NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND

TECHNICAL INFORMATION MEMORANDUM

REPORT NO: NAWCADPAX/TIM-2021/234

NAVAIR SUPPLEMENTAL REQUIREMENTS AND GUIDANCE FOR THE APPLICATION OF MIL-STD-461G

by

NAWCAD UAS & Integrated Systems
Electromagnetic Environmental Effects Engineering Branch

April 2021

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND

NAWCADPAX/TIM-2021/234
06 APRIL 2021

NAVAIR SUPPLEMENTAL REQUIREMENTS AND GUIDANCE FOR THE APPLICATION OF MIL-STD-461G

by

NAWCAD UAS & Integrated Systems Electromagnetic Environmental Effects Engineering Branch

RELEASED BY:

SQUIRES.MICHAEL.P.1229042242 Digitally signed by SQUIRES.MICHAEL.P.1229042242 Date: 2021.04.07 09:43:39 -04'00'

MICHAEL SQUIRES / AA15000 / April 2021
Head, Electromagnetic Environmental Effects Division
Naval Air Warfare Center Aircraft Division

REPORT DOCUMENTATION PAGE					Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**					
1. REPORT DATE 06 April 2021	2. REPORT TYPE Technical Information Memorandum			3. DATES COVERED	
4. TITLE AND SUBTITLE Supplemental Requirements and Guidance for the Application of MIL-STD-461G				5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Craig Simmons				5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Air Warfare Center Aircraft Division Code AA15200, Bldg. 2187 48110 Shaw Road, Room 3221 Patuxent River, MD 20670				8. PERFORMING ORGANIZATION REPORT NUMBER NAWCADPAX/TIM-2021/234	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Air Systems Command (AA15000) 48110 Shaw Road, Building 2187 Patuxent River, MD 20670				10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited .					
13. SUPPLEMENTARY NOTES .					
14. ABSTRACT Due to the unique nature of many of NAVAIR platforms and their specific electromagnetic environments, it is essential to detail the unique tailoring and applicability guidelines that NAVAIR's E3 engineers have developed over the years based on technical experience, fleet data, and USN needs. This Technical Information Memorandum does not replace MIL-STD-461G, but supplements it by providing tailoring guidance. This Technical Information Memorandum addresses the following areas of concern: reduce conflict and cost in the procurement process by providing guidance, clarification, and consistency concerning the applicability of certain MIL-STD-461 test requirements to NAVAIR platforms and missions; provide for more compatibility between MIL-STD-704 Power Quality and MIL-STD-461 for NAVAIR platforms; reduce test time and cost by eliminating redundancy and providing guidance in tailoring and selection of the MIL-STD requirements to NAVAIR's unique environments while also taking the required measurements to comply with Spectrum Certifications, without additional cost or schedule impacts; and formalize ground plane interference (GPI) test procedures. Certain critical areas should be kept in mind when applying MIL-STD-461 and identifying risks in the test results. The following guidelines are indicated: no emissions waivers permitted in the communications band or at specific frequencies needed for flight worthiness for UAS; radiated emissions outages at critical frequencies such as IFF or GPS or on emergency or Guard channels must be reviewed for acceptability; and for ship-based systems, if the EUT has an IBIT or MBIT function that is performed on the Flight Deck, the test should include running IBIT or MBIT during one of its RS103 scans at radar frequencies to ensure IBIT/MBIT can be performed in the Flight Deck EME.					
15. SUBJECT TERMS MIL-STD-461, radiated, conducted, emissions, susceptibility					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Craig Simmons
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified	SAR		19b. TELEPHONE NUMBER (include area code) 301-243-4907

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

NAVAIR Public Release 2021-234.

Distribution Statement A – Approved for public release; distribution is unlimited

SUMMARY

This document tailors MIL-STD-461G to meet NAVAIRSYSCOM's unique environmental and procurement needs without placing unnecessary burden on other Services or Commands. This tailoring guidance is intended to reduce costs, unnecessary testing, and redundancies.

Due to the unique nature of many of NAVAIR platforms and their specific electromagnetic environments, it is essential to detail the unique tailoring and applicability guidelines that NAVAIR's E3 engineers have developed over the years based on technical experience, fleet data, and USN needs. This Technical Information Memorandum does not replace MIL-STD-461G, but supplements it by providing tailoring guidance. This Technical Information Memorandum addresses the following areas of concern:

- Reduce conflict and cost in the procurement process by providing guidance, clarification, and consistency concerning the applicability of certain MIL-STD-461 test requirements to NAVAIR platforms and missions.
- Provide for more compatibility between MIL-STD-704 Power Quality and MIL-STD-461 for NAVAIR platforms.
- Reduce test time and cost by eliminating redundancy and providing guidance in tailoring and selection of the MIL-STD requirements to NAVAIR's unique environments while also taking the required measurements to comply with Spectrum Certifications, without additional cost or schedule impacts.
- Formalize ground plane interference (GPI) test procedures.

Certain critical areas should be kept in mind when applying MIL-STD-461 and identifying risks in the test results. The following guidelines are indicated:

- No emissions waivers permitted in the communications band or at specific frequencies needed for flight worthiness for Unmanned Aircraft Systems (UAS).
- Radiated emissions outages at critical frequencies such as Identification, friend or foe (IFF) or Global Positioning System (GPS), or on emergency or Guard channels (e.g. 121.5, 243, 406 MHz) must be reviewed for acceptability.
- For ship-based systems, if the Equipment under Test (EUT) has an Initiated BIT (IBIT) or Maintenance BIT (MBIT) function that is performed on the Flight Deck, the test should include running IBIT or MBIT during one of its RS103 scans at radar frequencies to ensure IBIT/MBIT can be performed in the Flight Deck Electromagnetic Environment (EME).

