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MIL-HDBK-704-8
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DEPARTMENT OF DEFENSE HANDBOOK

GUIDANCE FOR TEST PROCEDURES FOR DEMONSTRATION OF UTILIZATION EQUIPMENT COMPLIANCE TO AIRCRAFT ELECTRICAL POWER CHARACTERISTICS 28 VDC (PART 8 OF 8 PARTS)

This Handbook is for guidance only.
Do not cite this document as a requirement.

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FOREWORD

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

2. This handbook provides guidance on test procedures for demonstration of 28 VDC utilization equipment to determine compliance with the applicable edition of MIL-STD-704.

3. MIL-HDBK-704-8 is Part 8 in a series of 8 Parts. Part 8 describes the test methods and procedures to demonstrate that 28 VDC utilization equipment is compatible with the electric power characteristics of MIL-STD-704. These series of handbooks and MIL-STD-704 are companion documents.

4. Comments, suggestions, or questions on this document should be addressed to Commander, Naval Air Systems Command, Code 4.1.4, Highway 547, Lakehurst, NJ 08733-5100 or email to thomas.omara@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

CONTENTS

1. SCOPE

1.1 Scope. This handbook provides, as guidance, test methods used to demonstrate that 28 VDC utilization equipment is compatible with the electric power characteristics of the applicable edition(s) of MIL-STD-704. This handbook is for guidance only and cannot be cited as a requirement.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this handbook.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-704	DoD Interface Standard for Aircraft Electric Power Characteristics

(Copies of these documents are available online at http://assist. daps.dla.mil/quicksearch or www.dodssp.daps.mil/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

3. DEFINITIONS

3.1 Acronyms and definitions. The acronyms and definitions of MIL-STD-704 are applicable to this handbook.

4. TEST METHODS INFORMATION

4.1 Demonstration of compatibility. This section contains the test methods which will ensure that 28 VDC utilization equipment is compatible with the electric power characteristics of the applicable edition(s) of MIL-STD-704, by testing the Unit Under Test (UUT) in accordance with the test procedures as described in test methods LDC101 through LDC602.

4.1.1 Recording performance. In table LDC-I, record the edition(s) of MIL-STD-704 that defined the aircraft electric power characteristics used for testing and the performance of the UUT for each of the test methods.

4.2 Calibration of test equipment. Test equipment and accessories required for measurement in accordance with this handbook should be calibrated in accordance with an approved calibration program traceable to the National Institute for Standards and Technology.

The serial numbers, model, and calibration date of all test equipment should be included with the test data.

4.3 Test methods. The test methods listed in table LDC-I are provided in section 5 of this handbook.

TABLE LDC-I. Summary of 28 VDC utilization equipment MIL-STD-704 compliance tests.

UUT:			
Compliance to MIL-STD-704 Edition(s):			
Test Dates:			
Test Method	Description	Performance (Pass/Fail)	Comments
Normal, Aircraft Electrical Operation			
LDC101	Load Measurements		
LDC102	Steady State Limits for Voltage		
LDC103	Voltage Distortion Spectrum		
LDC104	Total Ripple		
LDC105	Normal Voltage Transients		
Transfer, Aircraft Electrical Operation			
LDC201	Power Interrupt		
Abnormal, Aircraft Electrical Operation			
LDC301	Abnormal Steady State Limits for Voltage		
LDC302	Abnormal Voltage Transients (Overvoltage/Undervoltage)		
Emergency, Aircraft Electrical Operation			
LDC401	Emergency Limits for Voltage		
Starting, Aircraft Electrical Operation			
LDC501	Starting Voltage Transients		
Power Failure, Aircraft Electrical Operation			
LDC601	Power Failure		
LDC602	Polarity Reversal		

5. TEST METHODS

METHOD LDC101
Load Measurements

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL
OPERATING CONDITION: Normal

PARAMETER: Load Measurements

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment meets the load limits, inrush limits, current distortion limits and current spectrum limits that may be required by the utilization equipment performance specification document.

2. Validation criteria. If required by the utilization equipment performance specification document, the utilization equipment is considered to have passed if the utilization equipment is within the load limits, inrush current limits, the current distortion limit, and the current spectrum limits specified in the utilization equipment performance specification document. As noted in table LDC101-I, the load limits, inrush current limits, the current distortion limit, and the current spectrum limits are not specified in MIL-STD-704 versions A through F. The utilization equipment must not suffer damage or cause an unsafe condition.

Note: The utilization equipment performance specification document should include requirements that reduce the likelihood of the equipment having an adverse effect on the electrical power characteristics of the aircraft. Load, inrush currents, current distortion and current spectrum limits may be imposed to minimize undesirable effects to the electrical power characteristics. These limits should take into account the utilization equipment power draw, aircraft electrical system capacity and distribution characteristics, trade-offs with weight, volume, cost, and reliability that are specific to each type of equipment and aircraft.

TABLE LDC101-I. MIL-STD-704 limits for load, inrush current, current distortion factor, and current spectrum for 28 volt DC utilization equipment.

Limit	704A	704B	704C	704D	704E	704F
Inrush Current	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]
Load (VA)	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]
Current Distortion Factor	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]
Current Spectrum	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]	N/A[1/]

1/. Limits for Load, Inrush Current, Current Distortion Factor, and Current Spectrum must be defined in the utilization equipment performance specification document and are unique to each equipment.

3. Apparatus. The test equipment should be as follows:

a. Adjustable DC power supply
b. True RMS voltmeter
c. Power meter
d. Spectrum analyzer
e. Distortion meter
f. Current transformer
g. Oscilloscope

4. Test setup. Configure the test setup as shown in figure LDC101-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT. The current measurement must be taken from the 28 volt DC conductor.

