INCH-POUND

MIL-PRF-24021K
08 July 1998
SUPERSEDING
MIL-E-24021J
30 June 1986

PERFORMANCE SPECIFICATION

ELECTRIC POWER MONITORS, EXTERNAL, AIRCRAFT

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers electric power monitors which are installed in aircraft to monitor external electric power to prevent power outside the limits of this specification from being applied to equipment in the aircraft.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 414100B120-3, Highway 547, Lakehurst, NJ 08733-5100, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6110

2.2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-E-81910 - Electrical Power Generating and Control Equipment, Aircraft, General Specification for

STANDARDS

FEDERAL

FED-STD-595 - Colors Used in Government Procurement

DEPARTMENT OF DEFENSE

MIL-STD-130 - Identification Marking of U. S. Military Property

(Unless otherwise indicated, copies of the above specifications and standards are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. External, aircraft, electric power monitors furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Materials. Materials used in the manufacture of electric power monitors shall meet the requirements specified herein. Materials conforming to contractor's specifications may be used provided the specifications contain provisions for tests and the required life, performance, reliability and warranty period are achieved. The use of the contractor's specifications does not constitute waiver of Government inspection.

3.2.1 Metals.

3.2.1.1 Corrosion resistance. Materials shall be corrosion resistant or processed to withstand the environmental test requirements of MIL-E-81910.

3.2.2 Toxicity and fire resistance. Non-metallic materials used shall be flame resistant, shall not support combustion, and shall be nontoxic when exposed to flame as well as when used under all operating and environmental conditions herein (see 3.5).

3.3 Performance and interface characteristics.

3.3.1 Mean flight hours between failure (MFHBF). While operating under specified conditions, the minimum MFHBF for the power monitor shall be 10,000 hours for its first 5.5 years of service life, including storage.

3.3.2 Maintainability. The electric power monitor shall meet the requirements of this specification for its complete 5.5 year service period, without the need for any routine servicing or maintenance actions. The monitor shall not include any provision for disassembly or inspection.

3.3.3 Repairability. The electric power monitor shall be non-repairable. The monitor shall be designed and constructed to hinder disassembly or access to internal components.

3.3.4 Adjustments. No provisions for external adjustments shall be provided and no adjustment or alignments shall be required during installation of any power monitor. All adjustments shall be made at the time of manufacture or when a monitor is being restored to a like new condition. If devices for making adjustments are installed within a monitor, means for locking and sealing shall be provided.

3.3.5 Electron tubes. Vacuum or gas filled electron tubes shall not be used.

3.3.6 Capacitors. Wet slug tantalum capacitors shall not be used.

3.3.7 Threaded parts. All internal or external parts which are threaded shall be positively locked. Accidental loosening of threaded parts shall be prevented by self-locking nuts, safety wiring, or other methods. Stacking shall not be used.

3.3.8 Moving parts. The monitor shall be a completely static solid-state device having no moving parts except that one electro-mechanical relay may be used for controlling the AC or DC power to operate the external power contactor.

3.3.9 Color. The monitor shall be finished in accordance with FED-STD-595, color number 17875, or equivalent.

3.3.10 Cooling. The monitor shall be self-cooled by convection and radiation. Conduction cooling shall not be allowed. Safe operation equilibrium temperature shall be maintained for all parts over the specified range of operating conditions, and rated temperatures of parts shall not be exceeded.

3.3.11 Ventilation openings. All ventilation and other openings shall be designed to prevent passage of foreign objects and shall be of such size as to prevent passage of spherical objects of 0.188 inch diameter or larger.

3.3.12 Operating attitude. The monitor shall operate in any attitude.

3.3.13 Dimensions. The dimensions of the monitors shall conform to figure 1. Where only minimum or maximum dimensions are shown on the figure, the monitor need not have the shape shown on the figure, but the monitor, including all protrusions, shall be contained within the outline shown on figure 1.

3.3.14 Part number, weight and height. The part number shall be in accordance with 6.7 and table I. The weight and height of each monitor shall be not greater than the value listed in table I.

3.3.15 Electric receptacle. Each monitor shall include an electric receptacle which shall be compatible with the mating electric plug called out in table I and shall be installed on the monitor in accordance with figure 1, with the largest polarizing key or keyway of the receptacle at the top center of the receptacle shell.

3.3.16 Compatibility. The monitor shall not degrade the power system's ability to provide the power characteristics specified in 3.4.4.1 or 3.4.4.2, as applicable. DC monitors shall include a method in the output circuit to clamp negative transients to ground.

3.3.17 Environmental protection. A means shall be provided for protecting printed circuit boards from environmental effects (see 6.5).

3.3.18 Sneak circuits. Sneak circuits shall not be allowed.

3.3.19 Installation. The monitors shall be connected in accordance with figures 2, 3, or 4, as applicable.

3.3.19.1 Reset switch. A reset switch shall be provided as shown on figures 2, 3, or 4, as applicable. The switch shall be a push-button type, spring-loaded to the normal (open) position, with momentary movement to the reset (closed) position. The switch shall not include any means for locking it in the reset position.

3.3.20 Overload protection. A circuit protective device shall be provided for each monitor in order to protect the circuit which supplies or carries (as applicable) the current to the contactor. Monitors shall be protected for 10 amperes as follows: M24021-3 monitors at pin 5, M24021-5 monitors at pin F, and M24021-6 monitors at pin A. The devices shall be a fast-acting type designed for protection of semi-conductor devices.

3.4 Performance. The power monitor shall meet the following performance requirements for AC and DC operation.

3.4.1 Input power requirements.

3.4.1.1 Input of electric power to AC monitors. Each AC monitor shall withstand without damage, and shall not reset automatically upon application of three-phase, four-wire, wye-connected, grounded-neutral, alternating potential having the following characteristics when applied according to figure 5 or 6, as applicable.

a. Three-phase, steady-state voltage, of a frequency between 300 and 500 Hz between line and neutral, and applied between monitor pin 4 and pins 1, 2, and 3, or between pins G and A, C and E, as applicable. The monitor shall not be damaged when these voltages in the range of 0 to 140 volts RMS are applied continuously and in the range of 140 to 200 volts RMS are applied for a period of one-half hour.

b. Total harmonic content shall be not greater than 5 percent of the fundamental. Individual harmonic content shall be not greater than 3 percent of the fundamental.

c. Any phase sequence.

d. Three phase steady-state voltages of 115 RMS volts and 60 Hz frequency applied between monitor pin 4 and 1, 2, 3 or between pins G and A, C and E, as applicable for 30 seconds.

3.4.2 Input power to DC monitors.

3.4.2.1 Input of electric power to power lead (pin G) and sense lead (pin B). Each DC monitor shall withstand without damage, and shall not reset automatically regardless of inhibit voltage value upon application of, grounded-negative direct potential having the following characteristics when applied to pins G and H, and B and H, in accordance with figure 7.

a. Any average value between -80 and +80 volts applied continuously.

b. Ripple from a power source whose individual frequency characteristics are in the 10 Hz to 40 kHz range and whose ripple voltage can vary from 0 to 10 volts peak-to-mean.

c. Spikes from 0 to ±600 volts from the average voltage level, with a 50-ohm source impedance, a waveform as shown on figure 8, and a repetition range of 0 to 50 pulses per second. Application of the spike shall not cause the monitor to disconnect power from the contactor.

d. The current drawn through the sense lead (pin B) shall be less than 50 milliamperes.

3.4.2.2 Inhibit voltage at pins C and E. The M24021-6 monitor shall be designed to accept at pins C and E (see figure 7) an aircraft-generated direct DC potential of -15 to +80 volts (inhibit voltage) originating at the starter system. When a 2 to 80 volt inhibit voltage is applied at pin C or E and the monitor is in the reset state (the external contactor on figure 7 is energized), the monitor shall remain reset and, in addition, shall be inhibited within 0.1 second from the time the 2 to 80 volt inhibit voltage is applied. In the inhibit mode of operation (2 to 80 volt inhibit voltage is applied at pins C or E), the monitor shall accept any input voltage present at pin G (input at pin G will be within the limits specified by curves on figure 9, 10 volts DC to 80 volts DC) and apply it to the aircraft contactor at pin A. The maximum voltage drop between pins G and A shall be not greater than 2.5 volts when the monitor input voltage is in the range of 10 to 29.1 volts DC. The 2 to 80 volt inhibit voltage shall not be applied to both pins C and E simultaneously when the monitor is operating in the inhibit mode. When a 2 to 80 volt inhibit voltage is applied at pin C or E and the monitor is in the trip state (monitor output at pin A is 0 volts), the monitor shall remain in the trip state and shall reset only manually as specified in 3.4.4.2.1.

a. When an inhibit voltage of -15 to +1.5 volts is applied to both pins C and E, the monitor shall function as specified in 3.4.4.2.1. If the inhibit voltage decreases from a higher value to a voltage of less than 1.5 volts and the monitor is in the reset state (the external contact on figure 7 is energized), the monitor shall function as specified in 3.4.4.2.1 within 0.1 second from the time the inhibit voltage decreases to a voltage of less than 1.5 volts.

b. The non-inhibited (normal) requirements stated herein shall be met also when pin C or E or both are not connected to any external circuit.

c. When the inhibit voltage at pins C or E is in the range of 1.5 to 2 volts, the monitor may operate either in the inhibited or in the non-inhibited (normal) mode.

d. The internal circuit of the monitor shall incorporate a 10 kilo-ohm resistor in series with pin C and a 10 kilo-ohm resistor in series with pin E.

