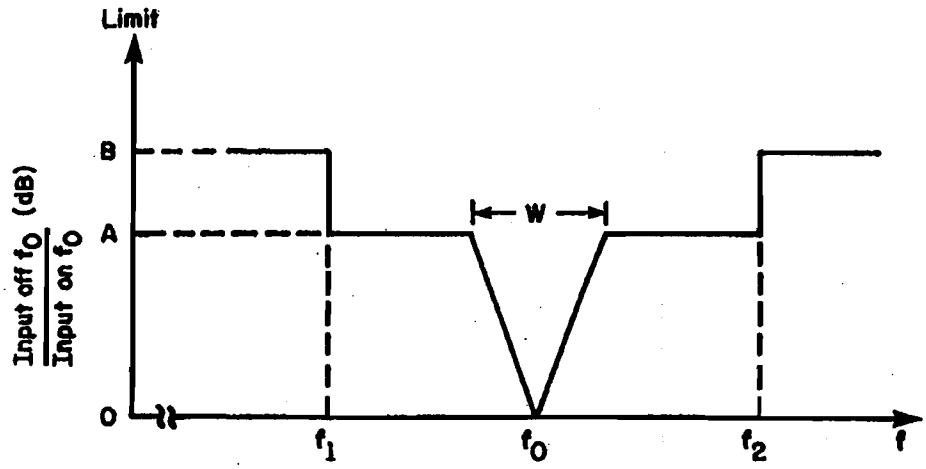

f_0 = Receiver tuned frequency or band center for amplifiers.

f_1 = Lowest tunable frequency of receiver band in use or the lowest frequency of amplifier passband.

f_2 = Highest tunable frequency of receiver band in use or the highest frequency of amplifier passband.

W = Bandwidth between the 80 dB points of the receiver selectivity curve as defined in the test sample's technical requirements or the control plan.

Limits:

1. The limit at A is 80 dB above the input level required to produce the standard reference output. (This limit shall not be used for amplifiers)
2. The limit at B shall be set as follows:
   a. Receivers: 0 dBm applied directly to the receiver input terminals.
   b. Amplifiers: The limit shall be as specified in the test sample's technical requirement or control plan. If no limit is defined in the above documents, the 0 dBm value shall be used.

FIGURE 5-8. LIMIT FOR CS04

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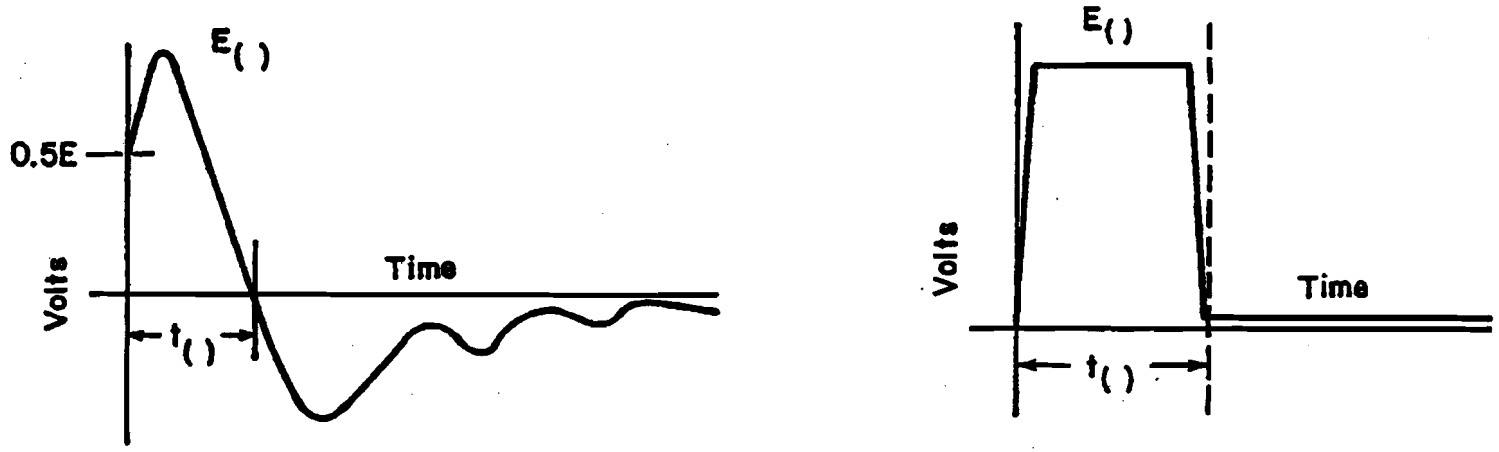

NOTE: The test sample shall be subjected to the spike(s) with the waveform shown and with the specified voltage(s) and pulsewidth(s).

FIGURE 5-9. ACCEPTABLE WAVESHAPES FOR CS06 AND RS02

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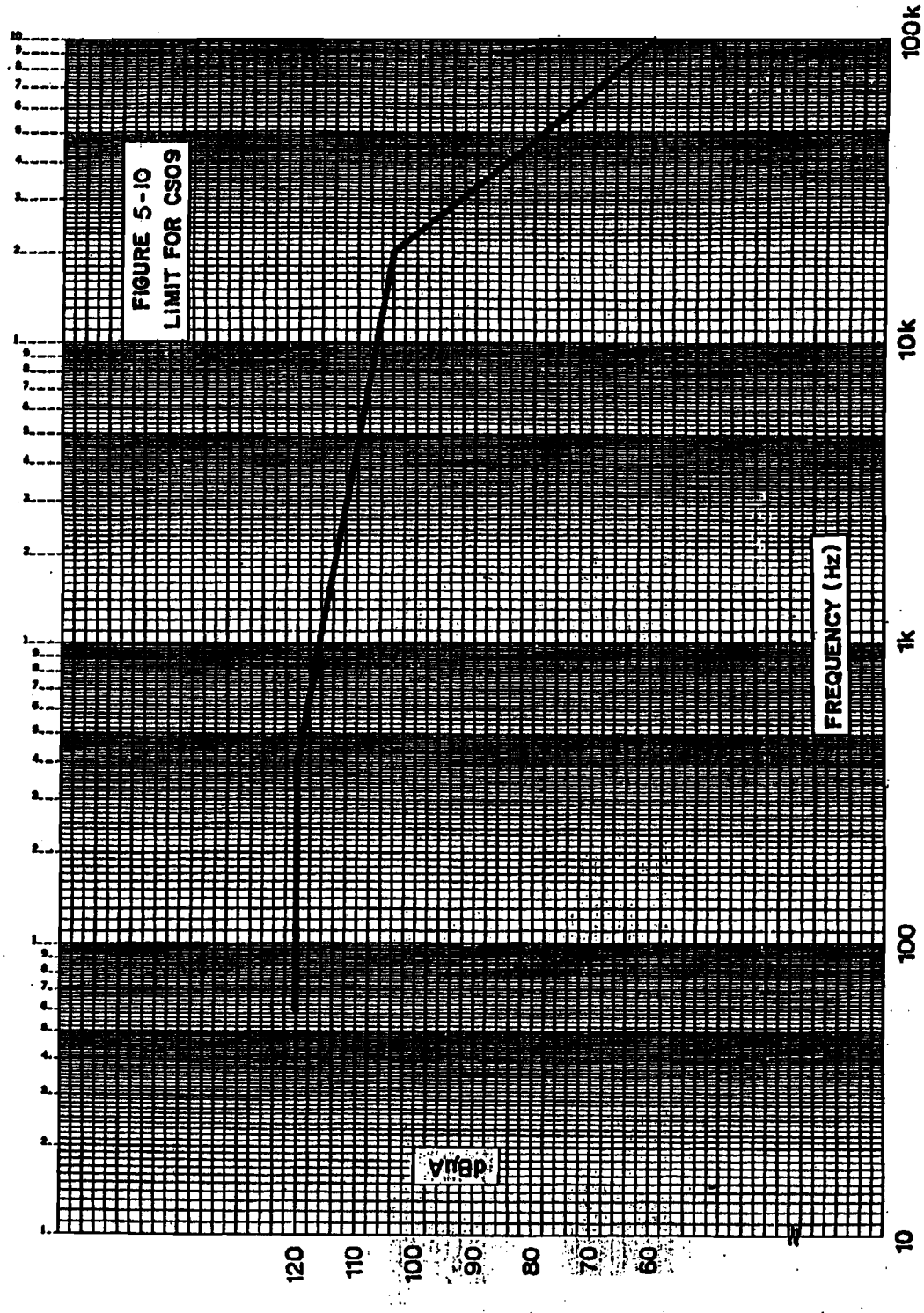

FIGURE 5-10. LIMIT FOR CS09

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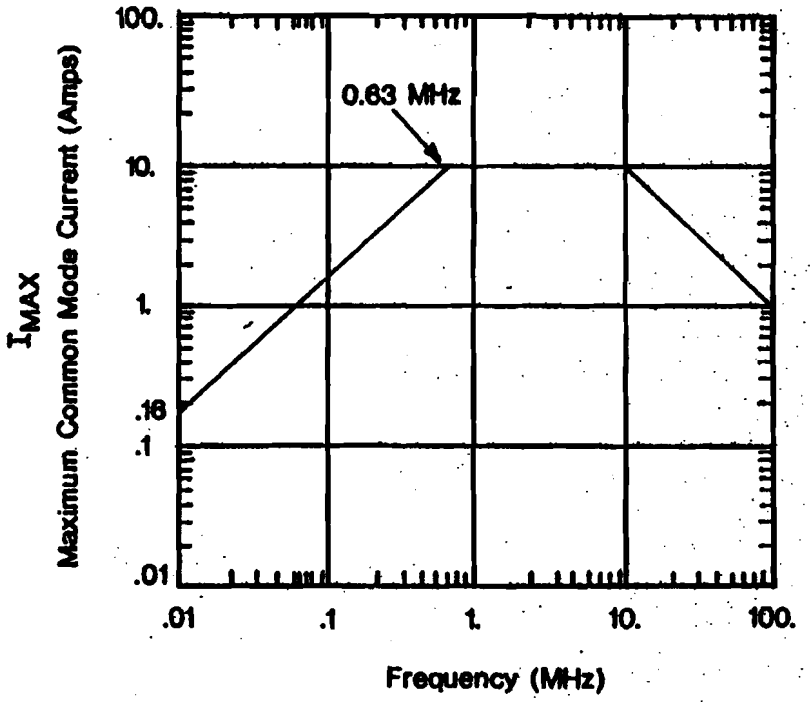

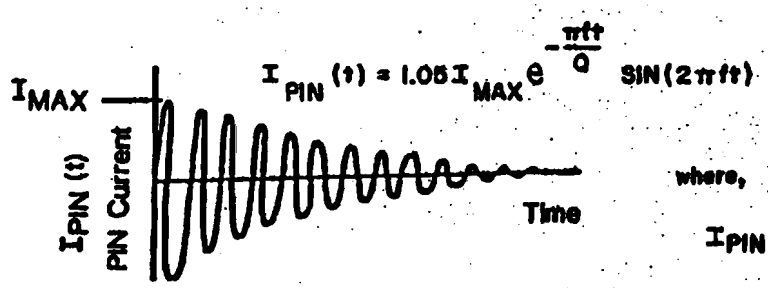

$$I_{PIN}(t) = 1.05 I_{MAX} e^{-\frac{\pi f t}{Q}} \sin(2\pi f t)$$

where,

$I_{PIN}(t)$ = common mode pin current in amps

f = frequency, hertz

t = time, seconds

Q = decay factor

FIGURE 5-11. LIMIT FOR CS10

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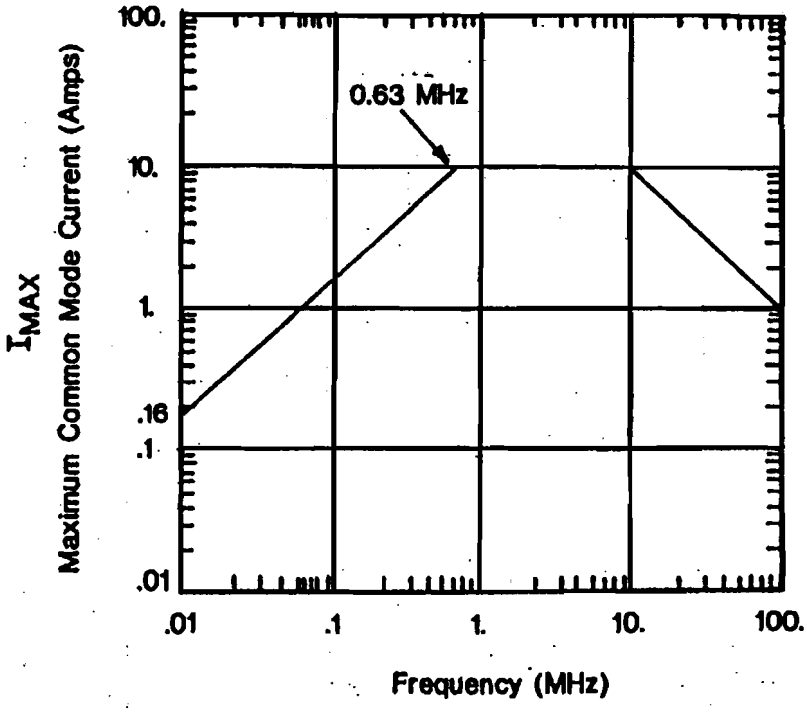

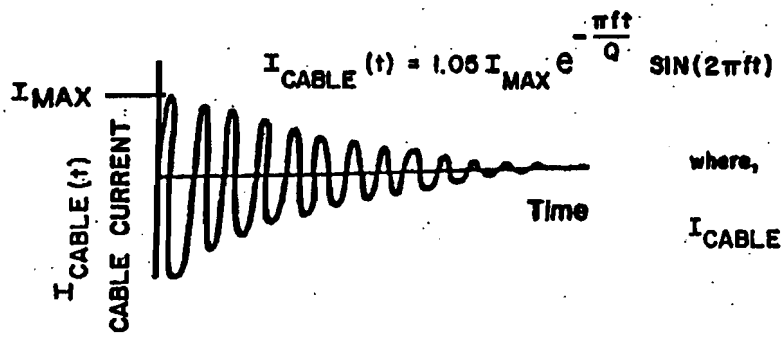

where,

$I_{CABLE}(t)$ = common mode cable current in amps

f = frequency, hertz

t = time, seconds

Q = decay factor

FIGURE 5-12. LIMIT FOR CS11

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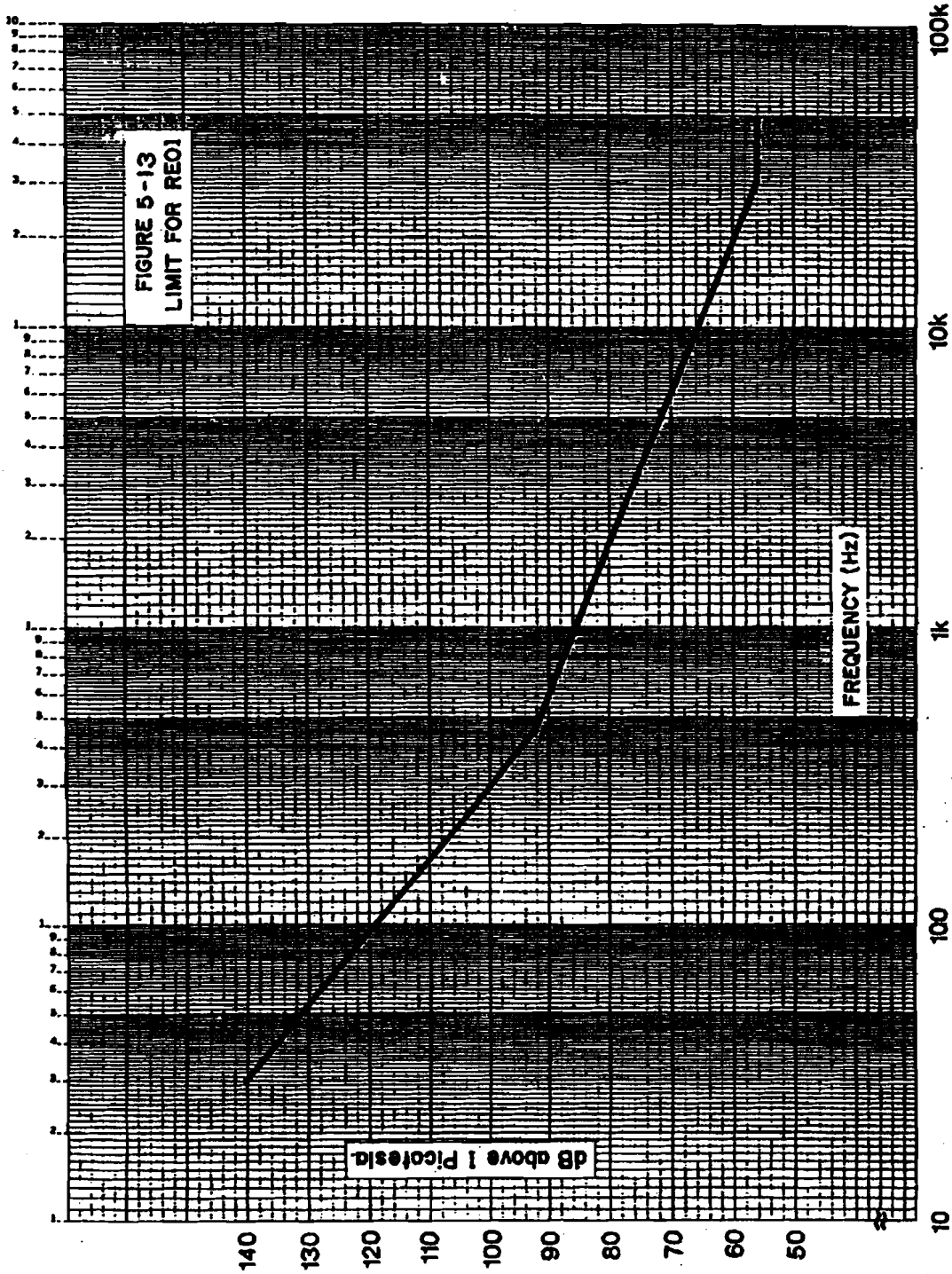

FIGURE 5- 13. LIMIT FOR REO1

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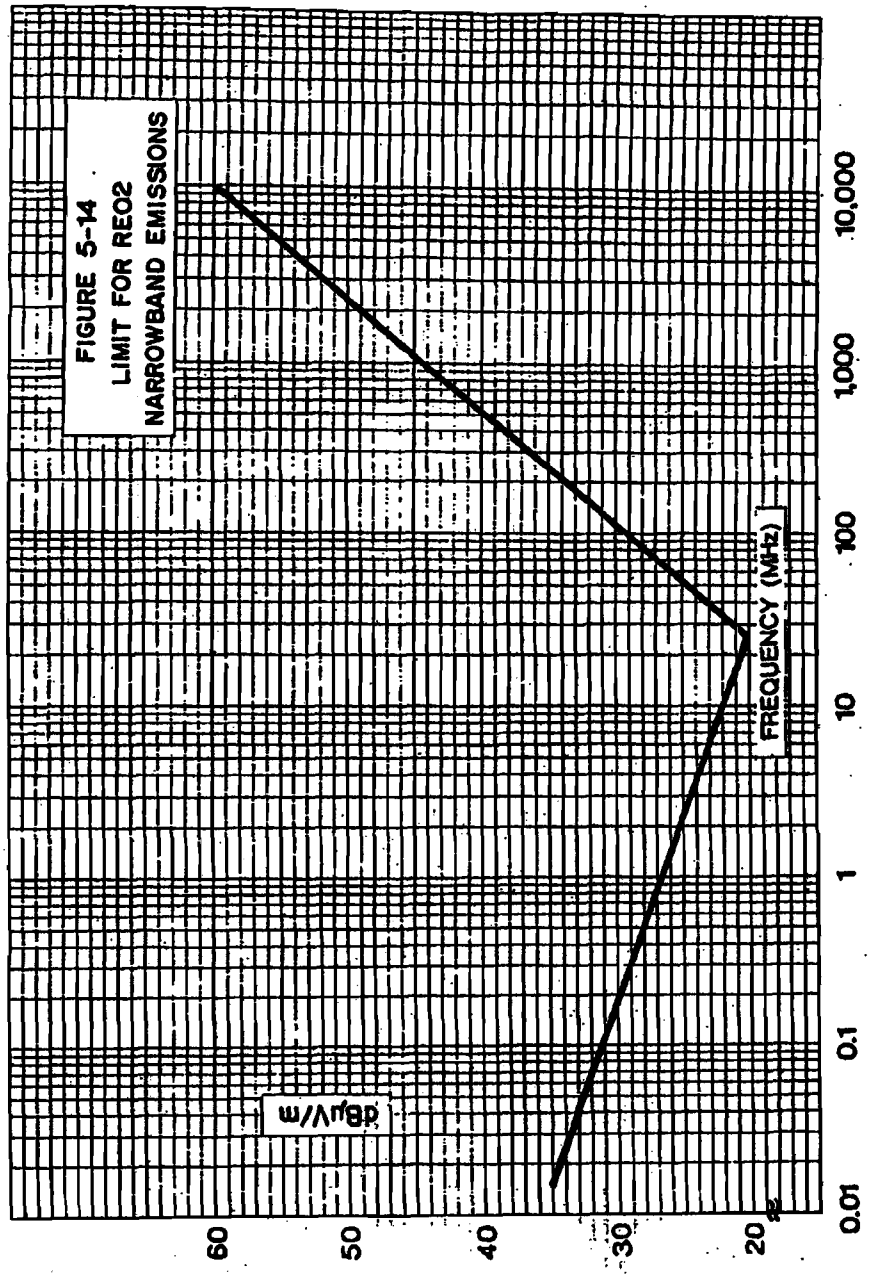