5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC101-1. Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. If the utilization equipment performance specification document:

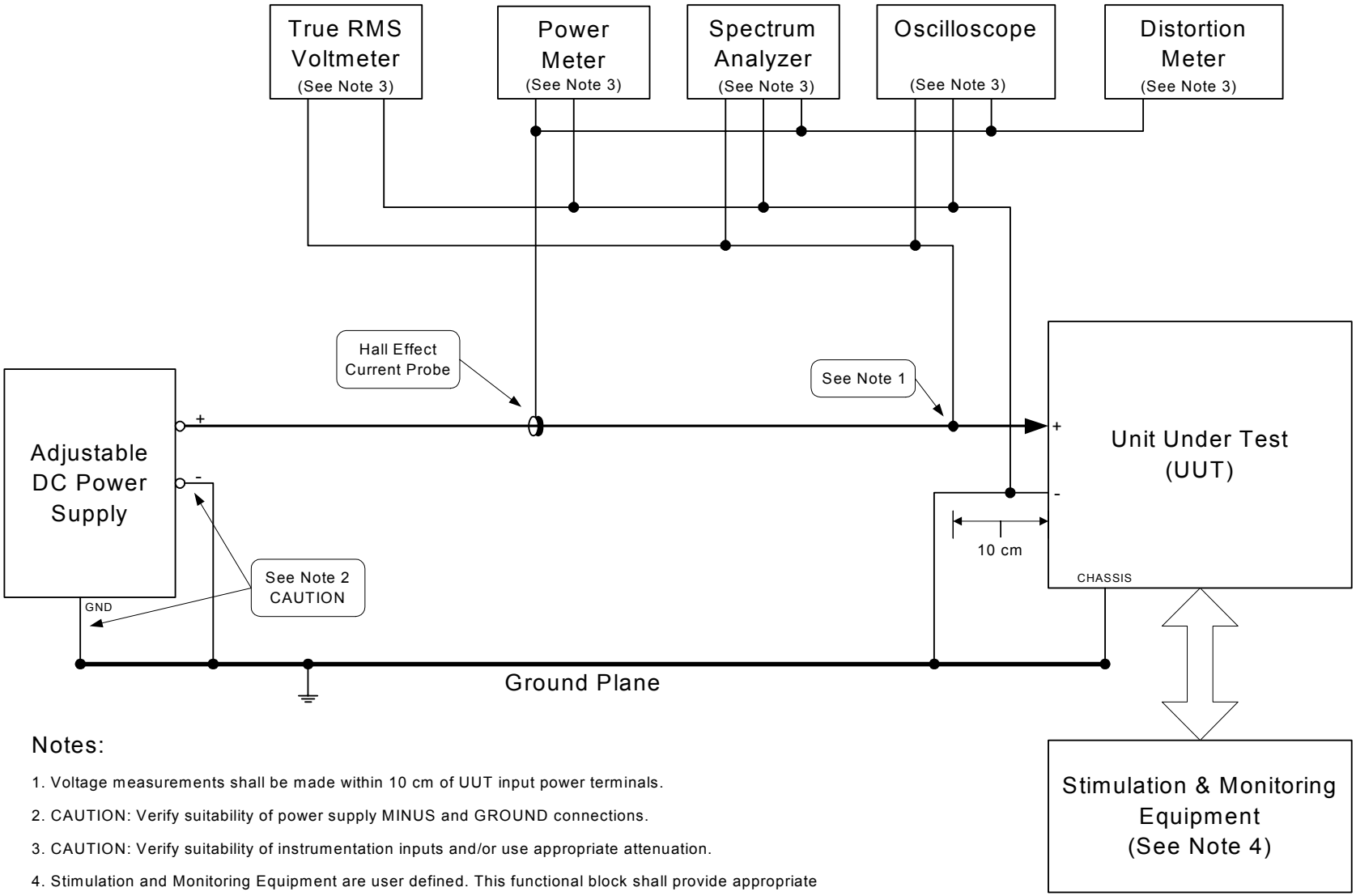
a. Imposes inrush current limits, close the circuit breaker, energizing the UUT. Record the inrush current in the data sheet shown in table LDC101-II and compare with the limits of utilization equipment performance specification document. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Repeat for each mode of operation of the UUT.

b. Imposes load limits, energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Record the load (Volt-Amps) and the voltage in the data sheet shown in table LDC101-II and compare with the limits of utilization equipment performance specification document. Repeat for each mode of operation of the UUT.

c. Imposes current distortion limits, energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Record the current distortion factor in the data sheet shown in table LDC101-II and compare with the limits of utilization equipment performance specification document. Repeat for each mode of operation of the UUT.

d. Imposes current spectrum limits, energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for

normal aircraft electrical conditions. Record the current spectrum (current amplitude vs. frequency) in the data sheet shown in table LDC101-II and compare with the limits of utilization equipment performance specification document. Repeat for each mode of operation of the UUT.



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC101-1. Normal operation - load and current distortion measurement.

TABLE LDC101-II. Sample data sheet for LDC101 load measurements.

Parameter	Measurement	Unit	Performance Pass/Fail
Inrush Current		Amps	
Voltage		V_{dc}	N/A
Load (VA)		VA	
Total Current Distortion		% Current Distortion	
Current Spectrum	Attach Spectrum Plot	Amplitude vs. Frequency	

METHOD LDC102
Steady State Limits for Voltage

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL OPERATING CONDITION: Normal

PARAMETER: Steady State Limits for Voltage

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when provided power with voltage at that the Normal Low Steady State (NLSS) limits and the Normal High Steady State (NHSS) limits as specified in the applicable edition(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for normal aircraft electrical conditions when supplied input power of voltage at the specified normal steady state limits of the applicable editions(s) of MIL-STD-704 and as noted in table LDC102-I. The utilization equipment must maintain specified performance for a length of time that confirms the utilization equipment can continuously operate at the steady state voltage and frequency limits and should be not less than thirty (30) minutes for each of the test conditions. The utilization equipment must demonstrate re-start at the steady state voltage limits. The utilization equipment must not suffer damage or cause an unsafe condition.

Note: If the utilization has exactly the same full performance requirements for abnormal steady state limits and emergency steady state limits as required for the normal aircraft electrical conditions, then performance of test methods LDC301 and LDC401 will constitute performance of LDC102.

TABLE LDC102-I. MIL-STD-704 normal limits for steady state voltage.