3.4.3 Output requirements.

3.4.3.1 AC monitor including source of DC for contactor. When the external power applied to the M24021-3 monitor meets the reset conditions specified in 3.4.4.1, the monitor shall, upon momentary closing of the reset switch, activate a switching circuit which will apply a direct

potential of 26 ±4 volts between pins 4 and 5 of the monitor receptacle. The internal circuit connected to pin 5 shall have a current capacity not less than 1.5 amperes continuously and 15 amperes for 200 milliseconds (msec) at 115 volts AC input. The output shall energize the aircraft AC external power contactor, thus connecting the AC external power to the aircraft load. The cyclic peak-to-mean of ripple voltage to the mean level of the monitor DC output voltage shall be less than 1.5 volts under all input and output conditions.

3.4.3.2 AC monitors excluding power supply. When the external power applied to the M24021-5 monitor meets the reset conditions specified in 3.4.4.1, the monitor shall, upon momentary closing of the reset switch, activate a switching circuit or relay which will connect together pins F and H of the monitor receptacle. The switching circuit between these pins shall have a DC or AC capacity of at least 5 amperes continuously and 15 amperes for 200 msec. The switching circuit shall control the application of 26 ±4 volts DC or 112.8 to 118.2 volts AC (externally applied to pin H) to the external power contactor, which will connect external AC power to the aircraft load. The voltage drop across pins F and H at the monitor receptacle shall be not greater than 0.25 volt under all input and output conditions.

3.4.3.3 DC monitors. When the external power applied between pins B and A of the M24021-6 monitor meets the reset conditions specified in 3.4.4.2, the monitor shall, upon momentary closing of the reset switch, activate a switching circuit between pins G and A which will apply external power to the aircraft power contactor coil. The switching circuit between pins G and A shall have a current capacity not less than 2.5 amperes at 28 volts DC and a current capacity of 15 amperes for 200 msec, which includes the current for the indicator lamp between pin D and ground. When the switching circuit is closed (power connected to the external power contactor coil) the voltage drop between pins G and A shall be not greater than 2.5 volts and the indicator light shall be on under all input and output conditions.

3.4.4 Operating values. Each monitor shall operate as specified in 3.4.4.1 or 3.4.4.2. The response time specified in 3.4.4.1.1, 3.4.4.2.1, or 3.4.4.2.2, applies to the monitor alone and does not include the response time of the contactor.

3.4.4.1 Operation of AC monitors. Each AC monitor shall connect the source of AC external power to the aircraft load via operation of the external power contactor (reset) only when all of the reset conditions specified in 3.4.4.1.1 and 3.4.4.1.2 are met for all three phase voltages and the reset switch is momentarily closed. The monitor shall not require the release of the reset switch to activate its switching circuit. Each AC monitor upon reset shall not connect the load or if in operation shall disconnect the load (trip) when any one or more of the trip conditions specified in 3.4.4.1.1 and 3.4.4.1.2 are met for any one or more of the three phase voltages. The reset and trip response times are specified in 3.4.4.1.3 and 3.4.4.1.4.

3.4.4.1.1 Frequency and voltage. Each AC monitor shall have reset and trip response times for voltage and frequency as specified in table II and on figures 10 and 11.

3.4.4.1.2 Phase sequence. The correct phase sequence at the electric receptacle of the monitor is 1-2-3 or A-C-E, as applicable, and the monitor shall not reset if the sequence is otherwise.

3.4.4.1.3 AC reset response time. The AC power monitor reset response time shall be measured from the time the reset switch is closed until the monitor connects power to the external power contactor coil. Reset response time shall be as specified in table II.

3.4.4.1.4 AC trip response time. The AC power monitor trip response time shall be measured from the time the applied voltage or frequency goes outside the steady-state voltage or frequency limits in table II until the monitor disconnects power from the external power contactor coil.

3.4.4.2 Operation of DC monitors.

3.4.4.2.1 Normal operation of DC monitors. The DC power monitor shall connect external power to the aircraft load via operation of the external power contactor (reset) only when the external power is of the proper polarity, the voltage and ripple are within the reset limits in table III and on figure 9, the voltage at pins C and E is less than 1.5 volts, and the reset switch is momentarily closed. The monitor shall not require the release of the reset switch to activate its switching circuit between pins G and A. The DC monitor upon reset shall not engage the load, or if in operation shall disconnect the load (trip) when the voltage or ripple or both are outside the limits in table III and on figure 9. The potential applied to pin G of the monitor shall be applied to the coil of the external power contactor by the switching circuit in the monitor. However, operation shall be controlled by the potential applied to pin B of the monitor.

3.4.4.2.2 Inhibited operation of DC monitors. The monitor shall perform in an inhibited mode as specified in 3.4.2.2.

3.4.4.2.3 DC reset response time. The reset response time shall be measured from the time the reset switch is closed until the monitor connects power to the external power contactor coil. Reset response time is specified in table III.

3.4.4.2.4 DC trip response time. The DC monitor trip response time shall be measured from the time the applied power goes outside the steady-state limits in table III until the monitor disconnects power from the external power contactor coil. Trip response times are specified in table III.

3.4.4.2.5 Polarity. The DC monitor shall sense the polarity of the applied voltage. The monitor shall not connect external power to the load (reset) when the polarity is incorrect.

3.5 Environmental.

3.5.1 Environmental service conditions. The external power monitor shall be subjected to the environmental test conditions of MIL-E-81910 specified as follows.

3.5.1.1 Sand and dust. The external power monitor shall meet all of the performance requirements of 3.4 when tested in accordance with the dust test of MIL-E-81910.

3.5.1.2 Salt fog. The external power monitor shall meet all of the performance requirements of 3.4 after being tested in accordance with the salt fog test of MIL-E-81910.

3.5.1.3 Mechanical shock. With the exception of the crash safety test, the external power monitor shall meet all of the performance requirements of 3.4 after being tested in accordance with the mechanical shock test of MIL-E-81910.

3.5.1.4 Fungus. The external power monitor shall meet all of the performance requirements of 3.4 after being tested in accordance with the fungus test of MIL-E-81910.

3.5.1.5 Humidity. The external power monitor shall meet all of the performance requirements of 3.4 when tested to the conditions and at the times specified in the humidity test of MIL-E-81910.

3.5.1.6 Vibration. With the exception of the endurance level testing, the external power monitor shall meet all of the performance requirements of 3.4 when subjected to the vibration test for non-engine-mounted components of MIL-E-81910. The external power monitor shall meet all of the performance requirements of 3.4 after being subjected to the endurance test.

3.5.1.7 Electromagnetic compatibility. The external power monitor shall pass the electromagnetic compatibility test of MIL-E-81910.

3.5.2 Temperature-altitude.

3.5.2.1 Temperature-altitude (operating). Each protective function of the monitor shall operate within the limits of 3.4.4 when tested in accordance with 4.4.3.1.

3.5.2.2 Temperature-altitude (non-operating). Each protective function of the monitor shall operate within the limits of 3.4.4 when tested in accordance with 4.4.3.2.

3.5.3 Burn-in. With applicable nominal voltage and frequency applied, the monitor shall pass the tests specified in 4.4.4.

3.5.4 Temperature.

3.5.4.1 Room temperature. Each protective function of the monitor shall operate within the limits of 3.4.4 when tested in accordance with 4.4.6.

3.5.4.2 High temperature. Each protective function of the monitor shall operate within the limits of 3.4.4 when tested in accordance with 4.4.7.

3.5.4.3 Low temperature. Each protective function of the monitor shall operate within the limits of 3.4.4 when tested in accordance with 4.4.8.

3.6 Dielectric strength. The monitor shall withstand a direct potential having an effective value of 1,500 ±100 volts applied between all the pins of the electric receptacle tied together and the monitor case for 1 ±0.1 minute. A notice (decal) shall be attached to the monitor to indicate: WARNING! A dielectric test shall not be performed as part of any inspection procedure. At the option of the manufacturer, markings in accordance with MIL-STD-130 may be used in lieu of decals.

3.7 External circuit. For all tests which require operation of the monitor, it shall be connected to an external circuit in accordance with figures 5, 6, and 7. A monitor shall not reset when an impedance of 10 kilo-ohms or greater is connected across the external circuit reset button shown on figures 5, 6, and 7.

3.8 Workmanship. After fabrication, parts and assembled equipment shall be cleaned of smudges; loose, spattered, or excess solder; weld metal; metal chips, and mold release agents; or any other foreign material which might detract from the intended operation, function, or appearance of the equipment. Screws, nuts, and bolts shall show no evidence of cross threading, mutilation, or detrimental or hazardous burrs, and shall be firmly secured. Bearing assemblies shall be free of rust, discoloration, and imperfections of ground, honed, or lapped surfaces. Contacting surfaces shall be free of tool marks, gouge marks, nicks, or other surface-type defects. There shall be no detrimental interference, binding, or galling. Wires and cables shall be positioned or protected to avoid contact with rough or irregular surfaces and sharp edges and to avoid damage to conductors or adjacent parts. Shielding on wires and cables shall be secured in a manner that will prevent it from contacting or shorting exposed current-carrying parts. The ends of the shielding or braid shall be secured to prevent fraying. Containment (harness and cable) shall be neat in appearance and shall not cause the wire or cable insulation to deform so that performance characteristics are adversely affected. There shall not be any evidence of burns, abrading or pinch marks in the insulation that could cause short circuits or leakage. Clearance of the wires shall prevent deterioration of the wires and cables from heat generating parts.