Contents

INTRODUCTION

BACKGROUND

Due to the unique nature of many of NAVAIR platforms and their specific electromagnetic environments, it is essential to detail the unique tailoring and applicability guidelines that NAVAIR's E3 engineers have developed over the years based on technical experience, fleet data, and USN needs.

PURPOSE

This document tailors MIL-STD-461G to meet NAVAIRSYSCOM's unique environmental and procurement needs without placing unnecessary burden on other Services or Commands. This tailoring guidance is intended to reduce unnecessary testing, redundancies, and program cost.

DISCUSSION

SPECIFIC GUIDANCE

To meet NAVAIR specific EMI requirements, the following are modifications to the language in MIL-STD-461G, by the Standard's paragraph number scheme:

Add 3.1.13 Minimum Detectable Signal.

A Minimum Detectable Signal is the signal a receiver can detect down in the background noise, but it is not strong enough to be converted or processed (to get a useable output).

Add 3.1.14 Minimum Discernable Signal.

A Minimum Discernable Signal is the lowest signal a receiver can detect but is strong enough to be converted to video or can be processed.

4.3.8.4 Safety grounds.

For avionics equipment, if the actual length of the safety ground wire cannot be determined from the 'as-built' drawings, then a length of 0.5 meters should be used for the test and terminated to the ground plane at less than 2.5 milliohms.

4.3.8.6 Construction and arrangement of EUT cables.

The cables attached to the EUT during testing become a part of the EUT for testing purposes. All emissions and susceptibilities that are derived from the attached cables are the responsibility of the EUT. The cables MUST be platform representative. In the case of multiplatform avionics, an analysis should be done up front to determine the suitable configuration for test cables such that they represent worst-case conditions.

Add 4.3.8.8 Antenna interfaces.

In certain circumstances, EUTs with antenna ports that are utilized on ship-capable aircraft need to install the EUT antenna into the test setup facing the test antenna during radiated susceptibility testing instead of terminating the antenna port, utilizing a ground plane as close as possible to of the actual installation or that indicated in Paragraph 4.3.8.7.

Certain EUTs with antenna ports must be able to perform their Power-On Self-Test (POST), IBIT, and/or MBIT (used by the pilot or maintenance personal) in the flight deck EME. Therefore, EUTs with these self-test modes used for check-out either prior to launch or after a maintenance action, shall have the antenna installed during RS103 at the test boundary facing the test antenna, and these modes exercised during an additional test scan, in addition to other required pass/fail criteria scans. In addition, for EUTs with active arrays that have a POST performing array mapping, a check should be made to ensure the POST / array mapping can occur during the RS103 scan, as it will be expected to perform this function in the flight deck EME.

With the antenna installed on the EUT's antenna port during RE102 scans, any unintentional emissions out the antenna port (e.g. local oscillator, mixer noise, final amp, power supply leakage, etc.) can be identified and measured. This is for ship's emissions control (EMCON), electronic warfare (EW) on-board source identification, and hazards of electromagnetic radiation to ordnance (HERO) loading purposes. This test set up would also satisfy RE103 as long as the intentional transmit signal was also captured and measurements included frequencies up to at least the 3rd harmonic.

Add 4.3.8.2.1 Electrical Bonding verification.

Electrical bonding (EB) shall be verified before any EMI testing begins. EB shall be measured between all connectors and chassis, between chassis and ground and between the LISNs and the ground plane. EB should be comply with MIL-STD-464 or per the equipment specification.

Add 4.3.10.3.5 Peak Hold Scan.

Prior to the beginning of the standard emissions scans, the test lab shall perform multiple sweeps in a high speed "max hold' configuration for at least 15 seconds or five times the EUT response time on the EUT, whichever is greater. This is to determine if there are any intermittent, random, low duty cycle, and transient emissions (usually due to such things as switching, background BIT, operational cycling, etc.), which may affect the standard emissions measurements.

4.3.10.4.2 Modulation of Susceptibility Signals.

Susceptibility test signals for CS114 and RS103 shall be pulse modulated (on/off ratio of 40 dB minimum) at a 1 kHz rate with a 50% duty cycle.

Square wave modulation into the test amplifier is not does not provide adequate depth of modulation due to the amplifier response time and should be avoided. However, upon NAVAIR E3 approval, an exception can be made if the input is put into the pulse port of the signal source, provided the off cycle is at least 55dB down.

5.4.1 CE101 applicability.

Applicability is limited to those avionics subsystems or equipment that draw more than 2 amps on the same platform power bus as the Anti-Submarine Warfare (ASW) equipment; or to equipment which represents non-linear loads located on other power buses on ASW platform. In addition, this requirement is applicable to any subsystem that represents any non-linear load greater than 1kVA, or for any EUT on any platform that has more than 4kVA linear load. It is applicable for any equipment using shipboard power.

5.4.3.3 CE101 Setup.

c.(2) Position the current probe 5 cm from the LISN. In the case of a EUT over 4kVA where the LISN is bypassed, place the current probe 30 cm from the EUT.

5.5.3.3 CE102 Setup.

For subsystems or equipment with 4kVA or greater power consumption, the LISN's and the shielded enclosure powerline filters can be bypassed and the EUT connected directly to the rotary generator. Since the LISNs are removed, a current probe will have to be utilized, and the measurement shall be made 30 cm from the EUT. Add 34 dB to convert dBμA to the dBμV limit for current probe measurements.

5.6.1 CE106 applicability.

This test method is not applicable to EUT's with active antennas, phased array antennas, or phasing antennas; test method RE103 shall be used in these cases, with the EUT both in Standby and Transmit modes.

5.6.3.4 CE106 Procedures.

If no discernable emissions greater than 6 dB below the limit line are seen after the seventh harmonic, stop test there to reduce test time.