Normal Limit	704A	704B	704C	704D	704E	704F
Voltage NLSS	24 Vdc	22 Vdc	22 Vdc	22 Vdc	22 Vdc	22 Vdc
Voltage NHSS	28.5 Vdc	29 Vdc	29 Vdc	29 Vdc	29 Vdc	29 Vdc

3. Apparatus. The test equipment should be as follows:

a. Adjustable DC power supply
b. True RMS voltmeter

4. Test setup. Configure the test setup as shown in figure LDC102-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

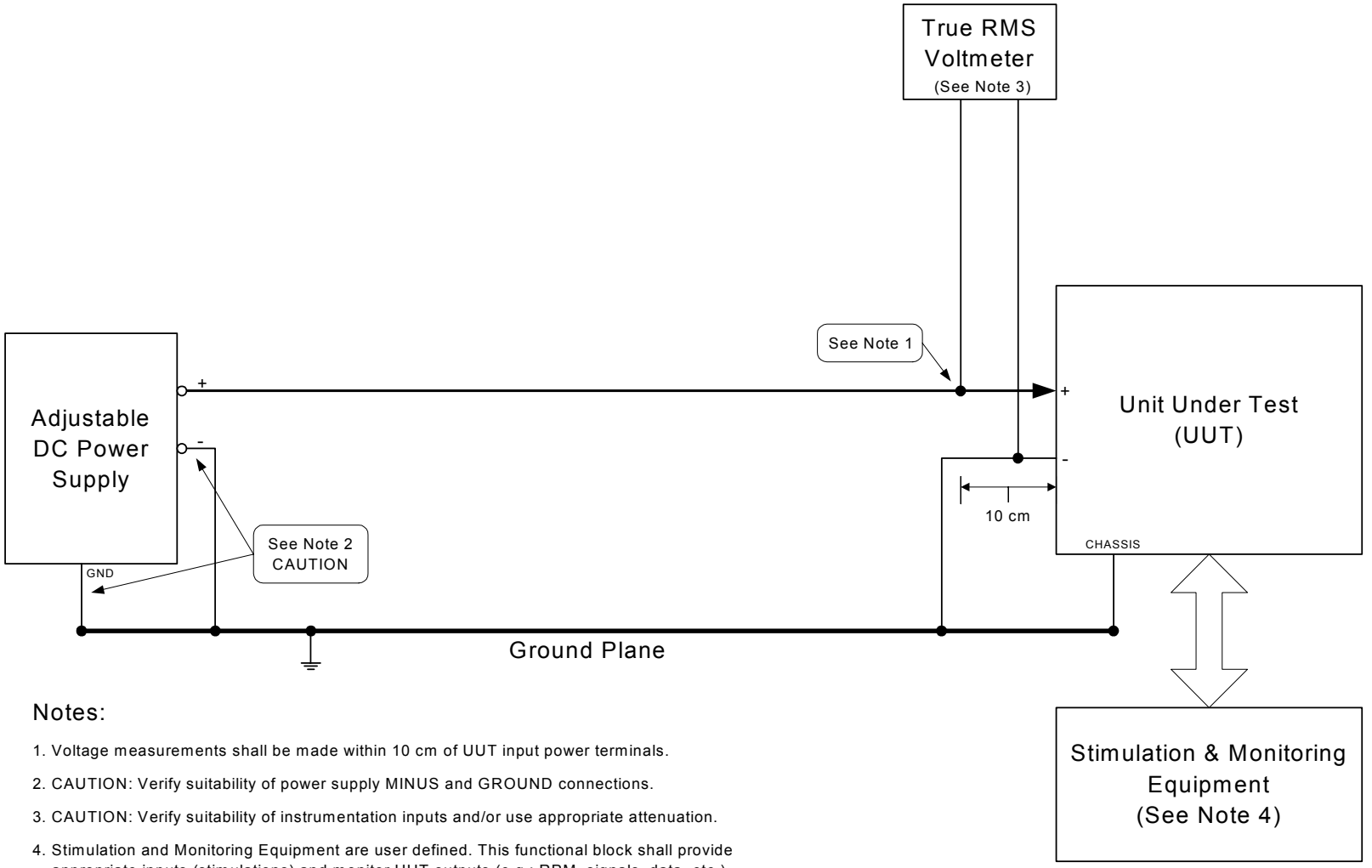
5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC102-1. Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

For each test condition A through C noted in table LDC102-II, the UUT must remain for a length of time that confirms the utilization equipment can continuously operate at the steady state voltage limits and should be not less than thirty (30) minutes. At each test condition conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. For each test condition shutdown the UUT and verify that the UUT can be re-started. After re-start conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Record the voltage, frequency, time duration at test condition, successful/unsuccessful re-start and the performance of the UUT for each test condition in the data sheet shown in table LDC102-III. Repeat for each mode of operation of the UUT.

After all test conditions are complete, adjust the voltage to the nominal steady state voltage of 28 VDC. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has not suffered damage and is providing specified performance for normal aircraft electrical conditions.

TABLE LDC102-II. Test conditions for steady state limits of DC voltage.

Test Condition	Voltage
A	Nominal Voltage
B	NLSS Voltage
C	NHSS Voltage



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC102-1. Normal operation - steady state limits for voltage.

TABLE LDC102-III. Sample data sheet for LDC102 steady state limits for voltage.

Test Condition	Parameters							Performance
	Voltage		Frequency		Time Duration at Condition		Re-Start (Yes/No)	Pass/Fail
A		V_{dc}		Hz		min		
B		V_{dc}		Hz		min		
C		V_{dc}		Hz		min		

METHOD LDC103
Voltage Distortion Spectrum

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL OPERATING CONDITION: Normal

PARAMETER: Voltage Distortion Spectrum

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when subjected to voltage distortion of frequencies and amplitudes as specified by the voltage distortion spectrum in the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for normal aircraft electrical conditions when subjected to voltage distortions as specified by the voltage distortion spectrum in the applicable editions(s) of MIL-STD-704 and as noted in table LDC103-I. The utilization equipment must maintain specified performance for a length of time that confirms the utilization equipment can operate continuously when provided power having voltage distortion. The utilization equipment must not suffer damage or cause an unsafe condition.

Note: This test method subjects the UUT to voltage distortion having frequencies components from 10 Hz to 10 kHz. These voltage distortions simulate voltage distortions within aircraft due to the cumulative effects of generators, electrical distribution systems equipments, and aircraft loads. MIL-STD-461, (Requirements For The Control of Electromagnetic Interference Characteristics of Subsystems and Equipment), Test Method CS101, (Conducted Susceptibility, Power Leads, 30 Hz to 150 kHz) is a complimentary test. Power levels of the voltage distortions differ for the two test methods. Performance of Test Method LDC103 of this handbook does not relinquish the requirement to perform test Method CS101 of MIL-STD-461, and performance of Method CS101 of MIL-STD-461 does not relinquish the requirement to perform Test Method LDC103 of this handbook.

TABLE LDC103-I. MIL-STD-704 limits for voltage distortion spectrum.

