METRIC
MIL-STD-1399(NAVY)
SECTION 390
2 October 1987

MILITARY STANDARD

INTERFACE STANDARD FOR SHIPBOARD SYSTEMS

SECTION 390

ELECTRIC POWER, DIRECT CURRENT, (OTHER THAN SHIP'S BATTERY) FOR SUBMARINES (METRIC)

AMSC N/A FSC 1990

MIL-STD-1399(NAVY)
SECTION 390
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DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362-5101

Interface Standard for Shipboard Systems, Electric Power, Direct Current, (Other Than Ship's Battery) for Submarines (METRIC)

1. This Military Standard is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available 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, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

Purpose. This standard defines the electrical interface requirements for, and the constraints on, the design of submarine systems/equipments which will utilize direct current (dc) electric power. This standard does not apply to, nor shall be used for, the design of ship service dc power system load connected to the main storage battery. Submarine equipment designers and users of the system must comply with these interface and systems constraints/requirements when developing, producing and acquiring equipments to assure that satisfactory equipment operation and performance are obtained.

Structure. This standard first delineates the electrical characteristics of the dc power interface in terms of voltage, continuity, source impedance, and other parameters. The constraints on system and equipment design which are necessary to achieve these characteristics are then established.

Standardization. The need for a dc power standard has been established with the use of dc power as primary power for electronic systems. Characteristics of submarine supplied dc electric power for electronic systems are delineated in this standard.

Numerical quantities. Numerical quantities are expressed in metric (SI) units.

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1. SCOPE AND INTERFACE

1.1 Scope. This standard defines and establishes interface requirements for submarine equipments utilizing dc electric power from sources other than the main storage battery to ensure compatibility between such user equipments and the power system, and between individual user equipments. It defines the submarine electric power system characteristics, requires that user equipments be designed to operate from power systems with these characteristics, and restricts any adverse effect of any user equipments on the power system. This standard does not apply to, nor shall it be used for, the design of ship service dc power system loads connected to the main storage battery.

1.2 Interface. The basic characteristics and constraints categories concerned with this interface are shown symbolically on figure 1. The interface, as it concerns the characteristics of dc electric power, is located at the input terminals of any user equipment.

2. REFERENCED DOCUMENTS

2.1 Government documents.

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

STANDARDS

MILITARY

MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.

MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.

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

3. DEFINITIONS

3.1 Ground (ground potential). Ground is the hull metal structure or grounding system of the ship which is connected to electric or electronic equipment or systems for creating a common reference point to establish zero potential.

3.1.1 Grounding (of electric systems/equipment). Grounding is the process of establishing a minimum impedance current path between a selected electric circuit or equipment and ground potential.

3.1.2 Grounded electric system. A grounded electric system is a system in which at least one conductor, or a point of the system is intentionally and effectively grounded.

3.1.3 Ungrounded electric system. An ungrounded electric system is a system which is not intentionally grounded, except for test purposes.

3.2 Electric power system. The electric power system is composed of the electric power generation and distribution system including generators, cables, switchboards, protective devices, converters and regulators up to the interface.

3.3 User equipment. User equipment is any system or component installed in the ship which uses dc electric power as specified by this standard, and which is supplied power directly from the ship's system (excluding the main storage battery dc system).

3.4 Interface. The interface is located at the input terminals of the user equipment.

3.5 Voltage. All voltages are dc, except as otherwise specified.

3.5.1 Nominal user voltage. Nominal user voltage is the designated voltage, at the interface.

3.5.2 User voltage tolerance (steady state). Steady state user voltage tolerance is the maximum permitted continuous departure from nominal user voltage during normal operation, excluding transients. Steady state user voltage tolerance includes ripple voltage and variations such as those caused by dc load changes, regulator variation and system voltage regulator drift. Tolerances are expressed in percent of nominal user voltage.

3.5.3 Voltage transients.

3.5.3.1 Voltage transient tolerance. A voltage transient is a single event characterized as a sudden change in system voltage (line-to-line) which goes outside the user voltage tolerance and returns to and remains within this tolerance. The voltage transient tolerance is in addition to the user voltage tolerance limit.

3.5.3.2 Voltage transient recovery time. Voltage transient recovery time is the time elapsed from initiation of the transient until the voltage recovers to the user voltage tolerance.

3.5.3.3 Voltage spike. A voltage spike is a voltage variation of less than 1 millisecond duration which exceeds the voltage transient tolerance. The voltage spike q ay be positive or negative, and occur from line-to-line or from line-to-ground.

3.5.4 System ripple voltage (percent). System ripple voltage is the alternating component of the unidirectional voltage from a dc power source. Percent ripple voltage is the ratio of the root mean square (rms) value of the ripple voltage to the nominal user voltage expressed in percent.

3.5.5 Overvoltage and undervoltage. Overvoltage and undervoltage are those voltages which exceed the user voltage tolerance limits for times exceeding those specified for the voltage transient recovery times.

3.6 Ripple current. Ripple current is the alternating component, including noise, of the unidirectional current from a dc power source.

3.7 Inrush current/initialization. Inrush current/initialization is usually characterized by a large (several times normal full load) peak instantaneous current which flows upon energizing the user equipment or part thereof.

3.8 Rate of change (slew rate). The rate of change is a change in a parameter of interest in a specified unit of time; for example, volts per second and amperes per second.

3.9 Isolation. Isolation is the degree of ohmic separation between two points .

3.10 Limited break supply. A limited break supply provides power from one of two or more independent power sources with automatic means for transferring the user equipment to one of the other power sources within a specified time.

3.11 No-break supply (uninterruptible power supply). A no-break supply provides power from two or more independent power sources such that the interface characteristics are continuously held within specified limits under a single failure condition.

3.12 Siemens. Siemens is the unit of conductance (mho) (end of admittance) in the International System of Units (SI). The siemens is the conductance of a conductor such that a constant voltage of 1 volt between its ends produces a current of 1 ampere.

3.13 Common mode interference. Common mode interference is interference that appears between both power leads and a common reference plane (ground) and causes the potential of both sides of the transmission path to be changed simultaneously and by the same amount relative to the common reference plane (ground).

3.14 Differential mode interference. Differential mode interference is interference that causes the potential of one side of the transmission path to be changed relative to the other side.

3.15 Auctioneering (OR' ing. Auctioneering is connecting two sources together by means of diodes. The two diodes have their cathodes connected at the common output and one of the anodes of the two diodes is connected to one

of the power sources and the second anode is connected to the second source. Additional sources can be added in the same manner with one diode for each added source.

3.16 Free wheeling. Free wheeling describes the condition where current that has been flowing through a series switch is provided with a path on the load side of the switch which connects the negative (return) power conductor to the positive power conductor whenever the switch is opened. This path is normally provided by a free wheeling diode whose anode is connected to the negative connector and whose cathode is connected to the positive conductor.

4. GENERAL REQUIREMENTS

4.1 Interface requirements and constraints. The specific interface requirements and constraints established herein are mandatory and shall be adhered to by all engaged in the design of submarine dc electric power systems and user equipment. This standard does not apply to the ship service dc power system which is connected to the main storage battery.

4.2 Conformance tests. Test requirements to ensure conformance of user equipments to the interface characteristics and constraints specified in this standard shall be included as part of the acquisition specification (see 5.4).

5. DETAILED REQUIREMENTS

5.1 Electric dc power source characteristics.

5.1.1 Type of power. The ship's dc power is provided from power conversion equipment and is in the form of a two-wire ungrounded system. Table I specifies the interface characteristics of this dc electric power.

TABLE I. Interface characteristics of the electric power system.

Parameter	Characteristic
(a) Nominal user voltage	155 volts direct current (Vdc)
(b) User voltage tolerance	plus or minus 12 percent (see figure 2)
(c) System voltage ripple (rms)	3.5 percent
(d) Voltage transient	
(1) Voltage transient tolerance[1]	plus or minus 16 percent of nominal (see figure 2)
(2) Voltage transient recovery time[1]	0.25 second
(e) Voltage spike (peak value)	750 volts (see figure 3)

TABLE I. Interface characteristics of the electric power system. - Continued

Parameter	Characteristic
(f) Dc ground isolation	>200 kilo ohms
(g) Alternating current (ac) ground isolation	<25 microfarad measured at 1 kilohertz (kHz)
(h) Power system impedance	(see figure 4)
(i) The maximum departure from nominal user voltage as a result of a combination of parameters (a), (b) and (d)	(see figure 2)
(j) Power interruption, limited-break (vital loads only)	Less than 3 milliseconds (see 5.1.2.1)
(k) Power interruption, no-break (vital loads only)	Uninterruptible (see 5.1.2.2)

[1] Voltage transients may occur anywhere in the user voltage tolerance range (see figure 2).

5.1.2 Power interruption.

5.1.2.1 Limited-break power. Limited-break power is accomplished by OR'ing two or more independent power sources. On loss of one of the power sources, loads are transferred to the other power sources. Limited-break power shall ensure that power characteristics during load transfer shall not exceed 3 milliseconds. During load transfer, the voltage transient shall deviate from those outlined in table I for a period not to exceed the upper transient limit specified in table I and shown on figure 2. During load transfer, the voltage may drop from plus 155 Vdc (plus or minus 12 percent) to as low as minus 3.0 volts, depending on the load and configuration of the electrical distribution system during the transfer interval. Negative transients below minus 3.0 volts shall be prevented by a free wheeling diode which is connected across the power source output terminals after the OR'ing diodes. The OR'ing and free wheeling functions shall be accomplished at the switchboard where the multiple sources are connected.

5.1.2.2 No-break power. No-break power is accomplished by OR'ing two or more independent power sources. On loss of one of the power sources, loads are transferred to the other power sources. No-break power shall ensure that the interface characteristics will be maintained within the upper and lower transient limits as specified in table I and shown on figure 2. Additional or different requirements beyond those in this standard may be imposed on the equipment or power source depending on individual ship configuration (see 6.5).

5.1.3 Grounding. The dc power system is ungrounded except for Intermittent grounding permitted for the operation of ground detection equipment which imposes 500 Vdc on each line-to-ground.

5.1.4 Power source ripple.

5.1.4.1 Power source ripple voltage. The total power source rms ripple voltage shall not exceed 1.5 percent when measured with a true rms voltmeter having a minimum bandwidth of 50 kilohertz (kHz) for a single power source driving a 1 kilowatt (kW) resistive load.

5.1.4.2 Power source ripple current. Any single frequency component of the power source ripple current shall not exceed the differential mode limits shown on figure 5 (30 hertz (Hz) to 15 kHz). Common mode ripple current (30 Hz to 15 kHz) shall not exceed the limits shown on figure 6. Above 15 kHz, the power source differential mode ripple current shall not exceed the limits of CE03 for A5 equipment specified in MIL-STD-461. Limits for common mode ripple current shall be as shown on figures 7 and 8 for narrowband and broadband, respectively.

5.1.5 Power source impedance. Typical source impedances for some selected power ratings are shown on figures 9 for 60 Hz transformer/rectifers. The power system Impedance (Thevenin Equivalent) measured at the interface shall be as shown on figure 4.

5.1.6 Power source voltage limits.

5.1.6.1 Power source nominal voltage. The power source shall provide a voltage of 155 Vdc plus or minus 8 percent from no load to full load.

5.1.6.2 Voltage interrupt limits. Built-in sensing and control circuits will be provided to interrupt the power source output within 0.30 seconds after the instant in time when the voltage exceeds and remains for 0.15 seconds outside the following limits.

(a) Overvoltage: above 200 ± 3 volts.
(b) Undervoltage: below 114 ± 2 volts.

5.1.7 Power source protection against externally caused disturbances. Built-in sensing and control circuits shall be provided to protect the source equipment against damage or malfunction from the following:

(a) Load induced negative voltage transients at the positive output terminal. Negative transients shall be limited to minus 3 volts (absolute) (see 5.1.2).
(b) Spike voltages with a maximum level of 750 volts including 155 Vdc. The spike test voltage characteristics are shown on figure 3. For test purposes, the spike voltage generator shall produce the waveform shown on figure 3 at the terminals of the power source under test.

5.1.8 Power source dc ground isolation. Each power source dc output power line, at the interface, shall be isolated from hull ground by a minimum dc resistance of 20 megohms.

5.1.9 Power source ac ground isolation. The leakage capacitance from each line-to-ground shall not exceed 0.01 microfarad per kilowatt (µF/kW) measured at 1 kHz. If filters are used, the sum of the leakage capacitance and the filter capacitance from each line-to-ground shall not exceed 0.02 µF/kW measured at 1 kHz.

5.1.10 Power source electromagnetic interference (EMI) limits. The power source EMI limits shall be as specified in 50.1 of the appendix.

5.2 Interface characteristics. Each shipboard dc electric power generating and distribution system shall supply dc electrical power at the interface with the characteristics specified in table I and in 5.2.1 through 5.2.10.

5.2.1 Nominal user voltage. The nominal user voltage is 155 Vdc.

5.2.2 User voltage tolerance. The user voltage tolerance is 155 Vdc plus or minus 12 percent (136 to 174 Vdc) as shown on figure 2.

5.2.3 System voltage ripple. The total rms voltage ripple at the interface shall not exceed 3.5 percent of nominal user voltage.

5.2.4 Voltage transient. The voltage excursion and recovery time envelope shall be as shown on figure 2 and as specified in table I.

5.2.5 Spike voltage. Spike voltages shall not exceed a maximum crest level of 750 volts (including 155 Vdc).

5.2.6 System dc ground isolation. The leakage resistance between each power conductor and ground shall be greater than 200 kilo ohms.

5.2.7 System ac ground isolation. The sum of leakage and filter capacitance between each line and ground shall be less than 25.0 microfarads (see table I) as measured at 1 kHz.

5.2.8 Power system impedance. The power system impedance is the impedance versus frequency at the user's input terminals looking toward the power source. The power system source impedance includes the power source, other user equipments and the distribution system. The power system impedance is shown on figure 4.

5.2.9 Continuity of power. The continuity of power shall be as specified in 5.1.2.

5.2.10 Other system interface characteristics.

5.2.10.1 Location of interface. The dc power characteristics specified in 5.2 are those which exist at the interface (see figure 1) under normal conditions. The location of the interface is dependent on the configuration of the load supplied and can be located at one of the following two places:

(a) The input terminals of a user equipment component; for example, at the input terminals of the console for navigation.
(b) The input terminals of the subsystem made up of many components, but not at the input terminals of each component. Therefore, the characteristics listed will be supplied to the input terminal of the subsystem, and not necessarily to each component. The dc power characteristics to each component of the system will be determined by the subsystem designer.