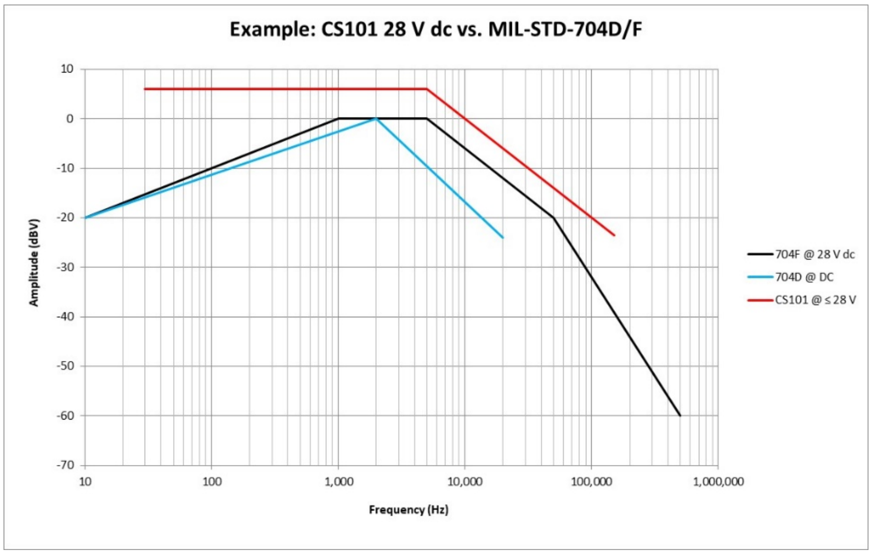
The addition of a YIG Tracking Filter or other bandpass filtering can help eliminate the harmonics and spurs from the signal source.

> NOTE: If the EUT is not provided its rated load (e.g. 50 Ohms) at its antenna port and at the frequency it is transmitting on; the EUT may generate spurs/harmonics that would not be present in the actual installation.

> NOTE: Federal agencies requesting Stage 4 Spectrum Certification for systems operating in the 390-413 MHz, and 960-1710 MHz frequency bands must provide measurements of the emission levels generated in the frequency bands used by the GPS. Refer to the National Telecommunications and Information Administration (NTIA) Red Book, Paragraph 8.2.55 and Paragraph M.2.1.f for additional information and guidance for spectrum certification data requirements. These measurements shall be taken during CE106 or RE103 testing, in addition to measuring 2^{nd}, 3^{rd} harmonics and other data required by 1494s.

5.7.1 CS101 applicability.

For avionics systems, if the EUT is fully compliant to MIL-HDBK-704 Voltage Distortion Spectrum Requirements and if approved, consider waiving CS101.While there is a 6dB difference in amplitude, there are no known aircraft issues for avionics that passed MIL-HDBK-704 yet failed CS101. Twenty-eight-volt DC example shown below.



5.8.1 CS103 applicability.

If receiver front ends have beamforming networks, separate preselectors, limiters, LNAs, triplexers, antenna couplers, or other devices that can alter or effect their front-end characteristics, then the receivers must be tested with these devices installed. This method is not applicable to receivers with non-removable antennas; in these cases, a free-space radiated version of CS103 shall be conducted. Interfering signals shall be determined based on the operational electromagnetic environment of the EUT and inputs from the vendor.

When possible, avoid using amplifiers as these can distort signals and introduce additional nonlinearities. Standard signal generators can typically reach the desired power levels. Spectral content of the interfering signals applied to the EUT should be monitored to ensure signal integrity.

Intermodulation testing was designed for “traditional” tunable super-heterodyne type radio receivers. Due to modern designs, (e.g., pseudo-noise code transmission techniques – Direct Sequence Spread Spectrum (DSSS) and Frequency Hopping Spread Spectrum (FHSS) systems), this test is particularly difficult to perform and as a result “Characterization” and not “Qualification” may be applicable.

5.9.1 CS104 applicability.

If receiver front ends have beamforming networks, separate preselectors, limiters, LNAs, triplexers, antenna couplers, or other devices that can alter or effect their front-end characteristics, then the receivers must be tested with these devices installed. This method is not applicable to receivers with non-removable antennas; in these cases, a free-space radiated version of CS104 shall be conducted.

When possible, avoid using amplifiers as these can distort signals and introduce additional nonlinearities. Standard signal generators can typically reach the desired power levels.

Rejection of Undesired Signals testing was designed for “traditional” tunable super-heterodyne type radio receivers. Due to modern designs, (e.g., DSSS and FHSS systems), this test is particularly difficult to perform and as a result “Characterization” to the EME tables defined in MIL-STD-464 and not “Qualification” may be applicable.

5.9.2 CS104 limit.

Interfering signals shall be determined based on the operational electromagnetic environment of the EUT and inputs from the vendor. Consider using 50dBm CW test signal as a baseline limit. The EUT is not required to perform any of its normal functions during in-band testing; but flight, safety, and combat critical EUTs must self-recover to full operating capabilities after the test signal is removed.

5.10.1 CS105 applicability.

If receiver frontends have beamforming networks, separate preselectors, limiters, LNAs, triplexers, antenna couplers, or other devices that can alter or effect their front-end characteristics, then the receivers must be tested with these devices installed. This is not applicable to receivers with non-removable antennas.

Cross Modulation testing was designed for “traditional” amplitude modulated (AM) tunable super-heterodyne type radio receivers, transceivers, and amplifiers.

5.12.2 CS114 limit.

It is recommended to use Curve #5 for external equipment, Flight Critical, Combat Critical, Safety Critical, and all equipment used on the flight deck; all other internal equipment such as Mission Systems use a combination of Curve #3 from 10 kHz to 2 MHz and Curve #5 from 2 MHz to 200 MHz.

5.12.3.4 CS114 Procedures.

d. EUT testing. If the EUT successfully passes GPI testing as defined in Appendix A, then differential mode testing of power lines should only be performed when specified by the performance specification or contract. GPI test should simulate this condition.

5.13.3.4 CS115 Procedures.

c. (2) (f) EUT testing. If the EUT successfully passes GPI testing, then differential mode testing of power lines should only be performed when specified by the performance specification or contract. GPI test should simulate this condition.