FIGURE 5-14. LIMIT FOR RE02 NARROWBAND EMISSIONS

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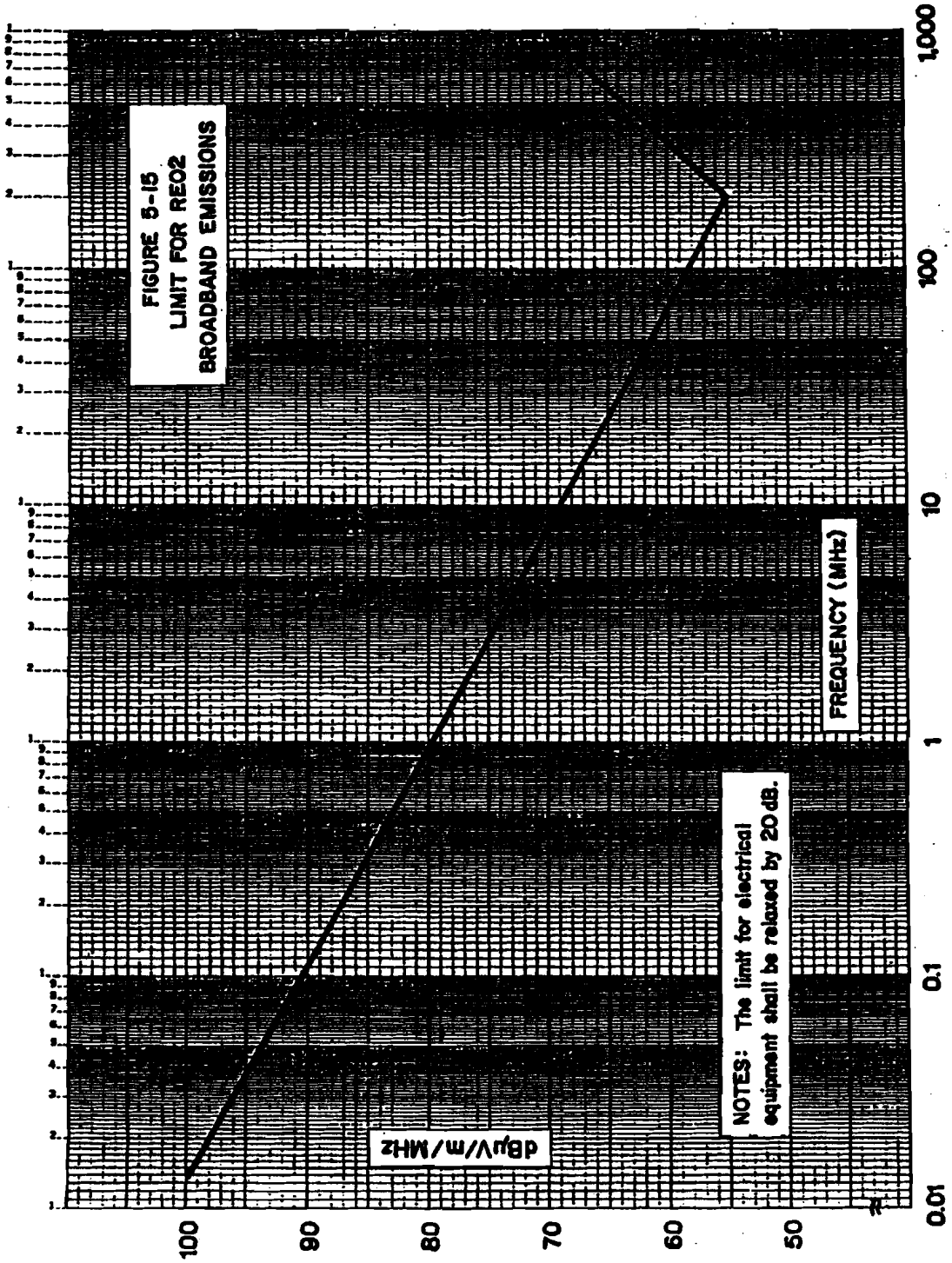

FIGURE 5-15. LIMIT FOR RE02 BROADBAND EMISSIONS

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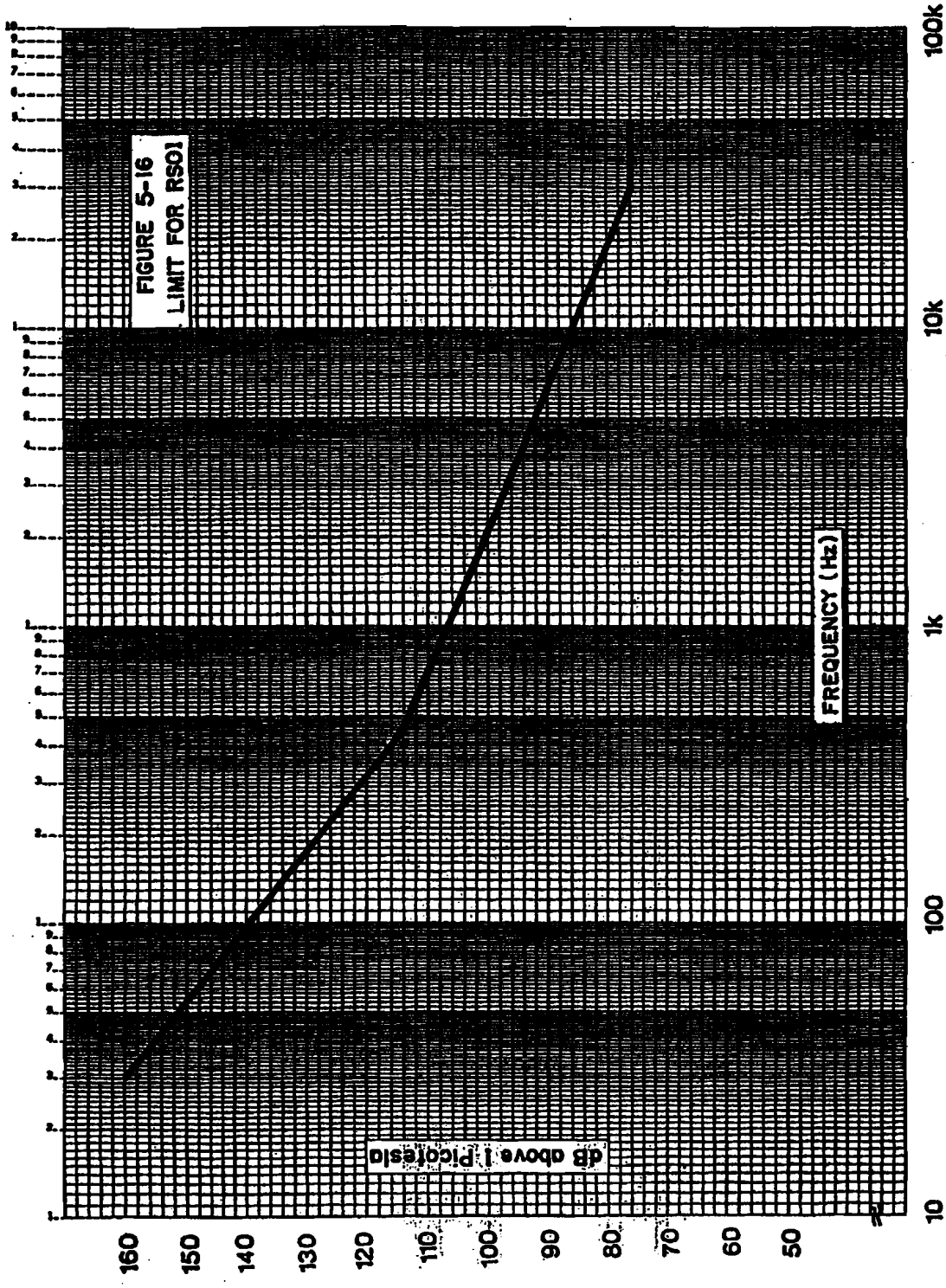

FIGURE 5-16. LIMIT FOR RS01

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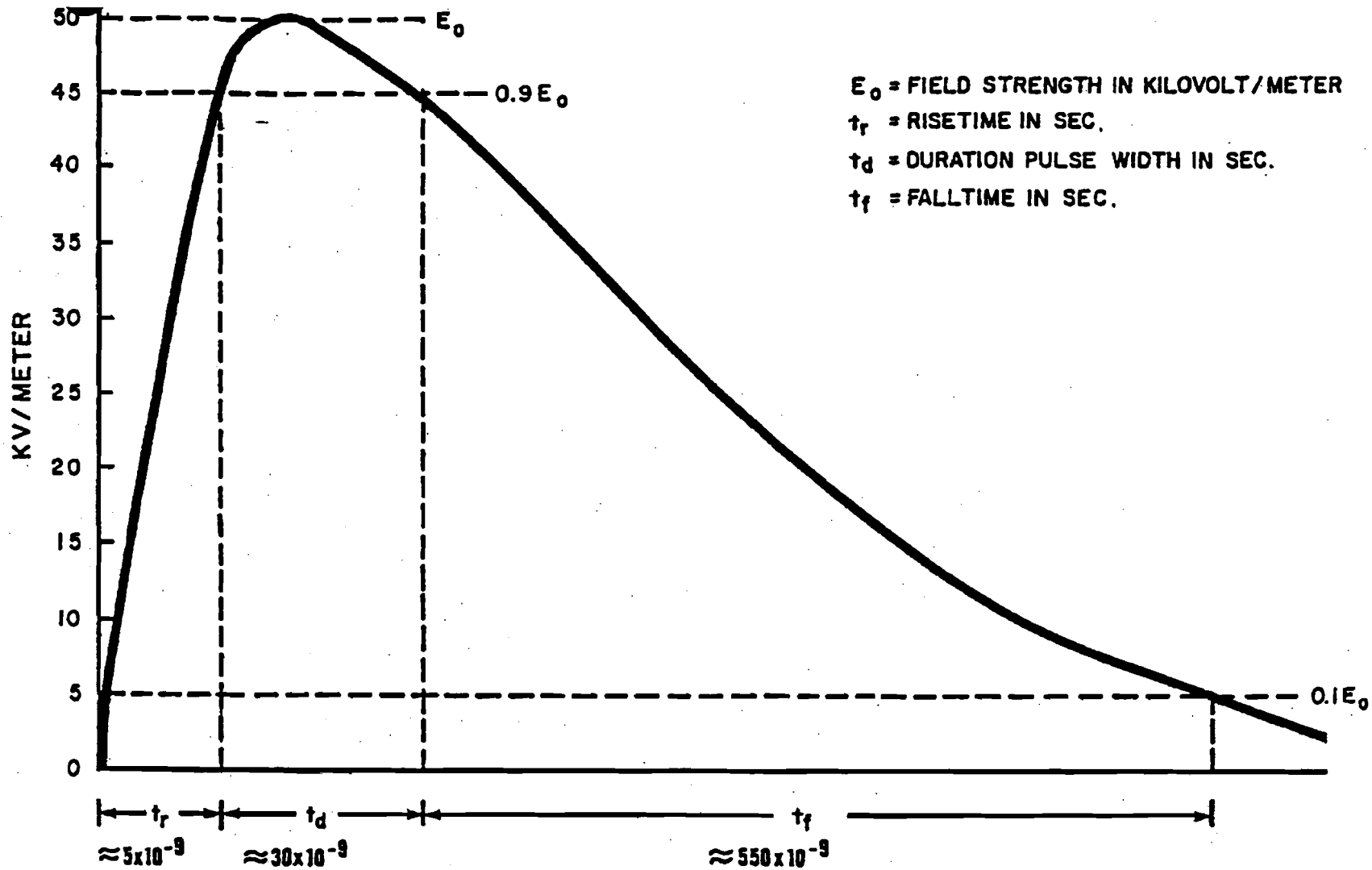

FIGURE 5-17. LIMIT FOR RS05

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Part 6. Equipment and Subsystems Installed in Submarines (Class A5)

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1. SCOPE

This part of MIL-STD-461 supplements Part 1 of the standard by defining emission and susceptibility requirements and limits for equipment and subsystems intended for use in submarines (Class A5).

1.1 Determining requirements. Table 6-I shall be used to determine the specific requirements for class A5 equipment and subsystems. The table also denotes the paragraphs wherein the requirements and limits are defined. A "Y" entry in the table means the requirement is applicable, and the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "Y_L" entry means the applicability of the requirement is limited and is specified in the appropriate corresponding paragraph. The limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "T" entry means that the applicability must be determined on a case-by-case basis and, if the requirement is to be imposed, it must be so specified in the appropriate procurement document. When required, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. Absence of an entry means the requirement is not applicable. For procurements of subsystems, such as radar, EW surveillance, and the like, comprised of individual equipment listed in Table 6-I, the applicable emission and susceptibility requirements for the subsystem shall be tailored by the procuring activity based on the requirements of the individual equipment.

1.2 Exceptions for interference free equipment. There are electrical and electromechanical equipment which are usually interference free and for which written approval to forego emission testing may be obtained when procured as individual equipment. As a means of establishing whether an equipment will require testing, the equipment manufacturer shall forward to the Command or agency concerned a complete electrical description of the equipment and the justification to forego testing. Written approval to forego testing must be obtained from the Command or agency concerned and shall be requested as early in the procurement cycle as possible.

1.3 Exceptions for nonessential electrical and electromechanical equipment. The following electrical and electromechanical equipment are considered nonessential and need not meet the susceptibility requirements specified herein.

- Recreational equipment, such as electrical games
- Vending machines

2. CE01

2.1 CE01 applicability. This requirement is applicable for alternating current (AC) and direct current (DC) leads, which obtain power from other sources or provide power to other equipment or subsystems; grounds or neutrals, which are not grounded internally to the subsystem or equipment being measured; and interconnecting control leads, which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as clock, IF, audio, firing, digital, RF, and the like, unless otherwise specified by the Command or agency concerned.

2.1.1 DC and interconnecting leads. This requirement is applicable for narrowband emissions from 30 Hz to 15 kHz.

2.1.2 AC leads. This requirement is applicable for narrowband emissions from the power frequency(ies) of the test sample to 15 kHz.

2.2 CE01 limits.

2.2.1 DC leads. Electromagnetic emissions shall not appear on DC leads in excess of the values shown on Figure 6-1. The following limits shall be met when measured with an effective bandwidth not exceeding 75 Hz.

2.2.2 AC leads. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on the applicable limit line on Figure 6-2. The limits shall be met when measured with an effective bandwidth not exceeding the primary power frequency plus 20% of the primary power frequency.

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TABLE 6-1. EMISSION AND SUSCEPTIBILITY REQUIREMENTS FOR CLASS A5 EQUIPMENT AND SUBSYSTEMS

Requirement / Specific Equipment/Subsystem	Receivers	Transmitters	Antenna Multicouplers	Amplifier, Tuned and Untuned	Periscopes	Intercom/Interphone	Modem	Repeater	Amplifier, Power/Audio	Modulators	Multiplexers	Laser Devices	IR Devices	Transponders	Beacons	Power Supplies	Sensors/Antennas	Inertial Guidance	Teletypewriters	Recorders	Visual Displays	Digital Equipment	Photographic Equipment	Receive Signal Junction Switching Connection Boxes	Telephone SWBD	Servo/Synchro	Test Equipment	Time/Frequency STDS	Ultrasonic Devices	Telephones	Missiles	Sonar Devices	Towed/Trailing Devices	Centralized Control And Monitoring Equipment And Sensors	Electrical Equipment Without Solid State	Electrical Equipment With Solid State	Portable Electric Hand Tools	All Others Not Listed Herein	Applicable Paragraph
CE01	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	2
CE03	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	3
CE06	Y_L	Y_L	T	Y_L	Y_L									Y_L	Y_L																Y_L		Y_L					Y_L	4
CS01	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y	5
CS02	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T		T	T	T	T	T	T	T	T	T	T		T		T	6
CS03	Y		T	T	T	Y			Y					Y			T			Y											Y_L		T						7
CS04	Y		T	T	T	T			T					T										Y_L							Y_L		T						8
CS05	Y		T	T	T	Y			Y					Y			T			Y											Y_L		T						9
CS06	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y	10
CS07	Y_L																																						11
CS09	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		Y_L			Y_L	12
CS10	T	T	T	T	T		T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T		T		T	T		T	T	T		T		T	T	13
CS11	Y_L	Y_L	Y_L	Y_L	Y_L		Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L	Y_L		Y_L		Y_L	Y_L		Y_L	Y_L	Y_L		Y_L		Y_L	Y_L	14
RE01	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y	Y	Y		Y	15
RE02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y	Y	Y		Y	16
RE03		Y_L												Y_L	Y_L																							Y_L	17
RS01	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	T	Y	Y	Y		Y		Y	18
RS02	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y	19
RS03	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y	20
RS05					Y_L																										Y_L		Y_L					T	21

COMPLY WITH REQUIREMENTS OF PART 10

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2.2.3 Interconnecting leads.

2.2.3.1 Connected outer shield and twisted pairs together. For interconnecting control and signal leads having the outer shield connected, and for twisted pairs with the pairs together, electromagnetic emissions shall not appear on the leads in excess of the values shown on Figure 6-1. The limits shall be met when measured with an effective bandwidth not exceeding the primary power frequency plus 20% of the primary power frequency for AC leads or 75 Hz for DC leads.

2.2.3.2 Disconnected outer shield and twisted pairs separated. For interconnecting control and signal leads having the outer shield disconnected, and for twisted pairs having the pairs separated, the limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

3. CE03

3.1 CE03 applicability. This requirement is applicable for alternating current (AC) and direct current (DC) leads, which obtain power from other sources or provide power to other equipment or subsystems; grounds or neutrals, which are not grounded internally to the subsystem or equipment being measured; and interconnecting control leads, which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as clock, IF, audio, firing, digital, RF, and the like, unless otherwise specified by the Command or agency concerned.

3.2 CE03 limits.

3.2.1 DC leads. Electromagnetic emissions shall not appear on DC leads in excess of the values shown on Figures 6-3 and 6-4 for narrowband and broadband emissions, respectively.

3.2.2 AC leads. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on Figures 6-5 and 6-6 for narrowband and broadband emissions, respectively.

3.2.3 Interconnecting leads.

3.2.3.1 Connected outer shield and twisted pairs together. For interconnecting control and signal leads having the outer shield connected, and for twisted pairs with the pairs together, electromagnetic emissions shall not appear on the leads in excess of the values shown on Figures 6-3 and 6-4 for narrowband and broadband emissions, respectively.

3.2.3.2 Disconnected outer shield and twisted pairs separated. For interconnecting control and signal leads having the outer shield disconnected, and for twisted pairs having the pairs separated, the limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

4. CE06 (limited applicability)

4.1 CE06 applicability. This requirement is applicable for those equipment and subsystems with antenna leads or those designed to be connected to antennas. The transmitter key-down harmonic and spurious emission portions of this requirement may be measured using the procedures in RE03 (in lieu of those of CE06) with the approval of the Command or agency concerned, when any of the following conditions exist: (a) transmitter power exceeds 5 kW average, (b) the fundamental frequency of the test sample exceeds 1.24 GHz, (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable dummy load, or (d) for equipment and subsystems with waveguide transmission lines and operating below 1.24 GHz. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The transmitter (key-down) portion of this requirement is not applicable within either the test sample's necessary bandwidth or ± 5 percent of the fundamental frequency.

4.2 CE06 limits. Conducted emissions in excess of the values given below shall not appear at the test sample's antenna terminals.

4.2.1 Receivers.

a. Narrowband emissions: 34 dB μV

b. Broadband emissions: 40 dB μV/MHz

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4.2.2 Transmitters (key-up and standby).

a. Narrowband emissions: 34 dB µV

b. Broadband emissions: 40 dB µV/MHz

4.2.3 Transmitters (key-down mode). Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

5. CS01

5.1 CS01 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem. The requirement is not applicable within ± 5 percent of the power frequency(ies). This requirement may be deleted for AC leads, with the approval of the Command or agency concerned, if no circuit within the equipment or system has a sensitivity of 100 mV or better.

5.2 CS01 limits. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to electromagnetic energy injected onto its power leads less than or equal to the values shown in Figure 6-7. The requirement is also met under the following condition: when the power source specified in MIL-STD-462, adjusted to dissipate 50 watts in a 0.5 ohm load, cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

6. CS02 (limited applicability)

6.1 CS02 applicability. Applications of this requirement are to be determined on a case-by-case basis. When specified, this requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

6.2 CS02 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to 1-volt from a 50 ohm source. The test signal shall be applied directly to the equipment input terminals, not through the test sample's power line cord. The requirement is also met under the following condition: when a 1-watt source of 50 ohms impedance cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

7. CS03 (limited applicability)

7.1 CS03 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

7.2 CS03 limits. The test sample shall not exhibit any intermodulation products from two signals, beyond those permitted in the individual equipment or subsystem specification, when:

a. Signal generator #1 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462; except that when f_1 is in the frequency range of either 200 to 400 MHz or 2 to 25 MHz, the generator output shall be 80 dB above the reference level, but the output of the signal generator shall not exceed 10 dBm.

b. Signal generator #2 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but the generator level shall not exceed a power level of 10 dBm.

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8. CS04 (limited applicability)

8.1 CS04 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

8.2 CS04 limits. The test sample shall not exhibit any undesired response when subjected to the test signal shown on Figure 6-8.

9. CS05 (limited applicability)

9.1 CS05 applicability. This requirement is applicable to receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

9.2 CS05 limits. The test sample shall not exhibit, due to cross modulation, any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the following from signal generator #2: a signal 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but not to exceed a power output level of 10 dBm.

10. CS06

10.1 CS06 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

10.2 CS06 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when the test spike having the waveform shown on Figure 6-9 is applied to the AC and DC power input leads for a period of not less than 1 minute at each phase position and for a total test period not exceeding 15 minutes in duration (in lieu of the values in MIL-STD-462). The values of $E_{()}$ and $t_{()}$ are given below. The spike shall be superimposed on the powerline voltage waveform.

a. Spike #1 E_1 = 400 Volts; t_1 = 5 microseconds $\pm$ 20%.

11. CS07 (limited applicability)

11.1 CS07 applicability. This requirement is applicable for receiving equipment and subsystems which utilize squelch circuits.

11.2 CS07 limits.

11.2.1 Requirement 1. The squelch circuits shall not open when the output of a 50-ohm impedance impulse generator, set at 90 dB µV/MHz, is applied and matched to the input terminals of the test sample.

11.2.2 Requirement 2. The squelch circuit shall not open when two signals are applied at the input of the test sample. One signal shall be an unmodulated RF signal at the receiver tuned frequency, whose amplitude is two-thirds of the RF voltage used to adjust the squelch threshold. The second signal shall be an impulse signal of 50 dB µV/MHz.

12. CS09 (limited applicability)

12.1 CS09 applicability. This requirement is applicable to equipment and subsystems that have an operating frequency range of 100 kHz or less and an operating sensitivity of 1 µV or less, such as 0.5 µV.

12.2 CS09 limit. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the levels less than or equal to those shown on Figure 6-10 across the applicable test points.

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13. CS10 (limited applicability)

13.1 CS10 applicability. This electromagnetic pulse (EMP) requirement is applicable to Navy equipment and subsystem interface pins and terminals of leads, including grounds and neutrals, connected to towed buoys, trailing devices, and periscopes. Applications of this requirement are to be determined on a case-by-case basis.

13.2 CS10 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the individual equipment or subsystem specification, after being subjected to a test signal having either the waveform and common mode current level shown on Figure 6-11, as determined in accordance with MIL-STD-462.

14. CS11 (limited applicability)

14.1 CS11 applicability. This EMP requirement is applicable to Navy equipment and subsystems having interconnecting or intraconnecting control, signal, or power cables connected to towed/trailing devices and periscopes. Actual cable types, sizes and configurations subjected to the specified RS05 levels are exempt from meeting this requirement.

14.2 CS11 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the equipment or subsystem specification, after being subjected to a test signal having the waveform shown in Figure 6-12 and having a maximum bulk common mode cable current of 10 amps, as determined in accordance with MIL-STD-462.

15. RE01

15.1 RE01 applicability. This requirement is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample. The requirement applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas.

15.2 RE01 limit. Magnetic field emissions shall not be radiated in excess of the levels shown on Figure 6-13. If the requirement cannot be met even with equipment modifications, the magnetic field level-versus-distance falloffs shall be determined, and the data submitted in the EMI Test Report.

16. RE02

16.1 RE02 applicability. This requirement is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample. For narrowband, it applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas. This requirement is applicable from 14 kHz to 1 GHz, except as noted below:

a. For sonar equipment, narrowband and broadband emission requirements are applicable up to 75 MHz.

b. For electrical equipment, narrowband and broadband emission requirements are applicable up to 400 MHz.

16.2 RE02 limits. E-field emissions shall not be radiated in excess of those given in 16.2.1 and 16.2.2. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves.

16.2.1 Narrowband electric field emissions. Narrowband E-field emissions shall not be radiated in excess of the limit curve shown on Figure 6-14 at the required test distance, as specified in MIL-STD-462.

16.2.2 Broadband electric field emissions. Broadband E-field emissions from all equipment and subsystems, including radiated switching transients resulting from: (1) automatic cycling of electronic or electrical switching circuitry, (2) actuation of push-to-talk mechanisms (that is, keying of transmitters), or (3) manual switching shall not be radiated in excess of the limit curve shown on Figure 6-15 at the required test distances, as specified in MIL-STD-462.

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17. RE03 (limited applicability)

17.1 RE03 applicability. This requirement is applicable, with the approval of the procuring activity, when the spurious emissions and harmonics cannot be determined using the procedures of CE06. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The requirement is not applicable within either the test sample's necessary bandwidth or ± 5 percent of the fundamental frequency.