5.2.10.2 User equipment failure. Since a limited break power supply provides power to several user's equipments, there may be a user equipment failure which causes the interface characteristics to deviate from those specified in table I.

5.2.10.3 Emergency operating conditions. When emergency operating conditions prevail (that is, conditions due to major generating equipment failures or battle damage), the characteristics specified in 5.2 may not be provided.

5.3 User equipment constraints. The intertace characteristics or the ship's dc electric power system impose certain constraints on the design of shipboard equipment utilizing dc electric power.

5.3.1 User equipment EMI limits. The user equipment EMI limits shall be as specified in 50.2 of the appendix.

5.3.2 User equipment ripple current. The user equipment differential mode ripple current (including ripple components resulting from pulse load effects) shall not exceed values shown on figure 10 for frequencies from 30 Hz to 15 kHz. Above 15 kHz, the user differential mode ripple current shall conform to the limits of CE03 in accordance with MIL-STD-461 for AS equipment. The common q ode ripple current shall not exceed values shown on figure 11 for frequencies from 30 Hz to 15 kHz. Above 15 kHz, the limits for common mode ripple current shall be as shown on figures 12 and 13 for narrowband and broadband, respectively.

5.3.3 User equipment ripple voltage. The rms ripple voltage caused by the user equipment shall be less than 1.5 percent when driven by power sources with ratings as defined in table II. The source impedance of the power source shall be as shown on figure 9.

TABLE II. Power source rating for measuring user equipment ripple voltage.

User equipment rating (kW)	Power source rating (kW)
Less than 10	10
10-20	20
20-50	50
50-75	75
75-100	100
100-200	200

5.3.4 User equipment inrush/initialization current. The peak amplitude of the inrush current shall not exceed 200 percent of the nominal user equipment rated load current. User equipments shall limit the inrush current rate of change to values specified in table III.

TABLE III. User equipment inrush limit.

Nominal rated load current at interface (amperes)	Inrush current rate of change (amperes per millisecond)
1 to 186	60
187 to 371	115
372 and higher	250

5.3.5 User equipment load current slew rate. User equipments shall be designed to limit load current slew rate of change to values specified in table IV. The peak amplitude of the load current shall not exceed 150 percent of the nominal user equipment rated load current.

TABLE IV. User equipment slew rate limit.

Nominal rated load current at interface (amperes)	Slew rate of change (amperes per millisecond)
1 to 186	30
187 to 371	58
372 and higher	125

5.3.6 User equipment dc ground isolation. Each user equipment dc input power line at the interface shall be isolated from hull ground by a dc conductance of less than 10^{-8} siemens per kilowatt (kW) of connected load.

5.3.7 User equipment ac ground isolation. The leakage capacitance from each line-to-ground at the user interface shall not exceed 0.02 µF/kW of connected load at 1 kHz. If filters are used, the sum of the leakage capacitance and the filter capacitance from each line-to-ground at the user interface shall not exceed 0.075 µF/kW of connected load measured at 1 kHz. For load more than 0.5 kW and less than 1 kW, the capacitance shall be reduced in proportion to the specified values for the 1 kW load; for example, the allowable capacitance for a 0.8-kW load is 0.8/1 X 0.075 = 0.06 µF). For loads less than 0.5 kW, the leakage capacitance shall not exceed 0.01 µF. If filters are used, the total shall not exceed 0.03 µF.

5.3.8 User equipment input/output isolation. User equipment 155-Vdc input terminals shall be isolated from all user equipment loads such as power conversion equipment outputs, by a dc conductance of less than 0.5 x 10^{-8} siemens per kW of connected load.

5.3.9 Protection of user equipment.

5.3.9.1 Equipment polarity. User equipment requiring protection from polarity reversal shall be internally protected from improper connection at any point in the system. Each piece of equipment shall have the polarity of the power connections clearly marked. Any inadvertent polarity reversal shall not result in equipment damage or cause any deviations from the interface characteristics shown in table I.

5.3.9.2 Other circumstances. The user equipment shall not sustain damage as a result of the following:

(a) Spike voltages with a maximum level of 750 volts including 155 Vdc. The spike test voltage characteristics are shown on figure 3. For test purposes, the spike voltage generator shall produce the waveform shown on figure 3 at the terminals of the user interface.
(b) Power interruption and automatic restoration of power (see 5.1.2 and 5.2.9).
(c) Active ground detector tests which impose 500 Vdc on each line-to-ground.
(d) Overvoltage and undervoltage as specified in 5.1.7.
(e) System faults caused by single component failures may cause conducted EMI voltages at the interface which may exceed the conducted susceptibility EMI levels defined in 50.2 of the appendix. User equipment shall not sustain damage when voltage levels versus frequency as shown on figures 14 and 15, occur at the interface. The contracting activity shall determine the equipment that is required to be operational during this fault condition. These equipments that are required to be operational shall not be susceptible when tested to voltages versus frequency levels, as shown on figures 14 and 15.

5.3.10 User input impedance. For each user system, subsystem, or equipment connected to the interface (see 5.2.10.1), an electrical schematic shall be prepared (see 6.2). The user input circuit schematic shall be used for the systems analysis required for each installation (see 6.4). A block diagram in Laplace notation (s operator), complete with a transfer function (gain/phase plot) from 10 Hz to 1 megahertz (MHz), shall be required for complex user systems, subsystems, or equipments. For purposes of satisfying these requirements, any circuit containing active components or feedback/feedforward functions shall be considered complex.

5.4 User equipment conformance tests. Verification of conformance of individual user equipment with the interface characteristics (see 5.2) and user equipment constraints (see 5.3) shall be required, and shall form part of the qualification data for the user equipment.

5.5 User equipment EMI test. An EMI qualification test shall be included as part of the user's power system proof of conformance (see 5.4). User qualification test procedures shall be in accordance with MIL-STD-462, except as specified in 50.5 of the appendix.

5.6 Power source conformance tests. Verification of conformance of individual power sources with the power source characteristics (see 5.1) shall be required, and shall form part of the qualification data for power source equipment.

5.7 Power source EMI test. Source qualification test procedures shall be in accordance with MIL-STD-462, except as specified in 50.4 of the appendix.

6. NOTES

6.1 Intended use. This standard does not prohibit the use of 60 Hz power. The dc electric power, as specified herein, will be in addition to the primary shipboard ac electric power as specified in DOD-STD-1399, section 300.

6.2 Data requirements. 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 DoD FAR Supplement, Part 27, Sub-Part 27.410-6 (DD Form 1423) 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 are cited in the following paragraph.

Paragraph no.	Data requirement title	Applicable DID no.	Option
5.3.10	Drawings, engineering and associated lists	DI-E-7031	Level 3

(Data item descriptions related to this standard, and identified in section 6 will be approved and listed as such in DoD 5010.12-L., 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 Systems analysis. A systems analysis is required for each installation in order to confirm system compatibility and system stability. Users are required to provide to NAVSEA the interface data specified in 5.3.10.

6.4 Electrical schematic. The electrical schematic (see 5.3.10) should show component values of the user's input circuitry and should include the following:

(a) All filters.
(b) All passive components.
(c) Diodes.
(d) All active components.
(e) Equivalent load resistor.

6.5 No-break power. Any user requiring no-break power (see 5.1.2.2) should request prior written approval from NAVSEA.

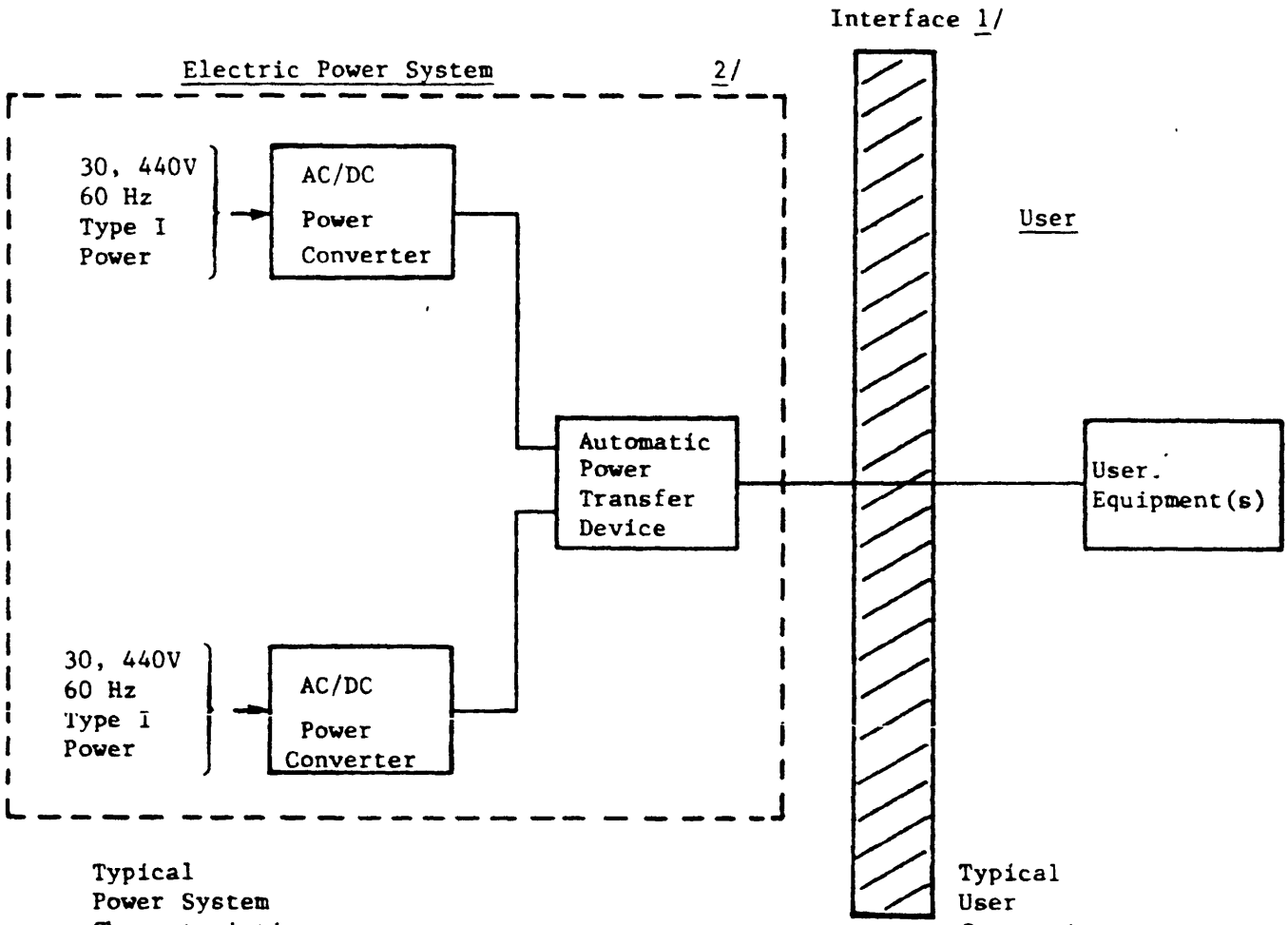
6.6 Deviations. The deviation provisions in DOD-STD-1399 and DOD-STD-480 should be adhered to during the early development stage of user equipment. Requests for deviation should be submitted for approval to NAVSEA with copies to NAVSEA Electrical Systems group. Unless the deviation is approved by NAVSEA, the user equipment will not be approved for shipboard use.

6.7 Subject term (key word) listing.

Interface characteristics
Dc power
Ripple voltage
EMI

Review activity:
EC

Preparing activity:
Navy - SH
(Project 1990-N046)



1/ The interface as it concerns the characteristics of dc electric power is located at the input terminals of the user equipment.
2/ Limited break supply.
3/ The two-ship service power sources are independent from each other.

SH 131875

FIGURE 1. Dc interface.

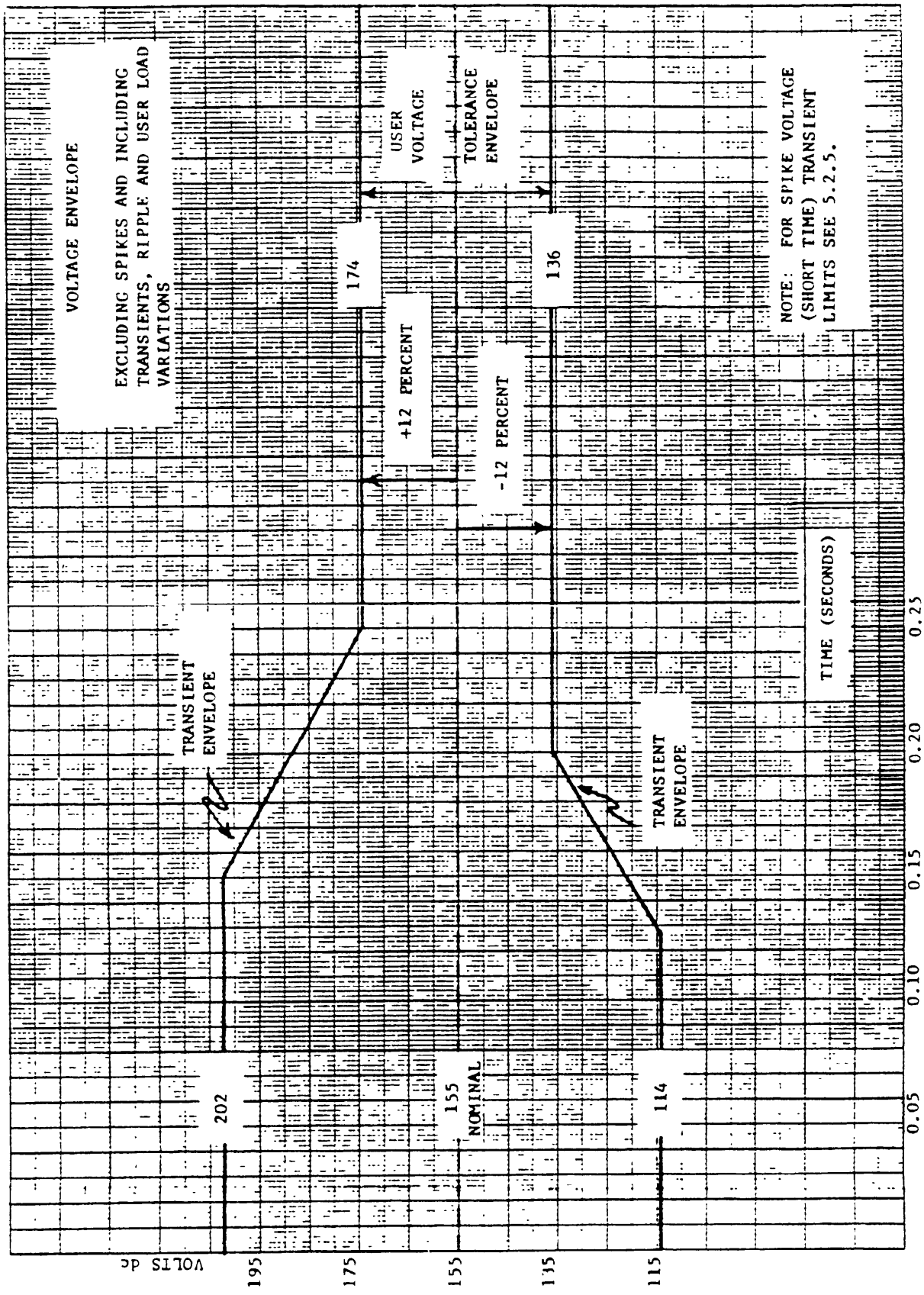


FIGURE 2. Voltage envelope.