5.14.2 CS116 limit.

Except for flight, safety, and combat critical equipment, the EUT is not expected to operate during the transient. The EUT shall recover within a specific limited amount of time (usually within a few seconds). Operator intervention is only allowed for recovery of non-critical systems, unless specified otherwise by end user, such as a pilot, when performance during combat is critical.

It is critical to ensure platform resonances are added to the general list of required frequencies. As an example, Table 1 from Naval Air Warfare Center Weapons Division (NAWCWD), Document NAWCWD TP 8347 shows various aircraft and the frequencies they would be most susceptible to, using $f = c/\lambda$, where λ matches the selected aircraft dimension for maximum "antenna reception effect." This should be a design consideration when trying to screen onboard avionics from the effects of EMP. If performing CS117 WF3 on the EUT, do not test CS116 at 1 and 10 MHz, as they are covered in CS117.

5.14.3.4 CS116 Procedures.

d. EUT testing. If the EUT successfully passes GPI testing, then differential mode testing of power lines should only be performed when specified by the performance specification or contract. GPI test should simulate this condition.

5.15.1 CS117 applicability.

This test is applicable for subsystems on aircraft that have a lightning requirement and, Flight Critical equipment and systems that are externally mounted or externally connected. It shall also apply to ground facilities used to control UASs, as well as ship and shore systems requiring lightning protection.

5.15.2 CS117 limit.

Except for flight, safety, and combat critical equipment, the EUT is not anticipated to operate during the transient without upset. The EUT should recover within a specific limited amount of time (usually within a few seconds). Operator intervention is only allowed for recovery of non-critical systems, unless specified otherwise by end user, such as a pilot, when performance during combat is critical. More levels may be indicated than internal/external, based on application.

5.16.1 CS118 applicability.

This requirement is applicable to electrical, electronic, and electromechanical subsystems and equipment that have a human-machine interface, such as cockpit / crew station instrumentation and equipment and internal weapons stations. It is also applicable to all externally and internally mounted aircraft subsystems and equipment, or subsystems with external connections such as external power monitors and infrared sensors.

5.16.3.3 CS118 Setup.

c. Calibration. If the ESD gun has current calibration, this step may be waived.

5.17.3.1 RE101 Purpose.

NOTE: In correcting a failure from this test, the solution used most often is either to move the offending source or move the susceptible unit in its applicable installation; upon extremely rare occasions shielding or isolating have been used, but be certain you have a problem before you attempt to fix; filters are usually impractical.

5.18.1 RE102 applicability.

For subsystems and equipment that transmit with detachable antennas such as handheld radios, the RF port shall be terminated during testing; no emissions shall exceed the specified limits including the transmitter fundamental (this is not meant for EUTs with remote antennas).

For the purposes of this test, the cables become a part of the EUT; covering the cables with aluminum foil or other shielding material is an unacceptable practice and voids the test. However, it is recommended that for analysis and/or troubleshooting purposes, the foil or shielding be utilized to localize the areas of concern. Its use cannot be used for qualification purposes.

In order to reduce the amount of test time required for large equipment, perform multiple sweeps in a high speed “max hold’ configuration for at least 15 seconds or five times the EUT response time on the EUT, whichever is greater. Look for areas of emission at higher frequencies prior to positioning the antennas to concentrate on those hot spots during the emissions test.

5.19.1 RE103 applicability.

RE103 shall be the preferred method used for phased array or phasing antennas, active antennas, resonant slot antennas, and antennas with deflector elements. This also applies to systems where antennas cannot be removed or when the antenna has a non-standard impedance curve or where the unique antenna loading impedance cannot be duplicated or replaced by standard loads. RE103 testing shall be conducted in both Transmit and Standby modes. For standby mode, the limit is 34 dBμV.

RE102 applicability is only acceptable if antennas are in the chamber at the test boundary facing the test antenna, and emissions scans run in both transmit and receive modes.

During RE103, testing all data required to complete the 1494s shall be measured.

NOTE: Federal agencies requesting Stage 4 Spectrum Certification for systems operating in the 390-413 MHz, and 960-1710 MHz frequency bands must provide measurements of the emission levels generated in the frequency bands used by the GPS. Refer to the NTIA Red Book, Paragraph 8.2.55 and Paragraph M.2.1.f for additional information and guidance for spectrum certification data requirements. Measurements shall be taken at both 1 kHz and 1 MHz bandwidths.

5.19.3.3 RE103 Setup.

Add Step c. Cover with anechoic material or any shielding material, all support equipment, including cables, which needs to be inside the chamber, including the fixture holding the receive antenna.

5.19.3.4 RE103 Procedures.

a. The measurements must be performed in the far field of the transmitting frequency. This far-field distance is determined by the intentional transmit frequency of the EUT, not the far field of spurs or harmonics to be measured. The formulas currently included in the standard, are applicable to simple antennas only, such as horns, dipoles, etc. For phased antenna arrays, the following formula should be used: Far Field = 10 x element spacing. For an antenna with a parabolic reflector: Far Field = 10x diameter of the reflector.

NOTE: When the far field of a system is too large to run RE103 inside an anechoic chamber, take measurements in the near field, both for the electric and magnetic fields, then use these field measurements to calculate the output power in the near field. Using the calculated power in the near field, calculate power in the far field. Calculate the electric field in the far field using a 377Ω impedance. Compare these values against the limits, to determine compliance.

b. Run an ambient scan each test setup.

c. (4) Repeat 5.19.3.4c(1) through 5.19.3.4c(3) for two lower and two upper frequencies, with respect to the intentional transmit frequency(ies), over the frequency range of test.

d. (2) Set the EUT to transmit (if in Transmit Mode) and use the measurement path to complete the rest of this procedure.

d. (3) Tune the measurement receiver to the intentional measurement frequency (f_o) of the EUT and adjust for maximum indication.