3.9 Identification marking. A nameplate in accordance with MIL-STD-130 or equivalent, shall be attached to each monitor and shall indicate the following information:

a. DO NOT DISASSEMBLE
b. NON-SERVICEABLE, NON-REPAIRABLE
c. Electric Power Monitor, External, Aircraft
d. Voltage and Frequency (as applicable)
e. Specification MIL-PRF-24021
f. Part or Identifying No. M24021-X
g. Manufacturer
h. Manufacturer's Part No.
i. Serial Number
j. Order or Contract Number
k. National Stock Number

3.9.1 Precautionary note. The following information shall be printed on the top or on a decal attached to the top (surface opposite the mounting surface).

On AC monitors the note shall read:

CAUTION: IF EXTERNAL POWER CANNOT BE APPLIED TO THE AIRCRAFT, CHECK FOR ACCEPTABLE EXTERNAL POWER LIMITS BEFORE REMOVING AND REPLACING THIS ELECTRIC POWER MONITOR. EXTERNAL POWER MUST BE WITHIN THE FOLLOWING LIMITS FOR THE MONITOR TO OPERATE AND TO PREVENT POSSIBLE DAMAGE TO AIRCRAFT EQUIPMENT:

Voltage: 113 to 118 volts per phase
Frequency: 393 to 407 Hz
Phase Sequence: A-B-C

On DC monitors, the note shall read:

CAUTION: IF EXTERNAL POWER CANNOT BE APPLIED TO THE AIRCRAFT, CHECK FOR ACCEPTABLE EXTERNAL POWER LIMITS BEFORE REMOVING AND REPLACING THIS ELECTRIC POWER MONITOR. EXTERNAL POWER MUST BE 24.0 TO 29.0 VOLTS TO OPERATE THIS MONITOR AND TO PREVENT POSSIBLE DAMAGE TO THE AIRCRAFT EQUIPMENT.

The notes shall be legible, prominent, and permanent. The word CAUTION shall be in all capital letters and not less than one-half inch tall. The rest of the information shall be all capital letters and not less than one-eighth inch tall.

3.9.2 Warranty marking. Power monitors shall contain a warranty marking in accordance with MIL-STD-130 or equivalent, and shall include the following additional information:

Warranty Expiration Date: _____

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3).

4.2.1 Qualification samples. The qualification samples shall consist of four identical monitors produced in accordance with this specification using production equipment and procedures. Qualification samples shall meet the examinations and tests in accordance with table IV and the conformance inspections of table V.

4.2.2 Qualification inspections and tests. Qualification inspections and tests shall be in the order listed in table IV. Any or all qualification inspections and tests required for any one of the qualification samples (tests listed under sample number 1, 2, 3, or 4 of table IV) may be conducted on any of the samples.

4.2.3 Qualification verification. Sampling of production monitors shall be used to verify requirements of this specification. Samples shall meet the examinations and tests in accordance with table IV. The number of samples will be as shown in the production contract.

4.3 Conformance inspection. Each electric power monitor produced under a contract requiring qualification to this specification will be accepted if:

a. The conformance inspections of table V are conducted by the supplier and are successfully completed.

b. Installation instructions are securely attached to each monitor in such a way that they need not be removed for check-out of the component prior to its installation on the aircraft.

4.4 Inspections. For the following inspections, the monitor shall be connected to a test circuit conforming to figure 5, 6, or 7.

4.4.1 Functional inspections.

4.4.1.1 Input power to AC monitors. The AC monitor shall be tested using an AC power source having the characteristics specified in 3.4.1.1. The AC monitor shall not be damaged and shall not reset automatically when the input power conditions specified in 3.4.1.1 are applied to the monitor.

4.4.1.2 Input power to power lead (pin G) and sense lead (pin B). The DC monitor shall be tested using a DC power source having the characteristics specified in 3.4.2.1. The DC monitor shall not be damaged and shall not reset automatically when the input power conditions specified in 3.4.2.1 are applied to the monitor.

4.4.1.3 Inhibit voltage at pins C and E test. The DC monitor shall be tested during application of an inhibit voltage having the characteristics specified in 3.4.2.2. The performance specified in 3.4.2.2 shall be met.

4.4.1.4 AC monitor including source of DC for contactor test. The specified output current capacity of the M24021-3 monitor shall be tested by applying loads to the monitor corresponding to the currents and time duration specified in 3.4.3.1. The performance specified in 3.4.3.1 shall be met.

4.4.1.5 AC monitors excluding power supply test. The specified output current capacity of the M24021-5 monitor shall be tested by applying loads to the monitor corresponding to the currents and time duration specified in 3.4.3.2. The performance specified in 3.4.3.2 shall be met.

4.4.1.6 Current capacity of DC monitors. The specified output current capacity of the M24021-6 monitor shall be tested by applying loads to the monitor corresponding to the currents and time duration specified in 3.4.3.3. The performance specified in 3.4.3.3 shall be met.

4.4.1.7 Operation of AC monitors test. Operation of the AC monitors shall be tested in accordance with and meet the requirements of 3.4.4.1.

4.4.1.8 Operation of DC monitors test. Operation of the DC monitors shall be tested in accordance with and meet the requirements of 3.4.4.2.

4.4.2 General environmental service conditions. After subjected to the environmental test requirements of MIL-E-81910, the external power monitor shall meet the requirements of 3.4 where applicable.

4.4.2.1 Sand and dust test. After subjected to the dust test of MIL-E-81910, the external power monitor shall meet the requirements of 3.4.

4.4.2.2 Salt fog test. After subjected to the salt fog test of MIL-E-81910, the external power monitor shall meet the requirements of 3.4.

4.4.2.3 Mechanical shock test. After subjected to the mechanical shock test of MIL-E-81910, the external power monitor shall meet the requirements of 3.4. The external power monitor is not required to meet the requirements of 3.4 after the crash safety test.

4.4.2.4 Fungus test. After subjected to the fungus test of MIL-E-81910, the external power monitor shall meet the requirements of 3.4.

4.4.2.5 Humidity test. After subjected to the tests and at the times specified by the humidity test of MIL-E-81910, the external power monitor shall meet the requirements of 3.4.

4.4.2.6 Vibration test. With the exception of the endurance level testing, the external power monitor, after subjected to the vibration test for non-engine-mounted components of MIL-E-81910, shall meet the requirements of 3.4.

4.4.2.7 Electromagnetic compatibility test. During and after the electromagnetic compatibility tests specified in MIL-E-81910, the external power monitor shall meet all of the requirements herein.

4.4.3 Temperature-altitude.

4.4.3.1 Temperature-altitude (operating) test. The monitor shall be subjected to 71° C at a simulated altitude of 10,000 feet for a period of 6 hours. At the conclusion of the exposure period and while still at test temperature and altitude, the monitor shall be operated to evaluate each protective function. Operation shall be within the limits specified in 3.4.4.

4.4.3.2 Temperature-altitude (non-operating) test. Starting at room ambient, the monitor shall be subjected to a simulated altitude condition of 50,000 feet at -55° C ambient temperature for a period of 2 hours or until the monitor stabilizes, after which the monitor shall be returned to room ambient and tested in accordance with 4.4.1. This process shall be repeated five times.

4.4.4 Burn-in test. With nominal voltage and frequency applied, the monitor shall be subjected to the burn-in test of MIL-E-81910, except that the 20-minute random vibration test shall be conducted after the 9-hour temperature test at room ambient temperature.

4.4.5 Visual and mechanical inspection. The monitor shall be inspected to determine compliance with this specification with respect to materials, workmanship, cleanliness, connections, markings, dimensions, and weight.

4.4.6 Room temperature test. Each protective function of the monitor shall be operated at room temperature.

4.4.7 High temperature test. The monitor shall be placed in the chamber and the temperature of the chamber shall be increased to 71° C. The monitor shall be exposed to that temperature for 6 hours. A relative humidity of not more than 15 percent shall be maintained in the chamber throughout the exposure period. At the conclusion of the exposure period and while still at 71° C, the monitor shall be operated to evaluate each protective function. Operation shall be within the limits specified in 3.4.4.

4.4.8 Low temperature test. The monitor shall be placed in the chamber and the temperature of the chamber shall then be reduced to and maintained at -55° C, for 6 hours. At the conclusion of the exposure period and while still at -55° C, the monitor shall be operated to evaluate each protective function. Operation shall be within the limits specified in 3.4.4.

4.4.9 Mean flight hours between failures. The MFHBF verification shall consist of the test or analysis specified in 4.4.9.1 and the tests specified in 4.4.9.2 and 4.4.9.3. The qualifying activity may, at its discretion, require that all qualification test samples be corrected and the failed test repeated in its entirety.

4.4.9.1 Predicted reliability. Analysis or test shall be used to verify an MFHBF of at least 10,000 hours (see 3.3.1).

4.4.9.2 Accelerated function test. The monitor shall undergo 20,000 operational cycles with each cycle consisting of the following:

a. Application of 115 ±2 volts at 400 ±10 Hz or 27 ±2 volts (as applicable to the monitor).

b. Closing the reset switch momentarily to pick up the monitor.

c. Operation of the monitor while picked up for at least 5 seconds.

d. Operation of the monitor in the trip mode by application of a voltage or frequency outside the steady-state limits for at least 5 seconds. This test may run either continuously or intermittently under room ambient conditions. After this test, the monitor shall be subjected to the tests of 4.4.1.

4.4.9.3 Endurance test. The monitor shall be operated for 1,000 hours in the following conditions:

Temperature and humidity:	Room ambient
Altitude:	0 - 5,000 feet
AC voltage (input):	115 ±2 volts at 400 ±10 Hz
DC voltage (output):	As required by 3.4.3.1, 3.4.3.2, and 3.4.3.3
DC voltage (input):	27 ±2 volts

The test may be run continuously or intermittently. Any period of operation shall be long enough to permit the temperature of the monitor to become stable. The monitor shall be tested in accordance with 4.4.1 at the end of the endurance test and at any time during the test at the discretion of the qualifying activity.