SH 131876

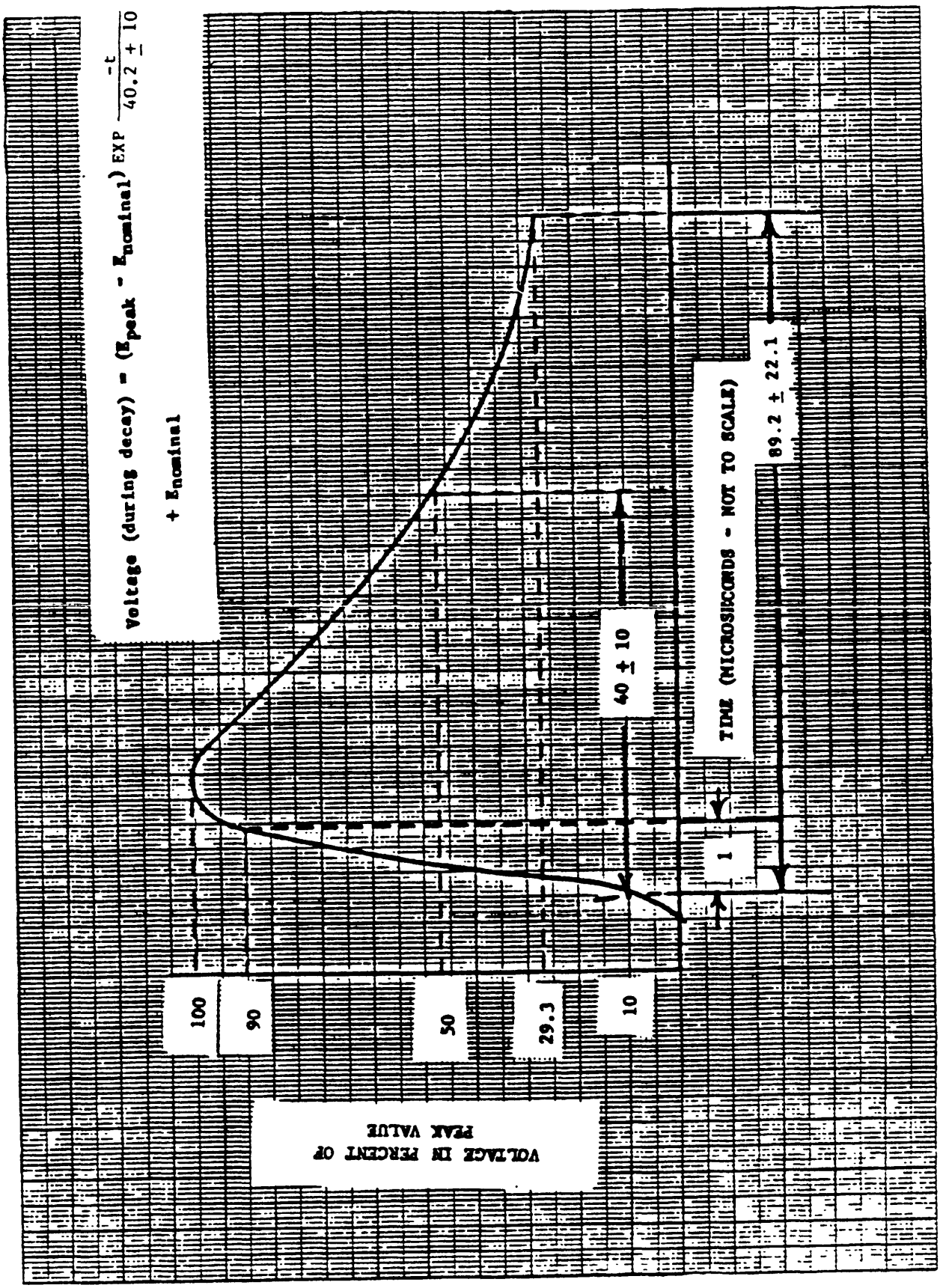


FIGURE 3. Voltage test spike (short time transient).

SH 131877

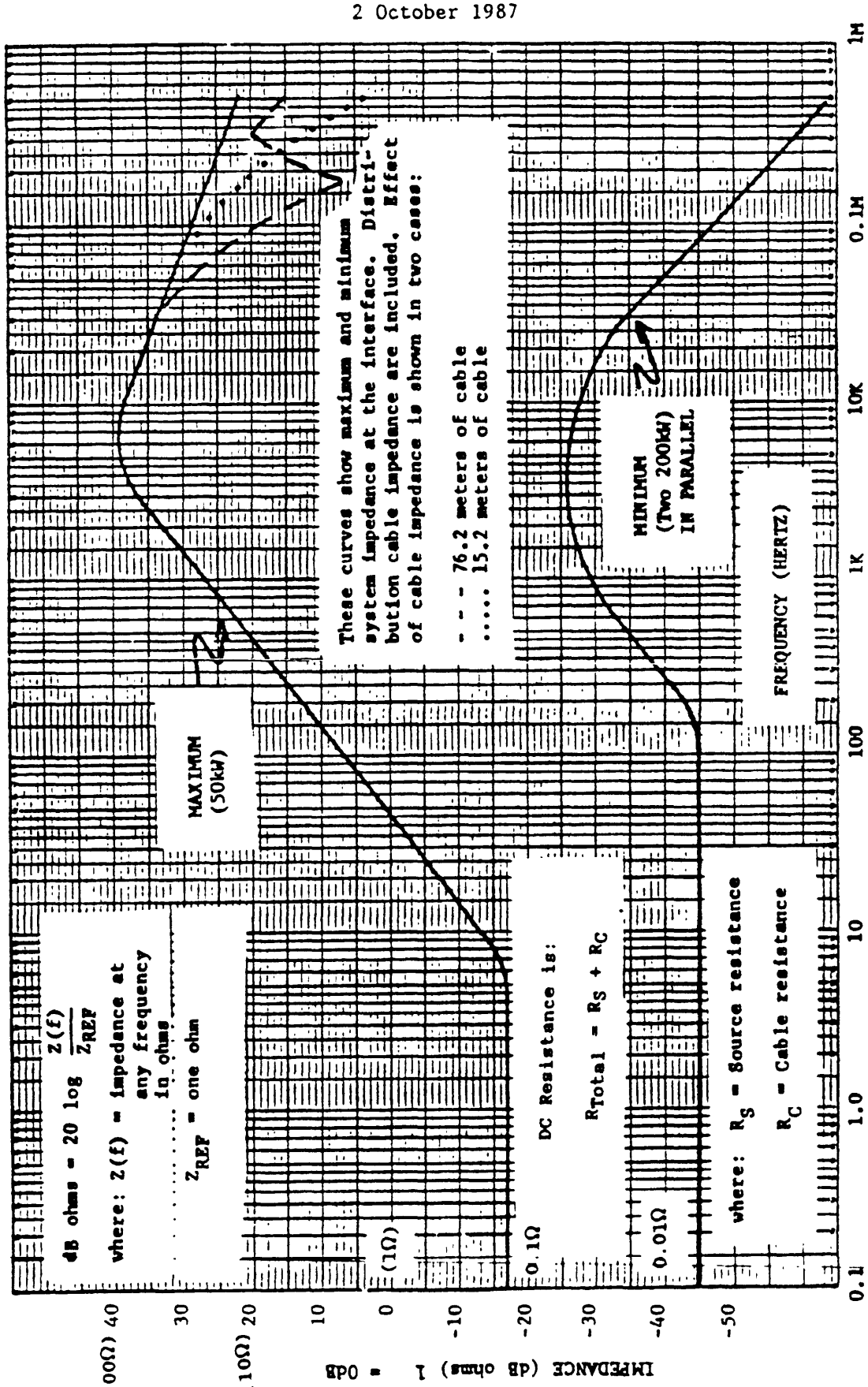


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FIGURE 4. Power system Z versus frequency.