Limit	704A	704B	704C	704D	704E	704F
Voltage Distortion Spectrum	Figure 7 MIL-STD-704A	Figure 6 MIL-STD-704B	Figure 9 MIL-STD-704C	Figure 9 MIL-STD-704D	Figure 8 MIL-STD-704E	Figure 15 MIL-STD-704F

3. Apparatus. The test equipment should be as follows:

a. Programmable DC power supply
b. Variable frequency power source
c. Coupling transformer
d. True RMS voltmeter
e. Spectrum analyzer
f. (2) Inductors, 50 µH
g. Capacitor, 10 µF
h. Resistor, calibrated load

4. Test setup (10 Hz and 25 Hz). Configure the test setup as shown in figure LDC103-1 voltage distortion spectrum setup for 10 Hz and 25 Hz. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

5. Compliance test (10 Hz and 25 Hz). With the programmable DC power supply off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC103-1. Turn on the programmable DC power supply and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

For test condition A noted in table LDC103-II, set the DC programmable power supply to vary the amplitude of the DC voltage at a 10 Hz rate at an average DC voltage of 28 VDC to create a voltage distortion (ripple) for test condition A of the appropriate edition of MIL-STD-704. Remain for a length of time that confirms the utilization equipment can continuously operate with the voltage distortion and should be not less than five (5) minutes. At each test condition, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. For each test condition, record voltage, frequency of voltage distortion, amplitude of voltage distortion, time duration at test condition, and the performance of the UUT in the data sheet shown in table LDC103-III. Repeat for test condition B by setting the DC programmable power supply to vary the amplitude of the DC voltage at a 25 Hz rate at an average DC voltage of 28 VDC to create a voltage distortion (ripple) specified for test condition B of the appropriate edition of MIL-STD-704. Repeat for each mode of operation of the UUT.

6. Test setup (50 Hz to 10 kHz). Configure the test setup as shown in figure LDC103-2. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

6.1 Calibration (50 Hz to 10 kHz). Install a calibrated resistive load in the test setup shown in figure LDC103-2 in place of the UUT. The calibrated resistive load must be sized to draw the same current as the UUT. Turn on the programmable DC power supply and adjust the voltage to the nominal steady state voltage of 28 VDC. Set the variable frequency power source to output a sine wave and adjust the frequency and amplitude so that the voltage distortion measured at the

input to the calibrated resistive load conforms to each test condition C through K as noted in table LDC103-II of the applicable editions(s) of MIL-STD-704. Record the settings of the variable frequency power source for each test condition.

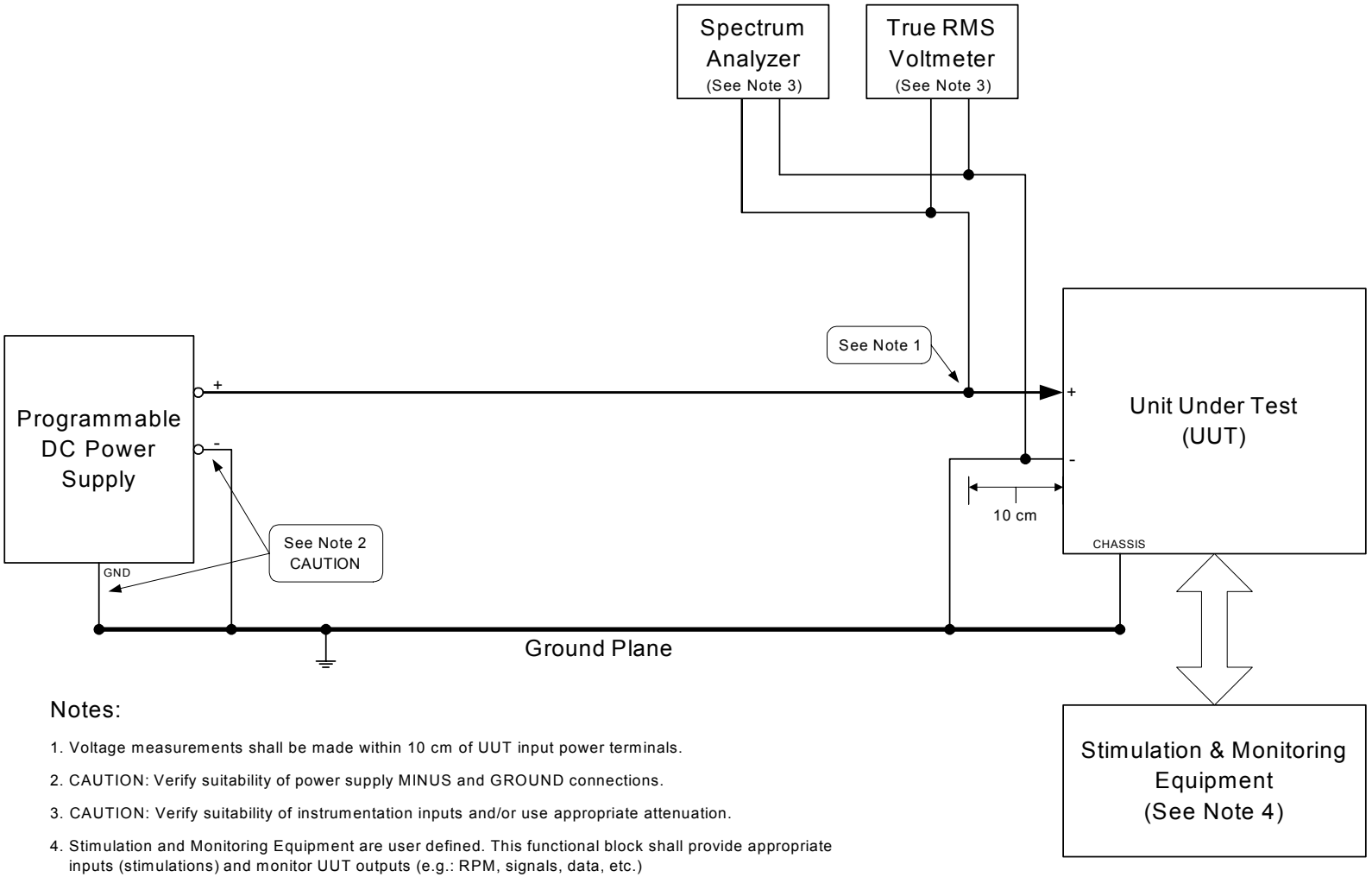
7. Compliance test (50 Hz to 10 kHz). With the programmable DC power supply off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC103-2. Turn on the programmable DC power supply and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

Set the variable frequency power source to the settings recorded for test condition C of the calibration procedure. For each test condition, remain for a length of time that confirms the utilization equipment can continuously operate with the voltage distortion and should be, not less than five (5) minutes. At each test condition, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. After each test condition, monitor the voltage distortion frequency and amplitude while slowly increasing the variable frequency power source frequency and adjusting the amplitude until the next test condition is reached. Do not exceed the voltage distortion spectrum limits. Repeat for each test condition C through K noted in table LDC103-II. For each test condition, record voltage, frequency of voltage distortion, amplitude of voltage distortion, time duration at test condition, and the performance of the UUT in the data sheet shown in table LDC103-III. Repeat for each mode of operation of the UUT.