4.4.10 Dielectric strength test. Before assembly, a direct potential having an effective value of 1,500 ±100 volts shall be applied between all the pins of the electrical receptacle tied together and the monitor case for 1 ±0.1 minute. There shall not be any insulation breakdown.

4.4.11 Sneak circuits. An analysis or tests shall be used to verify sneak circuits do not exist.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. Electric power monitors are designed to be installed in a variety of military aircraft to monitor external power and prevent the application of poor quality external power to the equipment on board the aircraft. There are two power monitors designed for an AC powered aircraft. One provides a DC output to close a DC external power contactor. The other provides a pass through circuit which can close either an AC or DC external power contactor depending on the

requirement. Power monitors designed for DC powered aircraft provide a DC output to close a DC external power contactor. The electric power monitors are exposed for prolonged periods to extreme seagoing environments not encountered by civilian aircraft. There are no comparable monitors used in commercial aviation.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.

b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1).

c. Part or identifying number (PIN) (see 3.3.14, 6.7, and table I).

d. Installation instructions, handbooks, or manuals, when required (see 4.2.1).

e. Qualification verification samples (see 4.2.3 and 6.4).

f. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL-24021, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the Electrical Power Systems Division, AIR-4.4.4.1, Building 1461, Naval Air Warfare Center Aircraft Division, 48298 Shaw Road, Unit 4, Patuxent River, MD 20670-1900.

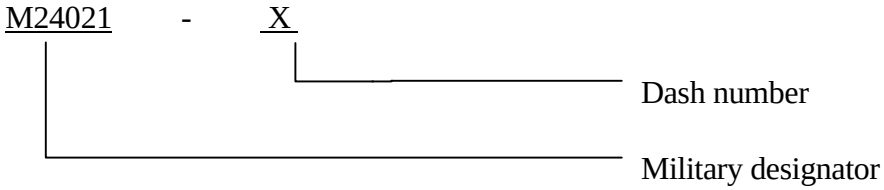
6.4 Qualification verification samples. For each quotation and based on all production contracts obtained, it will be the contractor's responsibility to inform the procuring activity of the exact number of qualification verification samples required for forwarding to the Qualifying Activity. If the proper number of verification samples is not itemized in the contract, then the contractor will, without additional cost to the Government, forward to the Qualifying Activity whatever number of verification samples is determined by the cognizant Government Inspector to be required by 4.2.3 of this specification.

6.5 Environmental protection. Conformal coatings have been used successfully in the past to protect printed circuit boards from environmental damage.

6.6 Subject term (key word) listing.

Alternating current
Direct current

6.7 Part or Identifying Number (PIN). The pin shall consist of the letter "M" the basic number of the specification and an assigned dash number shown in the example:



6.8 Supersession data.

M24021-3 supersedes M24021-2
M24021-5 supersedes M24021-4

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

TABLE I. Monitor Characteristics.

Part or Identifying Number	Type of Monitor	Mating Electric Plug	Maximum Weight (Pounds)	Maximum Height (H max) (Inches)
M24021-3	AC monitor for use with DC- operated contactor and including source of DC for contactor	MS3137-7-50S	2.5	3.0
M24021-5	AC monitor for use with AC or DC- operated contactor (but not including source of AC or DC for contactor)	MS3116-12-10S	2.0	3.0
M24021-6	DC monitor	MS3116-12-10SW	1.5	2.0

TABLE II. AC monitor reset and trip values.

Part 1. Operation when monitor has been previously tripped or been de-energized, and reset switch is not operated.

Function	Activation of external circuit or aircraft load		
	Not permitted	Permitted but not required	Required
Potential in Volts	Below 110.0 Above 121.0	110.0 to 112.8 118.2 to 121.0	112.8 to 118.2
Frequency in Hertz	Below 385.0 Above 415.0	385.0 to 390.0 410.0 to 415.0	390.0 to 410.0
Reset response time requirement is 0 to 1.5 seconds.			

Part 2. Operation when monitor has activated the external circuit or aircraft load in accordance with Part 1 and the power characteristics are now outside of the limits.

Function	Monitor tripping (disconnect external power from external circuit or the aircraft load)
Voltage	Figure 10
Frequency	Figure 11

TABLE III. DC monitor reset and trip values.

Part 1. Operation when monitor has been previously tripped or been de-energized, and reset switch is now operated.

Function	Activation of external circuit or aircraft load		
	Not permitted	Permitted but not required	Required
Potential in Volts	Below 23.0 Above 29.9	23.0 to 23.9 29.1 to 29.9	23.9 to 29.1
Ripple in Volts, Peak-to-Mean, 10 to 40 Kilohertz	Above 3.0	2.0 to 3.0	Below 2.0
Reset response time requirement is 0 to 1.5 seconds.			

Part 2. Operation when monitor has activated the external circuit or aircraft load in accordance with Part 1 and power characteristics are now outside of the limits.

Function	Monitor tripping (disconnect external power from the external circuit or the aircraft load)		
Voltage	See Figure 6		
Ripple in volts, Peak-to Mean, 10 to 40 Kilohertz	Not permitted	Permitted but not required	Required
	Below 2.0	2.0 to 3.0	Above 3.0
		Trip response time requirement is 0.5 to 1.0 second	

TABLE IV. Qualification inspection.

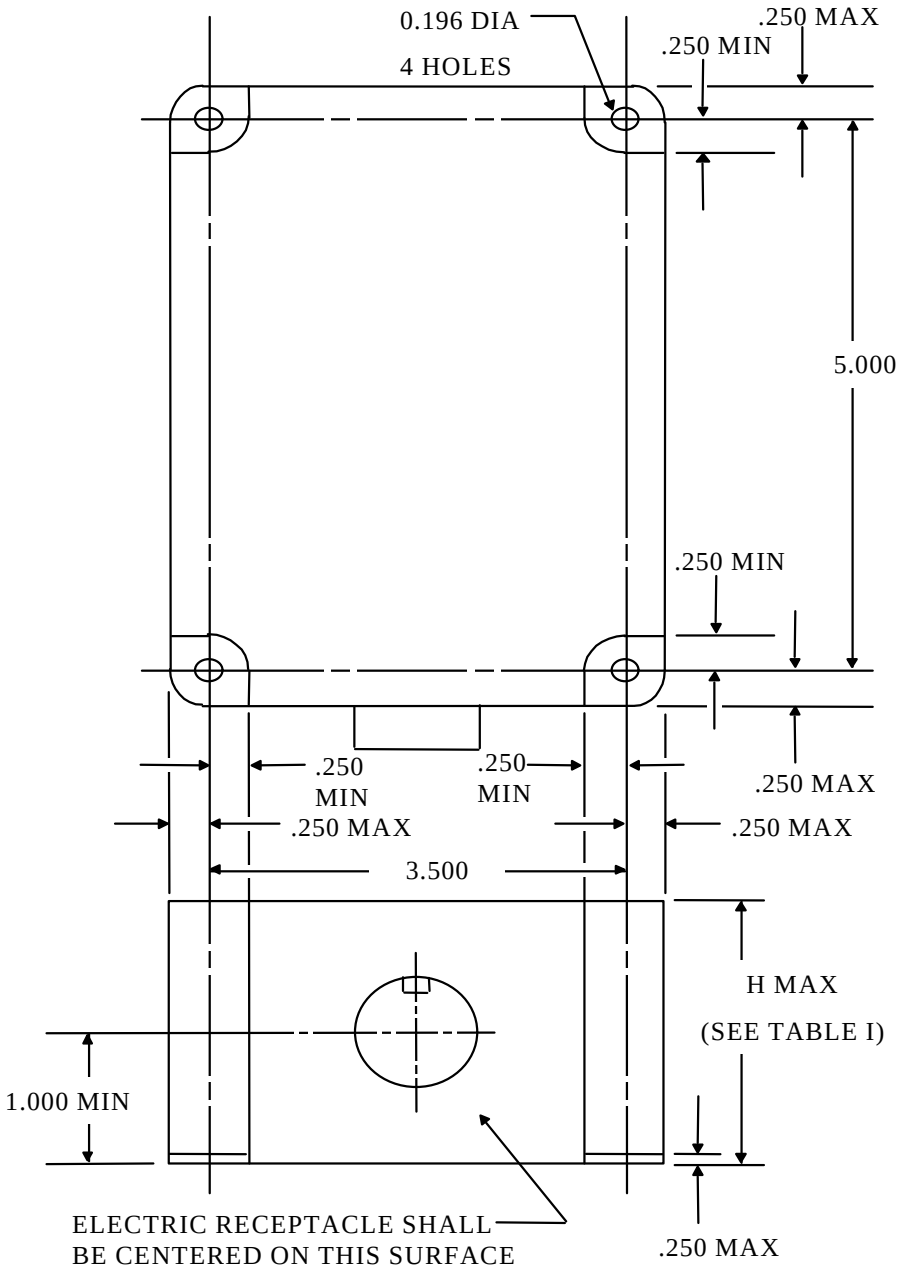
Inspection	Requirement paragraph	Test paragraph	Qualification Sample Number			
			1	2	3	4
			Qualification Verification Sample Number			
			1, 5, 9,	2, 6, 10,	3, 7, 11,	4, 8, 12,
Input power to AC monitors	3.4.1.1	4.4.1.1	X	X	X	X
Input power to power lead (pin G) and sense lead (pin B)	3.4.2.1	4.4.1.2	X	X	X	X
Inhibit voltage to pins C and E	3.4.2.2	4.4.1.3	X	X	X	X
AC monitor including source of DC for contactor	3.4.3.1	4.4.1.4	X	X	X	X
AC monitors excluding power supply	3.4.3.2	4.4.1.5	X	X	X	X
DC monitors	3.4.3.3	4.4.1.6	X	X	X	X
Operation of AC monitors	3.4.4.1	4.4.1.7	X	X	X	X
Frequency and voltage	3.4.4.1.1	4.4.1.7	X	X	X	X
Phase sequence	3.4.4.1.2	4.4.1.7	X	X	X	X
AC reset response time	3.4.4.1.3	4.4.1.7	X	X	X	X
AC trip response time	3.4.4.1.4	4.4.1.7	X	X	X	X
Operation of DC monitors	3.4.4.2	4.4.1.8	X	X	X	X
Normal operation of DC monitors	3.4.4.2.1	4.4.1.8	X	X	X	X
Inhibited operation of DC monitors	3.4.4.2.2	4.4.1.8	X	X	X	X
DC reset response time	3.4.4.2.3	4.4.1.8	X	X	X	X
DC trip response time	3.4.4.2.4	4.4.1.8	X	X	X	X
Polarity	3.4.4.2.5	4.4.1.8	X	X	X	X
Temperature-altitude (operating)	3.5.2.1	4.4.3.1		X		
Temperature-altitude (non-operating)	3.5.2.2	4.4.3.2		X		
Burn-in	3.5.3	4.4.4				
Room temperature	3.5.4.1	4.4.6	X	X	X	X
High temperature	3.5.4.2	4.4.7	X	X		
Low temperature	3.5.4.3	4.4.8	X	X		
Dielectric strength	3.6	4.4.10				