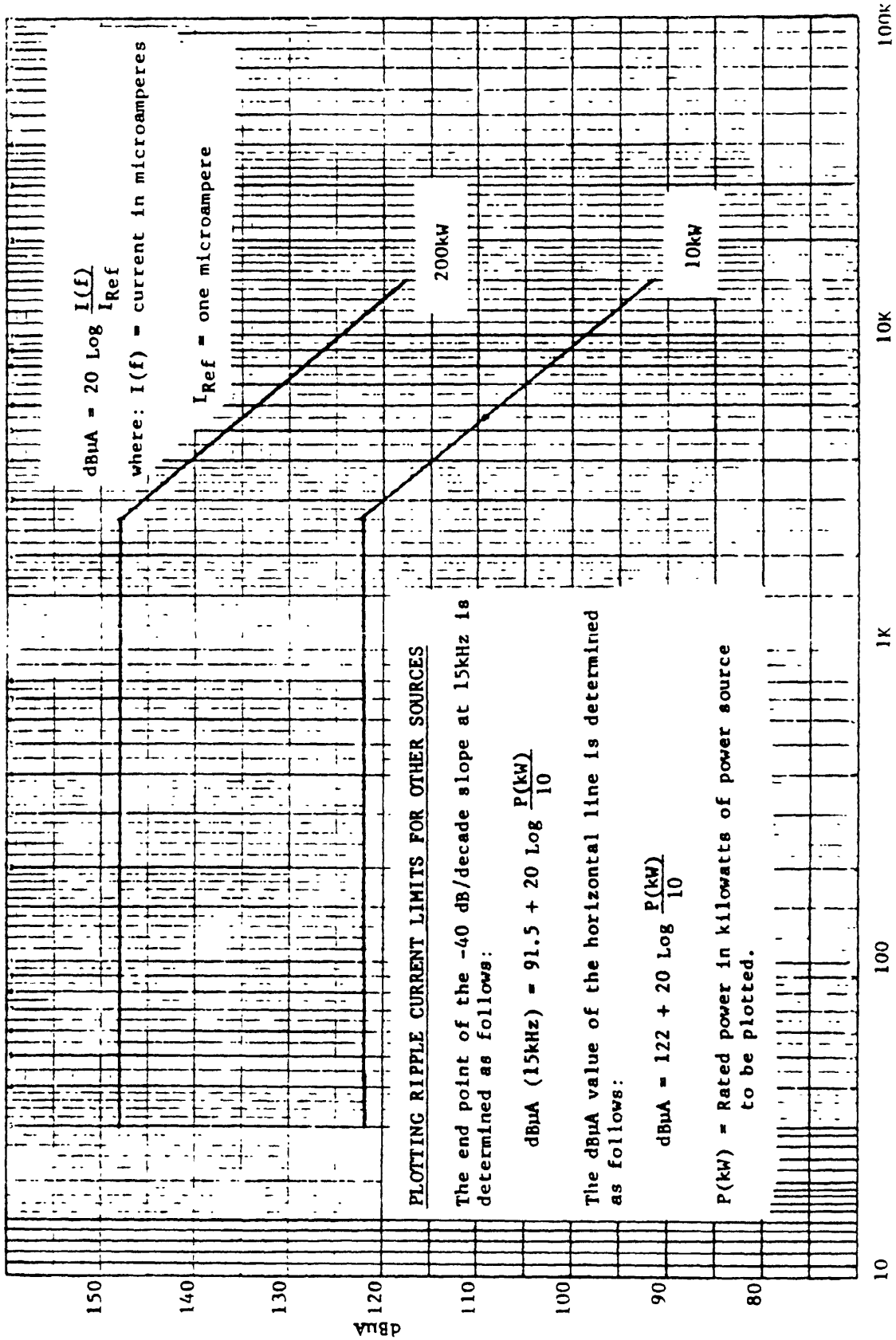

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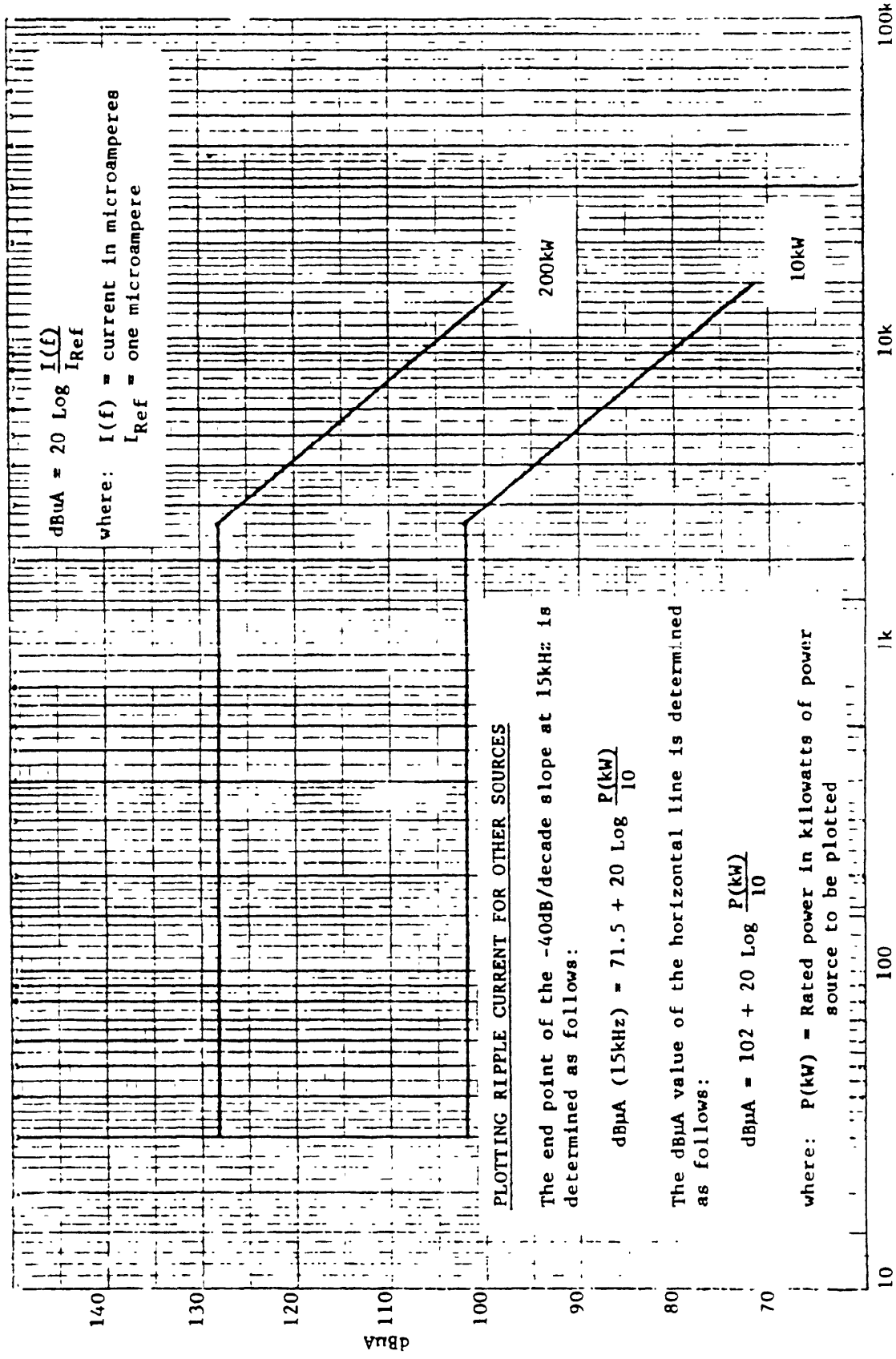
FIGURE 5. Power source CE01 differential mode ripple current limits.



SH 131680

FIGURE 6. Power source CE01 common mode ripple current limits.

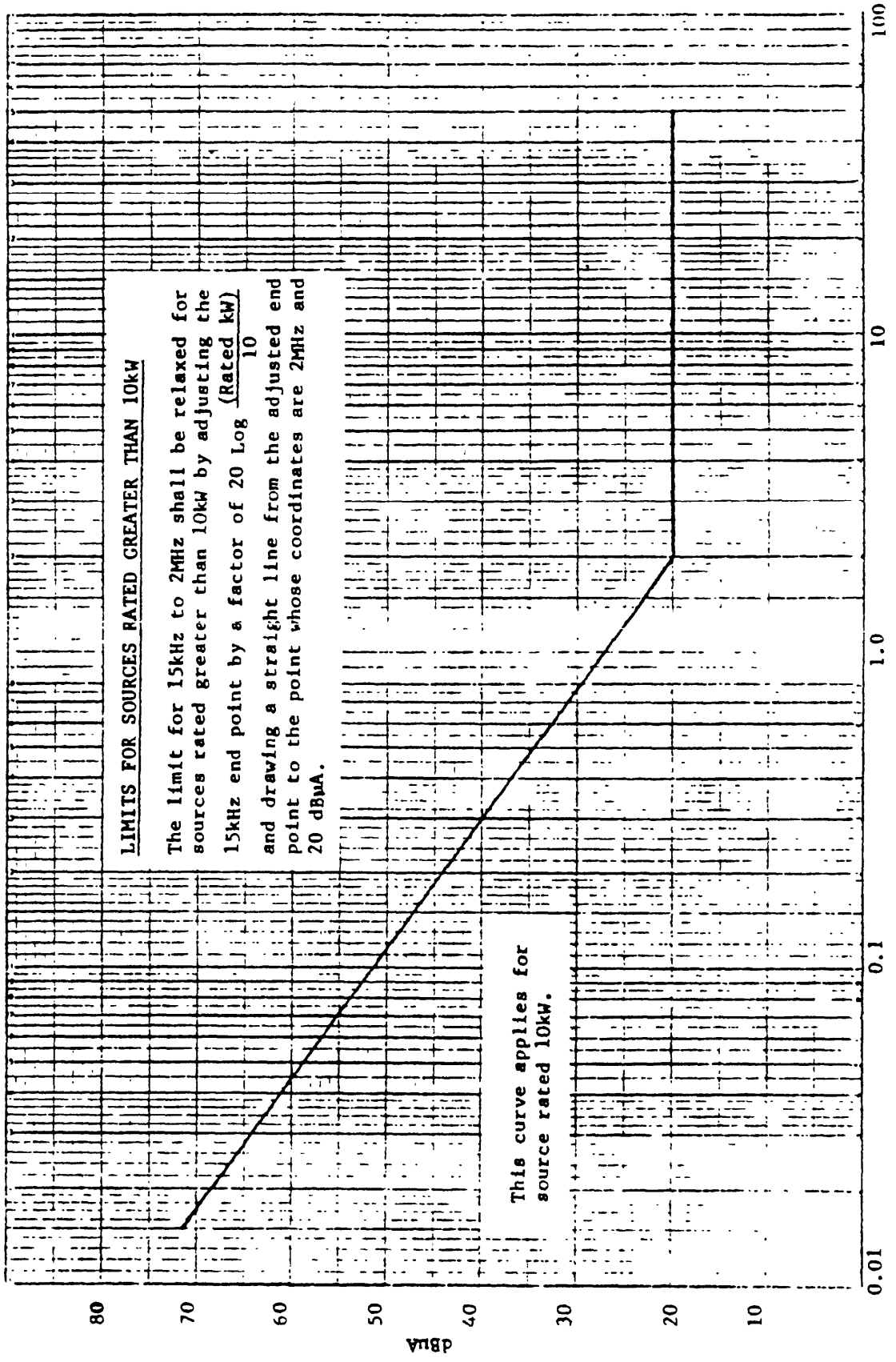


FIGURE 7. Power source CE03 common mode narrowband ripple current limits.

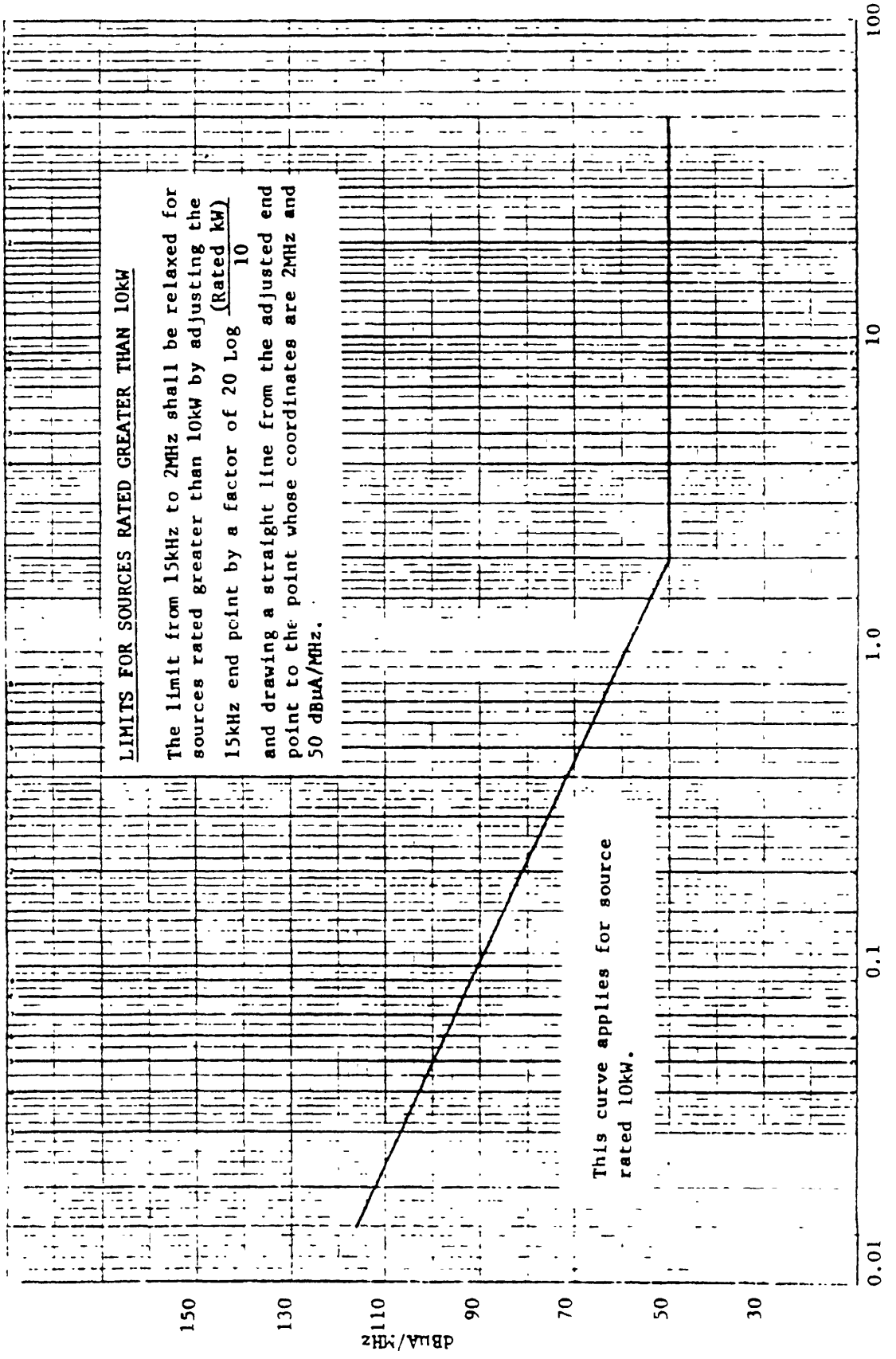


FIGURE 8. Power source CE03, ?on mode broadband limits.

SH 131882

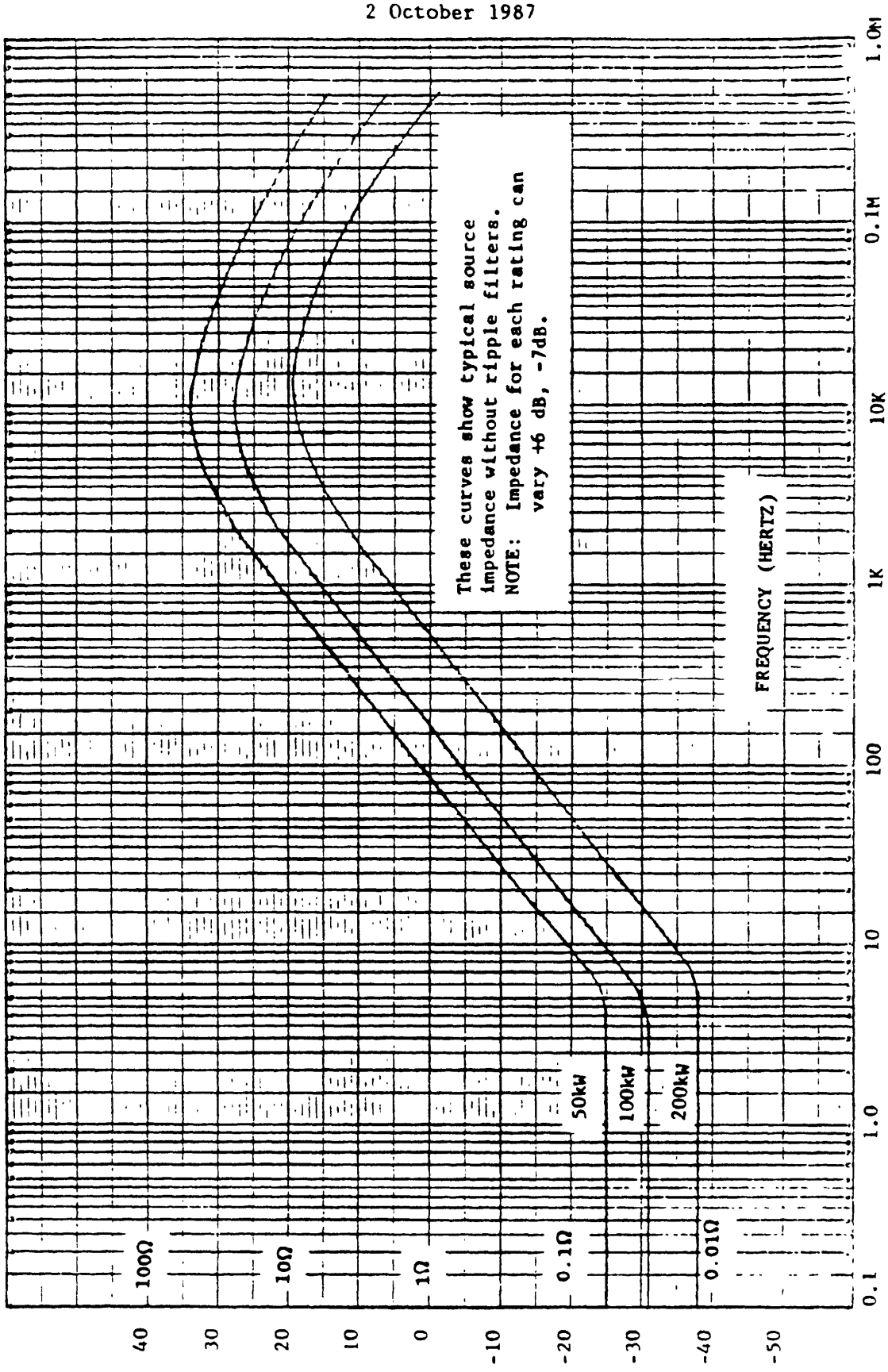


FIGURE 9. Typical source Z versus frequency - 60 Hz transformer/rectifier.