17.2 RE03 limit. Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

18. RS01

18.1 RS01 applicability. This requirement applies to equipment and subsystems and their associated cabling and connectors.

18.2 RS01 limit. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to magnetic fields less than or equal to the limit curve shown on Figure 6-16.

19. RS02

19.1 RS02 applicability. Parts I and II of this requirement are applicable for AC and DC equipment and subsystems procured for use on submarines.

19.2 RS02 limits.

19.2.1 Part I - spikes. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the test spike having the waveform shown on Figure 6-9. The values of $E_{()}$ and $t_{()}$ are given below:

a. Spike #1 E_1 = 400 Volts; t_1 = 5 microseconds ± 20%.

19.2.2 Part II - power frequency. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when 20 amperes are applied to the test wire at 60 and 400 Hz.

20. RS03

20.1 RS03 applicability. This requirement is applicable for all equipment and subsystems between 14 kHz and 1 GHz. Above 1 GHz, this requirement is not mandatory unless otherwise required by the procuring activity.

20.2 RS03 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the radiated electric field less than or equal to those specified herein. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circular polarized waves are also acceptable. Appropriate consideration shall be given to the operational radiated electromagnetic environment from both friendly and hostile emitters which an equipment or subsystem may encounter during its life cycle. Applicable portions of MIL-HDBK-235 shall be used to determine the anticipated environment. As a minimum, equipment and subsystems are to meet this requirement when subjected to a field of 1 volt/meter from 14 kHz to 1 GHz. If levels comparable to those in MIL-HDBK-235 are specified, modifications to the procedure in MIL-STD-462 may be required. Such modifications are to be described in the EMI Test Plan.

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21. RS05 (limited applicability)

21.1 RS05 applicability. This EMP requirement is intended for Navy equipment and subsystems and is applicable when both of the following conditions exist: (a) operation of the equipment or subsystem is essential for the success of a mission and (b) the equipment or subsystem is intended to be operated external to the hull of a submarine, including periscopes. Cables that can not be tested in accordance with MIL-STD-462 shall meet the requirements of CS11, and cables subjected to the specified CS11 levels are exempt from meeting this requirement.

21.2 RS05 limit. The test sample shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances and recovery times indicated in the individual equipment or subsystem specification, after being subjected to a test signal having the waveform and amplitude shown in Figure 6-17.

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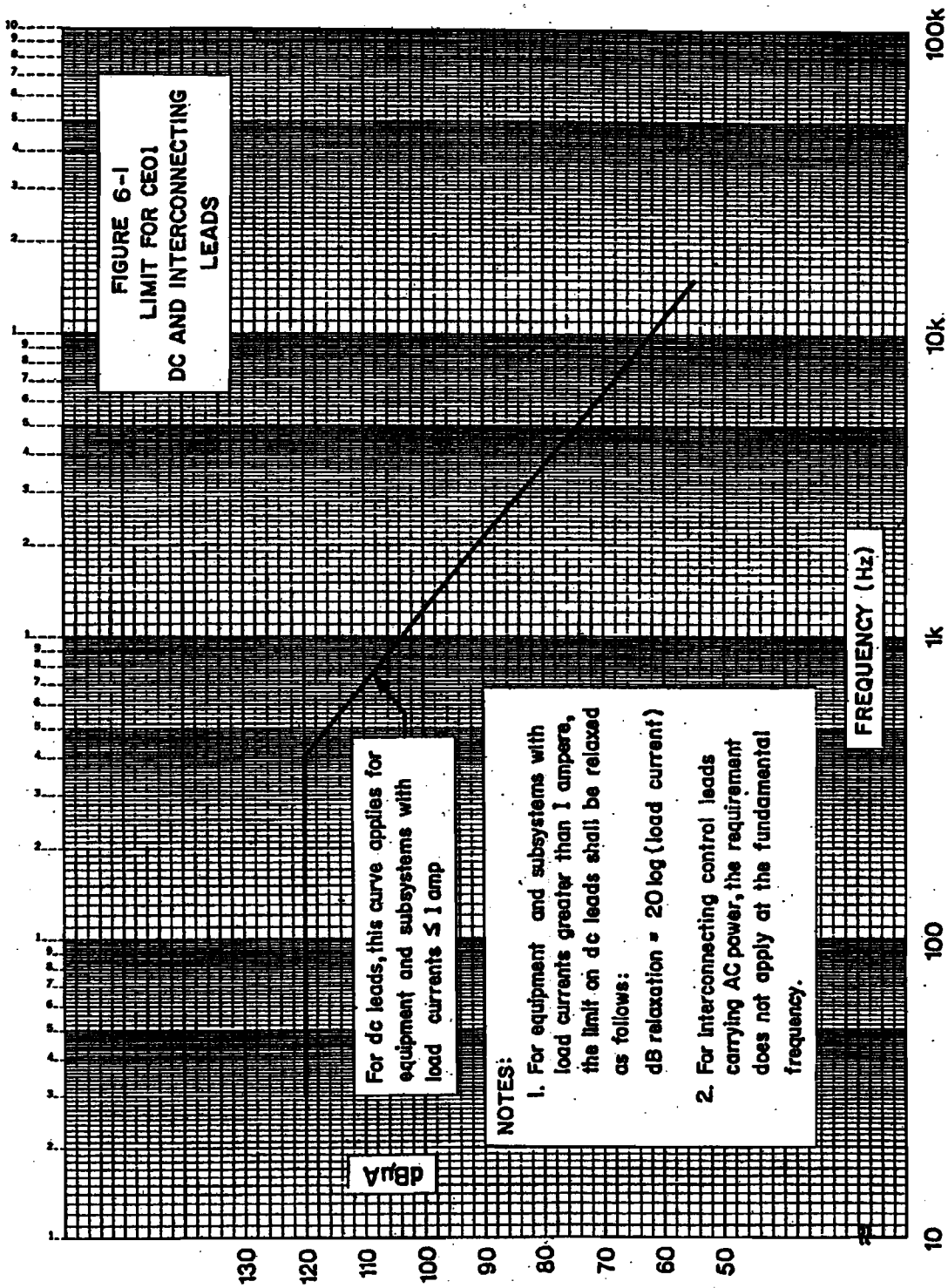

FIGURE 6-1: LIMIT FOR CE01 DC AND INTERCONNECTING LEADS

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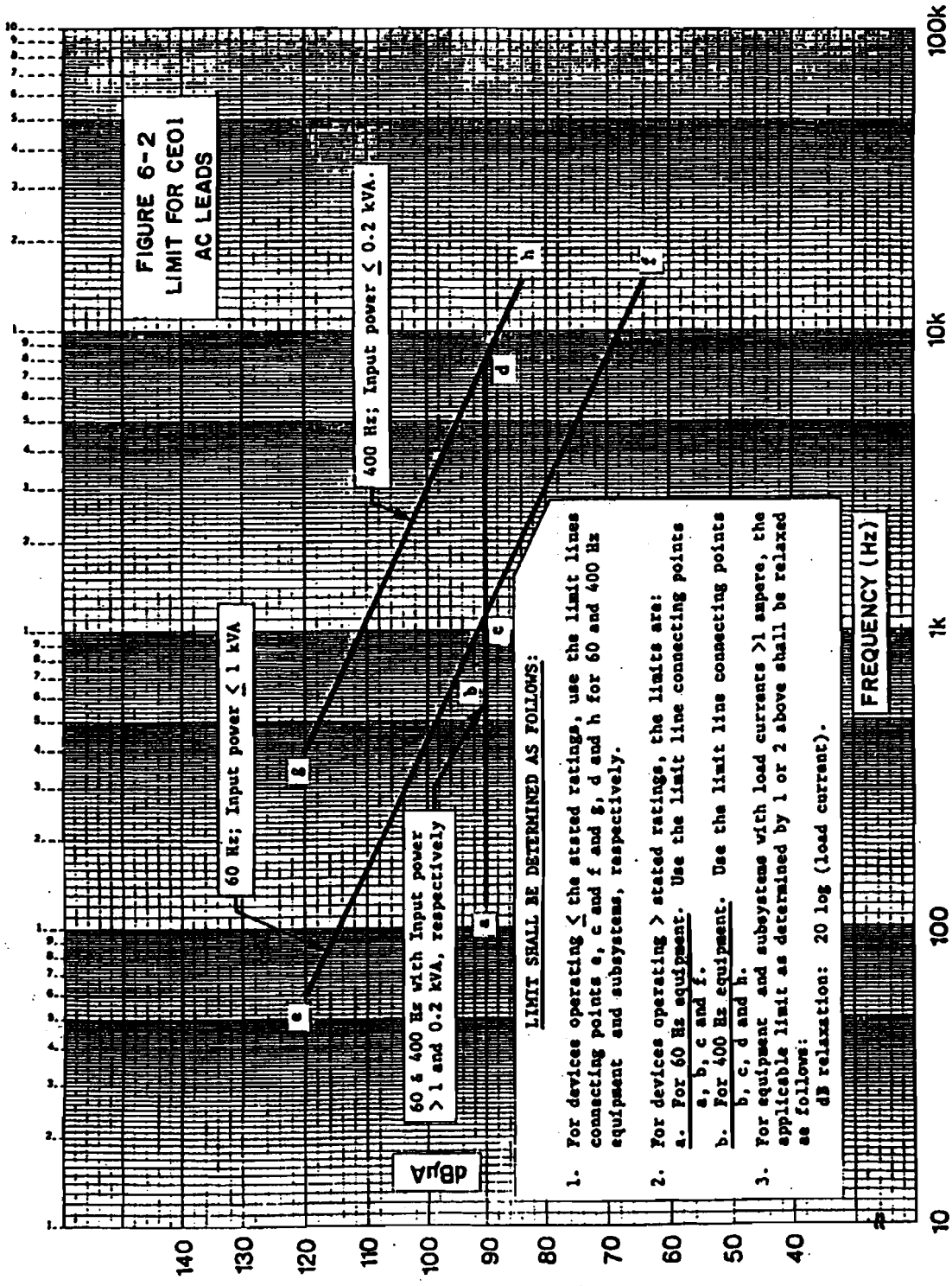

FIGURE 6-2. LIMIT FOR CEO1 AC LEADS

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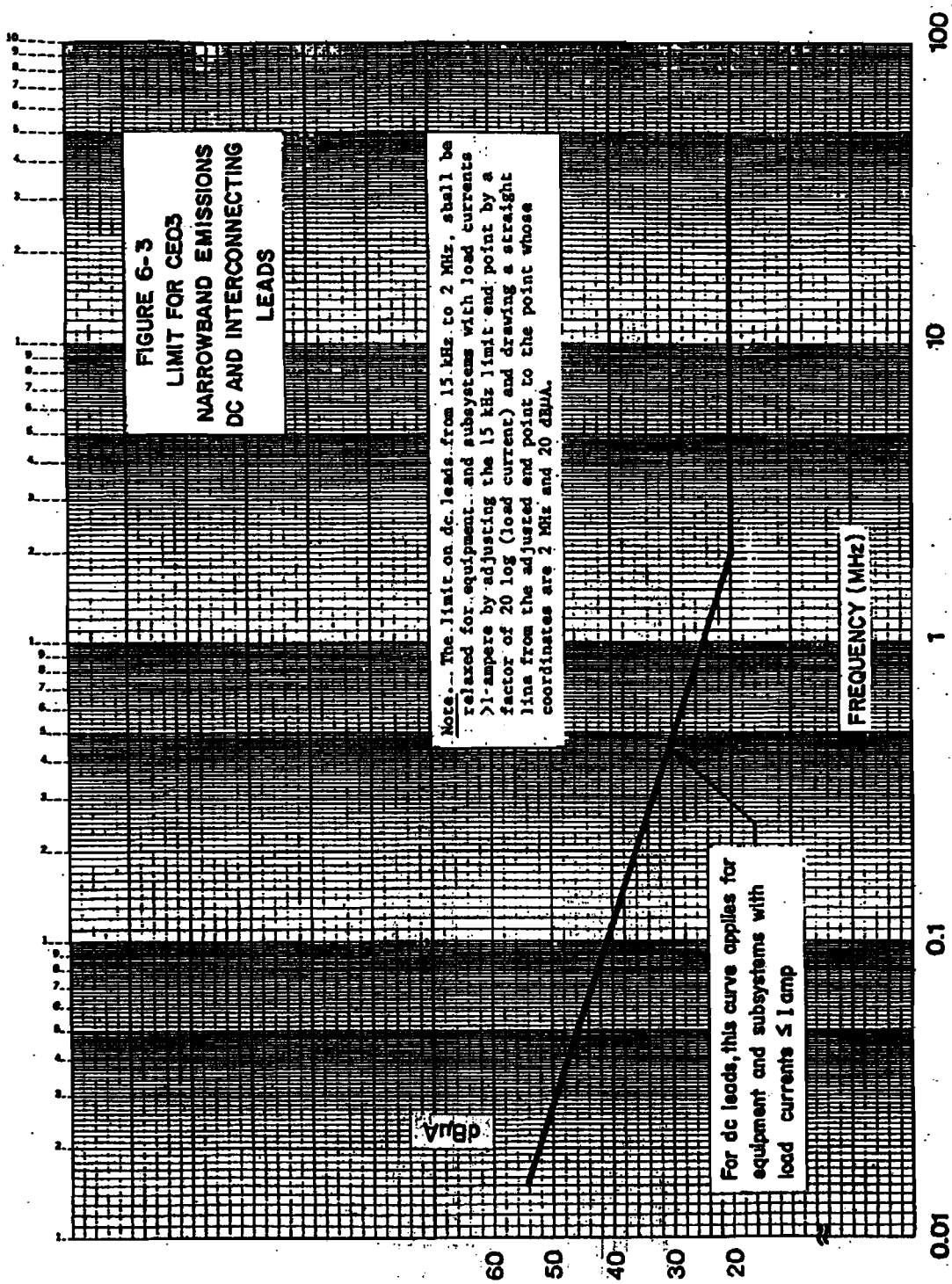

FIGURE 6-3. LIMIT FOR CE03 NARROWBAND EMISSIONS DC AND INTERCONNECTING LEADS

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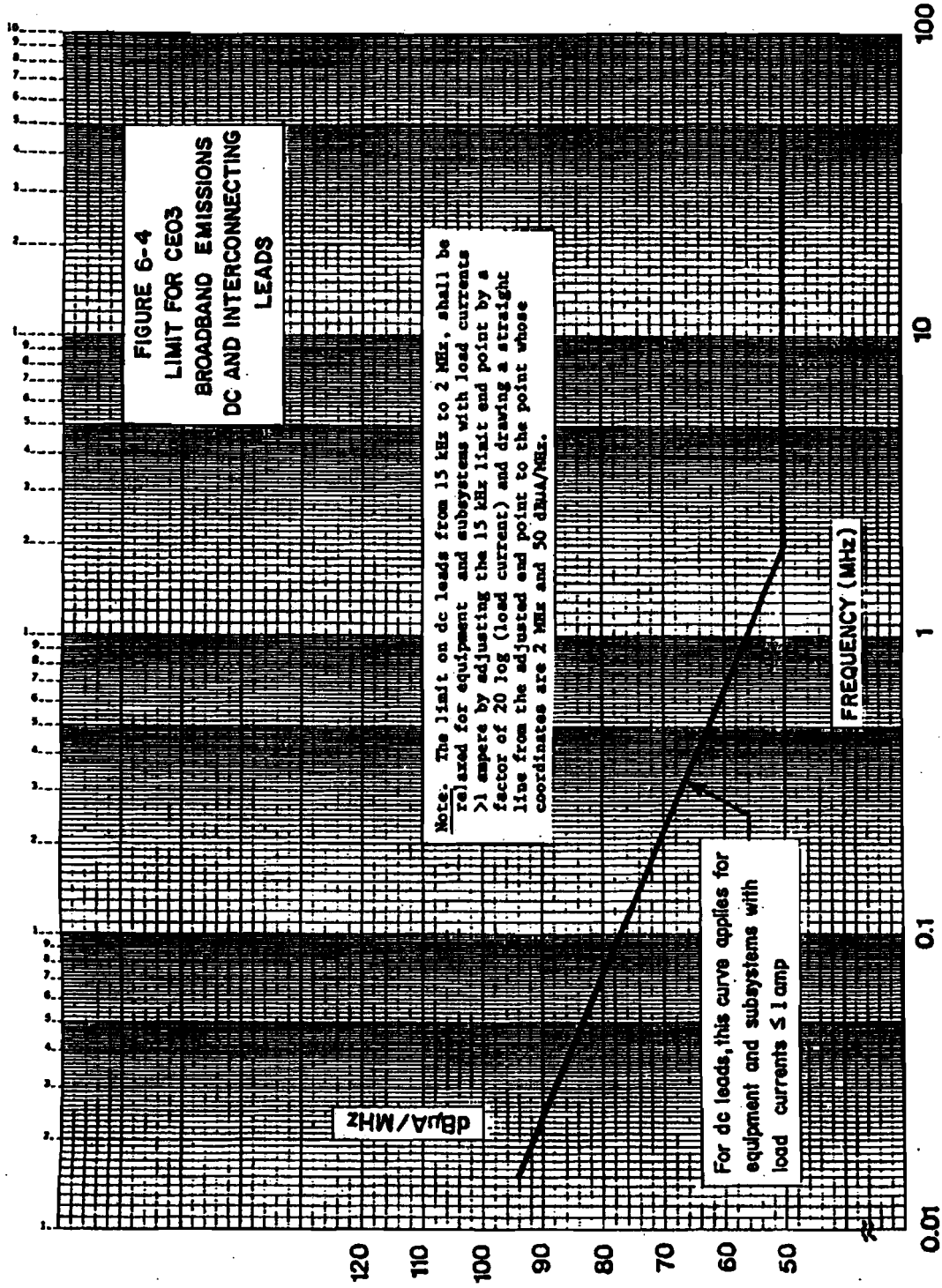

FIGURE 6-4. LIMIT FOR CE03 BROADBAND EMISSIONS DC AND INTERCONNECTING LEADS

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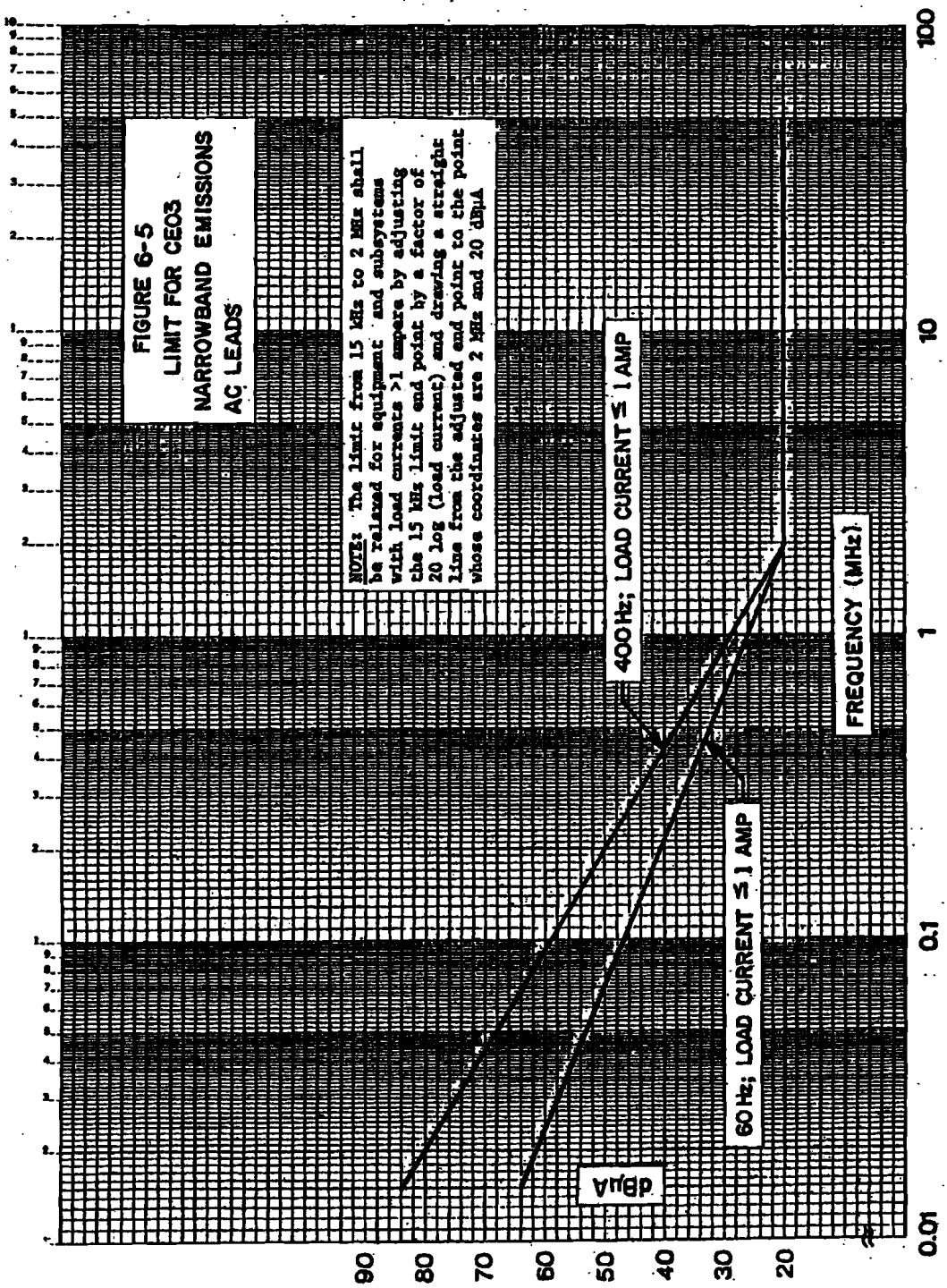