TABLE IV. Qualification inspection - Continued.

Inspection	Requirement paragraph	Test paragraph	Qualification Sample Number			
			1	2	3	4
			Qualification Verification Sample Number			
			1, 5, 9,	2, 6, 10,	3, 7, 11,	4, 8, 12,
Sand and dust	3.5.1.1	4.4.2.1				X
Salt fog	3.5.1.2	4.4.2.2	X			
Mechanical shock	3.5.1.3	4.4.2.3		X		
Fungus	3.5.1.4	4.4.2.4		X		
Humidity	3.5.1.5	4.4.2.5			X	
Vibration	3.5.1.6	4.4.2.6			X	X
Electromagnetic compatibility	3.5.1.7	4.4.2.7	X			X
Reliability	3.3.1	4.4.9	X	X		
Visual and mechanical inspection	3.3.7, 3.3.8 3.3.9, 3.3.11 3.3.19.1, 3.8 3.9, 3.9.1, 3.9.2	4.4.5	X	X	X	X

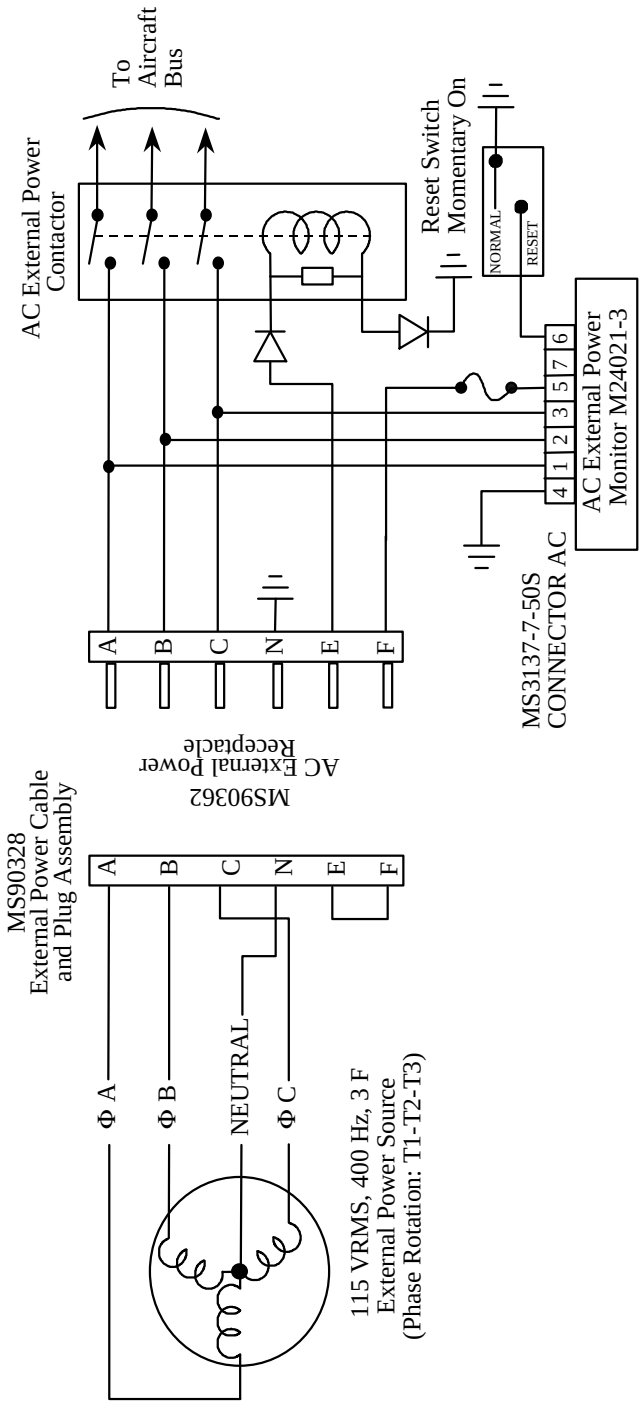
TABLE V. Conformance inspection.

Inspection	Requirement paragraph	Test paragraph
Burn-in	3.5.3	4.4.4
Visual and mechanical inspection	3.3.7, 3.3.8, 3.3.9, 3.3.11, 3.3.19.1, 3.8, 3.9, 3.9.1, 3.9.2	4.4.5
Dielectric strength	3.6	4.4.10



ALL DIMENSIONS ARE IN INCHES. ALL TOLERANCES ARE ± .010.

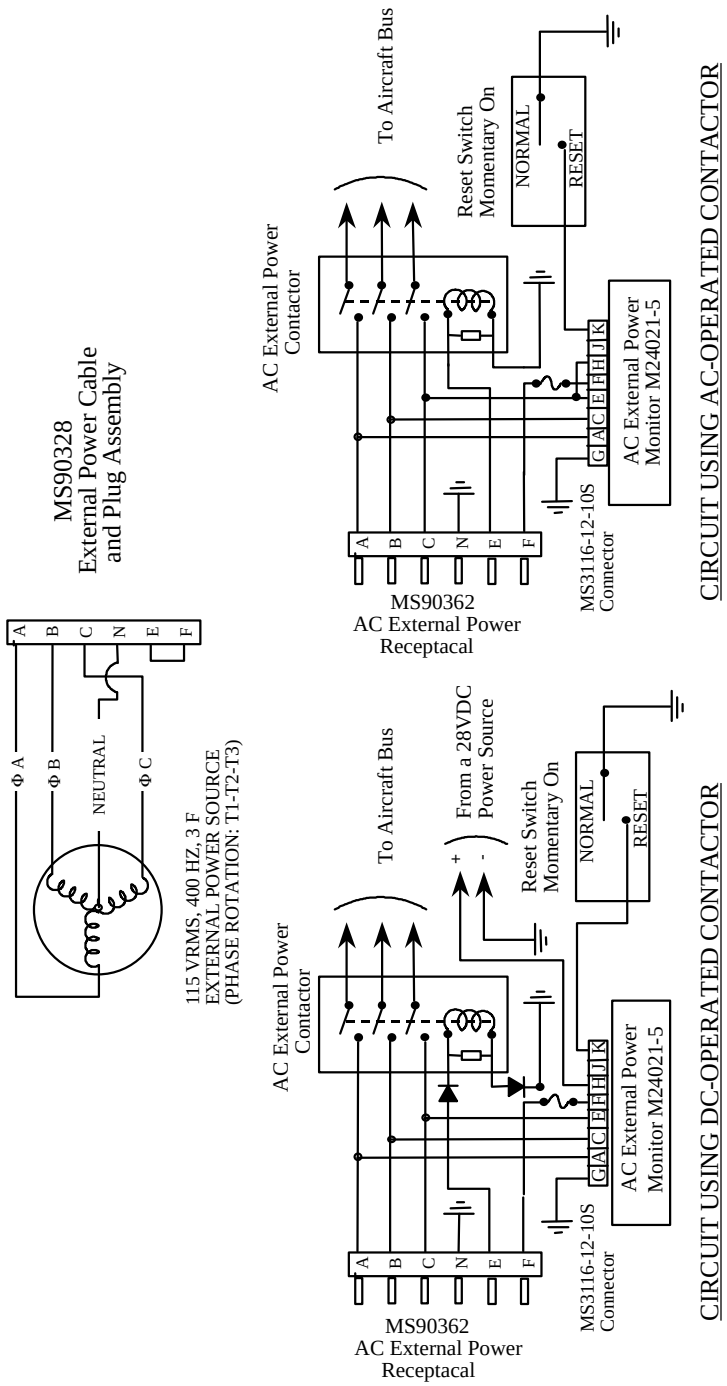
FIGURE 1. Dimensions.



NOTES:

1. Mechanical or electrical interlocks or both shall be provided to prevent paralleling external power with power generated in the aircraft.
2. An overload protection device is required on the monitor output (pin 5) to protect against 6 amperes or more.
3. Reverse polarity protection and spike suppression required on external power contactor coil.
4. The control switch shall be located at an aircrew station.