SH 131885

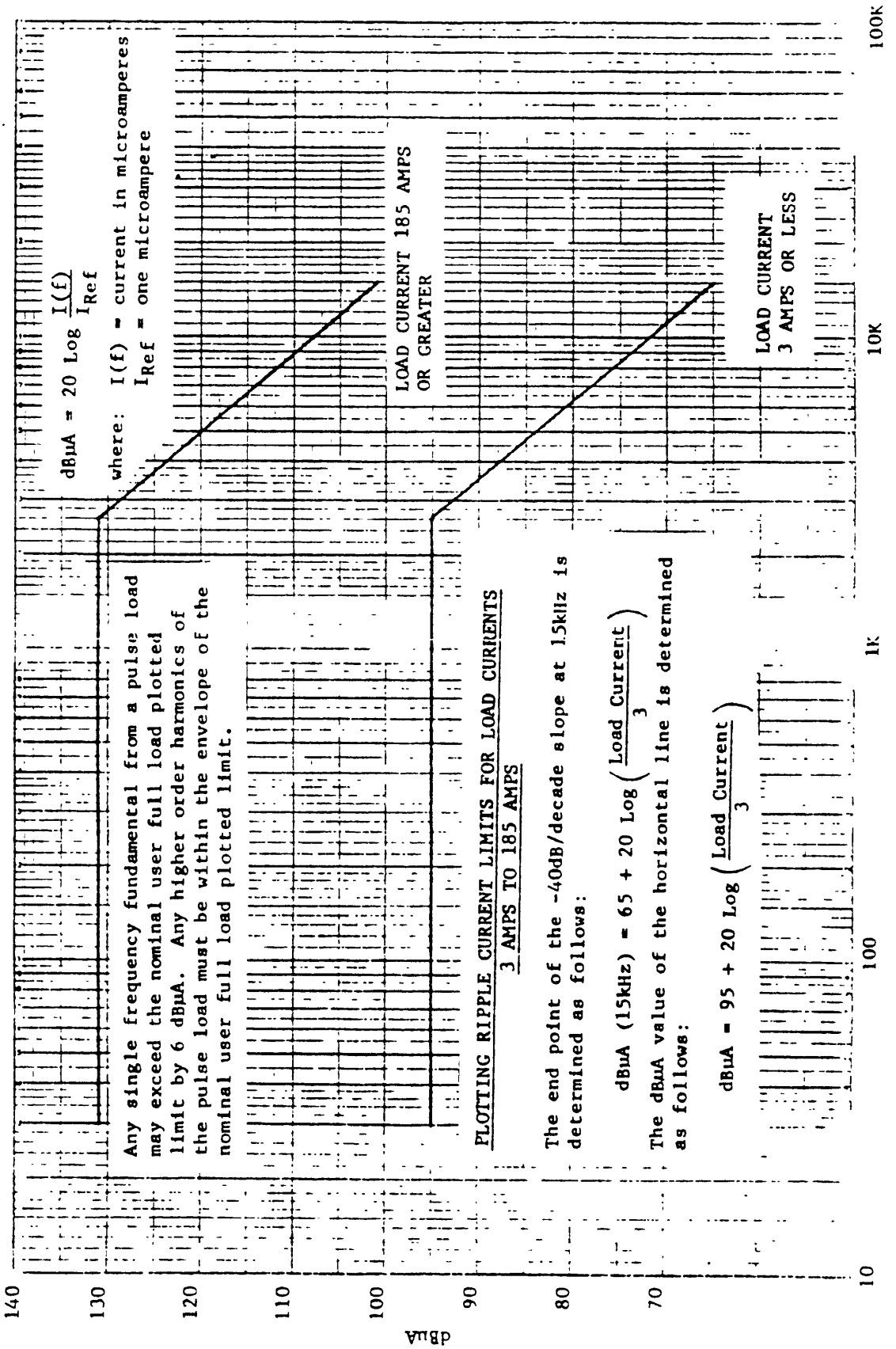
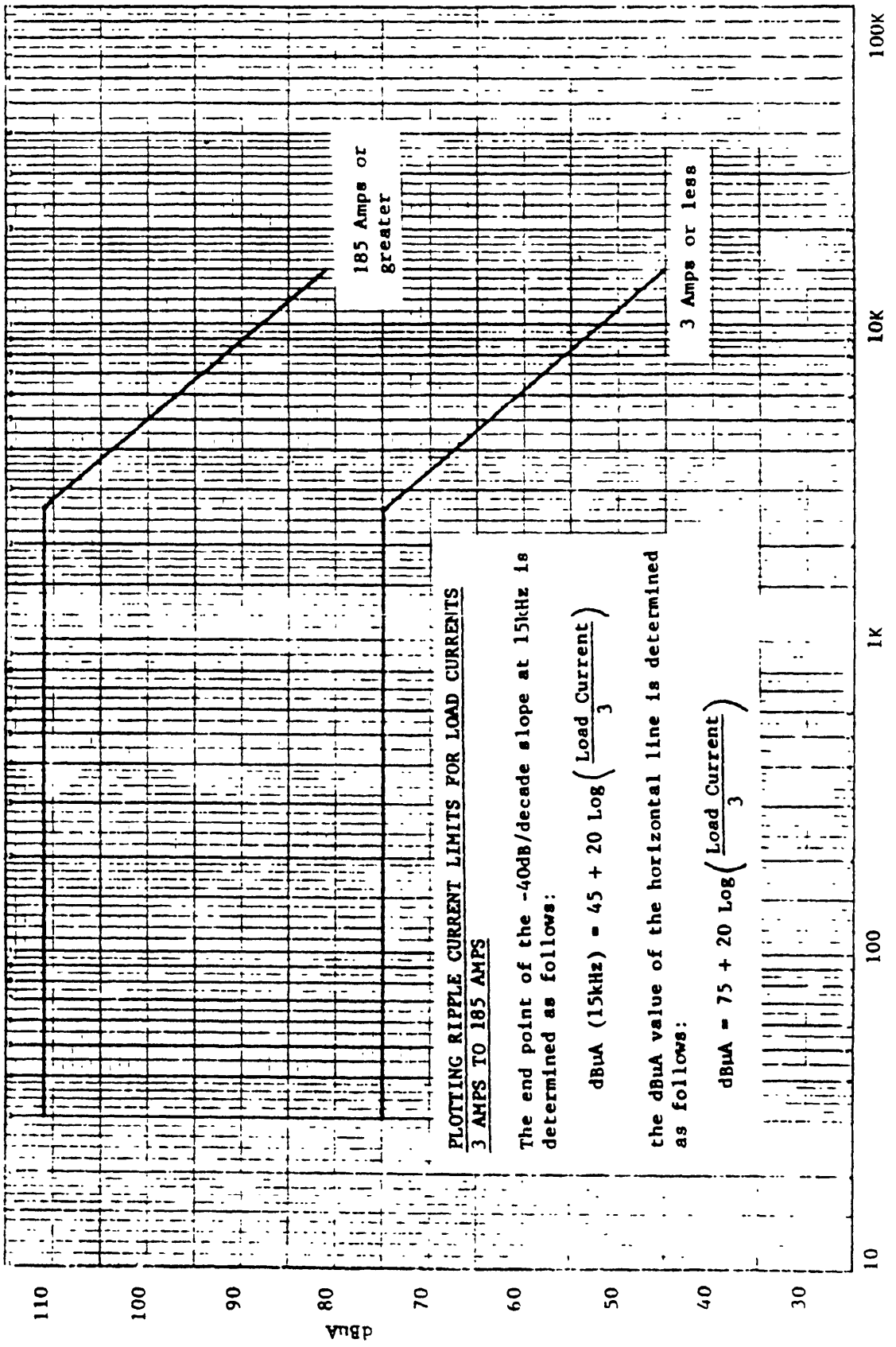
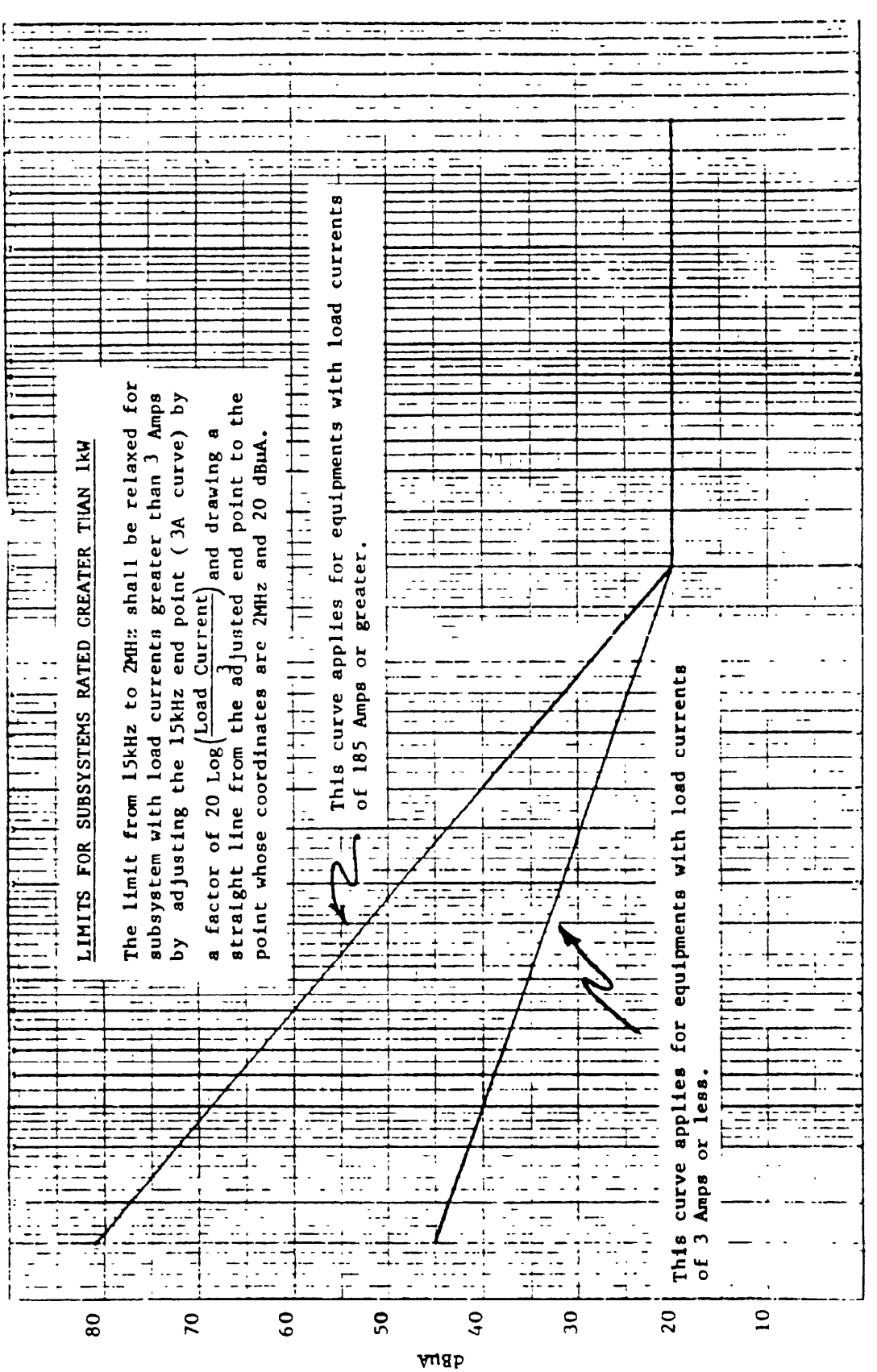


FIGURE 10. User equipments CE01 differential mode ripple current limits.

SH 131887



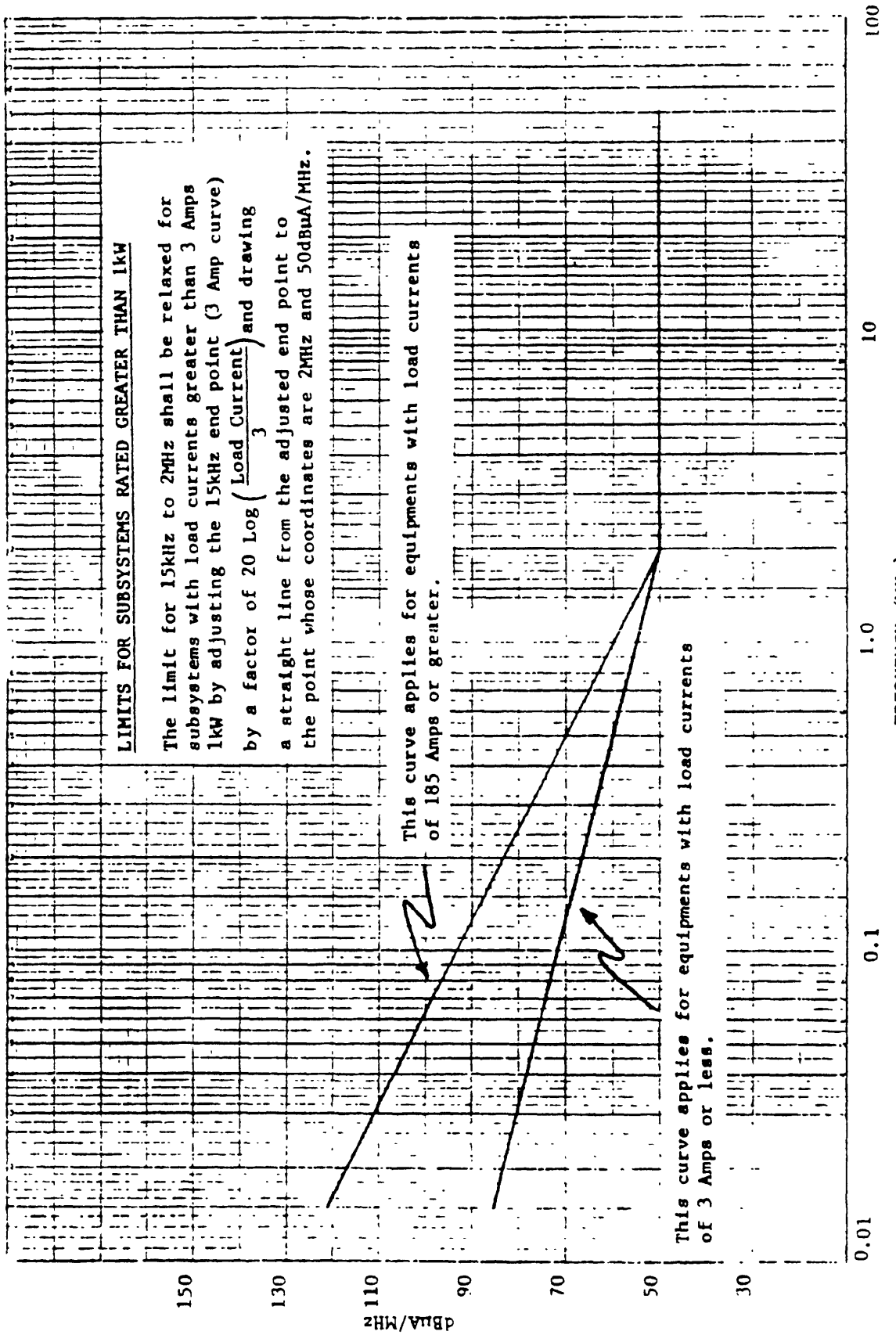
SH 131888



SH 131889

FREQUENCY (MHz)

FIGURE 12. User equipment CE03 common mode narrowband ripple current limits.