5.20.1 RS101 applicability.

This is NOT a standard ASW test. It is used primarily when placing equipment or its associated cabling near high current devices or sources like in engine compartments, around de-icing cables, and large motor drives and shipboard systems.

5.21.1 RS103 applicability.

For the purposes of this test, the cables become a part of the EUT; and covering the cables with aluminum foil or other shielding material is an unacceptable practice.

The requirement is applicable as follows:

- 2 MHz to 18 GHz All ship capable aircraft and equipment
- 30 MHz to 18 GHz* All land-based aircraft and equipment
- 18 GHz to 40 GHz* Optional- EUT must be an RF subsystem or equipment

*or as otherwise specified

5.21.2 RS103 limit.

Consideration should be given to limiting the test to 160 V/m from 30-200 MHz to reduce test complexity with biconical antenna. The operational EME at this frequency range supports this reduction with adequate margin.

For EUT's having receivers with attached antennas, unless otherwise stated in the system specification, must survive the RS103 requirement over the intended receiver band of operation with the EUT antenna facing the test antenna. Degraded performance in the receiver's operating band is acceptable, as long as it recovers without operator's intervention once the field is removed.

5.21.3.3 RS103 Setup.

E-field Generators such as EFG-3 and AT-3000 E-Field Generators, etc. are non-propagating antennas, and are not acceptable for use in formal qualification testing. An exception is for small objects less than ½ meter in size that can be placed between the pivoting projections of the EFG-3/B, such that it forms an extended transmission line and the EUT is subjected to a corresponding field intensity as a function of the applied voltage.

If the lab is using a parallel plate test antenna, field uniformity is the primary concern. The largest dimension of the EUT cannot be larger than one-third the distance between the plates (see RS105 for further info). In addition, at least two field monitoring probes placed in between the plates at sufficient distance apart to demonstrate field uniformity, and at no time during the test shall the difference between the probes read more than 30V/m (as in RS105).

5.21.3.4 RS103 Procedures.

If the EUT has an IBIT or MBIT, then the Vendor must perform an additional RS103 scan using the IBIT or MBIT as the monitored parameter to demonstrate that the BIT can be performed on the flight deck. If the EUT is a receiver or contains a receiver, then it is necessary that the receiver's antenna be connected to the receiver in the shielded enclosure at the test boundary and facing the test antenna while the BIT scan is performed. In some instances, at the NAVAIR E3 engineer's discretion, the BIT scan can be used as the performance scan.

5.21.4 RS103 alternative test procedures – reverberation chamber (mode-tuned).

This use of mode tuned reverb chamber testing should be highly encouraged for large or multi box systems with multiple tuner positions to shorten test time.

5.22.1 RS105 applicability.

This requirement is applicable to vehicles, ground equipment, and subsystem enclosures that are exposed to the EMP external electromagnetic transients and have an EMP requirement. For surface ships, this includes external, above deck and exposed below deck equipment.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A

GROUND PLANE INTERFERENCE TEST PROCEDURES

A1. Applicability.

This ground plane interference (GPI) requirement is applicable from 320 Hz to 100 MHz for equipment and subsystems installed on NAVAIR systems where there are high impedance grounds (composite racks and fiberglass panels for mounting equipment), equipment installed on primary lightning pathways or prime power return current pathways, near de-icing systems, etc., where there is potential for noisy ground systems.

A2. Limit.

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the CW and pulsed signals specified in Table A-1 and Table A-2 GPI limits.

TABLE A-1. GPI CW limits

Voltage (V rms)	Frequency (Hz)	I max (A rms)
3	320-500	10
1	500-50k	10
1	50k-100M	0.15

TABLE A-2. GPI Pulsed limits

Voltage (V)	Pulse width (µs)	PPS	I max (peak)	Dwell Time (minutes)
± 8	100	100	15	5
± 8	10	1000	15	5
± 8	5	1000	15	5
± 8	0.15	50	15	5

A3. Test procedures.

A3.1 Purpose.

This test procedure is used to verify the ability of the EUT to withstand noise signals applied between each WRA's local ground plane reference and a single ground plane reference for all interfacing WRAs. The purpose of the GPI test is to determine the susceptibility of a distributed electronic system to differences in the ground potential between the interconnected subsystems.

A3.2 Test Equipment.

The test equipment shall be as follows:

a. Signal generators (320 Hz to 100 MHz)
b. Spike generator
c. Amplifiers (if necessary)
d. Isolation transformer (the impedance of the secondary winding shall be < 0.5 ohm from 320 Hz to 50 kHz)
e. Insulator pad for WRA
f. 0.5-ohm resistor
g. Current meter (or Oscilloscope 50 Ω input impedance)
h. Voltmeters (or Oscilloscopes 1 MΩ input impedance)
i. Current probe
j. Voltage probes
k. Attenuator (in order to isolate / protect the generator and to provide 50-ohm impedance matching)
l. 50-ohm “T” connector or RF coupler
m. Coax feed adapter
n. RF voltmeter (or Oscilloscope 1 MΩ input impedance, 100 MHz bandwidth minimum)
o. 5-ohm resistor
p. Oscilloscope (1 MΩ input impedance)
q. RF Power Meter (50 Ω input impedance)

A3.3 Setup.

The test setup shall be as follows:

a. Maintain a basic test setup for the EUT as shown and described in MIL-STD-461G Figures 2 through 5, and section 4.3.8, excluding sections 4.3.8.2 -4.3.8.4.

b. For each test configuration, one WRA shall be electrically isolated from the ground plane. All other WRAs comprising the EUT shall be electrically bonded to the ground plane in accordance with MIL-STD-461G sections 4.3.8.2 and 4.3.8.3.

c. For each test configuration, the electrical wiring interfaces to the isolated WRA (see b above), which are terminated to local aircraft structure when installed (including but not limited to chassis ground wire connections and power return leads), shall be terminated together and electrically connected to the chassis of the isolated WRA using the same wire length as in the aircraft installation. Electrical wiring interfaces for all other WRAs comprising the EUT shall be as described in MIL-STD-461G section 4.3.8 (including section 4.3.8.4 Safety Grounds).

d. Calibration.