After all test conditions are complete, turn the programmable DC power supply off and remove the coupling transformer from the circuit. Turn on the programmable DC power supply. Adjust the voltage to the nominal steady state voltage of 28 VDC. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has not suffered damage and is providing specified performance for normal aircraft electrical conditions.

TABLE LDC103-II. Test conditions for voltage distortion spectrum.

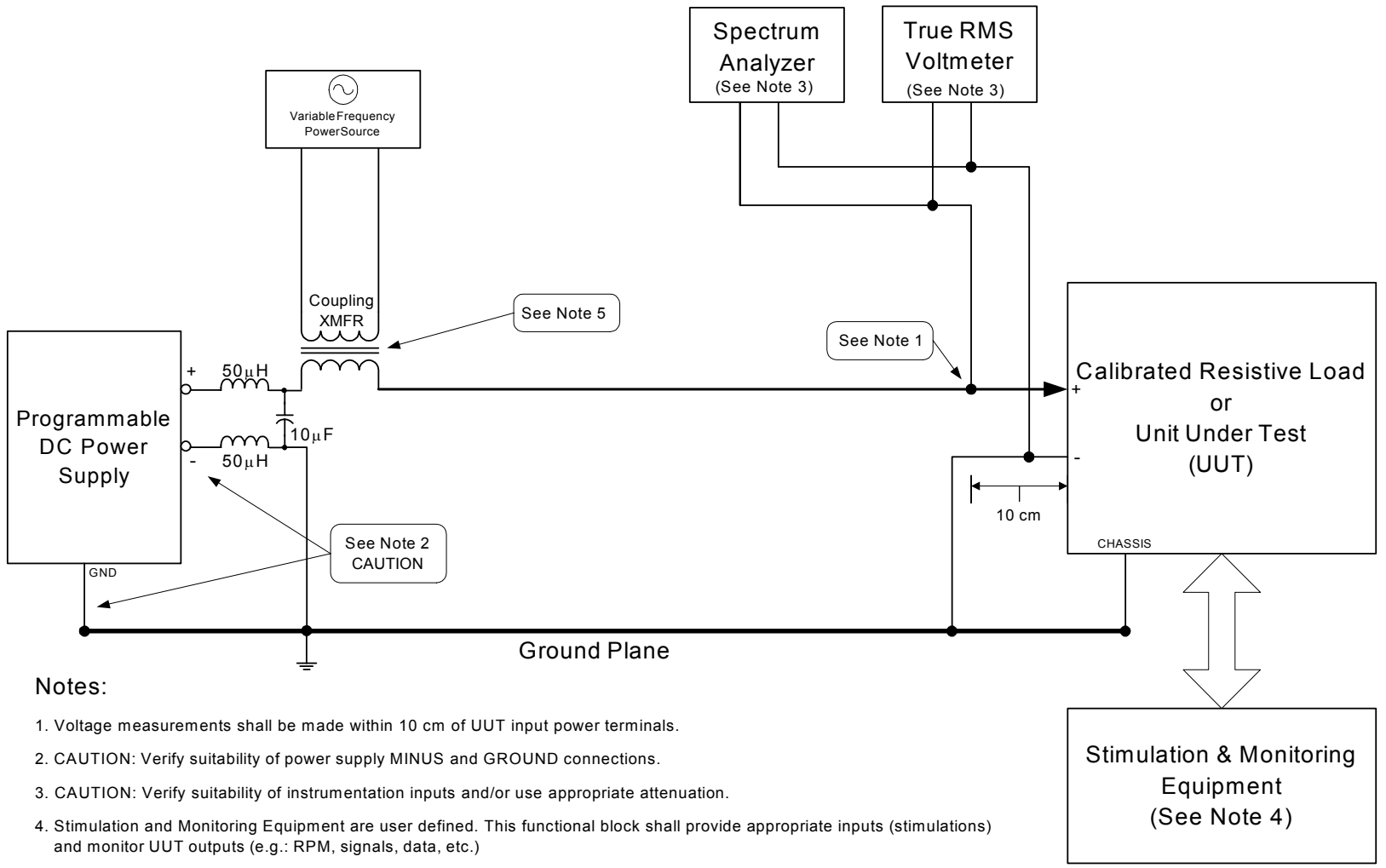
Test Condition	Frequency of Voltage Distortion	MIL-STD-704A Amplitude of Voltage Distortion Voltage rms	MIL-STD-704B, C, & D Amplitude of Voltage Distortion Voltage rms	MIL-STD-704E & F Amplitude of Voltage Distortion Voltage rms
A	10 Hz	0.900 Vrms	0.100 Vrms	0.100 Vrms
B	25 Hz	0.900 Vrms	0.158 Vrms	0.158 Vrms
C	50 Hz	0.400 Vrms	0.200 Vrms	0.223 Vrms
D	60 Hz	0.320 Vrms	0.224 Vrms	0.245 Vrms
E	250 Hz	0.320 Vrms	0.398 Vrms	0.500 Vrms
F	1 kHz	0.790 Vrms	0.707 Vrms	1.000 Vrms
G	1.7 kHz	1.000 Vrms	0.891 Vrms	1.000 Vrms
H	2 kHz	1.000 Vrms	1.000 Vrms	1.000 Vrms
I	5 kHz	1.000 Vrms	0.316 Vrms	1.000 Vrms
J	6.5 kHz	1.000 Vrms	0.707 Vrms	0.707 Vrms
K	10 kHz	0.400 Vrms	0.125 Vrms	0.500 Vrms



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC103-1. Normal operation - voltage distortion spectrum (10 Hz and 25 Hz).



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)
5. CAUTION: Verify suitability of variable frequency power source and coupling transformer for distortion spectrum testing.

FIGURE LDC103-2. Normal operation - voltage distortion spectrum (50 Hz and 10 kHz).

TABLE LDC103-III. Sample data sheet for LDC103 voltage distortion spectrum.