SH 131890

FREQUENCY (MHz)

FIGURE 13. User equipments CE03 common mode broadband limits.

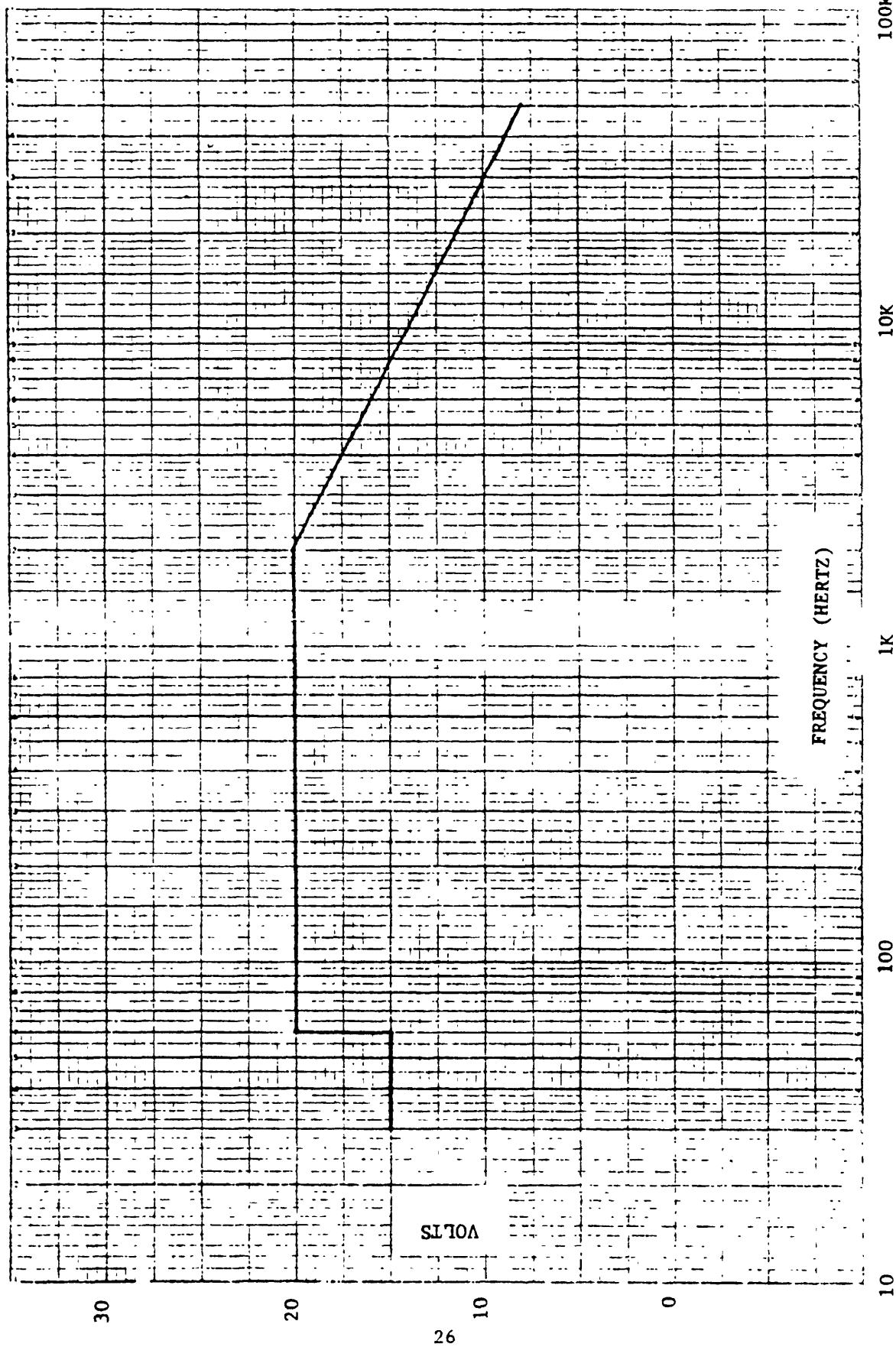
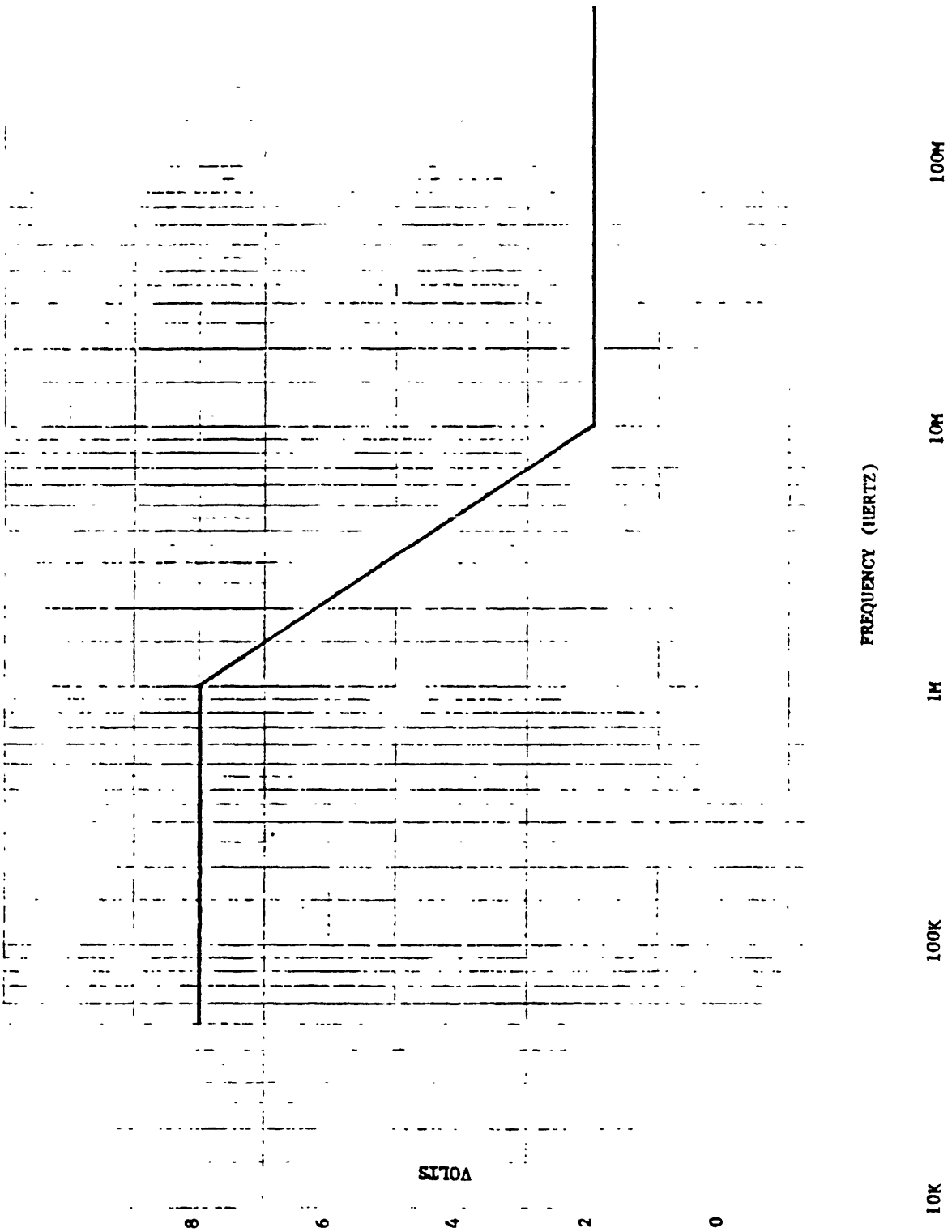
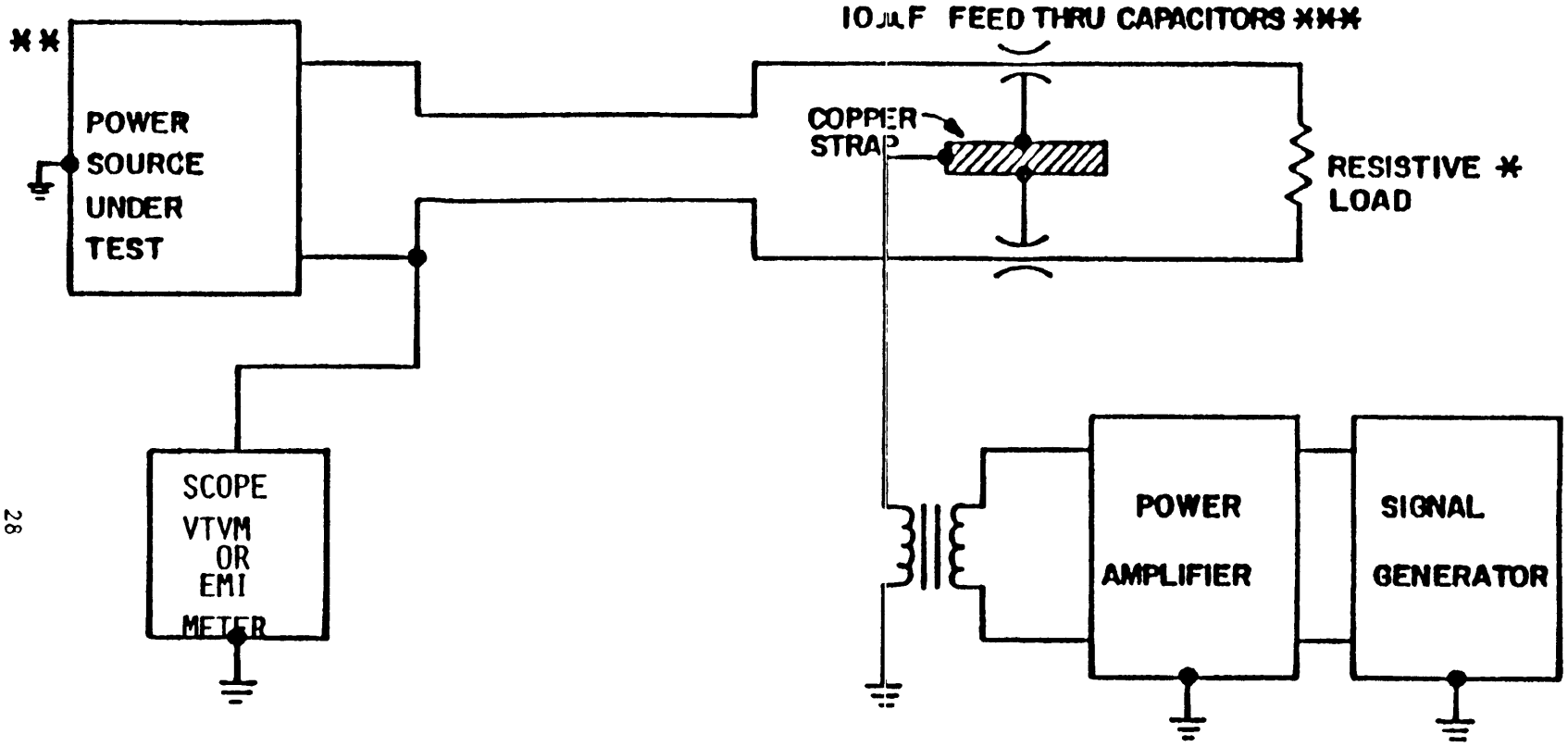


FIGURE 14. Power source CS01 limits.





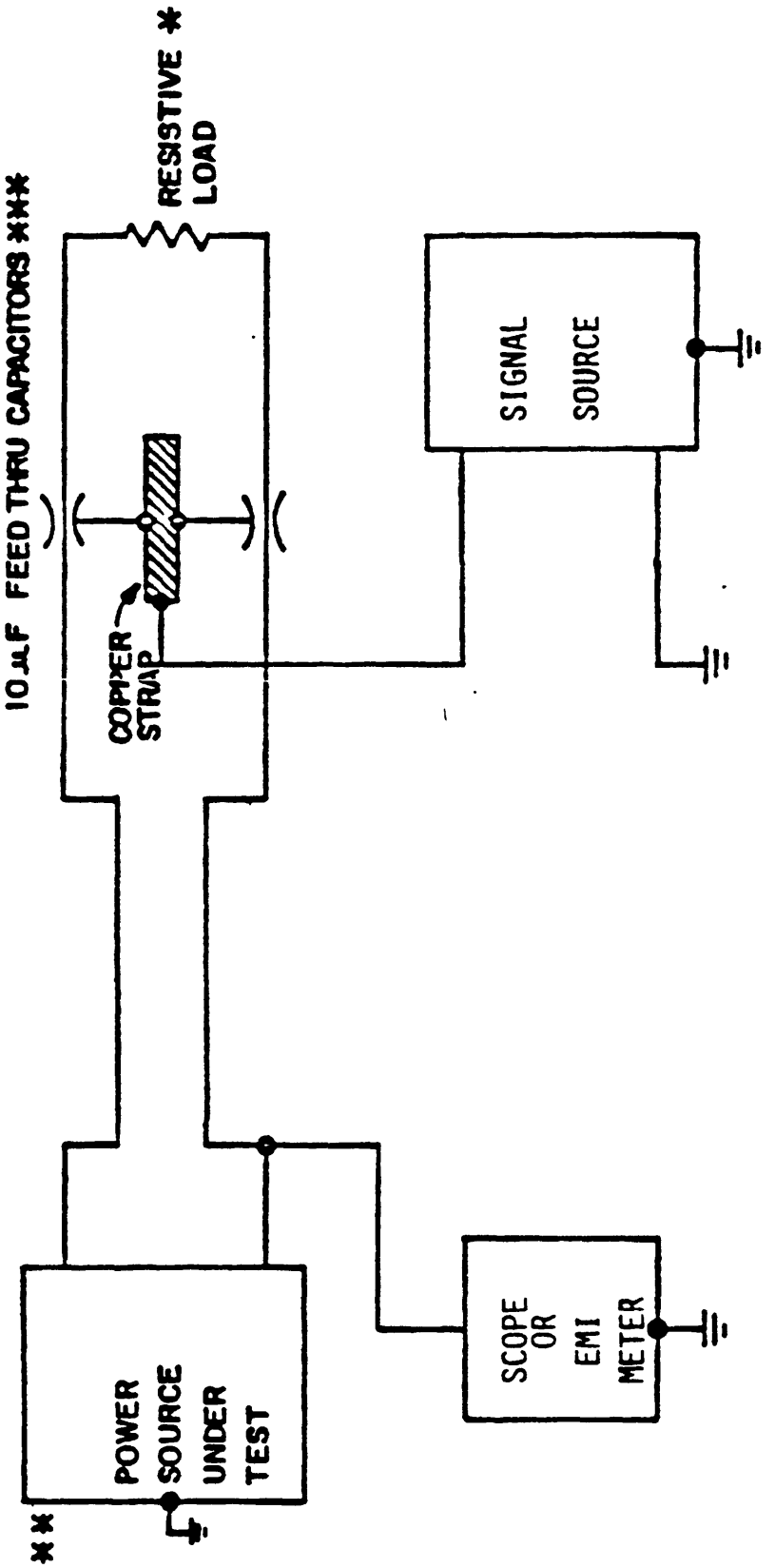
* LOAD EQUIVALENT TO SOURCE RATING

** USE PROVISIONS INCLUDED IN THE DESIGN AND SPECIFIED IN THE INSTALLATION INSTRUCTIONS TO BOND TEST SAMPLE TO THE GROUND PLANE. IF BOND STRAPS ARE USED, THEY SHALL BE IDENTICAL TO THOSE SPECIFIED FOR THE INSTALLATION.