(1) For low frequency (320 Hz to 50 kHz) and pulse noise signals, configure the test equipment in accordance with MIL-STD-461G Figure CS101-3. Set up the oscilloscope to monitor the voltage across the 0.5-ohm resistor.

(2) For the high frequency (50 kHz to 100 MHz) noise signals, configure the test equipment in accordance with Figure A-1. Set up the power meter to monitor the power delivered through the impedance matched attenuator.

e. EUT testing.

(1) For low frequency (320 Hz to 50 kHz) noise signals, configure the test setup as shown in Figure A-2.

(2) For high frequency (50 kHz to 100 MHz) noise signals, configure the test setup as shown in Figure A-3.

i. In the absence of applied noise signals, if functional performance of the EUT is compromised because the high frequency (50 kHz to 100 MHz) noise signal setup precludes a power return path, an additional power return path may be incorporated in the setup by connecting a return lead greater than or equal to 2 meters in length connected to a LISN. The power return lead connection to the chassis of the isolated WRA (see 3.3.c above) should remain in place.

(3) For pulse noise signals, configure the test setup as shown in Figure A-4.

A3.4 Procedures.

The test procedures shall be as follows:

a. Turn on the measurement equipment and allow enough time for stabilization.

b. Calibration.

(1) Low frequency (320 Hz to 50 kHz) noise signals.

i. Set the signal generator to the lowest test frequency. Increase the applied signal until the oscilloscope indicates the required voltage limit. Verify that the waveform is sinusoidal.

ii. Scan the required frequency range for testing varying the amplitude of the applied signal to match the required voltage limits. Verify that the waveform is sinusoidal.

(2) High frequency (50 Hz to 100 MHz) noise signals.

i. Set the signal generator to the lowest test frequency. Increase the applied signal until the power meter indicates the required power limit. Verify that the waveform is sinusoidal. Record the setting of the signal source.

ii. Scan the required frequency range for testing and record the signal source setting needed to maintain the required power level.

(3) Pulse noise signals.

i. Set the pulse generator to produce the required waveform. Increase the applied signal until the oscilloscope indicates the required voltage limit. Verify that the pulse shape and pulse repetition rate accurately represent the required waveform parameters.

c. EUT Testing.

(1) Low frequency (320 Hz to 50 kHz) noise signals.

i. Turn on the EUT and allow enough time for stabilization; ensure the EUT is operating in the first mode to be tested.

ii. Set the signal generator to the lowest test frequency. Increase the applied signal until the required voltage is reached, or not to exceed the maximum current level in the noise circuit connected to the electrically isolated WRA chassis.

iii. While maintaining at least the required signal level, scan through the required frequency range at a rate no greater than specified in MIL-STD-461G Table III.

iv. Susceptibility evaluation.

1. Monitor the EUT for degradation of performance.

2. If susceptibility is noted, determine the threshold level in accordance with MIL-STD-461G, section 4.3.10.4.3 and verify that it is above the limit.

v. Repeat A3.4.c (1).ii through A3.4.c.(1).iv for all required operating modes.

vi. Repeat A3.4.c.(1).ii through A3.4.c.(1).v for all required test configurations.

(2) High frequency (50 Hz to 100 MHz) noise signals.

i. Turn on the EUT and allow enough time for stabilization; ensure the EUT is operating in the first mode to be tested.

ii. Set the signal generator to the lowest test frequency. Increase the applied signal until the required voltage is reached, or not to exceed the maximum power level in the noise circuit connected to the electrically isolated WRA chassis. (Note: Power is limited to the level calibrated in A3.4.b.(2).ii.)

iii. While maintaining at least the required signal level, scan through the required frequency range at a rate no greater than specified in MIL-STD-461G Table III.

iv. Susceptibility evaluation.

1. Monitor the EUT for degradation of performance.

2. If susceptibility is noted, determine the threshold level in accordance with MIL-STD-461G, section 4.3.10.4.3 and verify that it is above the limit.

v. Repeat A3.4.c.(2).ii through A3.4.c.(2).iv for all required operating modes.

vi. Repeat A3.4.c.(2).ii through A3.4.c.(2).v for all required test configurations.

(3) Pulse noise signals.

i. Turn on the EUT and allow enough time for stabilization; ensure the EUT is operating in the first mode to be tested.

ii. Set the pulse generator to produce the required waveform. Increase the applied signal until the required voltage is reached or not to exceed the maximum current level in the noise circuit connected to the electrically isolated WRA chassis.

iii. Maintain at least the required signal level, polarization, and pulse repetition rate for a duration of 5 minutes, continuous.

iv. Susceptibility evaluation.

1. Monitor the EUT for degradation of performance.

2. If susceptibility is noted, determine the threshold level in accordance with MIL-STD-461G, section 4.3.10.4.3 and verify that it is above the limit.

v. Repeat A3.4.c.(3).ii through A3.4.c.(3).iv for each pulse polarity.

vi. Repeat A3.4.c.(3).ii through A3.4.c.(3).v for all required operating modes.

vii. Repeat A3.4.c.(3).ii through A3.4.c.(3).vi for all required test configurations.

A3.5 Data Presentation.

Data presentation shall be as follows:

a. Provide graphical and tabular data showing the frequencies and amplitudes at which the test was conducted.

b. Provide oscilloscope photographs of the calibration pulse waveform obtained in A3.4.b.(3).i. Clearly display amplitudes and waveform shapes. Clearly indicate applicable horizontal and vertical scales on the data records.

c. Provide oscilloscope photographs of the pulse waveform applied during EUT Testing (A3.4.c.(3).iii). Clearly display amplitudes and waveform shapes. Clearly indicate applicable horizontal and vertical scales on the data records.

d. Provide appropriately labeled photographs that clearly show the test setup.

e. Provide detailed test equipment list with calibration dates, model, manufacturer, and description.