FIGURE 6-5. LIMIT FOR CE03 NARROWBAND EMISSIONS AC LEADS

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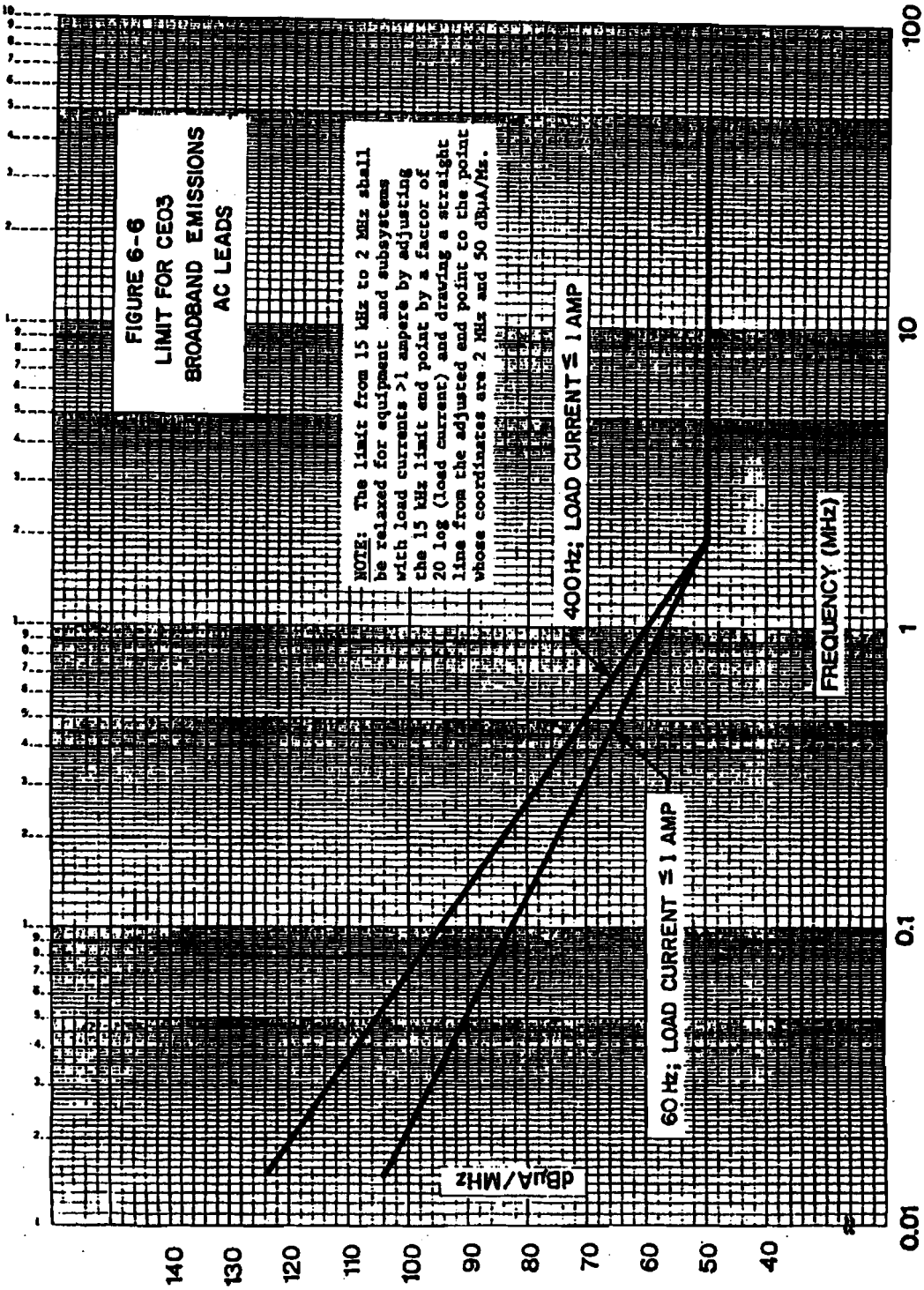

FIGURE 6-6. LIMIT FOR CE03 BROADBAND EMISSIONS AC LEADS

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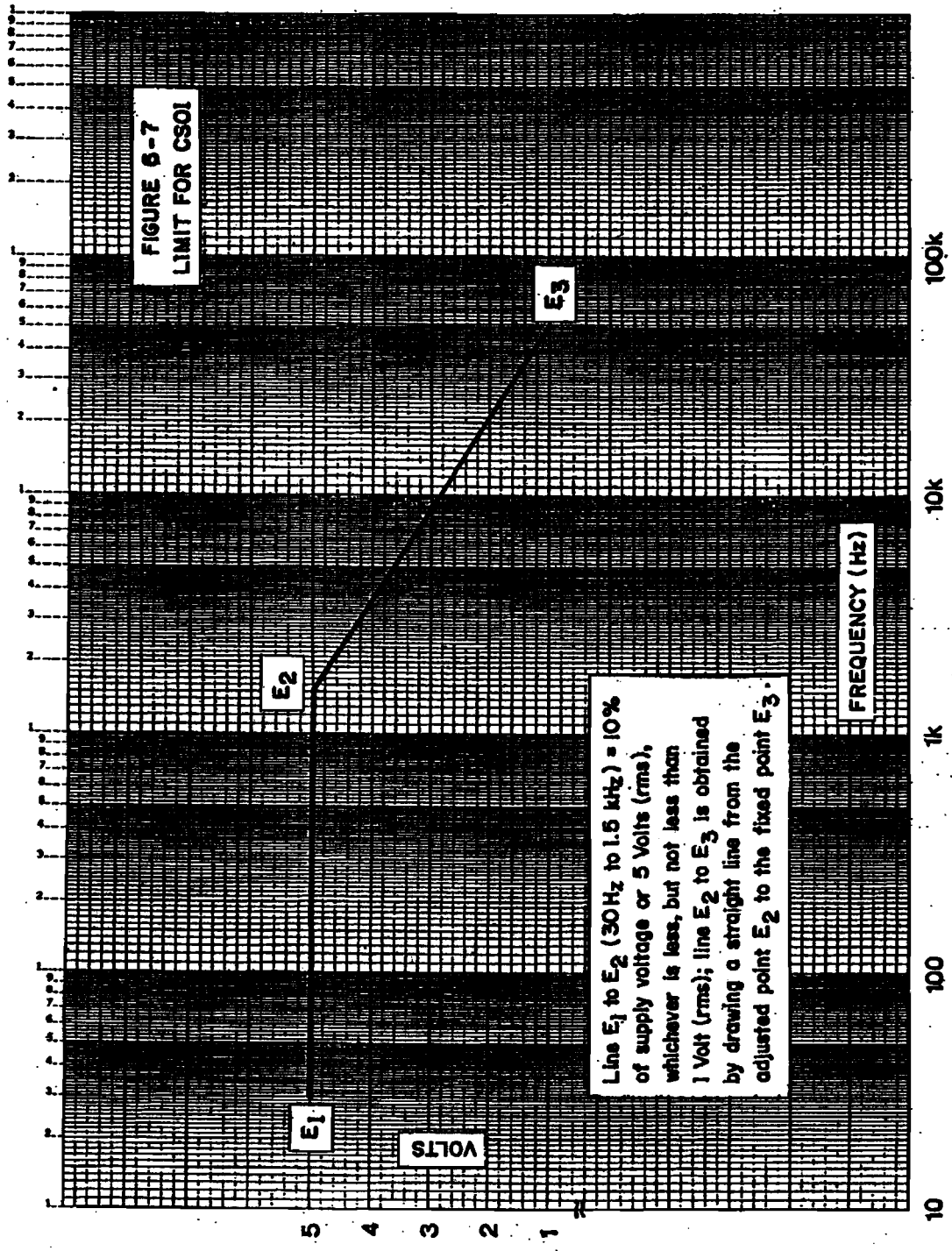

FIGURE 6-7. LIMIT FOR CS01

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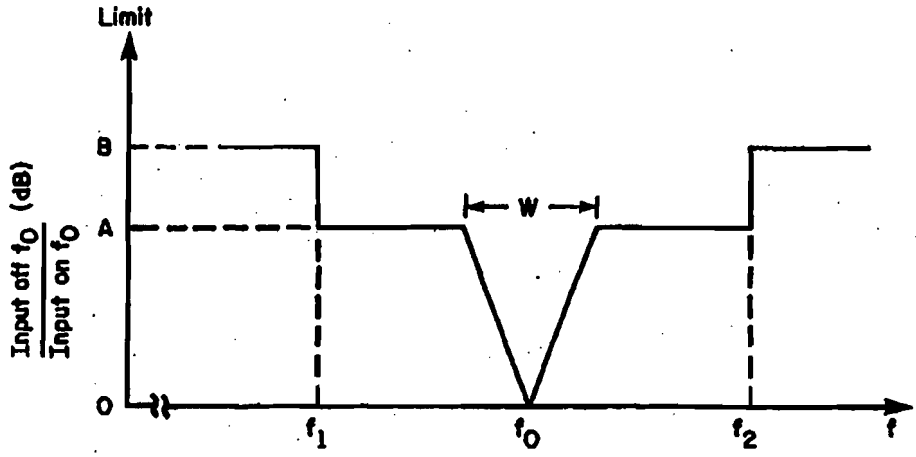

f_0 = Receiver tuned frequency or band center for amplifiers.

f_1 = Lowest tunable frequency of receiver band in use or the lowest frequency of amplifier passband.

f_2 = Highest tunable frequency of receiver band in use or the highest frequency of amplifier passband.

W = Bandwidth between the 80 dB points of the receiver selectivity curve as defined in the test sample's technical requirements or the control plan.

Limits:

1. The limit at A is 80 dB above the input level required to produce the standard reference output. (This limit shall not be used for amplifiers)
2. The limit at B shall be set as follows:
   a. Receivers: 0 dBm applied directly to the receiver input terminals.
   b. Amplifiers: The limit shall be as specified in the test sample's technical requirement or control plan. If no limit is defined in the above documents, the 0 dBm value shall be used.

FIGURE 6-8. LIMIT FOR CS04

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NOTE: The test sample shall be subjected to the spike(s) with the waveform shown and with the specified voltage(s) and pulsewidth(s).

FIGURE 6-9. ACCEPTABLE WAVESHAPES FOR CS06 AND RS02

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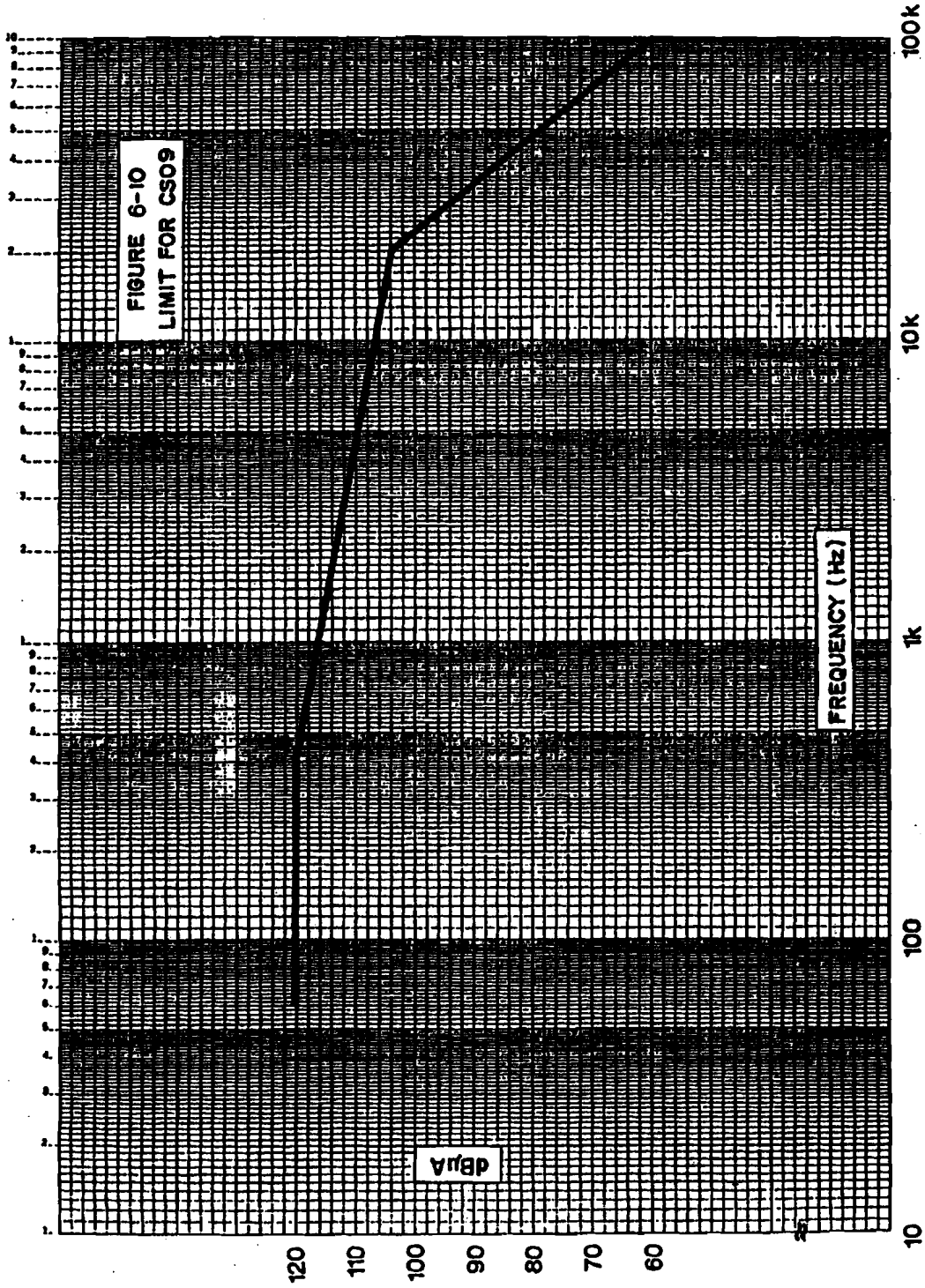

FIGURE 6-10. LIMIT FOR CS09

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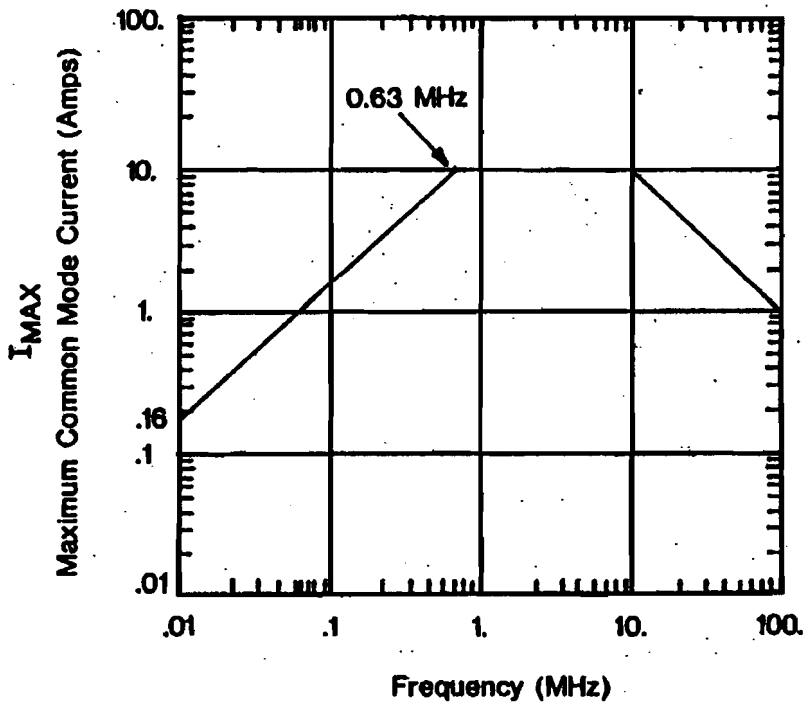

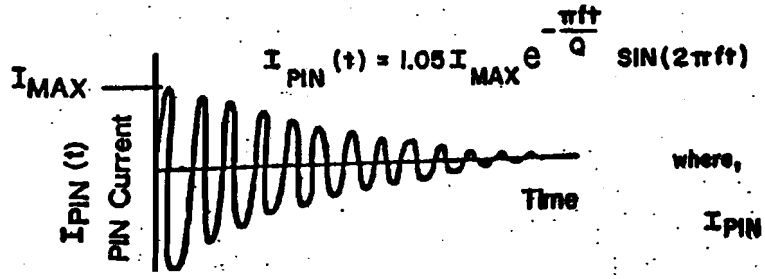

$$I_{PIN}(t) = 1.05\, I_{MAX}\, e^{-\frac{\pi f t}{Q}} \sin(2\pi f t)$$

where,

$I_{PIN}(t)$ = common mode pin current in amps

f = frequency, hertz

t = time, seconds

Q = decay factor

FIGURE 6-11. LIMIT FOR CS10

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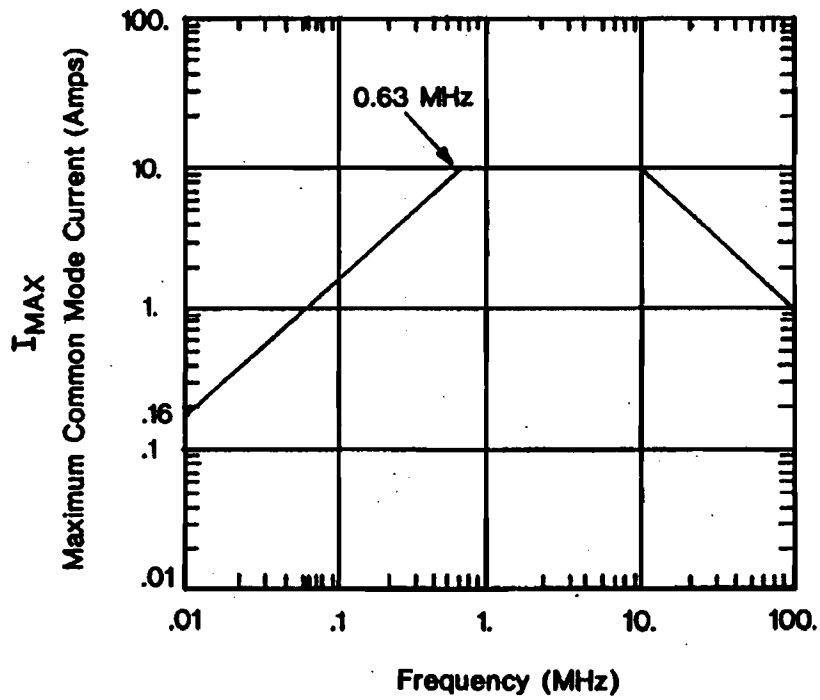

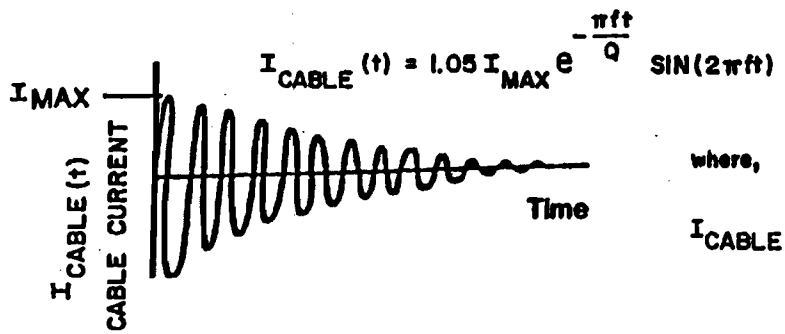

where,

$I_{CABLE}(t)$ = common mode cable current in amps

f = frequency, hertz

t = time, seconds

Q = decay factor

FIGURE 6-12. LIMIT FOR CS11

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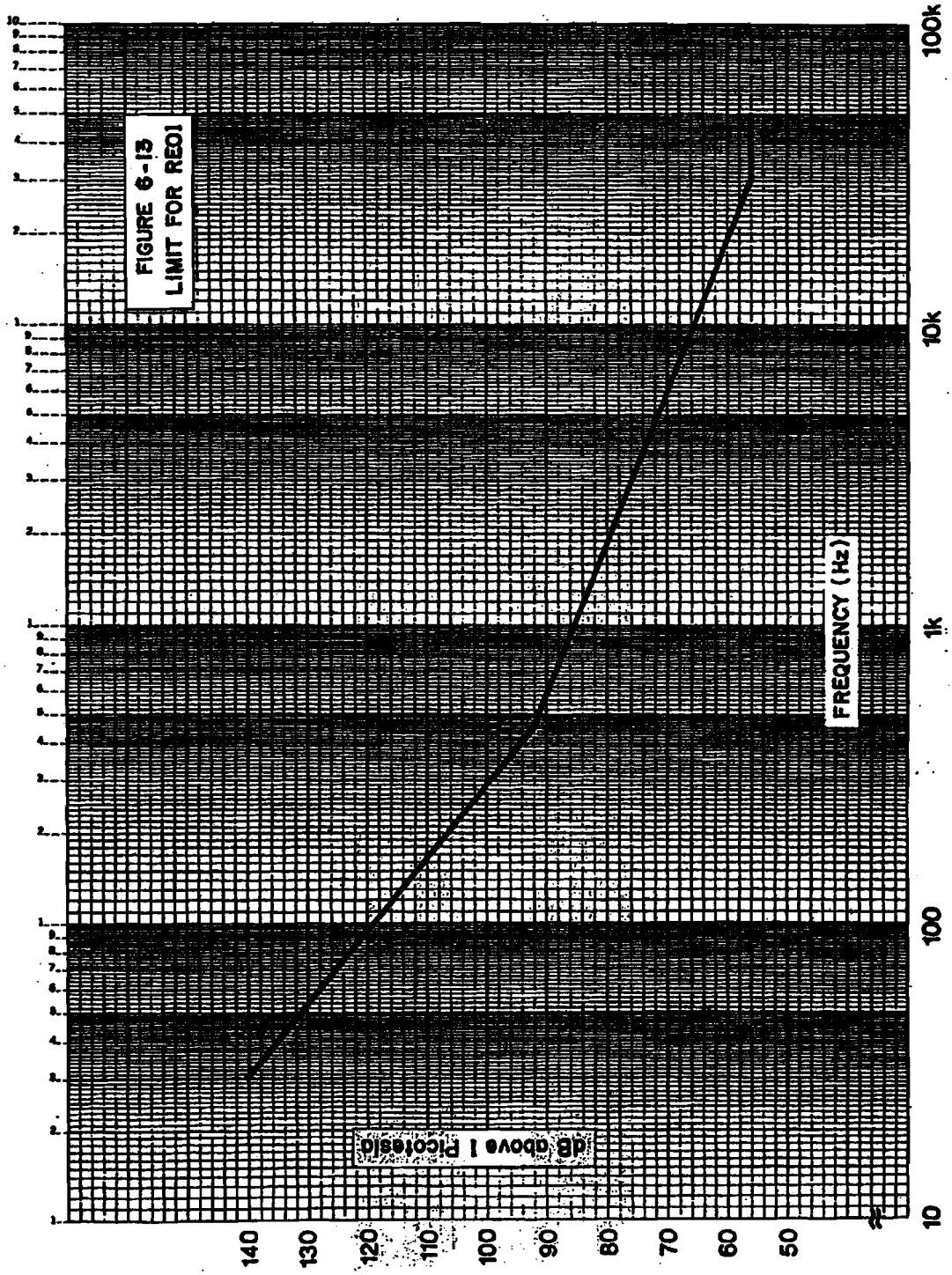

FIGURE 6-13. LIMIT FOR RE01

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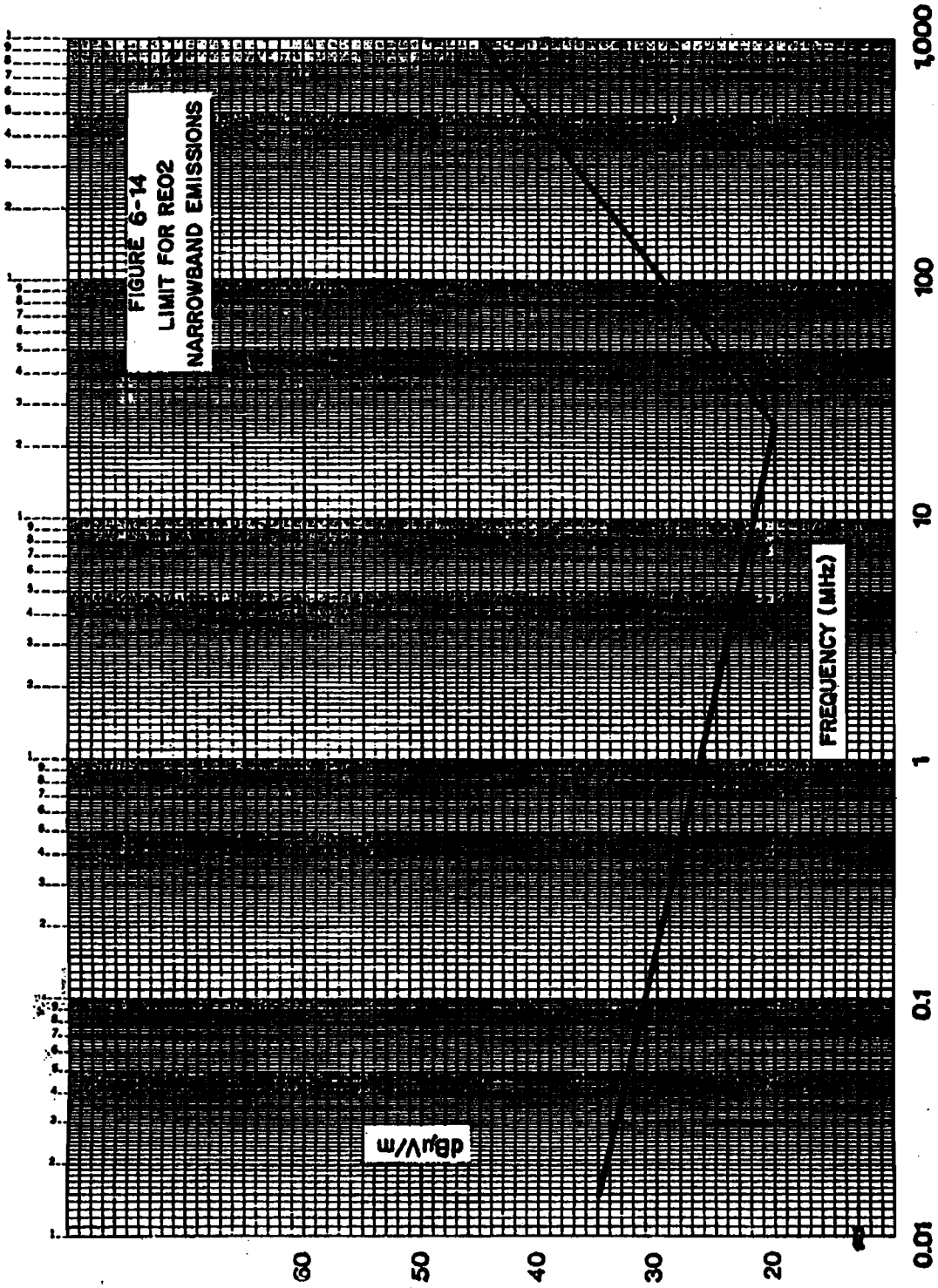