Test Condition	Parameters								Performance
	Voltage		Frequency of Voltage Distortion		Amplitude of Voltage Distortion		Time Duration at Condition		Pass/Fail
A		V_{DC}		Hz		V_{rms}		min	
B		V_{DC}		Hz		V_{rms}		min	
C		V_{DC}		Hz		V_{rms}		min	
D		V_{DC}		Hz		V_{rms}		min	
E		V_{DC}		Hz		V_{rms}		min	
F		V_{DC}		kHz		V_{rms}		min	
G		V_{DC}		kHz		V_{rms}		min	
H		V_{DC}		kHz		V_{rms}		min	
I		V_{DC}		kHz		V_{rms}		min	
J		V_{DC}		kHz		V_{rms}		min	
K		V_{DC}		kHz		V_{rms}		min	

METHOD LDC104
Total Ripple

POWER GROUP: LDC104

AIRCRAFT ELECTRICAL
OPERATING CONDITION: Normal

PARAMETER: Total Ripple

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when subjected to voltage having a ripple as specified by the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for normal aircraft electrical conditions when subjected to ripple as specified by the applicable editions(s) of MIL-STD-704 and as noted in table LDC104-I. The utilization equipment must maintain specified performance for a length of time that confirms the utilization equipment can operate continuously when subjected to a distorted voltage waveform and should be not less than thirty (30) minutes. The utilization equipment must not suffer damage or cause an unsafe condition.

TABLE LDC104-I. MIL-STD-704 limits for ripple DC voltage distortion.

Limit	704A	704B	704C	704D	704E	704F
Voltage Ripple	2 Volts Peak to Mean And Figure 7 MIL-STD-704A	1.5 Volts Peak to Average And Figure 6 MIL-STD-704B	1.5 Volts Peak to Average And Figure 9 MIL-STD-704C	1.5 Volts Peak to Average And Figure 9 MIL-STD-704D	1.5 Volts Peak to Average And Figure 8 MIL-STD-704E	1.5 Volts Peak to Average And Figure 15 MIL-STD-704F

3. Apparatus. The test equipment should be as follows:

a. Programmable DC power supply
b. True RMS voltmeter
c. Spectrum analyzer
d. Distortion meter

4. Test setup. Configure the test setup as shown in figure LDC104-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

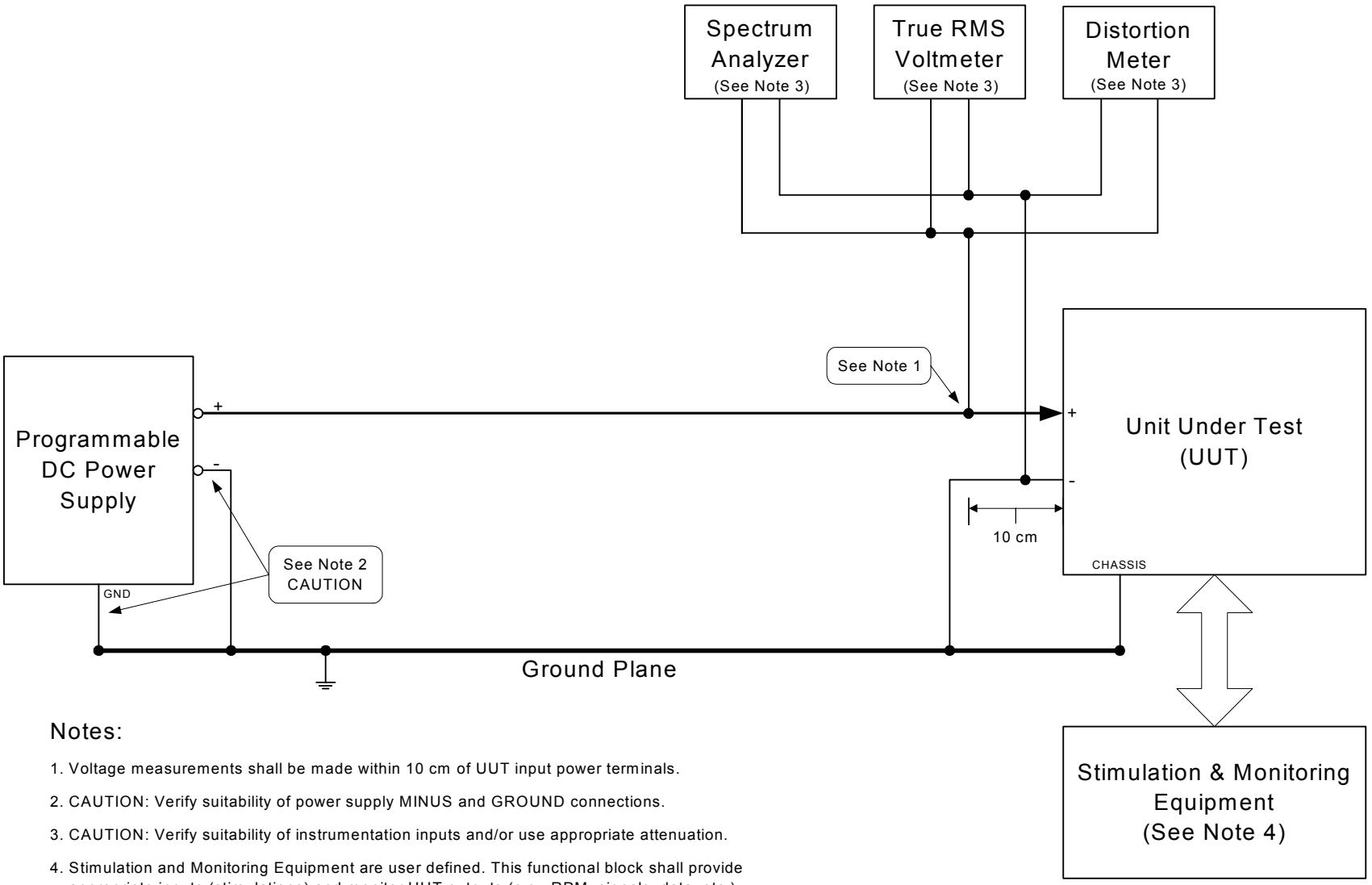
4.1 Calibration. Install a resistive load in the test setup shown in figure LDC104-1 in place of the UUT. The resistive load must be sized to draw the same current as the UUT. Set the programmable power supply to produce a DC voltage waveform having ripple as noted for test condition A in table LDC104-II for the applicable editions(s) of MIL-STD-704. The ripple should include all the frequencies components with amplitudes noted for test condition A. Turn on the programmable DC power supply and adjust the voltage to the nominal steady state voltage of 28 VDC. Confirm that the programmable power supply is producing a voltage waveform having ripple content listed in table LDC104-II. Record the settings of the programmable power supply. Repeat the process for test condition B in table LDC104-II.