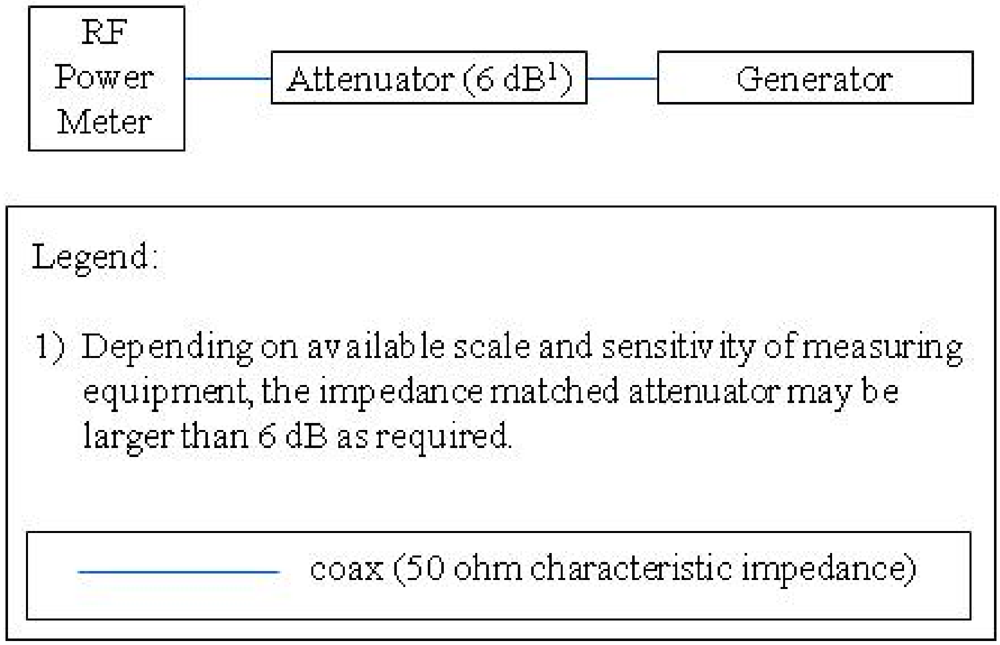


FIGURE A-1. Calibration for high frequency (50 kHz - 100 MHz)

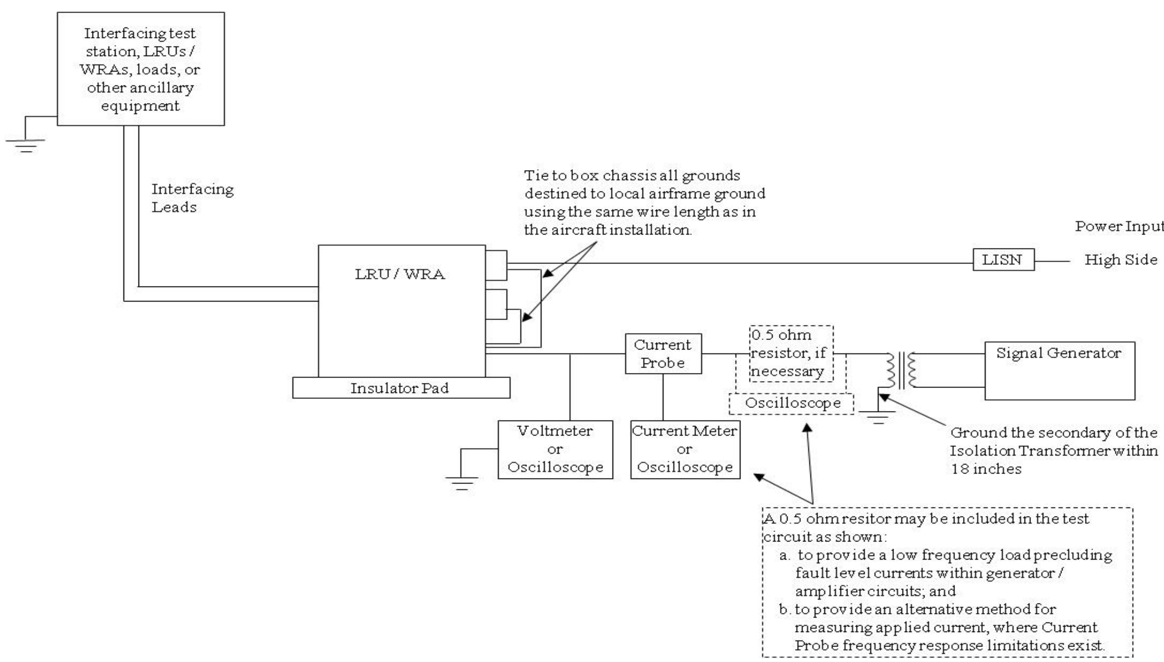


FIGURE A-2. CW Low Frequency set up (320 Hz - 50 kHz)