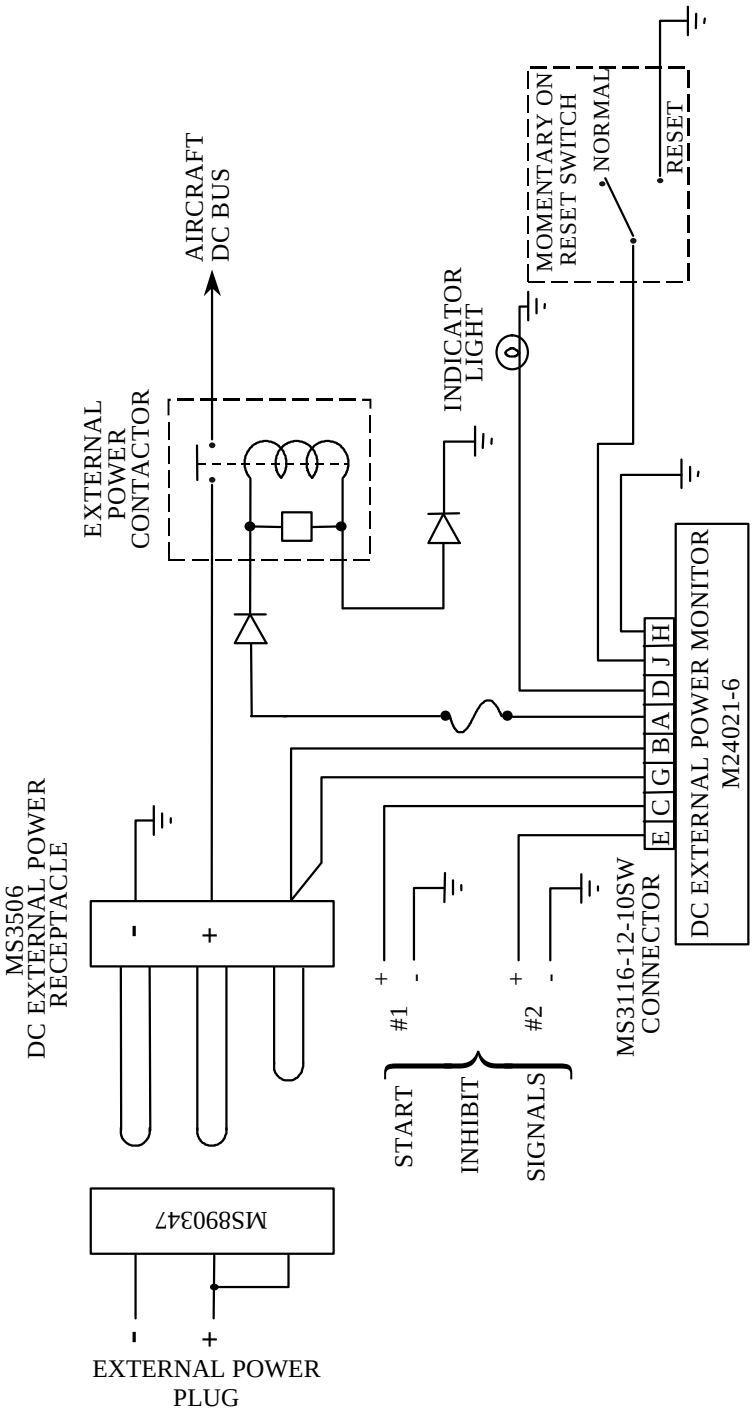
FIGURE 2. Aircraft installation circuit for the M24021-3 AC external power monitor.



NOTES:

1. 28 volt (nominal) DC control power for energizing the DC power relay shall be provided from the aircraft's 28 volt DC bus or from a transformer-rectifier unit energized from the AC input to the external power receptacle.
2. Mechanical or electrical interlocks or both shall be provided to prevent paralleling external power with the generator in the aircraft.
3. An overload protection device is required on the monitor output (Pin F) to protect against 10 amperes or more.
4. Reverse polarity protection is required on DC contactor coil. Spike suppression is required on AC or DC external power contactor coils.
5. The control switch shall be located at an aircrew station.

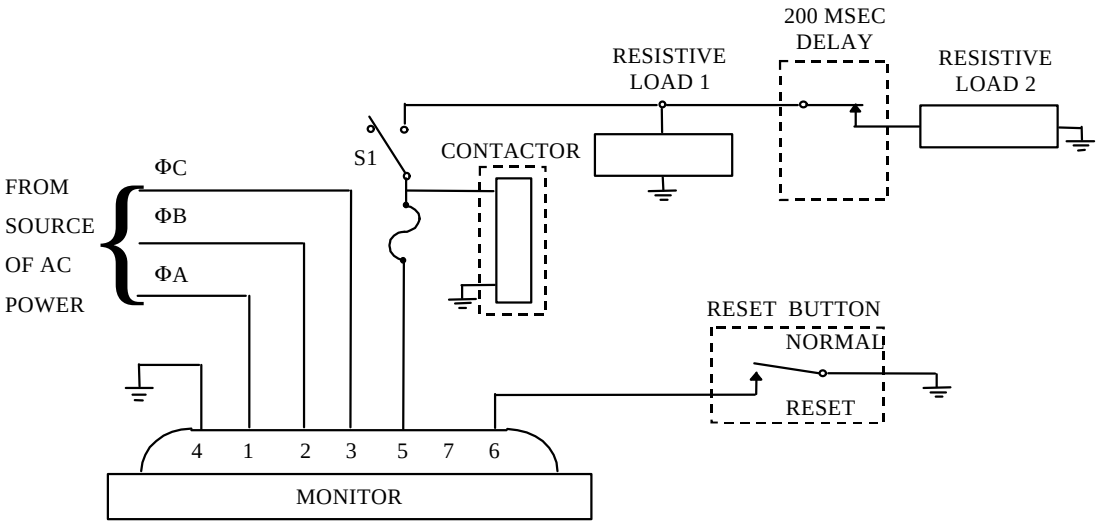
FIGURE 3. Aircraft installation circuits for the M24021-5 AC external power monitor.



NOTES:

1. An overload protection device is required on the monitor output Pin A to protect against 10 amperes or more.
2. Inhibit signals originate from the starter side of the starter relay contacts or from Pin D (current sensing) of the starter/generator. Two are provided for twin engine aircraft. If only one is used, the unused input is left open.
3. Reverse polarity protection and spike protection is required on the external power contactor coil.
4. The control switch shall be located at an aircrew station.

FIGURE 4. Aircraft installation circuit for the M24021-6 DC external power monitor.



NOTES:

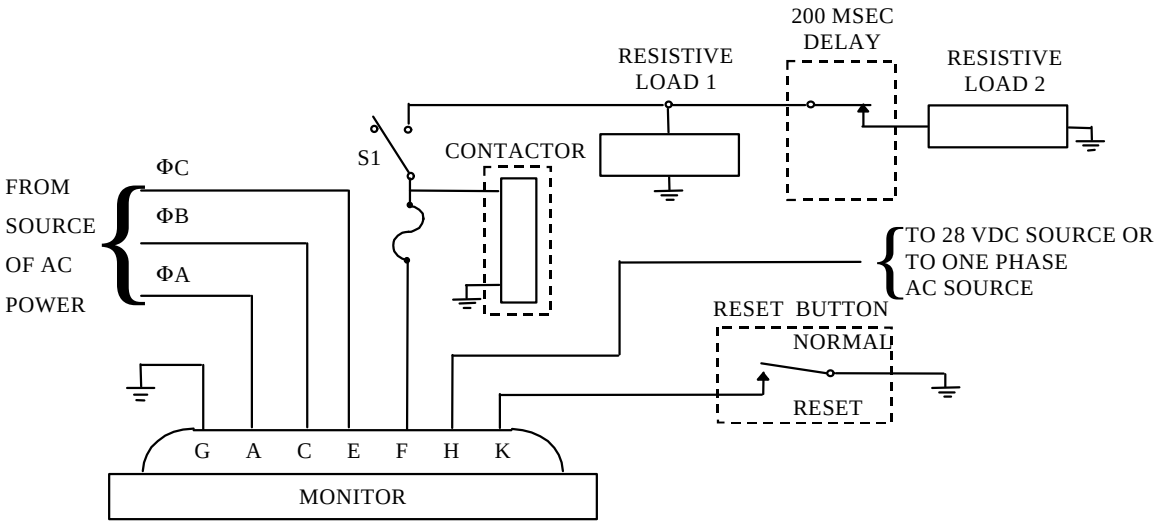
1. Switch S1 is closed (at least one second after contactor has been activated) only to perform test of 4.4.1.5.

2. The value of load 1 is selected so that the output current is equal to or greater than 1.5 amperes with load 2 not in the circuit (200 msec delay has timed out).

3. The value of load 2 is selected so that the monitor output current is equal to or greater than 15 amperes with load two connected to the circuit (during 200 msec delay).

4. The contactor shall have contacts rated 3 PDT, 115/200V, 400Hz, 200 amperes or greater.

FIGURE 5. Test circuit for M24021-3 monitor.



NOTES:

1. Switch S1 is closed (at least 1 second after contactor has been activated) only to perform test of 4.5.1.5. The two contactor types specified in Note 4 shall be utilized.