FIGURE 6-14. LIMIT FOR RE02 NARROWBAND EMISSIONS

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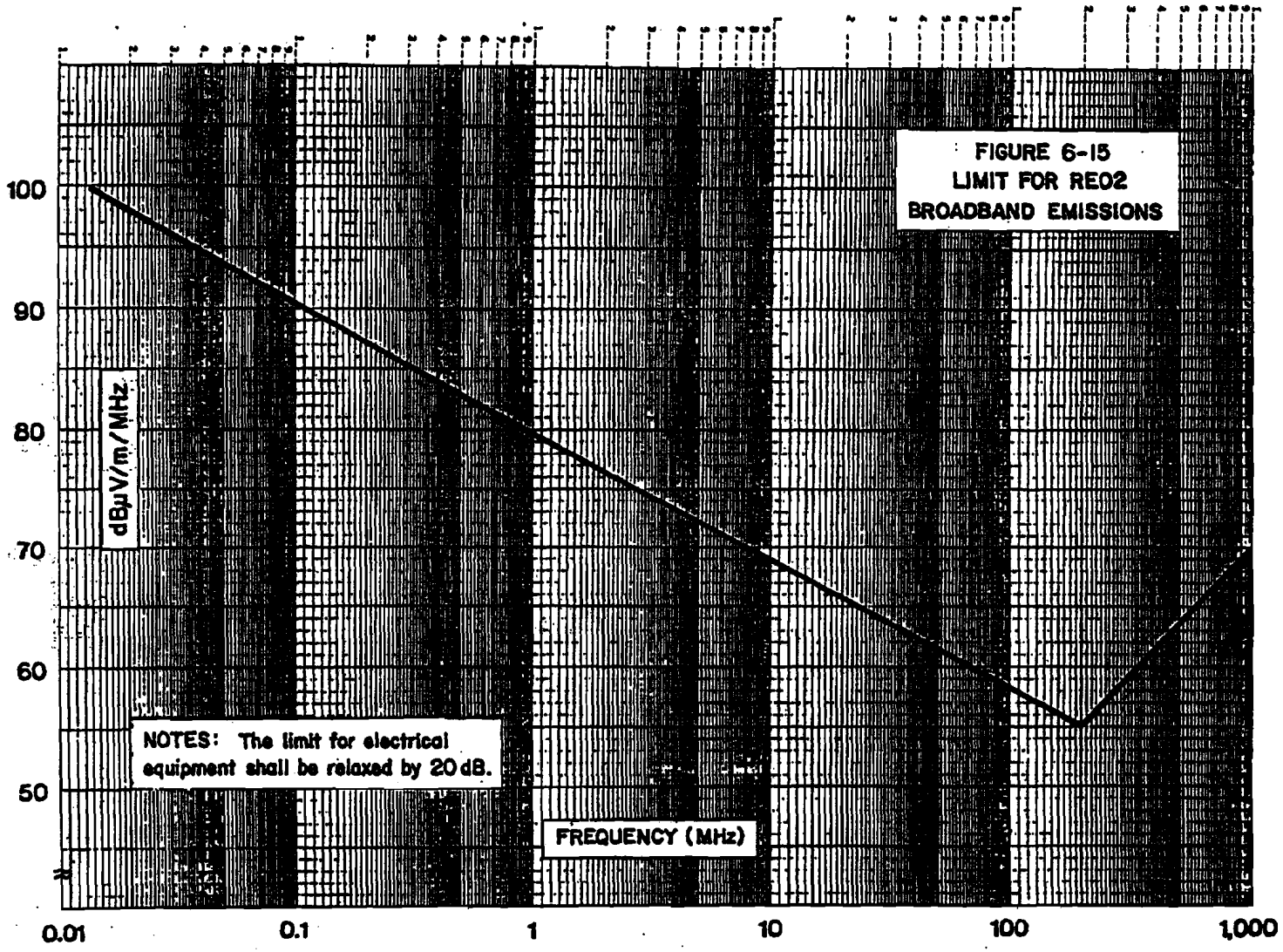

FIGURE 6-15. LIMIT FOR RE02 BROADBAND EMISSIONS

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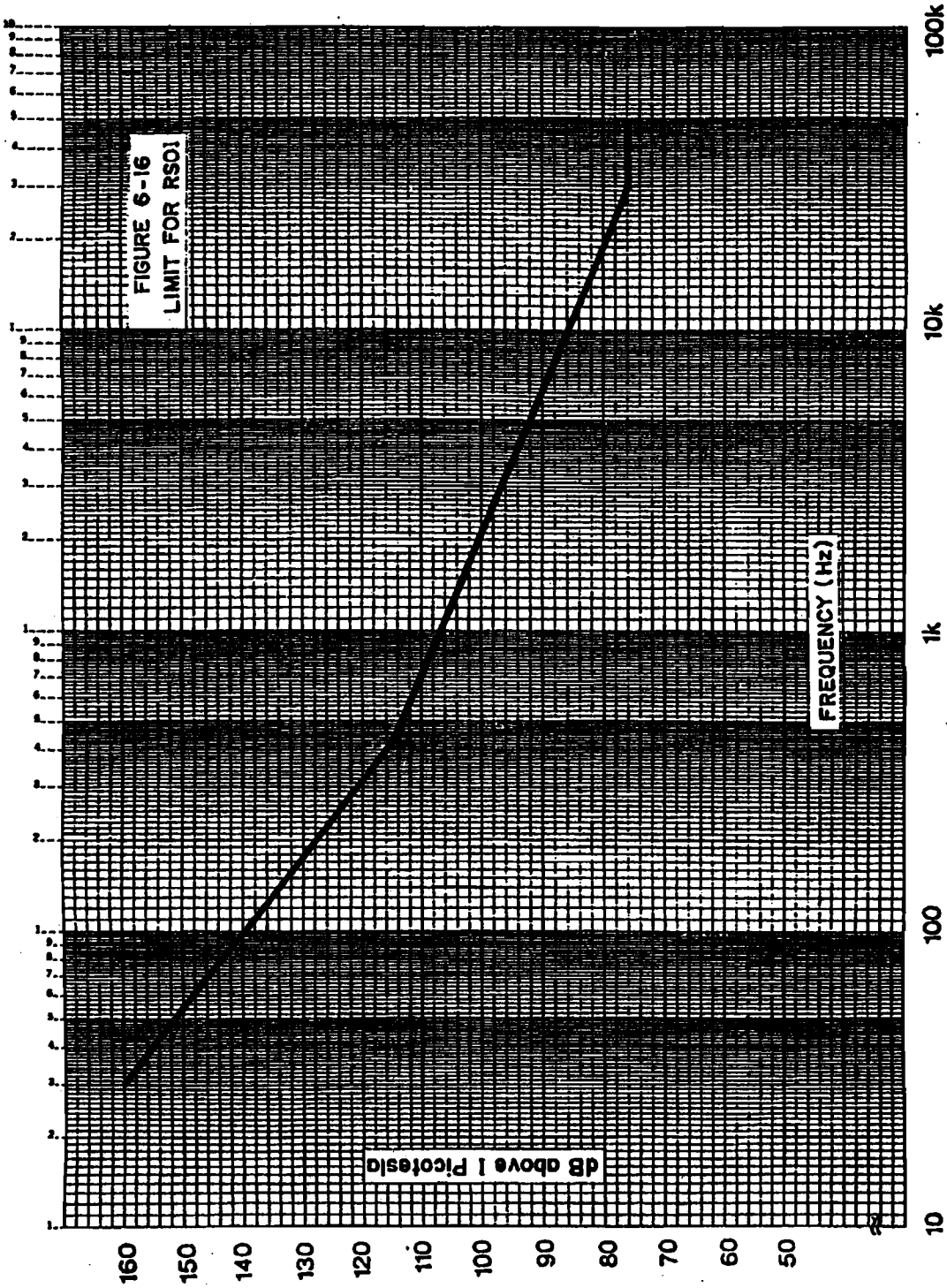

FIGURE 6-16. LIMIT FOR RSO1

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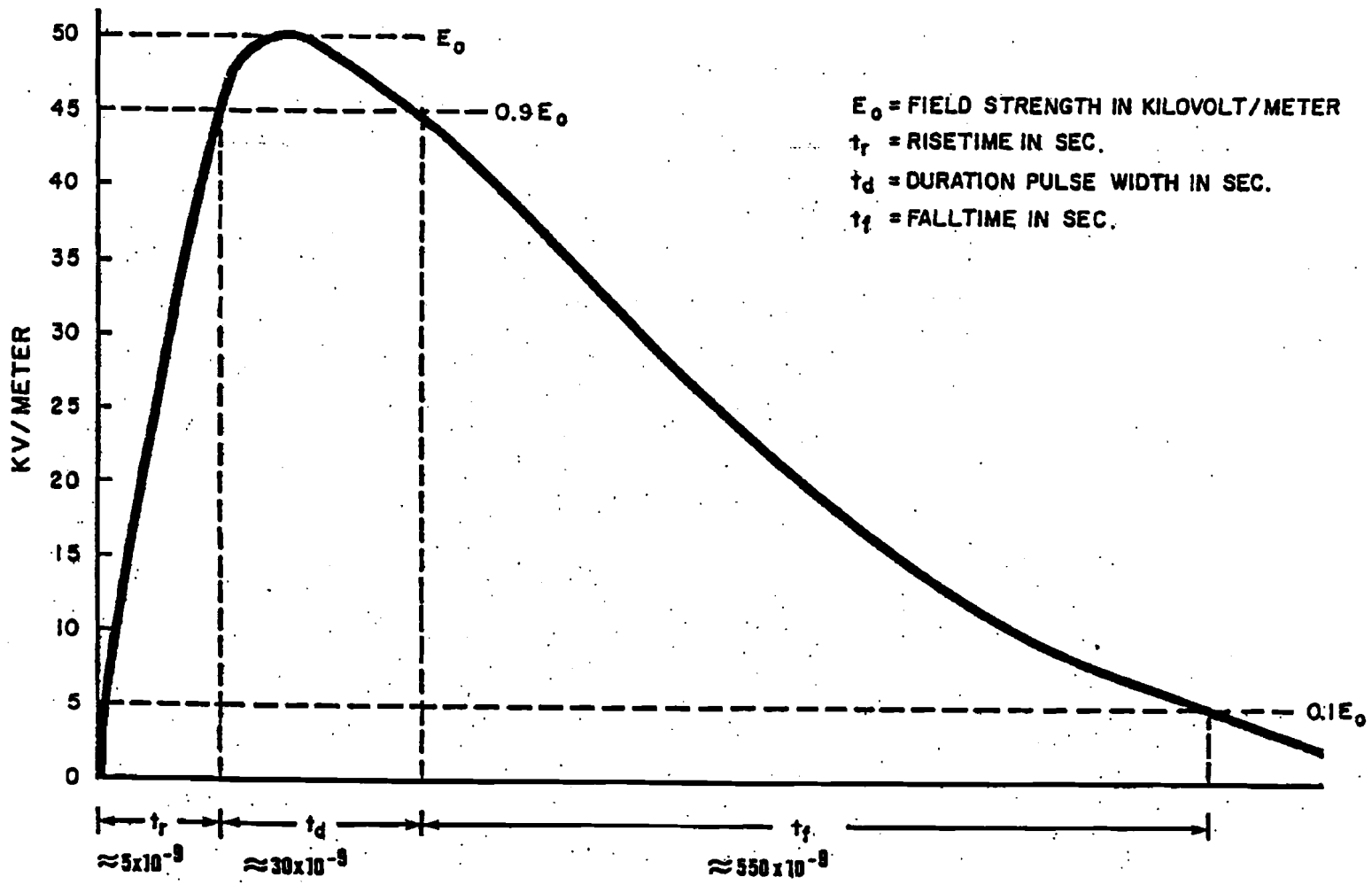

FIGURE 6-17. LIMIT FOR RS05

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Part 7. Ancillary or Support Equipment and Subsystems Installed in Non-Critical Ground Areas (Class B)

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1. SCOPE

This part of MIL-STD-461 supplements Part 1 of the standard by defining emission and susceptibility requirements and limits for equipment and subsystems which support the class A equipment and subsystems, but which will not be physically located in critical ground areas (class B). Examples of some of the class B equipment and subsystems include: electronic shop maintenance and test equipment used in non-critical ground areas; and theodolites, navaids, and other similar equipment and subsystems used in non-critical areas.

1.1 Determining requirements.

1.1.1 Air Force and Navy procurements. Table 7-I shall be used to determine the requirements applicable for equipment and subsystems procured for AF or Navy use. The table also denotes the paragraphs wherein the requirements and limits are defined. A "Y" entry in the table means the requirement is applicable, and the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "Y_L" entry means the applicability of the requirement is limited and is specified in the corresponding appropriate paragraph. The limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. A "T" entry means that the applicability of the requirement must be determined on a case-by-case basis and, if the requirement is to be imposed, it must be so specified in the appropriate procurement document. When required, the limit shall be met using the procedures in MIL-STD-462 or the approved EMI Test Plan. Absence of an entry means the requirement is not applicable.

1.1.2. Army procurements. This part of MIL-STD-461 shall not be used unless otherwise specified by the Command or agency concerned.

2. CE03

2.1 CE03 applicability. This requirement is applicable for alternating current (AC) and direct current (DC) leads, which obtain power from other sources or provide power to other equipment or subsystems, including grounds or neutrals which are not grounded internally to the subsystem or equipment being measured. For Navy procurements, this requirement is also applicable for interconnecting control leads which provide AC and DC power from or to the test sample. The requirement is not applicable for interconnecting signal leads such as clock, IF, audio, digital, RF, and the like, unless otherwise specified by the Command or agency concerned. Conducted switching transient emissions, including ON/OFF switching, shall meet the requirements of CE07.

2.2 CE03 limits.

2.2.1 DC and interconnecting control leads. Electromagnetic emissions shall not appear on DC and, where required, interconnecting control leads in excess of the values shown on Figures 7-1 and 7-2 for narrowband and broadband emissions, respectively.

2.2.2 AC leads.

2.2.2.1 Air Force procurements. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on Figures 7-1 and 7-2 for narrowband and broadband emissions, respectively.

2.2.2.2 Navy procurements. Electromagnetic emissions shall not appear on AC leads in excess of the values shown on Figures 7-3 and 7-4 for narrowband and broadband emissions, respectively.

2.2.3 Interconnecting signal leads. If compliance with this requirement is required for signal leads, limits shall be developed on a case-by-case basis considering the intentional transmission, its specified power level, necessary information bandwidth, and pulse rise time. Such limits must be approved by the Command or agency concerned.

3. CE06 (limited applicability)

3.1 CE06 applicability. This requirement is applicable for those equipment and subsystems with antenna leads or those designed to be connected to antennas. The transmitter (key-down), harmonic and spurious emission portions of this requirement may be measured using the procedures in RE03 (in lieu of CE06) with the approval of the Command or agency concerned, when any of the following conditions exist: (a) transmitter power exceeds 5 kW average, (b) the fundamental frequency of the test sample exceeds 1.24 GHz, (c) the test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable

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TABLE 7-1. EMISSION AND SUSCEPTIBILITY REQUIREMENTS FOR CLASS B EQUIPMENT AND SUBSYSTEMS

Requirement	Applicability	Applicable	
		Paragraph	Limit Curve
CE03	Y	2	7-1, 7-2, 7-3 and 7-4
CE06	Y_L	3	
CE07	T	4	
CS01	Y_L	5	7-5
CS02	T	6	
CS03	T	7	
CS04	T	8	7-6
CS05	T	9	
CS06	Y	10	7-7
RE02	Y	11	7-8 and 7-9
RE03	T	12	
RS02	T	13	7-7
RS03	Y	14	

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dummy load, or (d) for equipment and subsystems with waveguide transmission lines and operating below 1.24 GHz. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The transmitter (key-down) portion of this requirement is not applicable within either the test sample's necessary bandwidth or ± 5 percent of the fundamental frequency.

3.2 CE06 limits. Conducted emissions in excess of the values given below shall not appear at the test sample's antenna terminals.

3.2.1 Receivers.

a. Narrowband emissions: 34 dB µV

b. Broadband emissions: 40 dB µV/MHz

3.2.2 Transmitters (key-up and standby).

a. Narrowband emissions: 34 dB µV

b. Broadband emissions: 40 dB µV/MHz

3.2.3 Transmitters (key-down mode). Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

4. CE07 (limited applicability)

4.1 CE07 applicability. Applications of this requirement are to be determined on a case-by-case basis for the following types of leads: AC or DC leads which obtain power from or provide power to other equipment or subsystems.

4.2 CE07 limits. Conducted switching spikes of less than 50 microseconds in duration shall not exceed the following, as applicable:

a. AC leads: ± 50 percent of nominal rms voltage.

b. DC leads: + 50 percent, -150 percent of nominal line voltage.

Conducted switching spikes equal to or greater than 50 microseconds in duration shall meet the transient requirements as specified in the individual equipment or subsystem specifications. Spike duration is the time interval between the 50% amplitude point on the transient leading edge and the 50% amplitude point on the transient trailing edge; high frequency ringing superimposed on the pulse leading and trailing edges should be ignored.

5. CS01 (limited applicability)

5.1 CS01 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem. The requirement is not applicable within ± 5 percent of the power frequency(ies). For Navy procurements, this requirement may be deleted for AC leads, with the approval of the Command or Agency concerned, if no circuit within the equipment or system is more sensitive than 100 mV.

5.2 CS01 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to electromagnetic energy injected onto its power leads equal to the values on Figure 7-5. The requirement is also met under the following condition: when the power source specified in MIL-STD-462, adjusted to dissipate 50 watts in a 0.5 ohm load, cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

6. CS02 (limited applicability)

6.1 CS02 applicability. Applications of this requirement are to be determined on a case-by-case basis for equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

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6.2 CS02 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to 1-volt from a 50 ohm source. The test signal shall be applied directly to the equipment input terminals, not through the test sample's power line cord. The requirement is also met under the following condition: When a 1-watt source of 50 ohms impedance cannot develop the required voltage at the test sample power input terminals, and the test sample is not susceptible to the output of the signal source.

7. CS03 (limited applicability)

7.1 CS03 applicability. Applications of this requirement are to be determined on a case-by-case basis for receiving equipment and subsystems, such as receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample as specified in MIL-STD-462.

7.2 CS03 limits. The test sample shall not exhibit any intermodulation products from two signals, beyond those permitted in the individual equipment or subsystem specification, when:

a. Signal generator #1 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462; except that when f_1 is in the frequency range of either 200 to 400 MHz or 2 to 25 MHz, the generator output shall be 80 dB above the reference level, but the output of signal generator #1 shall not exceed 10 dBm.

b. Signal generator #2 is set 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but the generator output level shall not exceed a power level of 10 dBm.

8. CS04 (limited applicability)

8.1 CS04 applicability. Applications of this requirement are to be determined on a case-by-case basis for receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

8.2 CS04 limits. Test sample shall not exhibit any undesired response when subjected to the test signal shown on Figure 7-6.

9. CS05 (limited applicability)

9.1 CS05 applicability. Applications of this requirement are to be determined on a case-by-case basis for receivers, RF amplifiers, transceivers, and the like. The applicable frequency range of this requirement is dependent on the operating frequency of the test sample, as specified in MIL-STD-462.

9.2 CS05 limits. The test sample shall not exhibit, due to cross modulation, any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the following from signal generator #2: a signal 66 dB above the level required to obtain the standard reference output, as specified in MIL-STD-462, but not to exceed a power output level of 10 dBm.

10. CS06

10.1 CS06 applicability. This requirement is applicable to equipment and subsystem AC and DC power leads, including grounds and neutrals which are not grounded internally to the equipment or subsystem.

10.2 CS06 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when the test spike having the waveform shown on Figure 7-7 is applied to the AC and DC power input leads for a period of not less than 1 minute at each phase position, and for a total test period not exceeding 15 minutes in duration (in lieu of the values in MIL-STD-462). The values of E() and t() are given below. The spike shall be superimposed on the powerline voltage waveform.

a. Spike #1 E_1 = 400 Volts; t_1 = 5 microseconds $\pm$ 20%.

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11. RE02

11.1 RE02 applicability. This requirement is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power, and antennas transmission lines) and interconnecting wiring of the test sample; for narrowband, it applies at the fundamental frequencies and all spurious emissions, including harmonics, but does not apply to radiation from antennas. This requirement is applicable for broadband emissions from 14 kHz to 1 GHz and for narrowband emissions from 14 kHz to 10 GHz.

11.2 RE02 limits. E-field emissions shall not be radiated in excess of those given in 11.2.1 and 11.2.2. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves.

11.2.1 Narrowband electric field emissions. Narrowband E-field emissions shall not be radiated in excess of the applicable limit curve shown on Figure 7-8 at the required test distance, as specified in MIL-STD-462.

11.2.2 Broadband electric field emissions. Broadband E-field emissions from all equipment and subsystems, including radiated switching transients resulting from (a) automatic cycling of electronic or electrical switching circuitry, (b) actuation of push-to-talk mechanisms (that is, keying of transmitters), or (c) manual switching shall not be radiated in excess of the limit curve shown on Figure 7-9 at the required test distances, as specified in MIL-STD-462.

12. RE03 (limited applicability)

12.1 RE03 applicability. This requirement is applicable, with the approval of the procuring activity, when the spurious emissions and harmonics cannot be determined using the procedures of CE06. The frequency range of this requirement is dependent on the operating frequency of the test sample (see MIL-STD-462). The requirement is not applicable within either the test sample's necessary bandwidth or $\pm$ 5 percent of the fundamental frequency.

12.2 RE03 limit. Harmonics, except the second and third, and all other spurious emissions shall have peak powers 80 dB down from the power at the fundamental. The second and third harmonics shall be suppressed by: 50 + 10 log P (where P = peak power, in watts, at the fundamental) or 80 dB, whichever requires less suppression.