*** CAPACITOR VALUES MUST BE BALANCED TO WITHIN PLUS OR MINUS 5 PERCENT.

SH 131891

FIGURE 16. Power source CS01 line-to-ground test set-up.

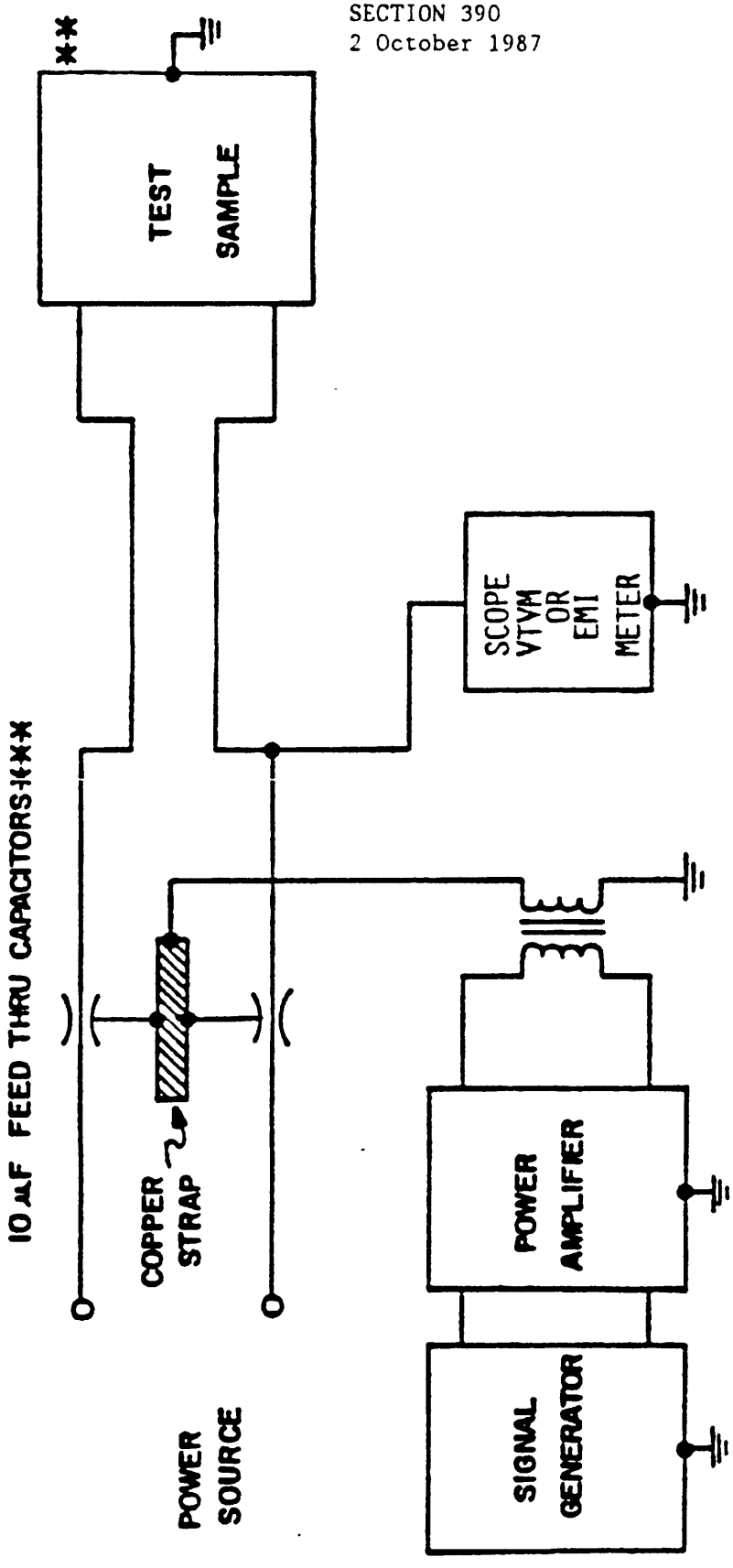


* LOAD EQUIVALENT TO SOURCE RATING

** USE PROVISIONS INCLUDED IN THE DESIGN AND SPECIFIED IN THE INSTALLATION INSTRUCTIONS TO BOND TEST SAMPLE TO THE GROUND PLANE. IF BOND STRAPS ARE USED, THEY SHALL BE IDENTICAL TO THOSE SPECIFIED FOR THE INSTALLATION.

*** CAPACITOR VALUES MUST BE BALANCED TO WITHIN PLUS OR MINUS 5 PERCENT. FOR TESTS ABOVE 1 MHZ, USE 0.47 UF HIGH FREQUENCY CAPACITORS.

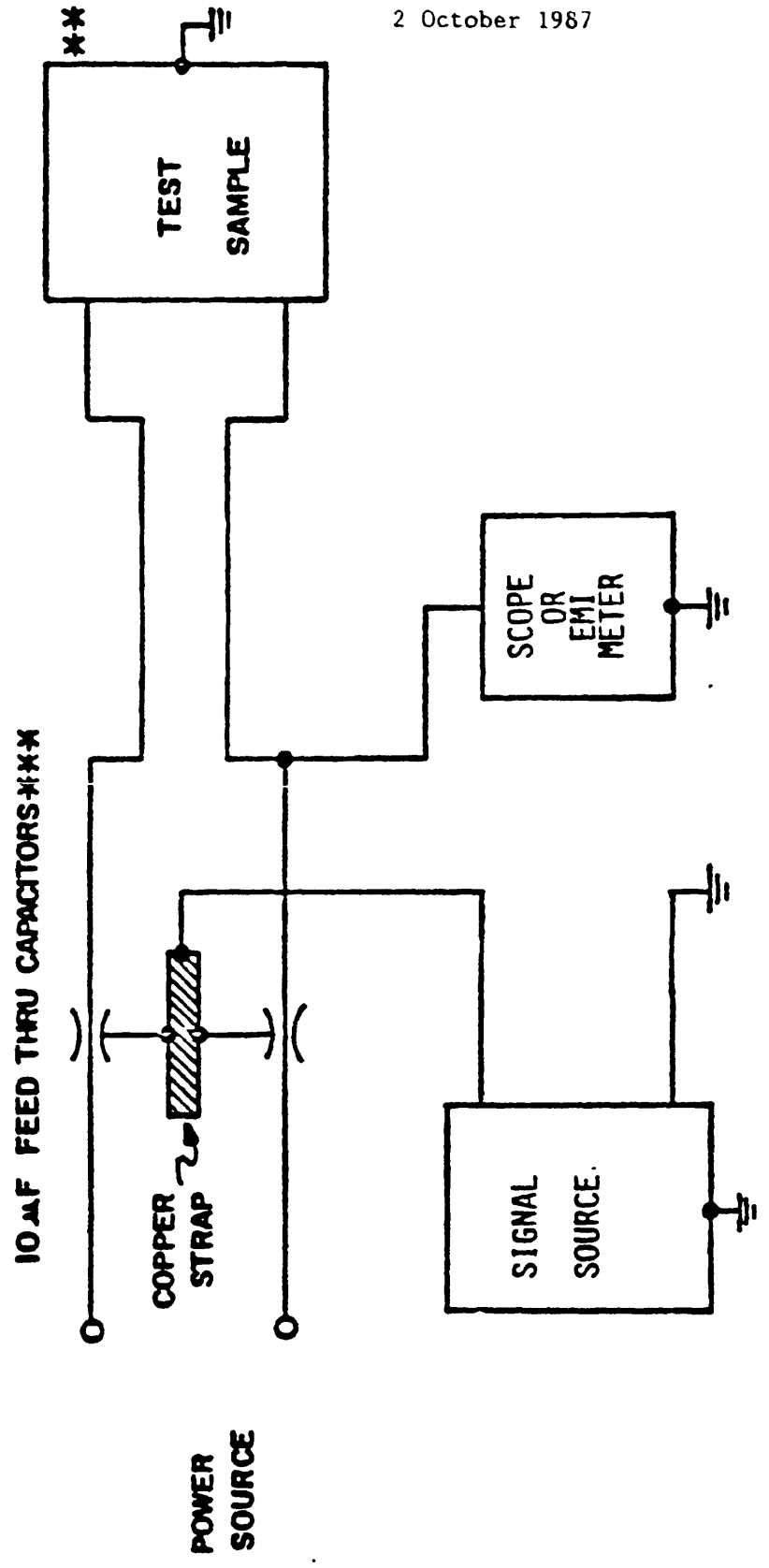
FIGURE 17. Power source CS02 line-to-ground test set-up.



**USE PROVISIONS INCLUDED IN THE DESIGN AND SPECIFIED IN THE INSTALLATION INSTRUCTIONS TO BOND TEST SAMPLE TO THE GROUND PLANE. IF BOND STRAPS ARE USED, THEY SHALL BE IDENTICAL TO THOSE SPECIFIED FOR THE INSTALLATION.

***CAPACITOR VALUES MUST BE BALANCED TO WITHIN PLUS OR MINUS 5 PERCENT.

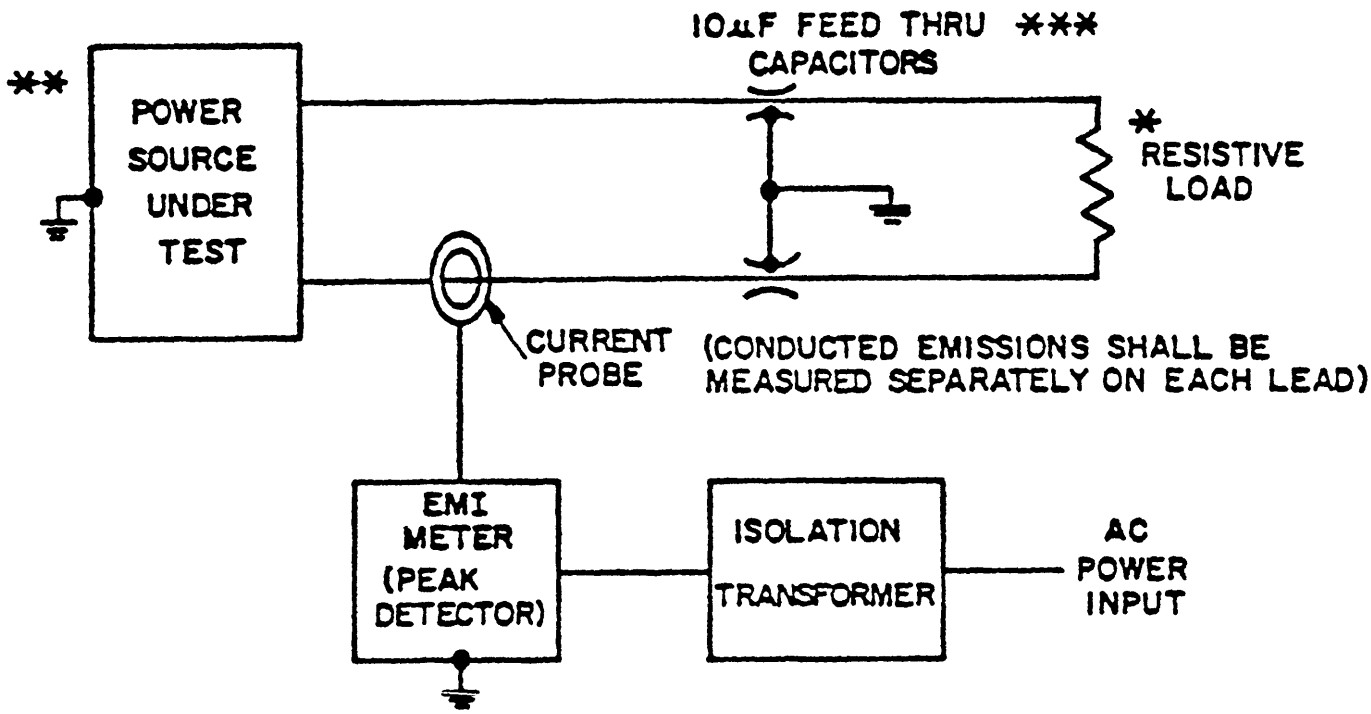
FIGURE 18. User equipment CS01 line-to-ground test set-up.



**USE PROVISIONS INCLUDED IN THE DESIGN AND SPECIFIED IN THE INSTALLATION INSTRUCTIONS TO BOND TEST SAMPLE TO THE GROUND PLANE. IF BOND STRAPS ARE USED, THEY SHALL BE IDENTICAL TO THOSE SPECIFIED FOR THE INSTALLATION.

***CAPACITOR VALUES MUST BE BALANCED TO WITHIN PLUS OR MINUS 5 PERCENT. FOR TESTS ABOVE 1 MHZ, USE 0.47 UF HIGH FREQUENCY CAPACITORS.