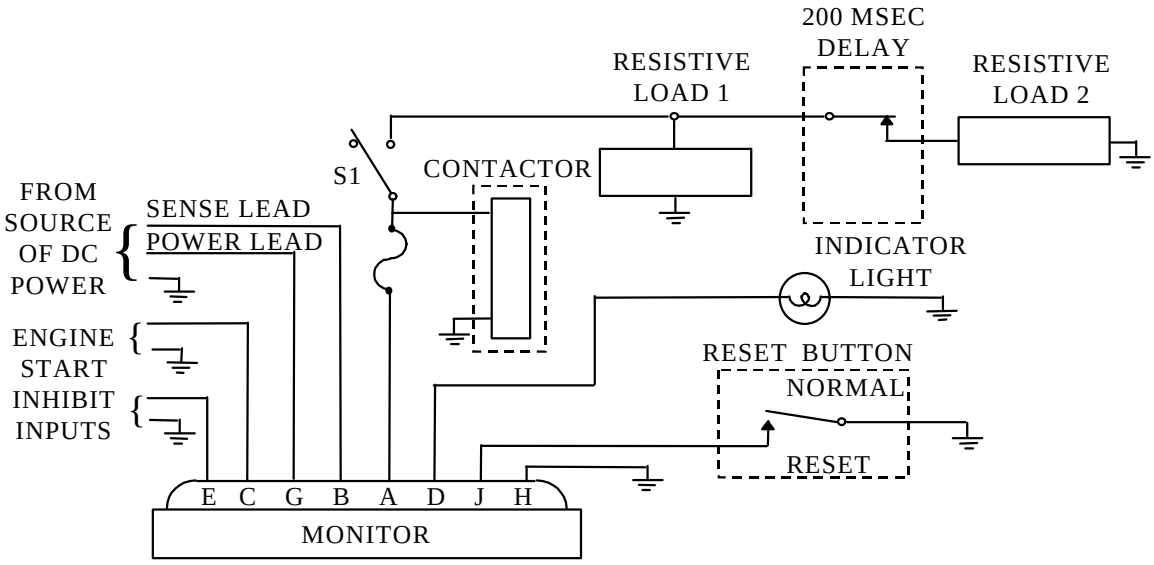
2. The value of load 1 is selected so that the output current is equal to or greater than 5 amperes with load 2 not in the circuit (200 msec delay has timed out).

3. The value of load 2 is selected so that the monitor output current is equal to or greater than 15 amperes with load two connected to the circuit (during 200 msec delay).

4. The contactor shall have contacts rated 3 PDT, 115/200V, 400Hz, 200 amperes or greater. Two types of this contactor shall be used: one operated by 28 VDC and one operated by 115 VAC.

5. Approximately one-half the tests shall be performed using each of the two contactor types.

FIGURE 6. Test circuit for M24021-5 monitor.



NOTES:

1. Switch S1 is closed (at least 1 second after contactor has been activated) only to perform test of 4.4.1.6.

2. The value of load 1 is selected so that the output current is equal to or greater than 2.5 amperes with load 2 not in the circuit (200 msec delay has timed out).

3. The value of load 2 is selected so that the monitor output current is equal to or greater than 15 amperes with load two connected to the circuit (during 200 msec delay).

4. The contactor shall have contacts rated 28 VDC, 300 amperes or greater.

FIGURE 7. Test circuit for M24021-6 monitor.

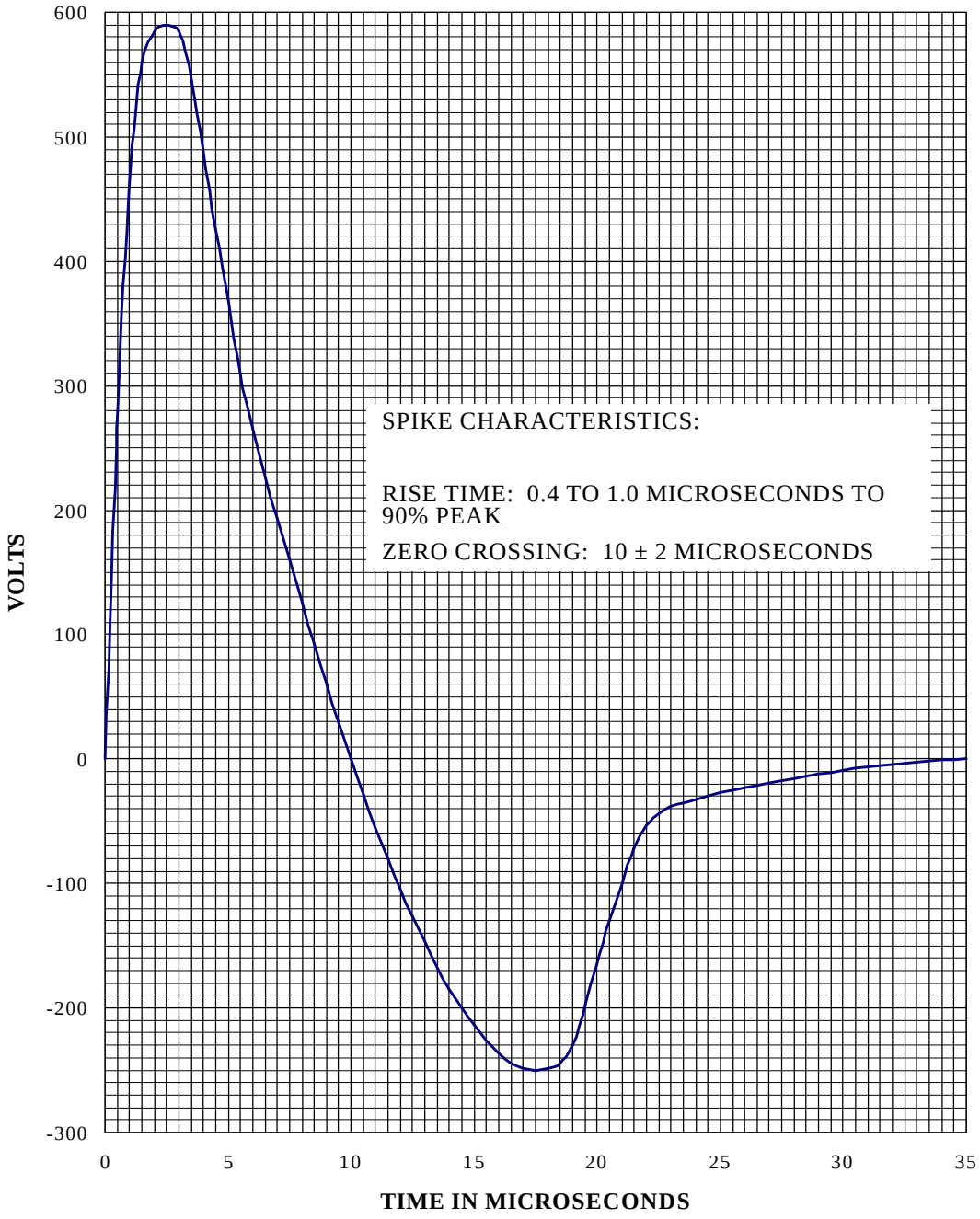


FIGURE 8. Spike susceptibility test wave form.

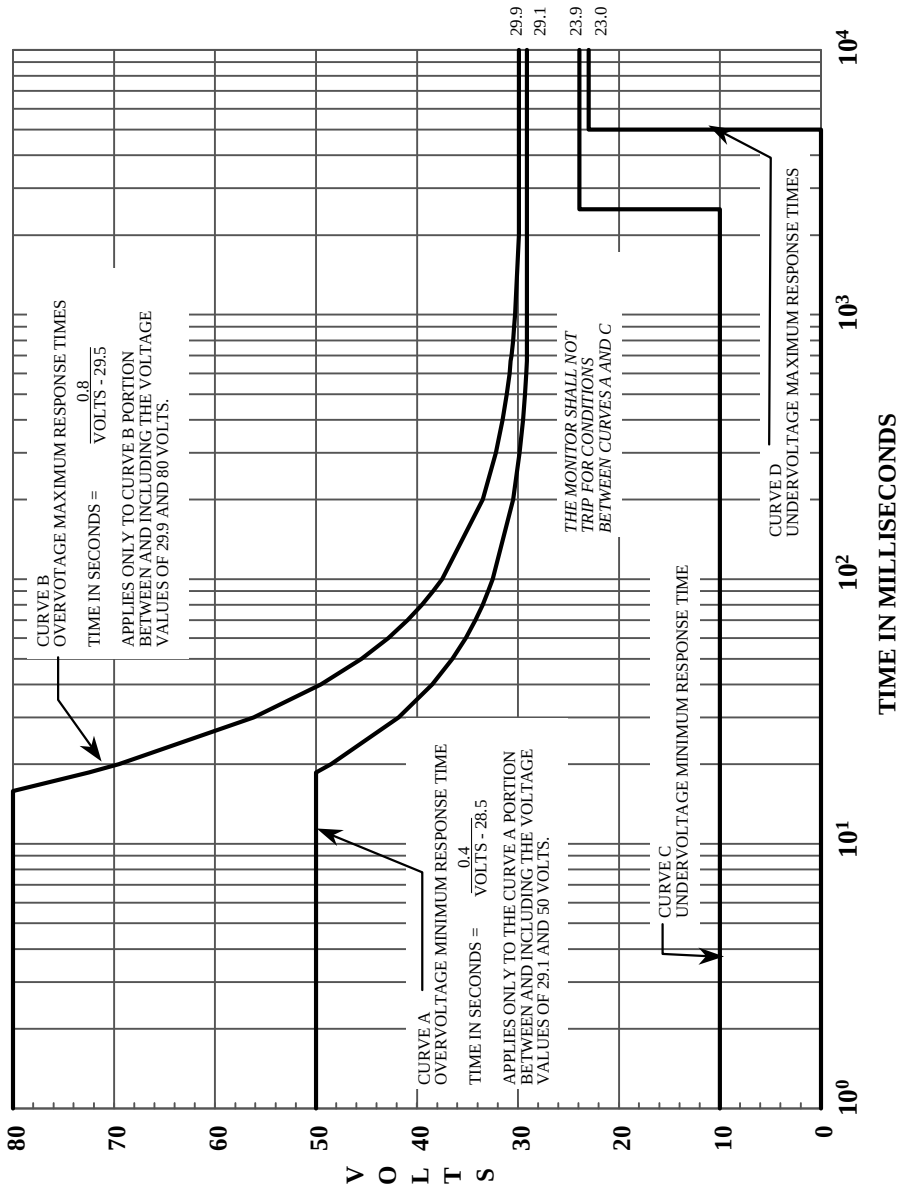


FIGURE 9. DC overvoltage / undervoltage response curves.