13. RS02 (limited applicability)

13.1 RS02 applicability. Applications of Parts I and II of this requirement are to be determined on a case-by-case basis.

13.2 RS02 limits.

13.2.1 Part I - spikes. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the test spike having the waveform shown on Figure 7-7. The values of $E_{()}$ and $t_{()}$ are given below:

a. Spike #1 E_1 = 400 Volts; t_1 = 5 microseconds $\pm$ 20%.

13.2.2 Part II - power frequency. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when 20 amperes are applied to the test wire at the power frequency(ies) of the test sample.

14. RS03

14.1 RS03 applicability. This requirement is applicable for all equipment and subsystems between 14 kHz and 10 GHz. Above 10 GHz, this requirement is not mandatory unless otherwise required by the procuring activity.

14.2 RS03 limits. The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to a radiated electric field of 1 Volt/meter. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circular polarized waves are also acceptable.

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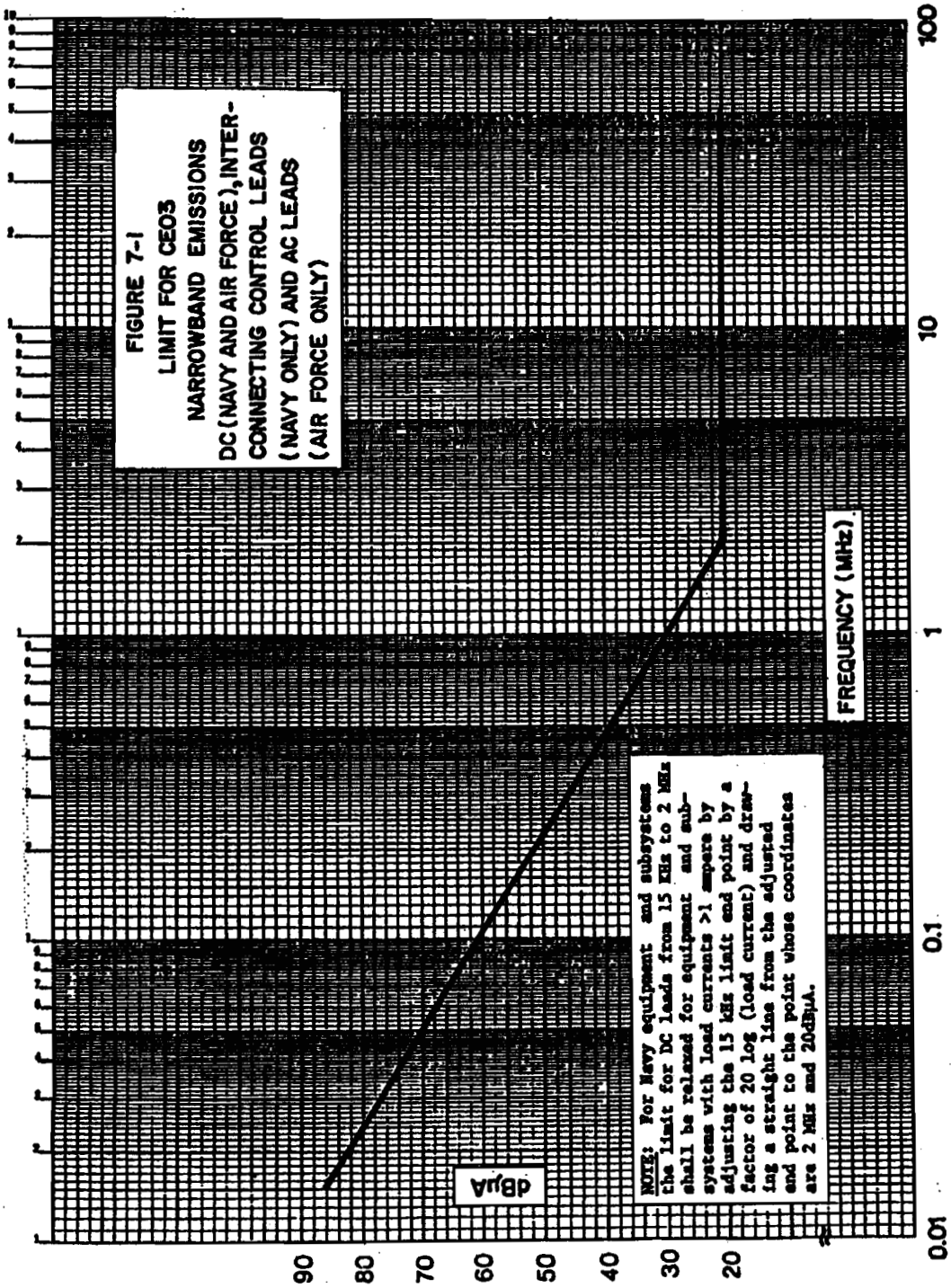

FIGURE 7-1. LIMIT FOR CE03 NARROWBAND EMISSIONS, DC (NAVY AND AIR FORCE), INTERCONNECTING CONTROL LEADS (NAVY ONLY) AND AC LEADS (AIR FORCE ONLY)

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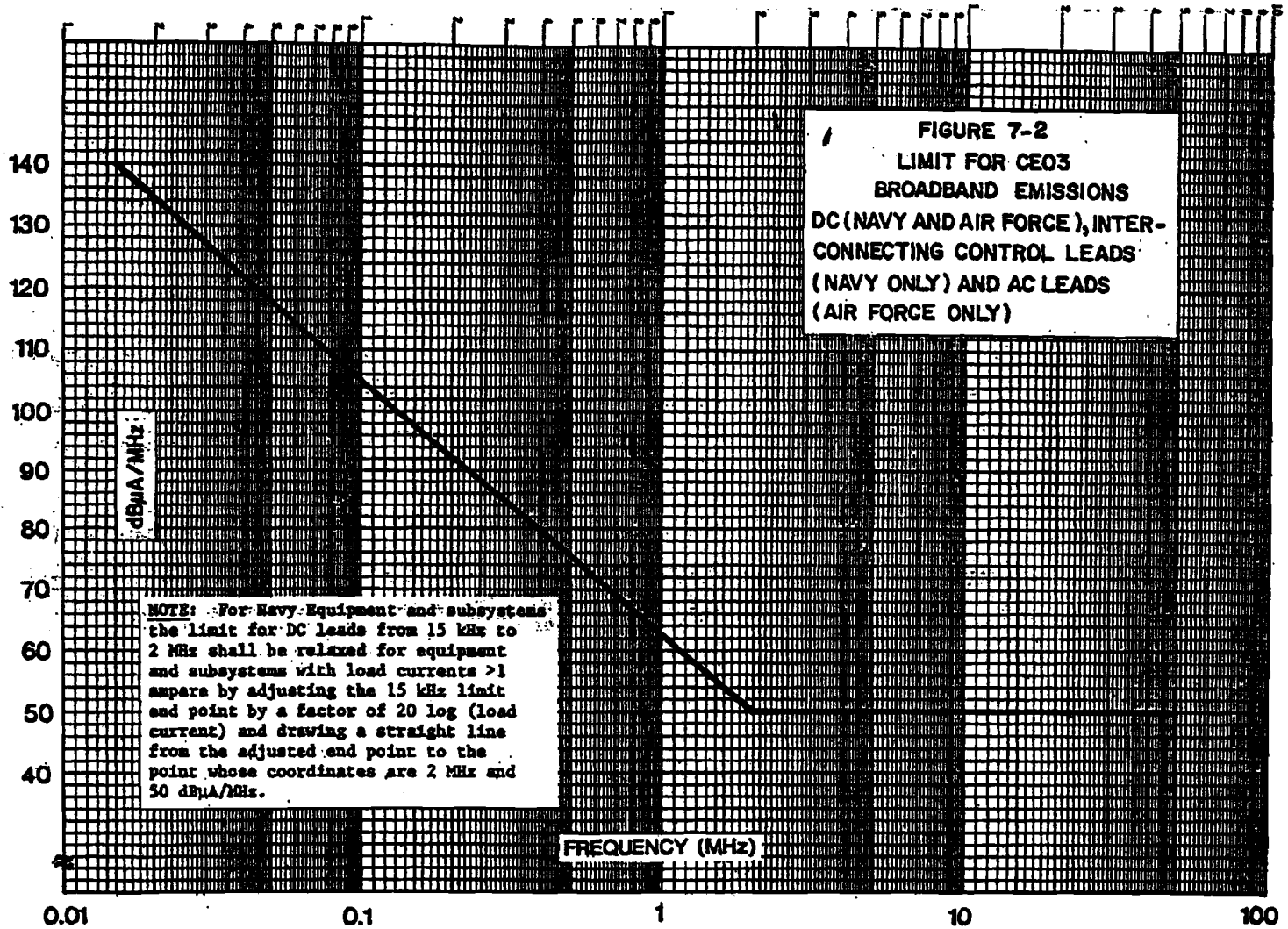

FIGURE 7-2. LIMIT FOR CE03 BROADBAND EMISSIONS, DC (NAVY AND AIR FORCE), INTERCONNECTING CONTROL LEADS (NAVY ONLY) AND AC LEADS (AIR FORCE ONLY)

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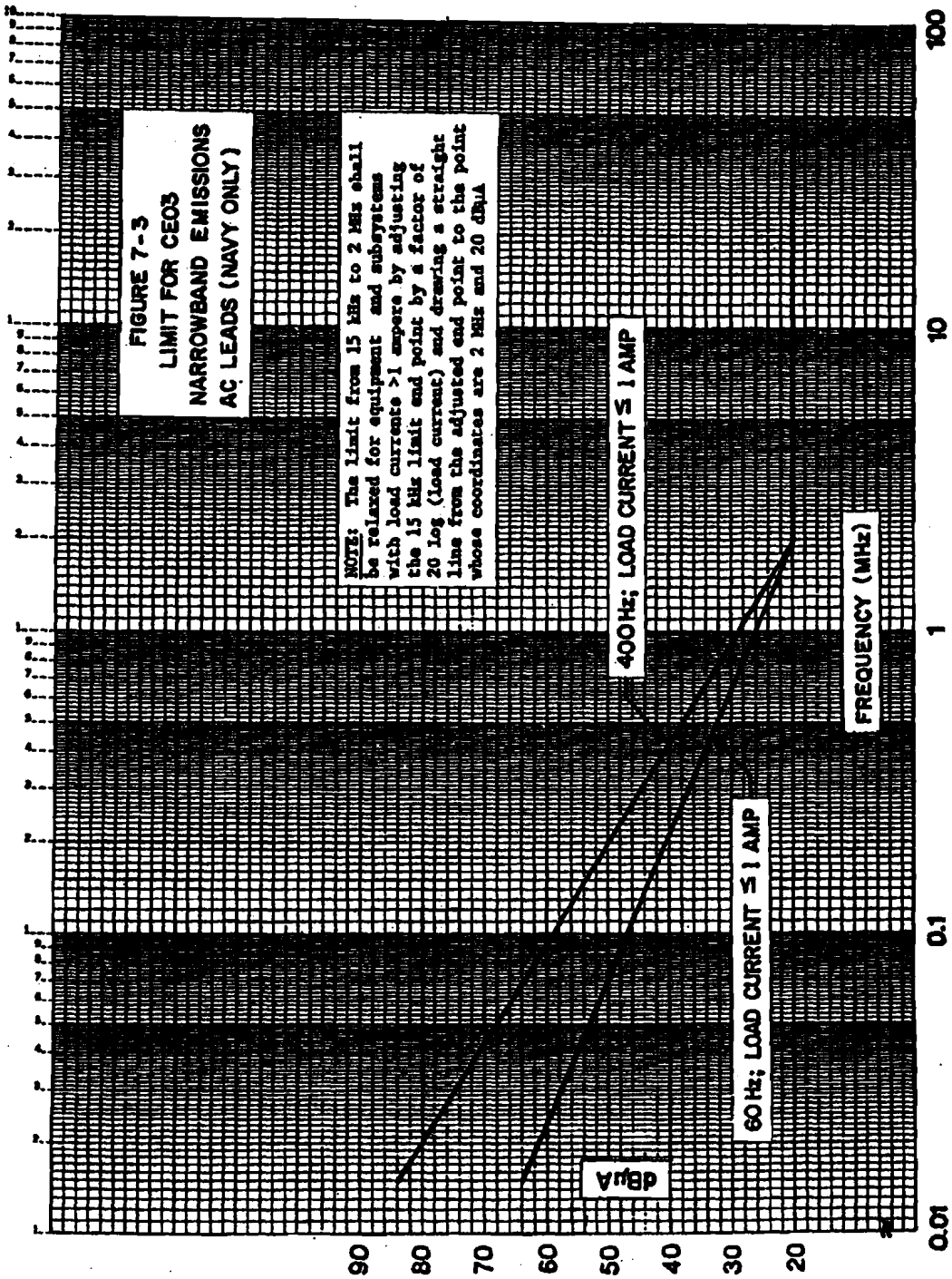

FIGURE 7-3. LIMIT FOR CE03 NARROWBAND EMISSIONS AC LEADS (NAVY ONLY)

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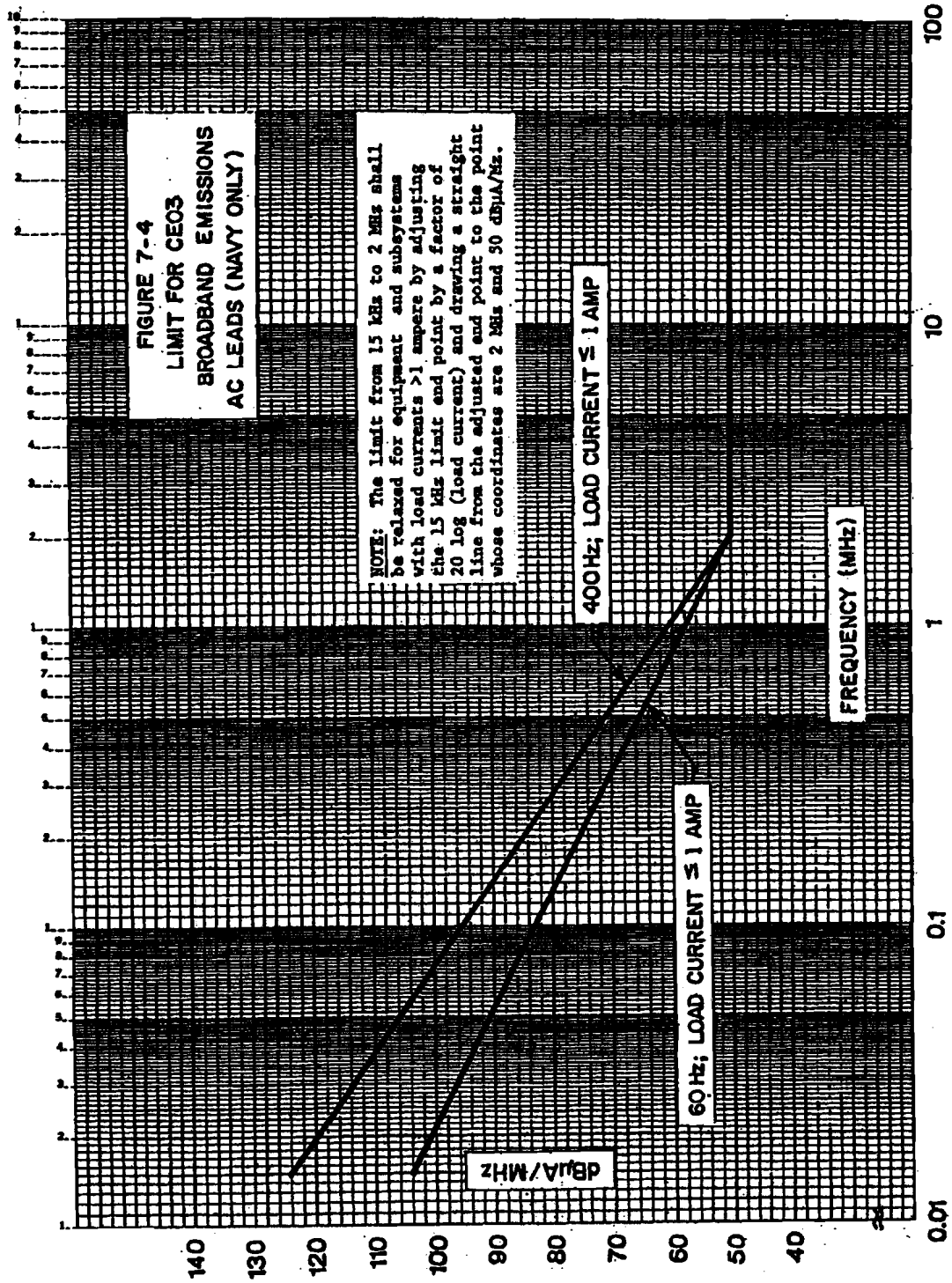

FIGURE 7-4. LIMIT FOR CE03 BROADBAND EMISSIONS AC LEADS (NAVY ONLY)

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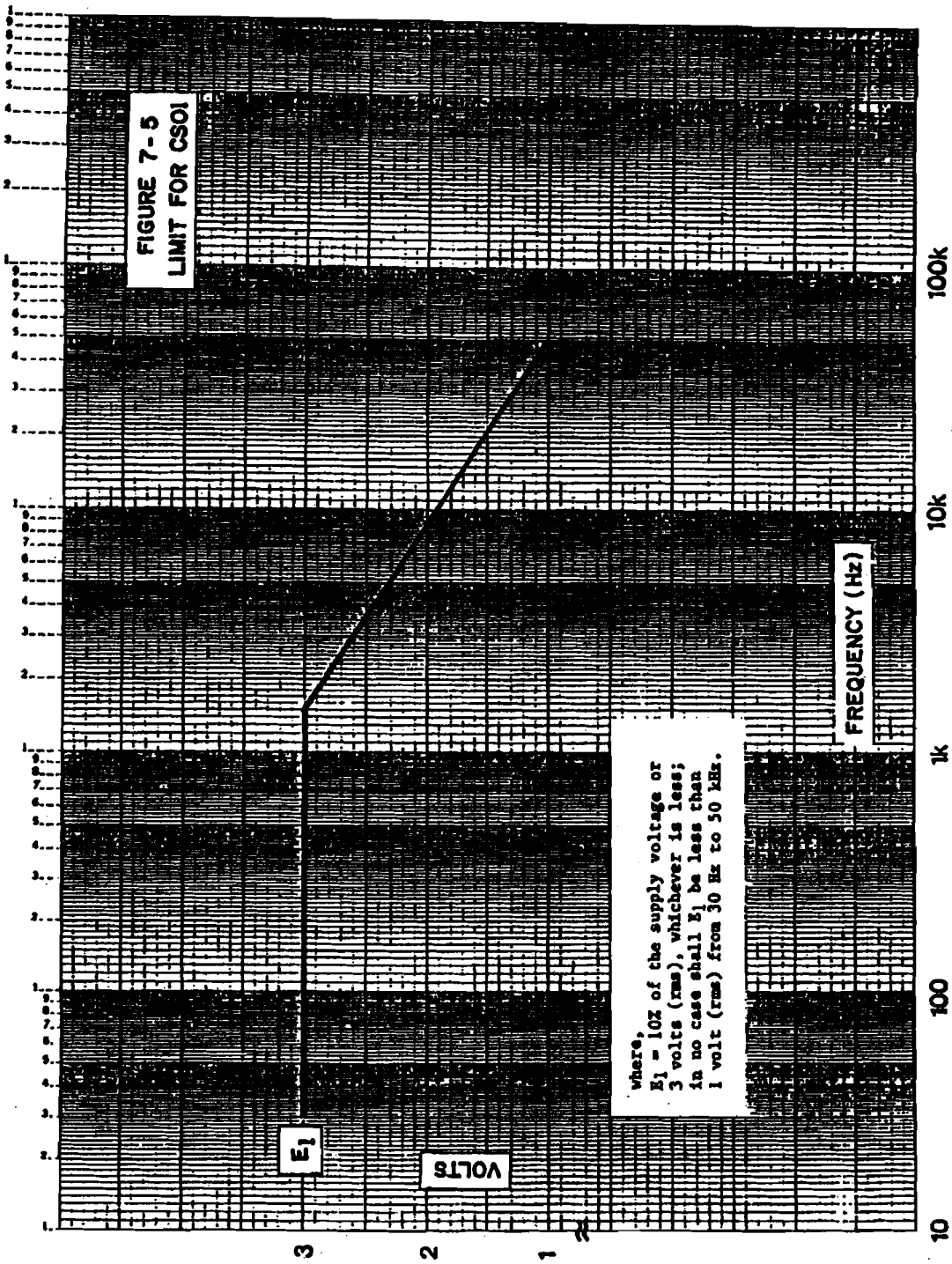

FIGURE 7-5. LIMIT FOR CS01

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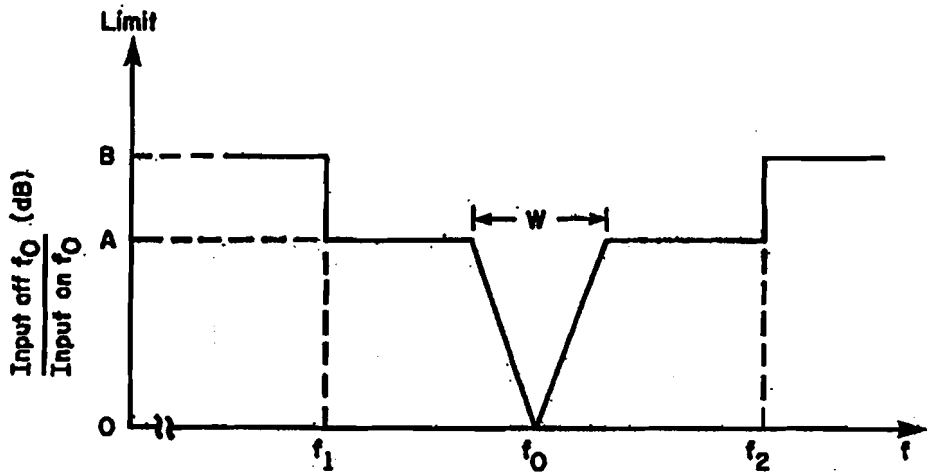

f_0 = Receiver tuned frequency or band center for amplifiers.

f_1 = Lowest tunable frequency of receiver band in use or the lowest frequency of amplifier passband.

f_2 = Highest tunable frequency of receiver band in use or the highest frequency of amplifier passband.

W = Bandwidth between the 80 dB points of the receiver selectivity curve as defined in the test sample's technical requirements or the control plan.

Limits:

1. The limit at A is 80 dB above the input level required to produce the standard reference output. (This limit shall not be used for amplifiers)
2. The limit at B shall be set as follows:
   a. Receivers: 0 dBm applied directly to the receiver input terminals.
   b. Amplifiers: The limit shall be as specified in the test sample's technical requirement or control plan. If no limit is defined in the above documents, the 0 dBm value shall be used.