5. Compliance test. With the programmable DC power supply off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC104-1. Set the programmable power supply to the settings recorded during the calibration procedure for condition A. Turn on the programmable DC power supply and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Measure the ripple frequencies spectrum and record the DC ripple frequency components and amplitudes. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Remain for a length of time that confirms the utilization equipment can continuously operate with the ripple voltage, and should be not less than thirty (30) minutes. Repeat for test condition B noted in table LDC104-II. For each test condition, record the voltage, distortion factor, frequency spectrum of ripple, time duration at test condition, and the performance of the UUT in the data sheet shown in table LDC104-III. Repeat for each mode of operation of the UUT.

After all test conditions are complete, set the programmable power supply to produce a DC waveform without ripple. Adjust the voltage to the nominal steady state voltage of 28 VDC. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has not suffered damage and is providing specified performance for normal aircraft electrical conditions.

TABLE LDC104-II. Ripple frequency and amplitude.

Test Condition	Ripple Frequency Components	MIL-STD-704A Amplitude of Ripple Component Vrms	MIL-STD-704B, C, D, E, & F Vrms
A	1200 Hz	1.00 Vrms	0.80 Vrms
	2400 Hz	0.20 Vrms	0.16 Vrms
	3600 Hz	0.33 Vrms	0.26 Vrms
	4800 Hz	0.10 Vrms	0.08 Vrms
	6000 Hz	0.16 Vrms	0.13 Vrms
	7200 Hz	0.05 Vrms	0.04 Vrms
	8400 Hz	0.08 Vrms	0.06 Vrms
B	2400 Hz	0.80 Vrms	0.80 Vrms
	4800 Hz	0.16 Vrms	0.16 Vrms
	7200 Hz	0.26 Vrms	0.26 Vrms
	9600 Hz	0.08 Vrms	0.08 Vrms
	12000 Hz	0.13 Vrms	0.13 Vrms
	14400 Hz	0.04 Vrms	0.04 Vrms
	16800 Hz	0.06 Vrms	0.06 Vrms



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC104-1. Normal operation - total ripple.

TABLE LDC104-III. Sample data sheet for LDC104 total ripple.

Test Condition	Parameters						Performance
	Voltage		Voltage Distortion Factor		Time Duration at Condition		Pass/Fail
A		Vdc		No Units		min	
	Ripple Frequency Component		Amplitude of Ripple				
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
B	Voltage		Voltage Distortion Factor		Time Duration at Condition		Pass/Fail
		Vdc		No Units		min	
	Ripple Frequency Component		Amplitude of Ripple				
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			
		Hz		Vrms			

METHOD LDC105
Normal Voltage Transients

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL OPERATING CONDITION: Normal

PARAMETER: Normal Voltage Transients

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when subjected to normal voltage transients as specified in the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for normal aircraft electrical conditions when subjected to voltage transients within the normal limits of the applicable editions(s) of MIL-STD-704 and as noted in table LDC105-I. The utilization equipment must maintain specified performance during and after the voltage transients. The utilization equipment must not suffer damage or cause an unsafe condition.

TABLE LDC105-I. MIL-STD-704 limits for normal voltage transients.

Limit	704A	704B	704C	704D	704E	704F
Normal Voltage Transients	Figure 9 MIL-STD-704A Locus of Equivalent Step Function Curves 2 and 3	Figure 7 MIL-STD-704B	Figure 10 MIL-STD-704C	Figure 10 MIL-STD-704D	Figure 9 MIL-STD-704E	Figure 13 MIL-STD-704F

3. Apparatus. The test equipment should be as follows:

a. Programmable DC power supply
b. True RMS voltmeter
c. Oscilloscope

4. Test setup. Configure the test setup as shown in figure LDC105-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC105-1. Turn on the power source and

adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

5.1 Compliance test for MIL-STD-704A. The UUT must be subjected to the voltage transients for each test condition A through V noted in table LDC105-II. The voltage must increase or decrease from steady state voltage as noted in table LDC105-II to the voltage transient level within 1 milliseconds. The voltage must remain at the voltage transient level for the duration noted in table LDC105-II. The voltage must return to steady state over the time duration noted in table LDC105-II. For test condition E and J, three over-voltage transients of 70 Vdc for 12 milliseconds are performed, separated by 0.5 second. For test condition O and T, three under-voltage transients of 8 Vdc for 12 milliseconds are performed, separated by 0.5 second. For test condition U and V, an under-voltage transient of 8 Vdc for 10 milliseconds is immediately followed by an over-voltage transient of 70 Vdc for 15 milliseconds and the voltage returns to steady state over the time duration noted. For each test condition, monitor the performance of the UUT during the voltage transient according to the equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Repeat each test condition 5 times. After the power returns to normal steady state limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Record the steady state voltage, voltage transient (oscilloscope trace), and the performance of the UUT for each test condition in the data sheet shown in table LDC105-IV. Repeat for each mode of operation of the UUT. In addition, for MIL-STD-704A test compliance perform the repetitive voltage transient test described below.

5.2 Compliance test for MIL-STD-704B, C, D, E, & F. The UUT must be subjected to the voltage transients for each test condition AA through RR noted in table LDC105-III. The voltage must increase or decrease from steady state voltage as noted in table LDC105-III to the voltage transient level within 1 milliseconds. The voltage must remain at the voltage transient level for the duration noted in table LDC105-III. The voltage must return to steady state over the time duration noted in table LDC105-III. For test condition EE and JJ, three over-voltage transients of 50 Vdc for 10 milliseconds are performed, separated by 0.5 second. For test condition MM and PP, three under-voltage transients of 18 Vdc for 10 milliseconds are performed, separated by 0.5 second. For test condition QQ and RR, an under-voltage transient of 18 Vdc for 10 milliseconds is immediately followed by an overvoltage transient of 50 Vdc for 12.5 milliseconds and the voltage returns to steady state over the time duration noted. For each test condition, monitor the performance of the UUT during the voltage transient according to the equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Repeat each test condition 5 times. After the power returns to normal steady state limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Record the steady state voltage, voltage transient (oscilloscope trace), and the performance of the UUT for each test condition in the data sheet shown in table LDC105-V. Repeat for each mode of operation of the UUT. In

addition, for MIL-STD-704B, C, D, E, & F test compliance perform the repetitive voltage transient test described below.