FIGURE 19. User equipment CS02 line-to-ground test set-up.



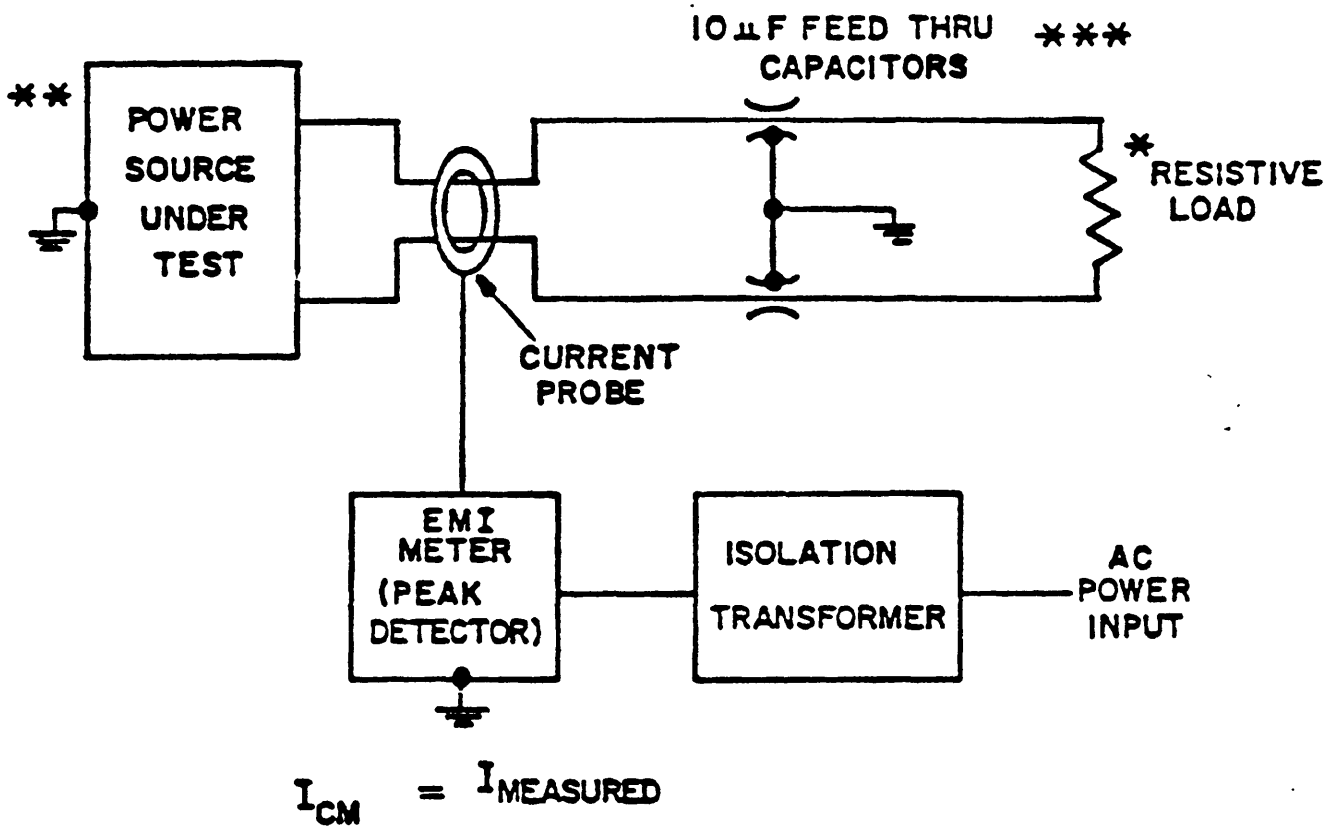
* LOAD EQUIVALENT TO SOURCE RATING

** USE PROVISIONS INCLUDED IN THE DESIGN AND SPECIFIED IN THE INSTALLATION INSTRUCTIONS TO BOND TEST SAMPLE TO THE GROUND PLANE. IF BOND STRAPS ARE USED, THEY SHALL BE IDENTICAL TO THOSE SPECIFIED FOR THE INSTALLATION.

*** CAPACITOR VALUES MUST BE BALANCED TO WITHIN PLUS OR MINUS 5 PERCENT.

SH 131893

FIGURE 20. Power source CE01 and CE03 differential mode ripple current test set-up.



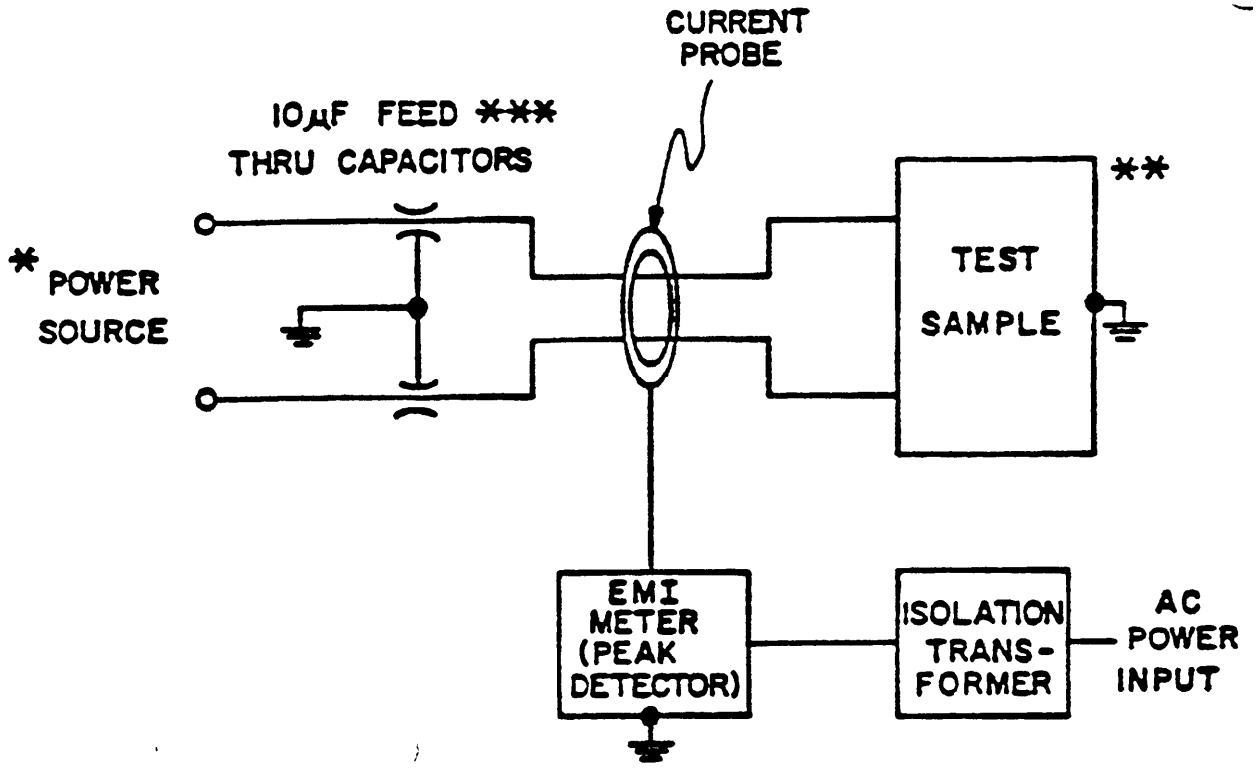
* LOAD EQUIVALENT TO SOURCE RATING

** USE PROVISIONS INCLUDED IN THE DESIGN AND SPECIFIED IN THE INSTALLATION INSTRUCTIONS TO BOND TEST SAMPLE TO THE GROUND PLANE. IF BOND STRAPS ARE USED, THEY SHALL BE IDENTICAL TO THOSE SPECIFIED FOR THE INSTALLATION.

*** CAPACITOR VALUES MUST BE BALANCED TO WITHIN PLUS OR MINUS 5 PERCENT.

SH 131894

FIGURE 21. Power source CE01 and CE03 common mode ripple current test set-up.



* ELECTROMAGNETIC INTERFERENCE LEVEL OF POWER SOURCE USED FOR TEST SHALL BE AT LEAST 10DB BELOW THE ALLOWABLE SPECIFIED LIMIT WHEN DRIVING AN EQUIVALENT PASSIVE RESISTIVE LOAD.

$$I_{CM} = I_{MEASURED}$$

** USE PROVISIONS INCLUDED IN THE DESIGN AND SPECIFIED IN THE INSTALLATION INSTRUCTIONS TO BOND TEST SAMPLE TO THE GROUND PLANE. IF BOND STRAPS ARE USED, THEY SHALL BE IDENTICAL TO THOSE SPECIFIED FOR THE INSTALLATION.

*** CAPACITOR VALUES MUST BE BALANCED TO WITHIN PLUS OR MINUS 5 PERCENT.

SH 131895

FIGURE 22. User equipment CE01 and CE03 common mode ripple current test set-up.

APPENDIX

ELECTROMAGNETIC INTERFERENCE REQUIREMENTS FOR DC SOURCES AND USER EQUIPMENT THAT UTILIZE DC POWER

The material covered by this appendix forms a mandatory part of this standard.

10. GENERAL

10.1 Scope. The purpose of this appendix is to specify the emission and susceptibility requirements for dc power sources and user equipments that utilize standard dc power intended for use in submarines (class A5). Exceptions and q edifications to the EMI limits specified in MIL-STD-461 for A5 equipment are delineated for these equipments in this appendix.

20. REFERENCED DOCUMENTS

Not applicable.

30. DEFINITIONS

Not applicable.

40. GENERAL REQUIREMENTS

Not applicable.

50. DETAILED REQUIREMENT'S

50.1 Power source EMI limits. EMI limits for dc power sources shall be as specified in MIL-STD-461 for AS equipment, except that the following modifications apply:

CE01 For dc power leads, the limits for differential for mode currents shall be in accordance with figure 5 and the common mode currents shall be in accordance with figure 6.

CE03 For dc power leads, the limits for differential mode currents shall be in accordance with MIL-STD-461 for both narrowband and broadband emissions, and the limits for common mode currents shall be in accordance with figures 7 and 8 for narrowband and broadband emissions, respectively.

CS01 The limit shall be in accordance with figure 14 for power sources from 30 Hz to 50 kHz. Voltage shall be applied with a transformer inserted in the power line in accordance with MIL-STD-462, and from each line-to-ground (see figure 16).

NOTE: The requirement is also met when a 600 watt power source of 1.5 ohms impedance, adjusted to dissipate 150 watts in a 0.5 ohm load, cannot develop the required voltage at the test sample terminals, and the test sample is not susceptible to the output of the signal source.

CS02 The limit shall be in accordance with figure 15. Tests shall be conducted with voltage applied from line-to-line and from each line-to-ground (see figure 17).

NOTE: The requirement is also met when a 100 watt source of 50 ohms impedance cannot develop the required voltage at the appropriate test sample terminals, and the test sample is not susceptible to the output of the test signal source when the test is run.

RS02 For part II, use power frequencies of 60 Hz and 400 Hz.

50.2 User equipment EMI limits. EMI limits for user equipments shall be as specified in MIL-STD-461 for A5 equipment, except that the following modifications shall apply:

CE01 For dc power leads, the limits for differential mode currents shall be in accordance with figure 10, and the limits for common mode currents shall be in accordance with figure 11.

CE03 For dc power leads, the limits for differential mode currents shall be in accordance with MIL-STD-461 for both narrowband and broadband emissions, and the limits for common mode currents shall be in accordance with figures 12 and 13 for narrowband and broadband emissions, respectively.

CS01 Five volts rms from 30 Hz to 50 kHz shall be used. Vo1tage shall be applied with a transformer inserted in the power line in accordance with MIL-STD-462, and from each line-to-ground (see figure 18).

NOTE : The requirement is also met 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.

CS02 Tests shall be conducted with voltage applied from line-to-line and from each line to ground (see figure 19).

RS02 For part II, use power frequencies of 60 and 400 Hz.

50.3 Filtering. The use of line-to-ground filters for EMI control shall be minimized. If line-to-ground filters are used, the total line-to-ground capacitance shall conform to the applicable requirements in 50.3.1 and 50.3.2.

50.3.1 Power source capacitance to ground. The sum of the leakage capacitance and the filter capacitance from each line-to-ground shall not exceed 0.02 µF/kW measured at 1 khz.

50.3.2 User equipment capacitance to ground. The sum of the leakage capacitance and the filter capacitance from each line-to-ground at the user interface shall not exceed 0.075 µF/kW of connected load measured at 1 kHz. For loads more than 0.5 kW and less than 1 kW, the allowable capacitance shall be reduced in proportion to the specified values for the 1-kW capacitance value (for example, the allowable capacitance for a 0.8 kW load is 0.8/1 x 0.075 = 0.06 µF). For loads less than 0.5 kW, the leakage capacitance and the filter capacitance shall not exceed 0.03 µF microfarad.

50.4 Power source EMI test. Source qualification test procedures shall be in accordance with MIL-STD-462, except as specified in 50.4.1 and 50.4.2.

50.4.1 The test set-up for CE01 and CE03 differential mode current emissions shall be in accordance with MIL-STD-462, except as modified by figure 20. The test set-up for CE01 and CE03 common mode current emissions shall be in accordance with MIL-STD-462, with the exception that common mode current emissions shall be measured by placing the current probe around both leads as shown on figure 21.

50.4.2 The test set-up for CS01 and CS02 shall be in accordance with MIL-STD-462, except that the power lines shall not be grounded. The test set-up for CS01 and CS02 line-to-ground injected voltages shall be in accordance with figure 16 and 17, respectively.

50.5 User equipment EMI test. An EMI qualification test shall be included as part of the user's power system proof of conformance. User qualification test procedures shall be in accordance with MIL-STD-462, except as specified in 50.5.1 and 50.5.2.

50.5.1 The test set-up for CE01 and CE03 differential mode current emissions shall be in accordance with MIL-STD-462. The test set-up for CE01 and CE03 common mode current emissions shall be in accordance with MIL-STD-462 with the exception that common mode current emissions shall be measured by placing the current probe around both leads as shown on figure 22.

50.5.2 The test set-up for CS01 and CS02 shall be in accordance with MIL-STD-462, except that the power lines shall not be grounded. The test set-up for CS01 and CS02 line-to-ground injected voltages shall be in accordance with figures 18 and 19, respectively.

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3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
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