FIGURE 7-6. LIMIT FOR CS04

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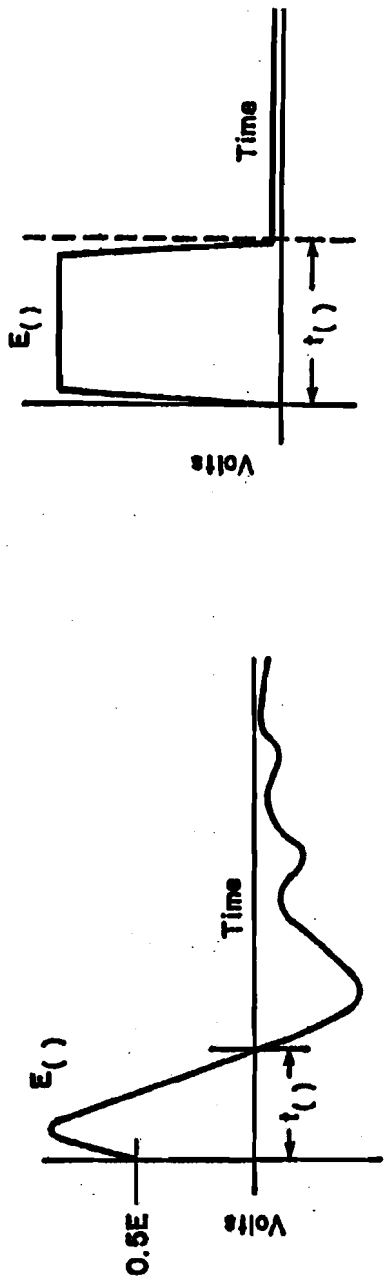

NOTE: The test sample shall be subjected to the spike(s) with the waveform shown and with the specified voltage(s) and pulsewidth(s).

FIGURE 7-7. ACCEPTABLE WAVESHAPES FOR CSO6 AND RSO2

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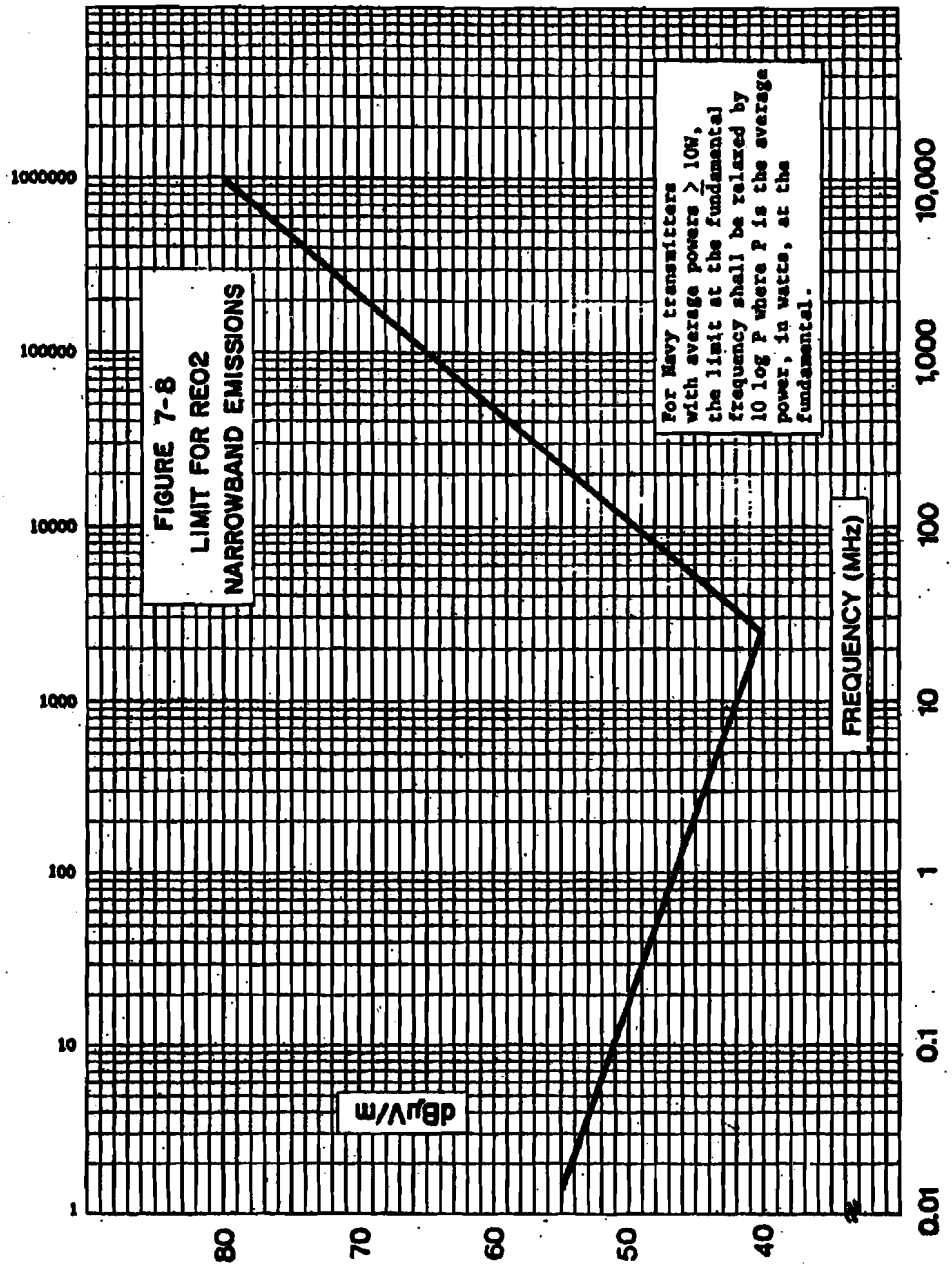

FIGURE 7-8. LIMIT FOR REO2 NARROWBAND EMISSIONS

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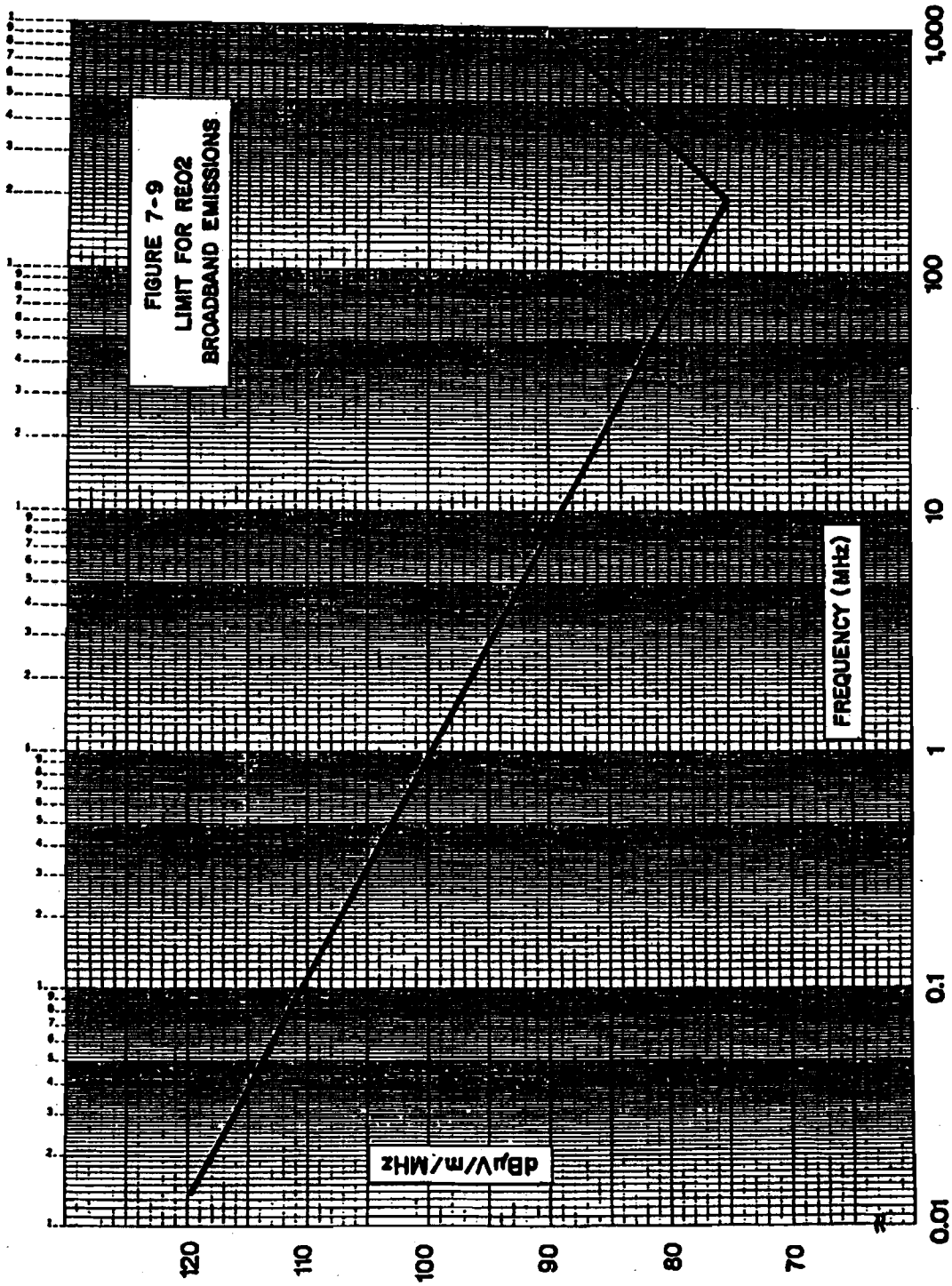

FIGURE 7-9. LIMIT FOR RE02 BROADBAND EMISSIONS

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Part 8. Tactical and Special Purpose Vehicles and Engine-Driven Equipment (Class C1)

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1. SCOPE

This part of MIL-STD-461 supplements Part 1 of this standard by defining emission and susceptibility requirements and limits for tactical and special purpose vehicles and engine-driven equipment (class C1). Ancillary equipment intended for use on these vehicles shall meet the applicable requirements of other parts of this document.

2. REQUIREMENTS

The following requirements apply for the groups of tactical and special purpose vehicles and engine-driven equipment defined in Table 8-I.

2.1 Group I. Group I items shall comply with UM03 over the frequency range of 150 kHz to 1000 MHz.

2.2 Group II. Group II items shall comply with UM03 over the limited frequency range of 1.5 to 400 MHz, except that commercial general-purpose and construction Group II items procured for use solely in non-critical areas may be exempt from UM03 when specified by the Command or agency concerned.

2.2.1 Group II items with electronic equipment, mobile telephones or communications. When electronic equipment, mobile telephones or communications are to be installed in Group II items, including those used in non-critical areas, additional EMI suppression is required. This suppression shall be provided in a kit to be installed by the user and shall include installation components, parts, and instructions necessary for suppressing the ignition, windshield wiper, brake and signal lights, siren, and so forth, so as to result in compliance with UM03.

2.3 Group III. Group III items shall meet the requirements of SAE J551.

2.3.1 Group III items with electronic equipment, mobile telephones or communications. When electronic equipment, mobile telephones or communications are to be installed in Group III items, including those used in non-critical areas, additional EMI suppression is required. This suppression shall be provided in a kit to be installed by the user and shall include installation components, parts, and instructions necessary for suppressing the ignition, windshield wiper, brake and signal lights, siren, and so forth. This suppression kit, when installed, shall result in compliance with UM03.

2.4 Group I, Group II, and Group III items with electronic sensing and control circuitry. Tactical and special purpose vehicles and engine-driven equipment utilizing electronic sensing and control circuitry shall, when required by the Command or agency concerned, meet the radiated susceptibility requirement of UM03, in addition to the applicable requirements in 2.1, 2.2, and 2.3. See SAE AIR 1425 for methods of achieving EMC in gas turbine engine accessories.

3. UM03

3.1 UM03 applicability. UM03 applies to tactical and special purpose vehicles and engine-driven equipment, including the electrical equipment and parts installed thereon.

3.2 UM03 limits.

3.2.1 Radiated emissions. E-field broadband and narrowband emissions shall not be radiated in excess of the levels shown on Figures 8-1 and 8-2 respectively at the required test distance, as specified in MIL-STD-462 for the applicable frequency range of the requirement. Above 30 MHz, the limit shall be met for both horizontally and vertically polarized waves. The radiated emission limit shall be met utilizing the procedures of RE02 of MIL-STD-462 or an approved EMI test plan.

3.2.2 Radiated susceptibility. Group I, Group II, and Group III items required by 2.4 to meet this requirement shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual specifications, when subjected to the following radiated E-fields in the frequency range of 2 MHz to 10 GHz:

Frequency Range	E-Field (Volts/meter)
150 kHz to 400 MHz	10
400 MHz to 1000 GHz	5

Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circular polarized waves are also acceptable. The radiated susceptibility limit shall be met by utilizing the procedures of RS03 of MIL-STD-462 or an approved EMI test plan.

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TABLE 8-I. GROUPINGS OF CLASS CI VEHICLES AND EQUIPMENT

GROUP I	GROUP II	GROUP III
Crash rescue trucks	Motorcycles	Sedans
Wheeled vehicles, tactical	Harbor tugs	Staff cars
Armored and track vehicles	Fork-lift trucks	Delivery trucks
Off-the-road cargo carriers	Outboard motors	Moving vans
Armored personnel carriers	Floodlight trailers	Ambulances
Assault and landing craft	Cargo loading and handling equipment	Cargo trucks
Amphibious vehicles	Engine-driven air conditioners	Fire trucks
Patrol boats	Maintenance and service trucks/vans	Other similar administrative vehicles which are basically civilian in nature
Gun motor carriages		
Railway maintenance-of-way equipment	Earth augers	
Storm boats	General purpose and construction equipment (i.e., cranes, bulldozers, heaters (gasoline and water), ditch diggers, air compressors, cement loaders, concrete mixer, pumps, blowers, etc.	
Heaters, gasoline		
Replacement engines for all of the above	Replacement engines for all of the above	

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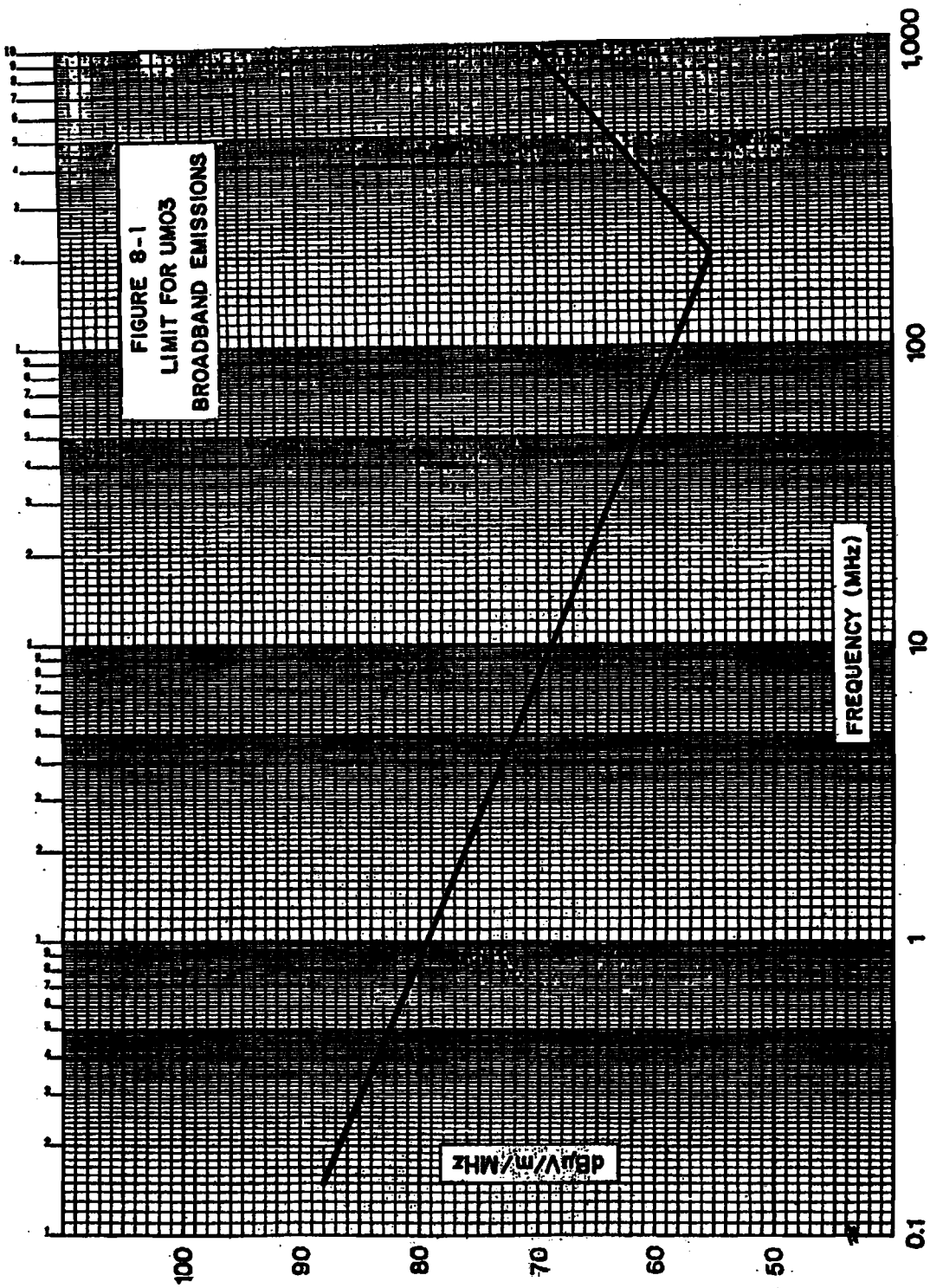

FIGURE 8-1. LIMIT FOR UMO3 BROADBAND EMISSIONS

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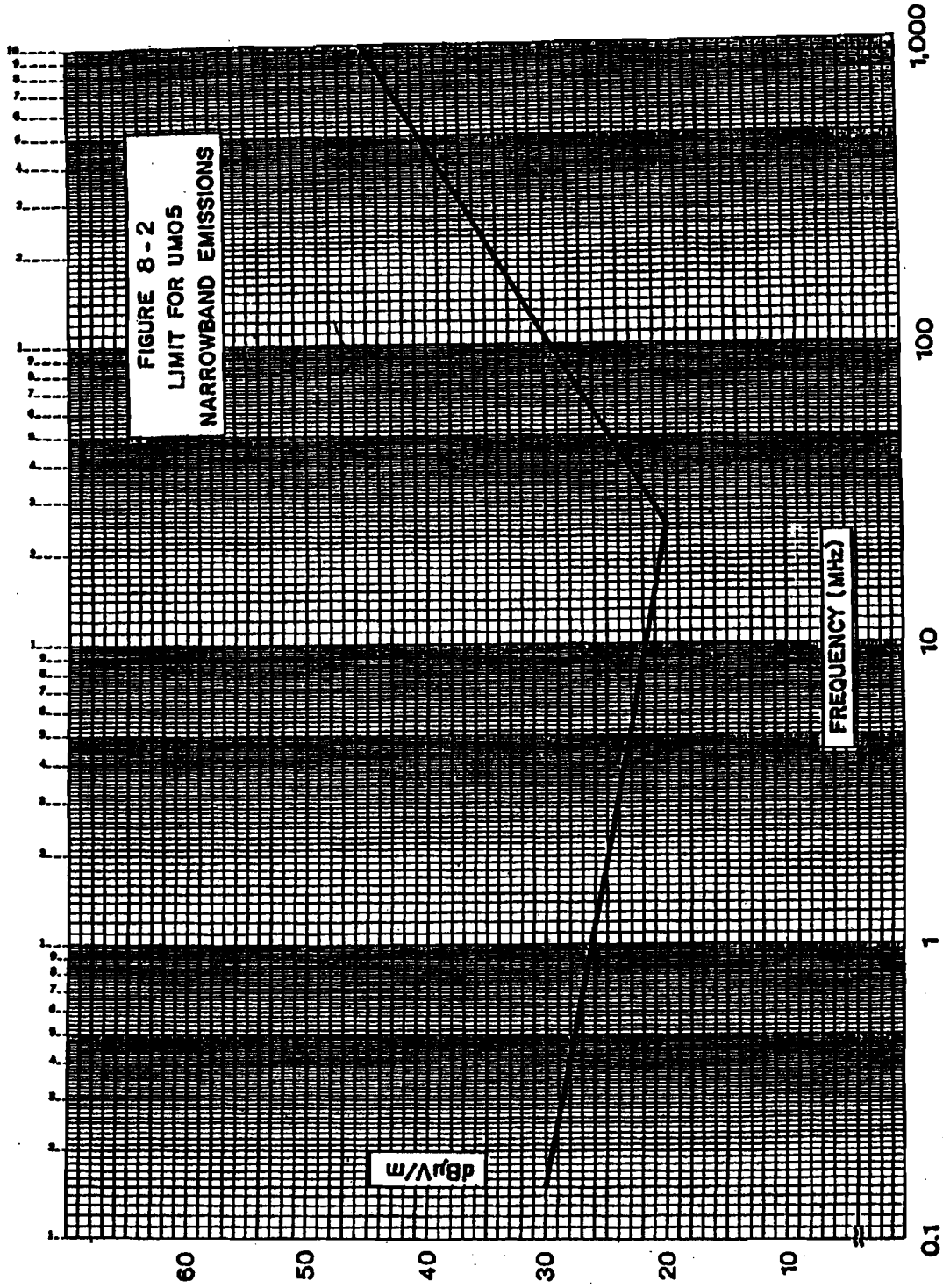

FIGURE 8-2. LIMIT FOR UMO3 NARROWBAND EMISSIONS

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Part 9. Engine Generators and Associated Components, Uninterruptible Power Sets (UPS), and Mobile Electric Power (MEP) Equipment Supplying Power To or Used in Critical Areas (Class C2)

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1. SCOPE

This part of MIL-STD-461 supplements Part 1 of this standard by defining emission and susceptibility requirements and limits for engine generators and associated components, uninterruptible power sets (UPS), and mobile electric power (MEP) equipment supplying power to or used in critical areas (class C2).

2. REQUIREMENTS

The following requirements apply for class C2 items.

2.1 Class C2 items with power output ratings $\leq$ 240 kilovolt amperes (kVA). All class C2 items with power output ratings $\leq$ 240 kVA shall meet the conducted and radiated emission requirements of UM04 (with the radiated emission requirements applicable at a distance of 1 meter).

2.2 Class C2 items with power output ratings > 240 kVA. All class C2 items with power output ratings > 240 kVA shall meet the radiated emission requirements of UM04 (at a distance of 1 meter), when specified by the Command or agency concerned.

2.3 Engine generators with electronic circuitry. Engine generators employing electronic circuitry for regulation or control, or sets with amplifiers for electronically controlling regulation, temperature, frequency, stability, and so forth, shall meet the radiated susceptibility requirement of UM04, in addition to the applicable requirements in 2.1, and 2.2.

3. UM04

3.1 UM04 applicability. UM04 applies to engine generators and associated components, UPS, and MEP equipment supplying power to or used in critical areas.

3.2 UM04 limits.

3.2.1 Conducted emissions. Broadband electromagnetic emissions shall not appear on the power leads in excess of the levels shown on Figure 9-1. The broadband conducted emissions limit shall not be exceeded over the frequency range of .015 to 50 MHz, when measured using the appropriate CE procedure of MIL-STD-462 or an approved EMI test plan.

3.2.2 Radiated emissions. Broadband electromagnetic emissions shall not be radiated in excess of the levels shown on Figure 9-2 at the required test distance. Above 30 MHz, the limit shall be met for both horizontally and vertically polarized waves. The broadband radiated emissions limit shall not be exceeded when measured using the procedures of RE02 of MIL-STD-462 or an approved EMI test plan.

3.2.3 Radiated susceptibility. Engine generators required by 2.3 to meet this requirement shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment specification, when subjected to the following radiated E-fields in the frequency range of 2 MHz to 10 GHz, utilizing the procedures of RS03 of MIL-STD-462 or an approved EMI test plan.

Frequency Range	E-Field (Volts/meter)
2 to 400 MHz	10
400 MHz to 10 GHz	5

Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circular polarized waves are also acceptable.