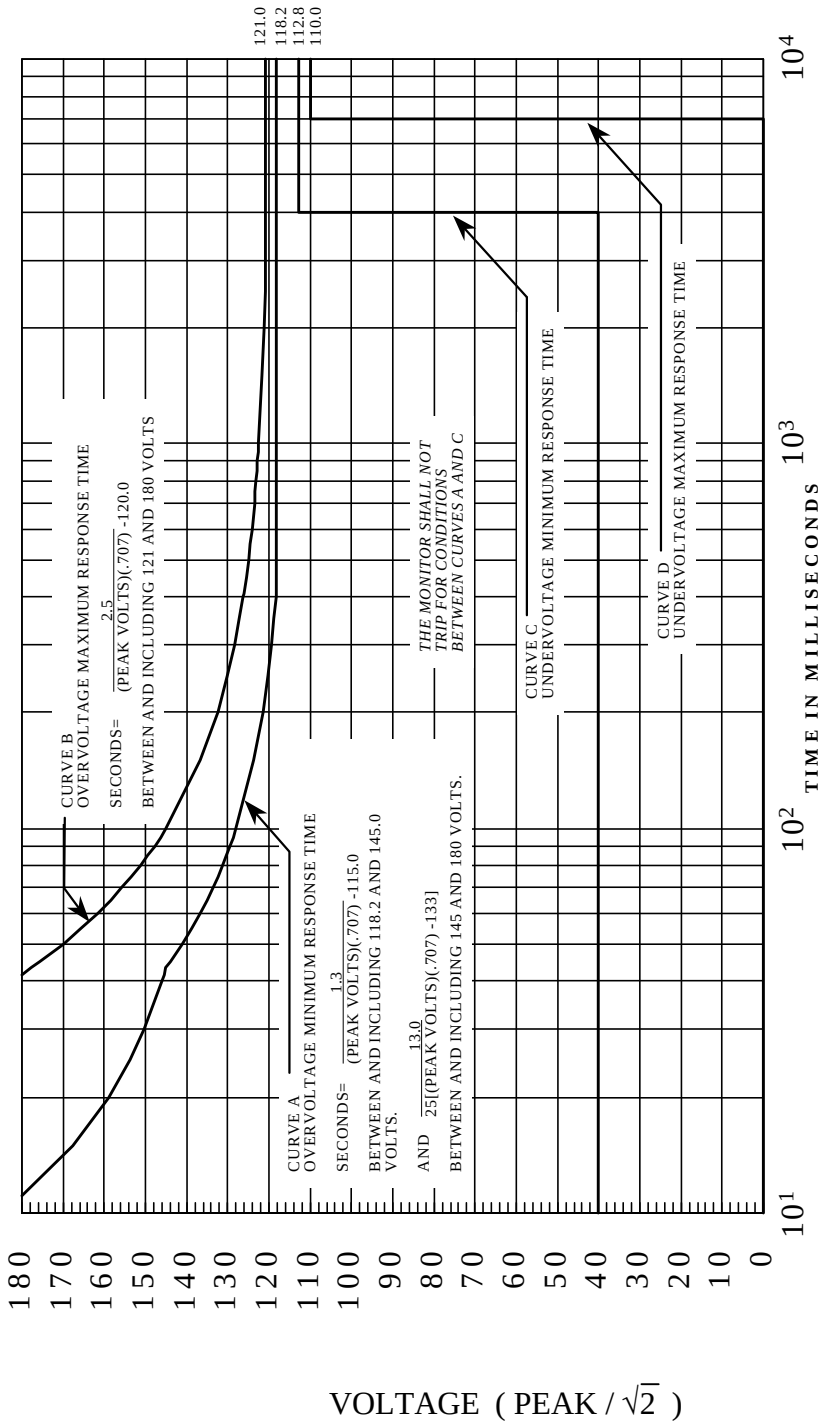


FIGURE 10. AC overvoltage/undervoltage response curves.

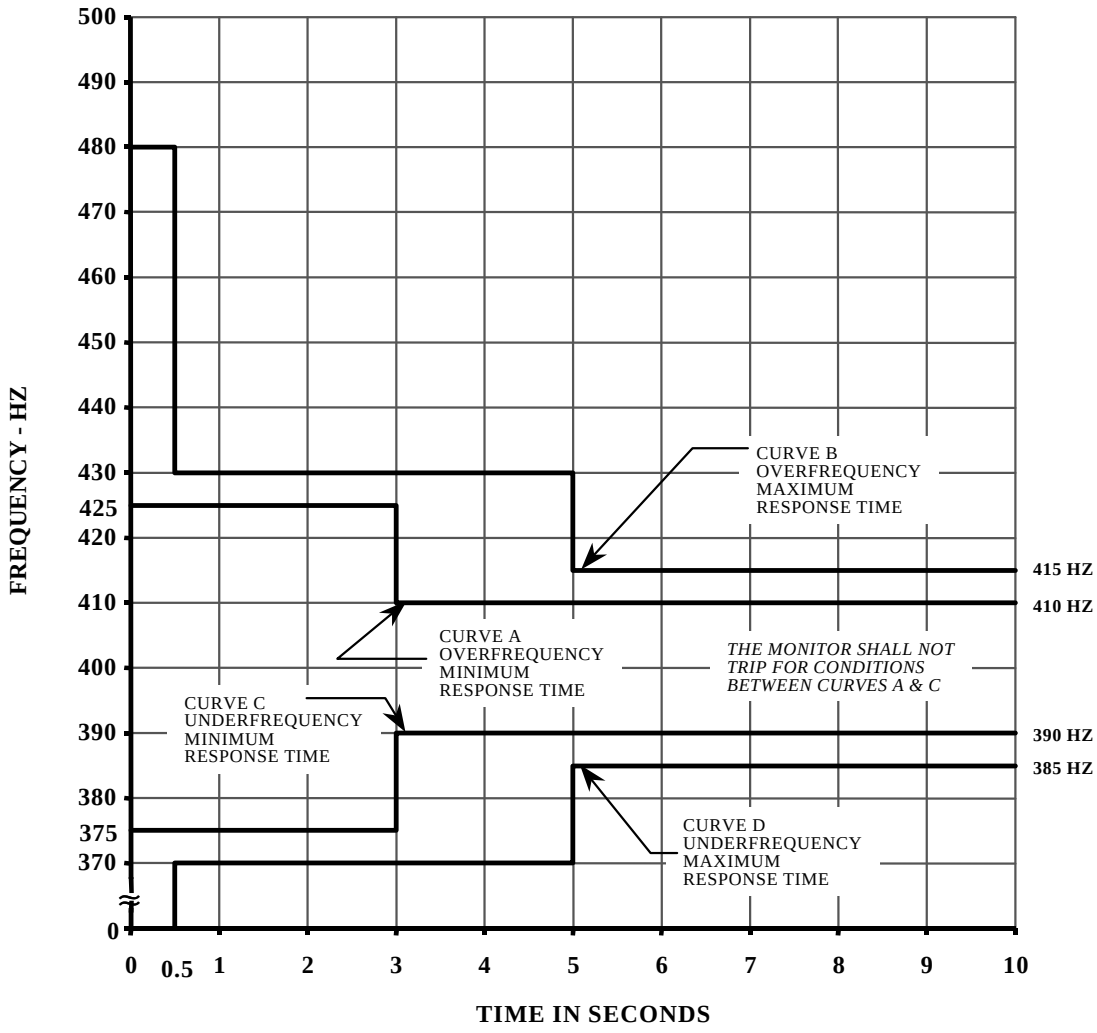


FIGURE 11. Frequency versus response time.

CONCLUDING MATERIAL

Custodians:
Army - AV
Navy - AS

Preparing activity:
Navy - AS
(Project 6110-0396)

Review activities:
DLA - GS

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.
   NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-24021K	2. DOCUMENT DATE (*YYMMDD*) 08 July 1998

3. DOCUMENT TITLE
ELECTRIC POWER MONITORS, EXTERNAL, AIRCRAFT

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.*)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (*Last, First, Middle Initial*)	b. ORGANIZATION	
c. ADDRESS (*Include Zip Code*)	d. TELEPHONE (*Include Area Code*) (1) Commercial: (2) DSN: (*If Applicable*)	7. DATE SUBMITTED (*YYMMDD*)

8. PREPARING ACTIVITY

a. NAME COMMANDER NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION	b. TELEPHONE NUMBER (*Include Area Code*) (1) Commercial: (732) 323-2947 (2) DSN: 624-2947
c. ADDRESS (*Include Zip Code*) CODE 414100B120-3 HIGHWAY 547 LAKEHURST, NJ 08733-5100	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Logistics Agency (DLSC-LM), Attn: Carla Jenkins/John Tascher 8725 John J. Kingman Road, Ste 2533 Fort Belvoir, VA 22060-6221 Telephone (703) 767-6874