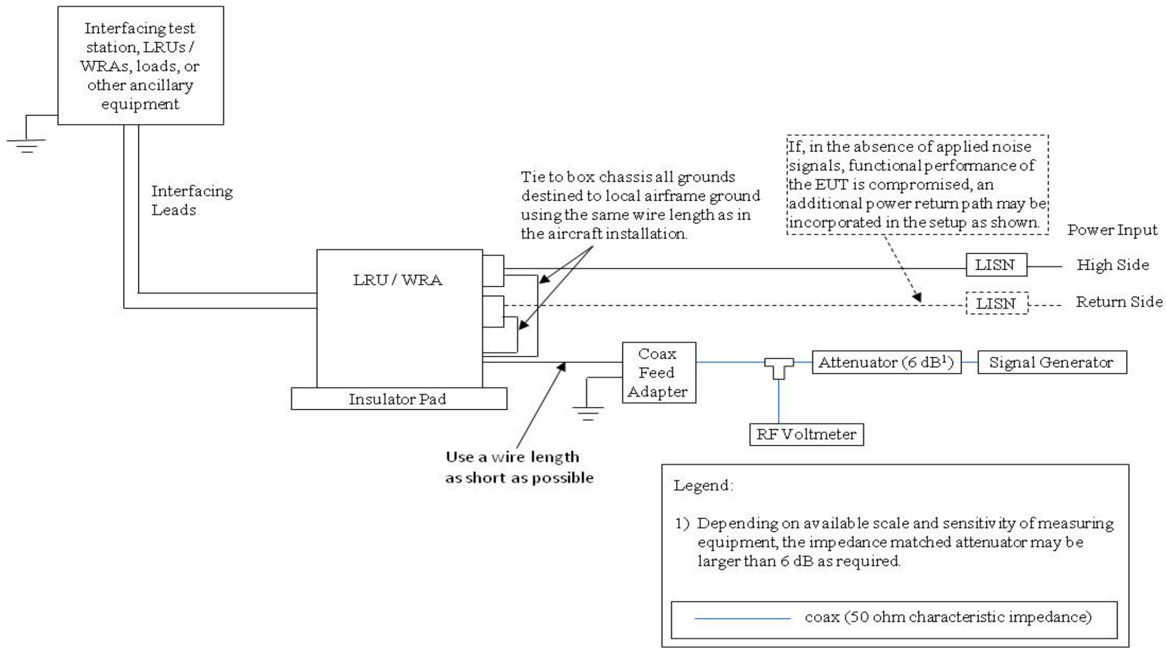


FIGURE A-3. CW High Frequency set up (50 kHz - 100 MHz)

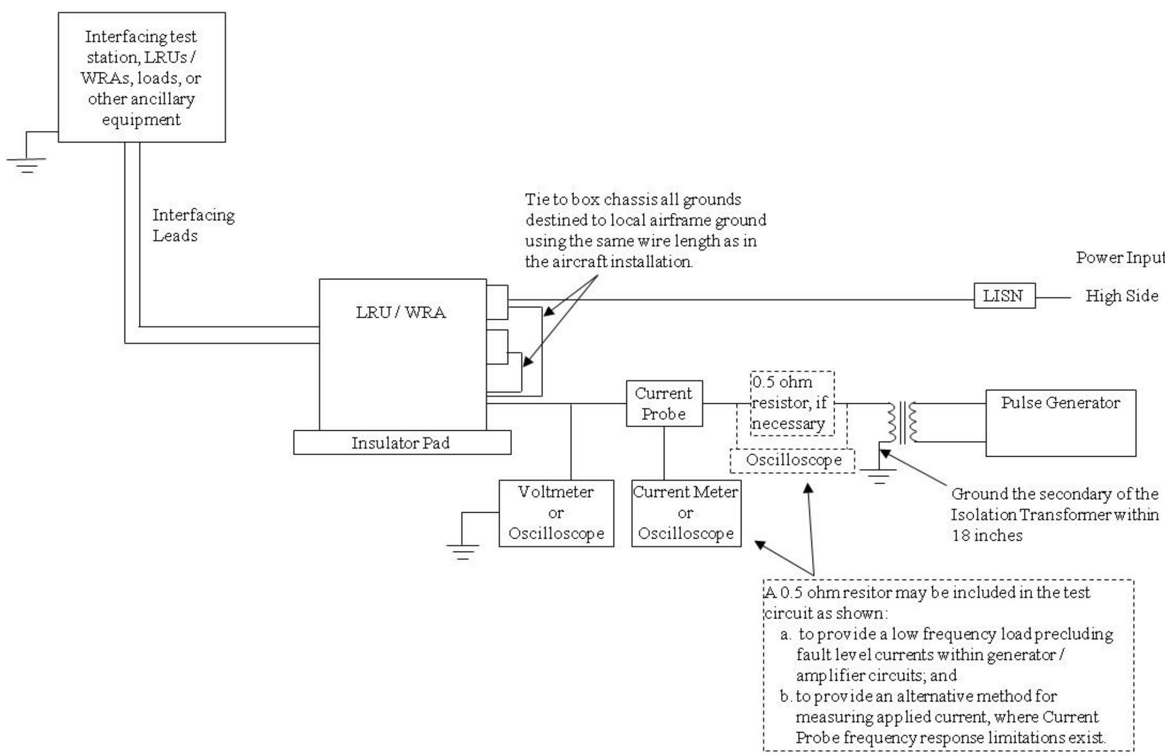


FIGURE A-4. Set up for pulse noise signals.

DISTRIBUTION:

NOTE: The following are standard for TIMs, please add additional addressees as needed to the top of this list. Include email addresses for recipients so reports can be electronically distributed.

NAVAIRWARCENACDIV (AA15000). Bldg. 2187, Room 3256	(3)
48110 Shaw Road, Patuxent River, MD 20670	
NAVAIRWARCENACDIV (AD6250M), Bldg. 144	(1)
48202 Standley Road, Unit 5, Patuxent River, MD 20670	
NAVAIRWARCENWPNDIV (D515000), Bldg. 02670	(1)
1900 Knox Rd, China Lake, CA 93555	
NAVAIRSYSCOM (AA10000), Bldg. 2185, Room 2230	(1)
22347 Cedar Point Rd, Patuxent River, MD 20670	
NAVAIRSYSCOM (Scientific & Technical Library), Bldg. 407, Room 116	(1)
22269 Cedar Point Road, Patuxent River, MD 20670	
DTIC	(1)
8725 John J. Kingman Road, Suite 0944, Ft. Belvoir, VA 22060	