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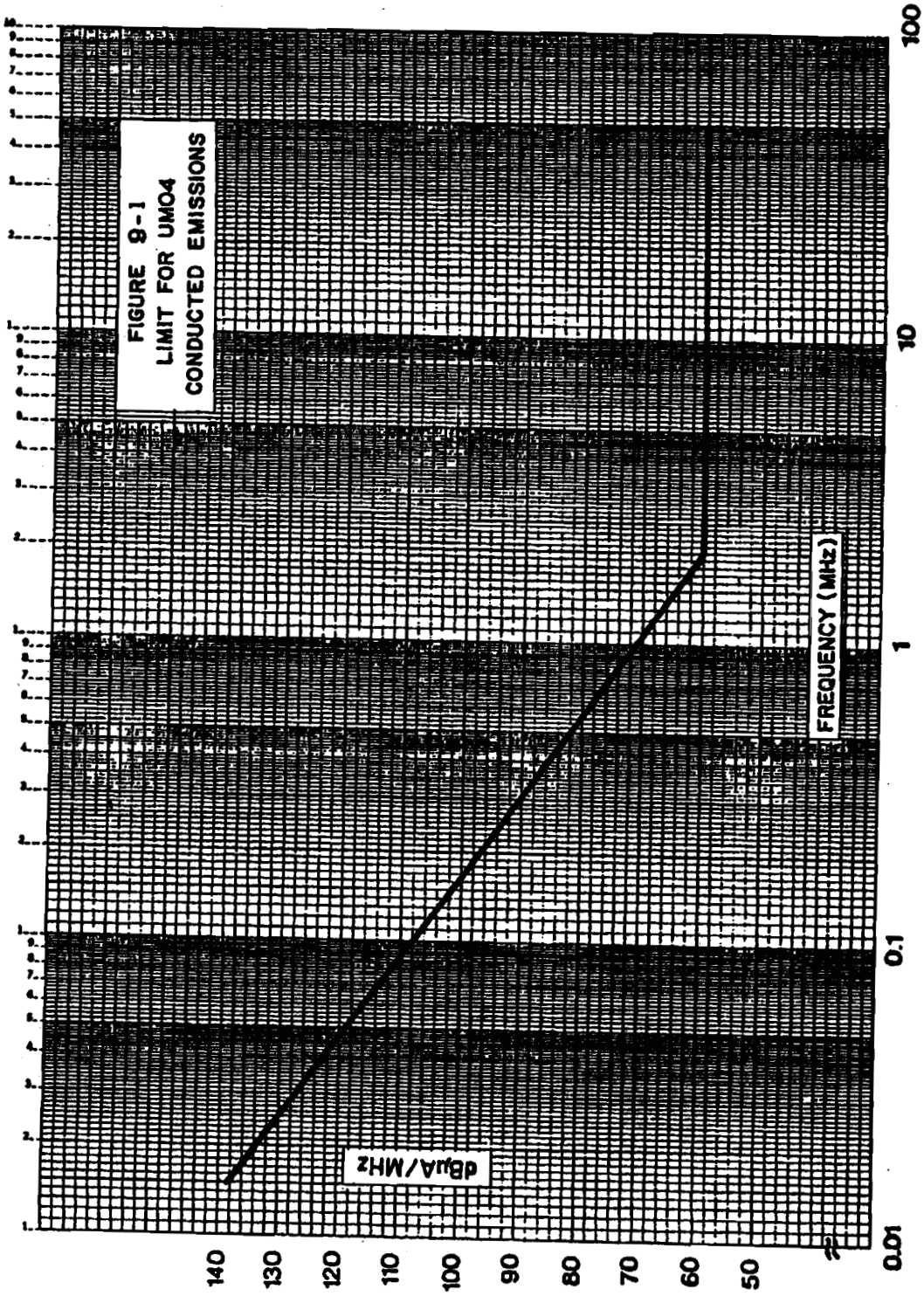

FIGURE 9-1. LIMIT FOR UM04 CONDUCTED EMISSIONS

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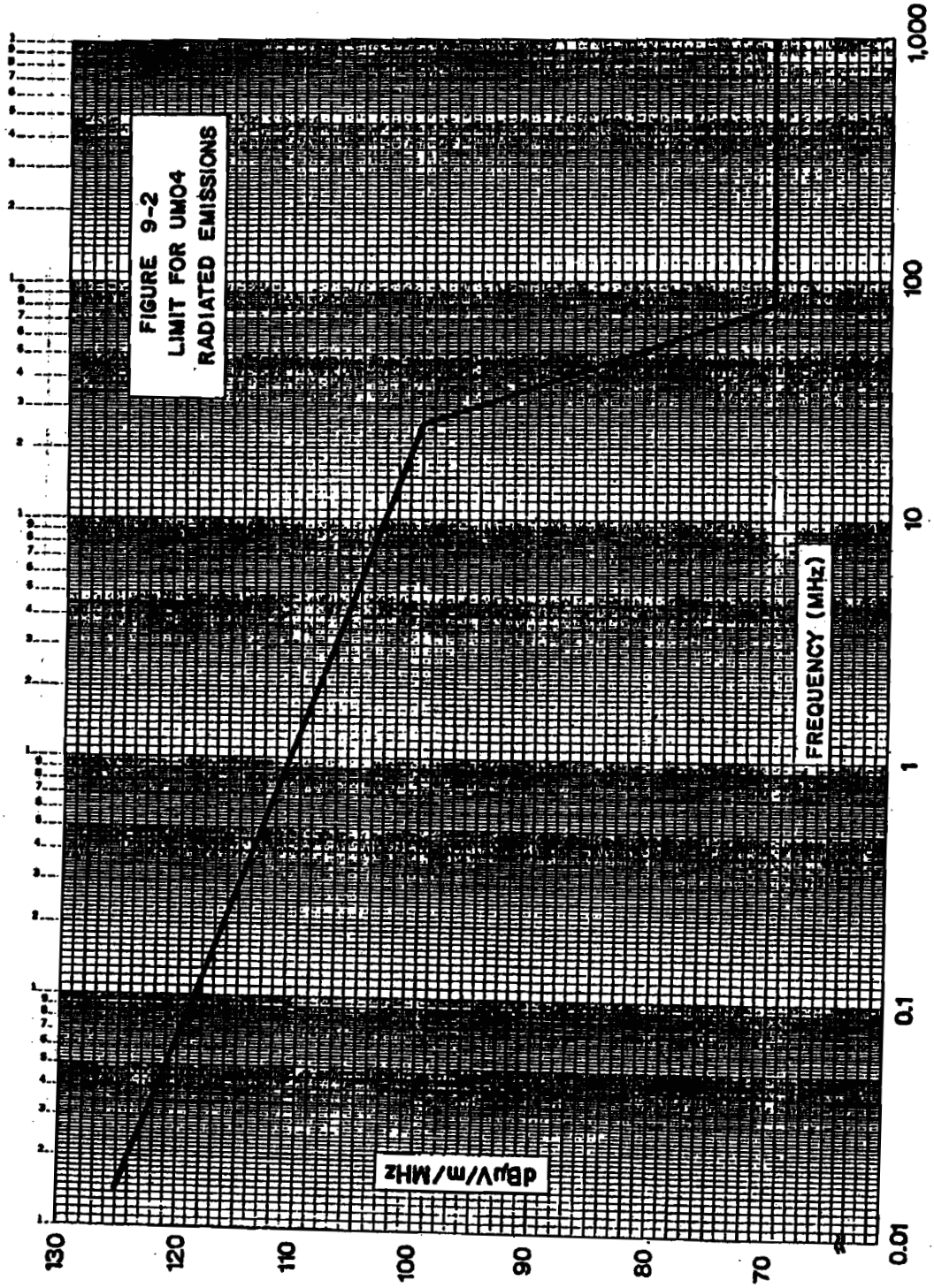

FIGURE 9-2. LIMIT FOR UM04 RADIATED EMISSIONS

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Part 10. Commercial Electrical and Electromechanical Equipment (Class C3)

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1. SCOPE

This part of MIL-STD-461 supplements Parts 1, 5, and 6 of the standard by defining emission requirements and limits for commercial electrical and electromechanical equipment and subsystems.

2. REQUIREMENTS

The following requirements apply for the groups of commercial electrical and electromechanical equipment defined in Table 10-I.

2.1 Group I. Except as noted in 2.1.1, all Group I items shall meet the conducted and radiated emission requirements of UM05. Except for portable electric tools, Group I equipment intended for use aboard ships shall meet the applicable requirements of either Part 5 or Part 6 of this document.

2.1.1 Group I items with electronic sensing and control circuitry. Commercial electrical and electromechanical equipment and subsystems utilizing electronic sensing and control circuitry shall, when required by the Command or agency concerned, meet the radiated susceptibility requirement of UM05, in addition to the applicable requirements in 2.1.

2.1.2 Group I items used in non-critical areas. Group I items procured for use solely in non-critical areas are exempt from the emission and susceptibility requirements of this standard.

2.2 Group II. Group II items are exempt from the emission requirements of this standard unless otherwise specified by the Command or agency concerned. However, these equipment shall display a label or sign with the following wording:

WARNING

DO NOT OPERATE WITHIN 30 METERS (100 FEET) OF ELECTRONIC
EQUIPMENT OR SUBSYSTEMS OR ASSOCIATED ANTENNAS

2.3 Group III. Group III items are examples of electrical and electromechanical equipment which are usually interference free and for which written approval to forego emission testing may be obtained when procured as individual equipment. As a means of establishing whether an equipment will require testing, the equipment manufacturer shall forward to the Command or agency concerned a complete electrical description of the equipment and the justification to forego testing. Written approval to forego testing must be obtained from the Command or agency concerned and shall be requested as early in the procurement cycle as possible.

3. UM05

3.1 UM05 applicability. UM05 applies to all Group I commercial electrical and electromechanical equipment procured for use in critical areas.

3.2 UM05 limits.

3.2.1 Conducted emissions. Broadband electromagnetic emissions shall not appear on the power leads in the frequency range of 50 kHz to 50 MHz in excess of the levels shown on Figure 10-1. The broadband conducted emissions limit shall not be exceeded over the frequency range of .05 to 50 MHz when measured using the CE procedure of MIL-STD-462 or an approved EMI test plan.

3.2.2 Radiated emissions. Broadband and narrowband electromagnetic emissions shall not be radiated in the frequency range of 150 kHz to 400 MHz in excess of the applicable limit curves shown on Figures 10-2 and 10-3 respectively, when measured at the required test distance as specified in MIL-STD-462. The broadband and narrowband radiated emissions limit shall be met utilizing the procedures of RE02 of MIL-STD-462 or an approved EMI test plan.

3.2.3 Radiated susceptibility. Group I items required by 2.1.1 to meet this requirement shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual specification, when subjected to the following radiated E-fields in the frequency range of .15 MHz to 400 MHz:

Frequency Range	E-Field (Volts/meter)
.15 to 400 MHz	10

Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves; circular polarized waves are also acceptable. The radiated susceptibility limit shall be met by utilizing the procedures of RS03 of MIL-STD-462 or an approved EMI test plan.

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TABLE 10-I. GROUPINGS OF CLASS C3 EQUIPMENTS

GROUP I	GROUP II	GROUP III
Portable electric tools, both double insulated and metal case, such as sabre saws, drills, impact wrenches, rivet guns, nut drivers and so forth.	Machine and semi-portable tools, such as lathes, ring grinders, welders, stamping presses and so forth.	Inherently interference-free items, such as;
Repair and maintenance shop equipment	Arc welders	Ammeter
Facilities equipment installed in buildings or at sites such as air conditioners, generators, elevators, exhaust fans	Engine generators used for construction or shop support	Antennas, passive
		Controller, motor manual (except those using electronic components)
		Cubicle, power
Reperforators		Distribution Networks, passive
Projectors and flash units		Incandescent Lighting Fixture
Heaters (all types)		Main Line Switch
Lithographic and photoprocessing equipment		Motor, induction
Battery chargers		Panel, welding
Fixed garrison type kitchen and commissary equipments		Regulator, passive element line
Office equipment		Starter, motor, manual
Vending machines		Switchboard, power
Laundry and dry cleaning equipments		Transformer used below saturation level
		Voltmeter

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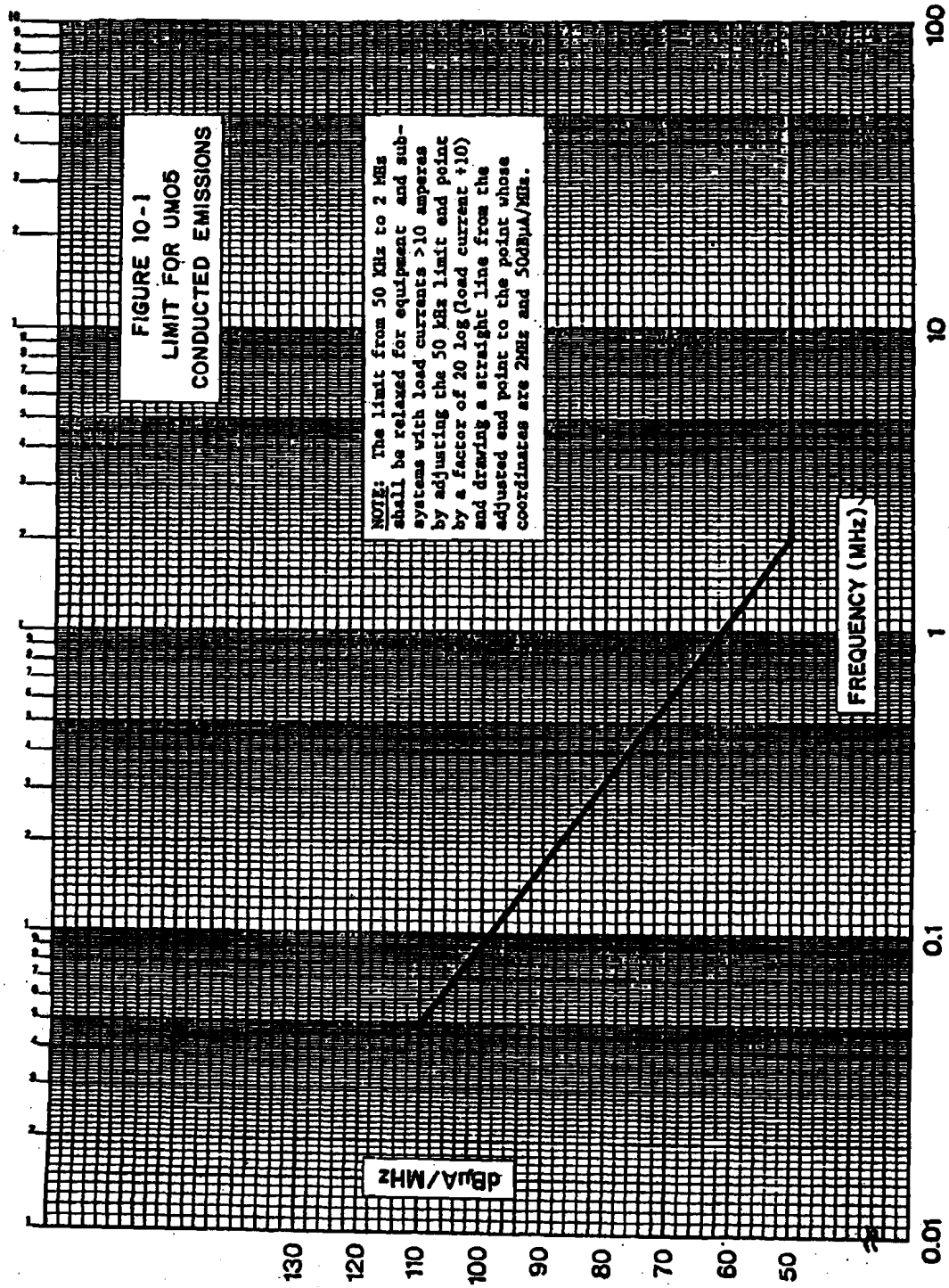

FIGURE 10-1. LIMIT FOR UMO5 CONDUCTED EMISSIONS

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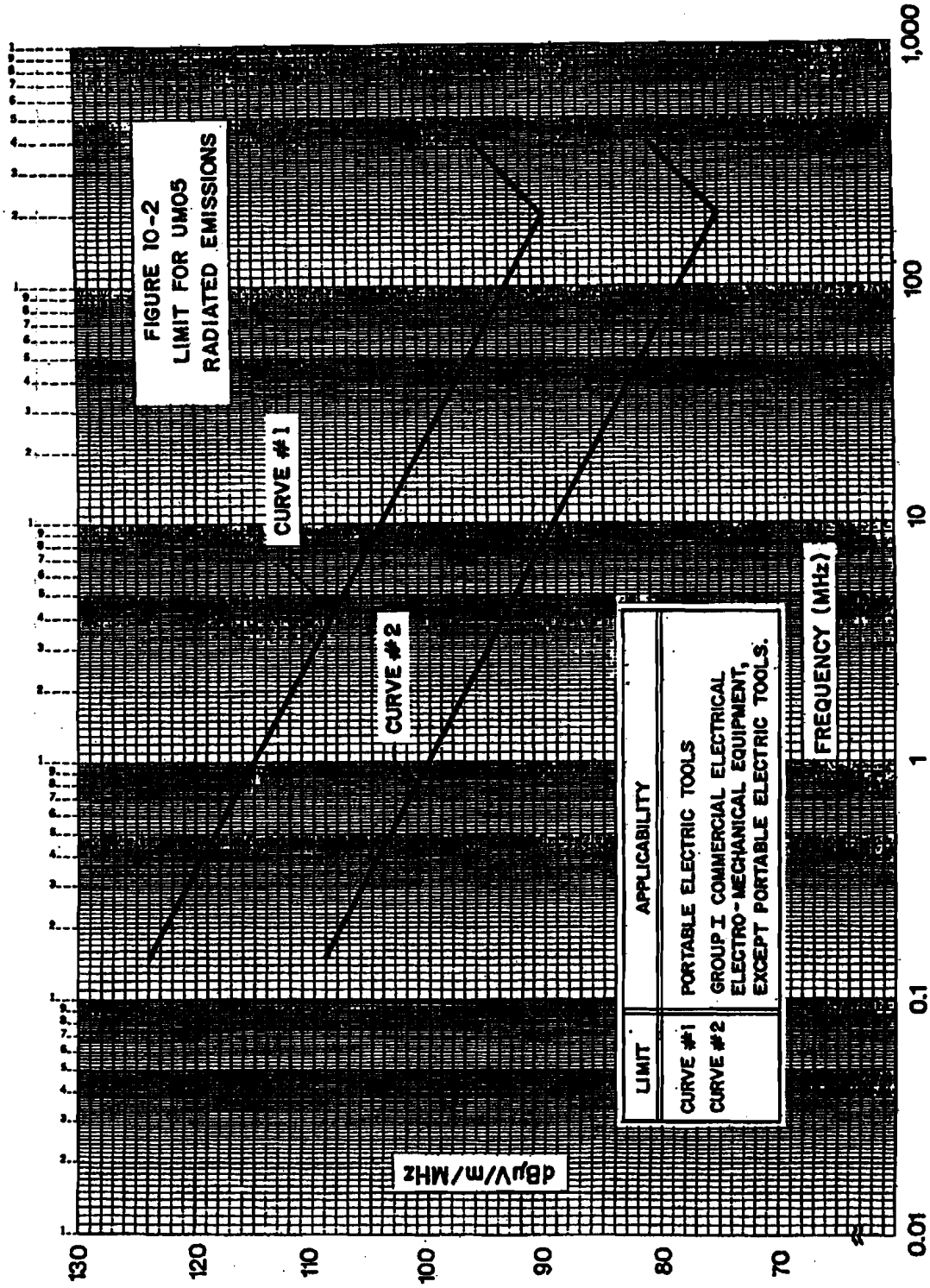

FIGURE 10-2. LIMIT FOR UM05 RADIATED EMISSIONS

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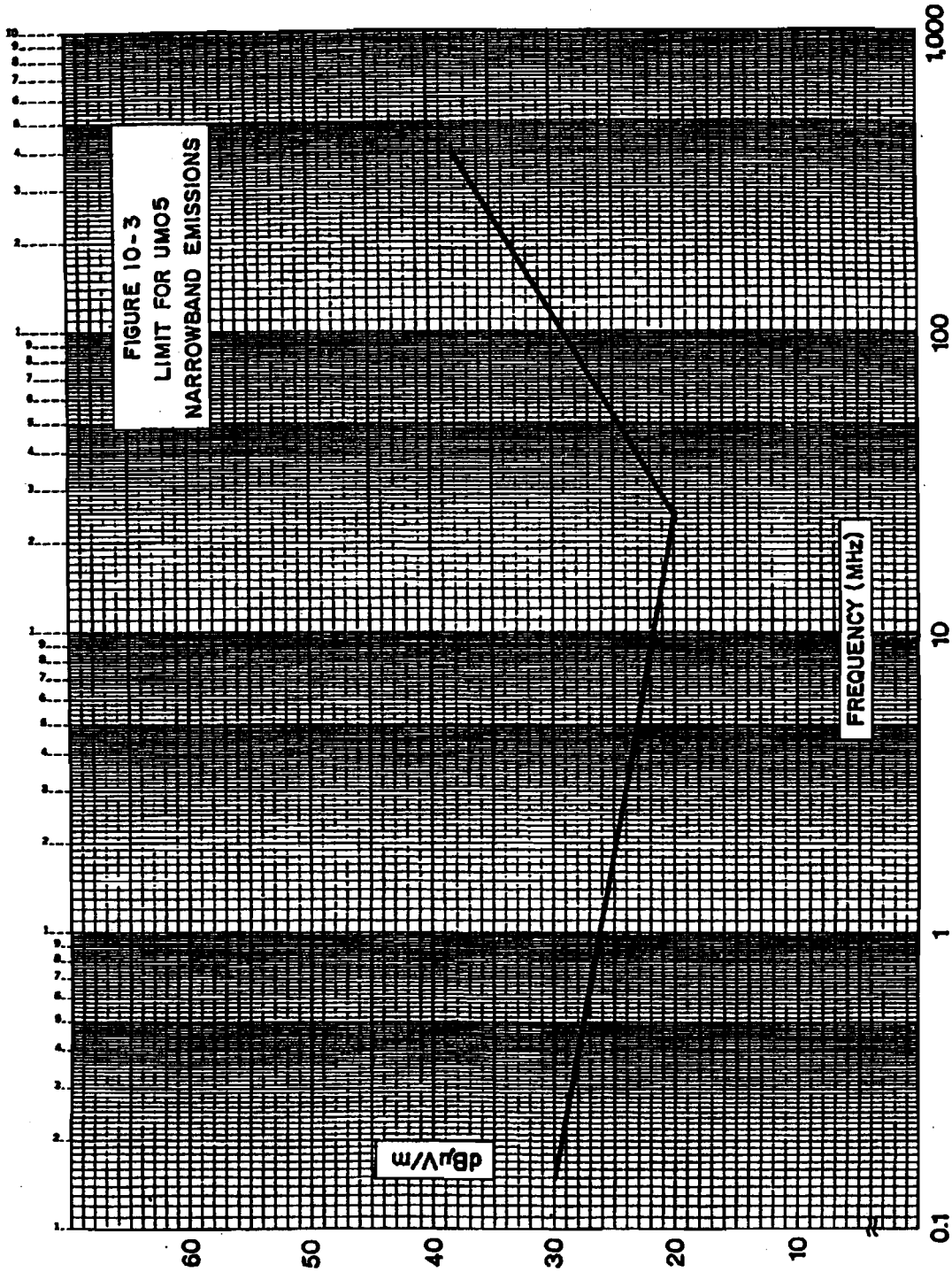

FIGURE 10-3. LIMIT FOR UM05 NARROWBAND EMISSIONS

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