5.3 Repetitive normal voltage transients test. Program the power supply to provide a continually repeating voltage transient that decreases from 28.5 Vdc to 18 Vdc in 2.5 msec, then increases to 45 Vdc over 30 msec, then decreases to 28.5 Vdc over 2.5 msec. The voltage transient is repeated every 0.5 second, see figure LDC105-2. The UUT must be subjected to the repetitive voltage transient for a length of time that confirms the utilization equipment can continuously operate and should be not less than thirty (30) minutes. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Record the voltage, voltage transient (oscilloscope trace), time duration at test condition, and the performance of the UUT in the data sheet shown in table LDC105-V. Repeat for each mode of operation of the UUT.

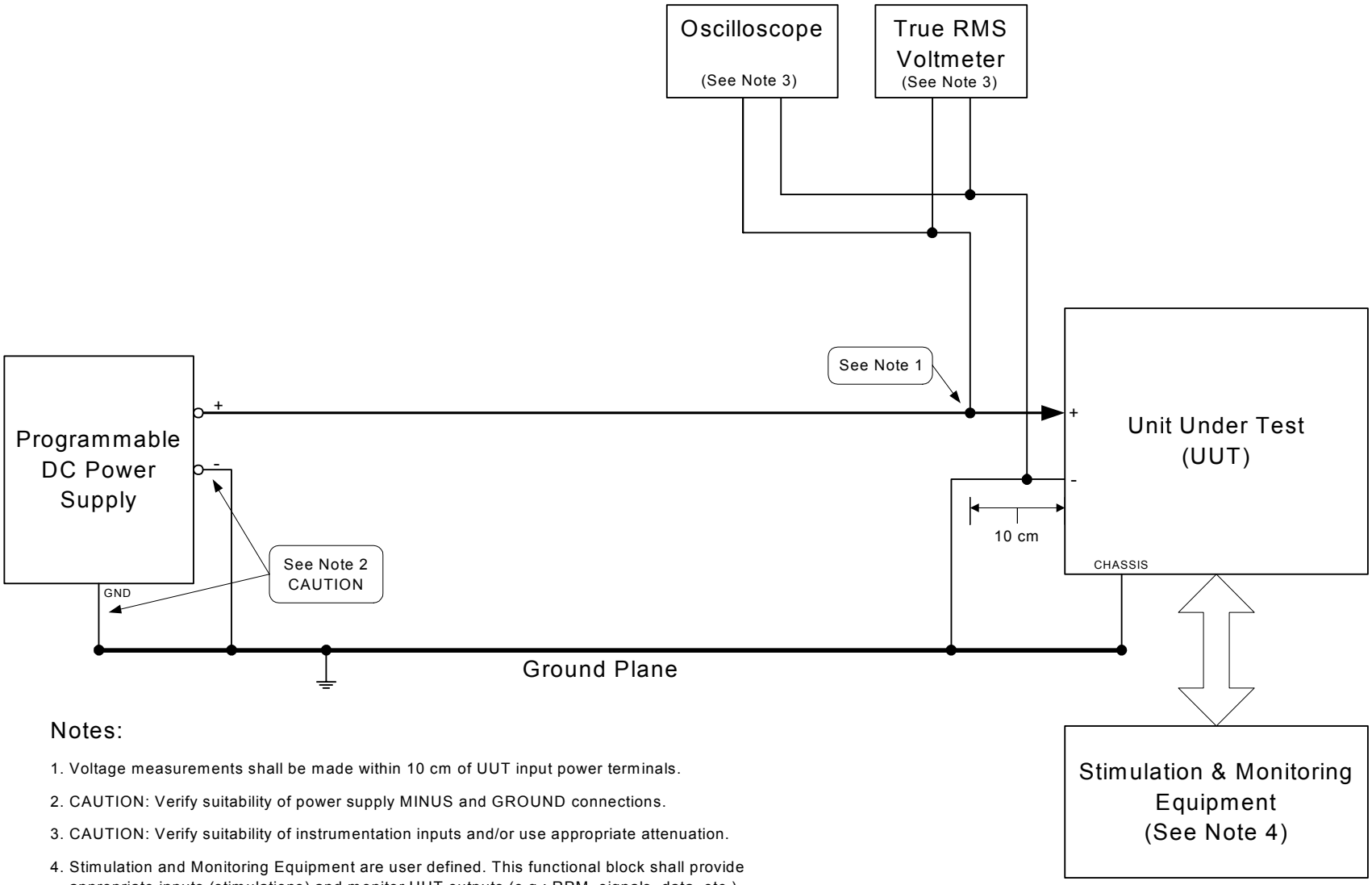
After all test conditions are complete, adjust the voltage to the nominal steady state voltage of 28 Vdc. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has not suffered damage and is providing specified performance for normal aircraft electrical conditions.

TABLE LDC105-II. Test conditions for MIL-STD-704A normal voltage transients.

Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Duration at Voltage Transient Level milliseconds	Time From Voltage Transient Level to Steady State Voltage milliseconds
Overvoltage Transients					
A	28.5 Vdc	< 1 msec	70 Vdc	20 msec	< 1 msec
B	28.5 Vdc	< 1 msec	70 Vdc	15 msec	9 msec
C	28.5 Vdc	< 1 msec	50 Vdc	75 msec	< 1 msec
D	28.5 Vdc	< 1 msec	50 Vdc	55 msec	40 msec
E	28.5 Vdc	< 1 msec	70 Vdc (3 times)	12 msec Every 0.5 sec	< 1 msec
F	24 Vdc	< 1 msec	70 Vdc	20 msec	< 1 msec
G	24 Vdc	< 1 msec	70 Vdc	15 msec	10 msec
H	24 Vdc	< 1 msec	50 Vdc	75 msec	< 1 msec
I	24 Vdc	< 1 msec	50 Vdc	55 msec	48 msec
J	24 Vdc	< 1 msec	70 Vdc (3 times)	12 msec Every 0.5 sec	< 1 msec
Undervoltage Transients					
K	28.5 Vdc	< 1 msec	8 Vdc	50 msec	< 1 msec
L	28.5 Vdc	< 1 msec	8 Vdc	38 msec	23 msec
M	28.5 Vdc	< 1 msec	14 Vdc	170 msec	< 1 msec
N	28.5 Vdc	< 1 msec	14 Vdc	128 msec	83 msec
O	28.5 Vdc	< 1 msec	8 Vdc (3 times)	12 msec Every 0.5	< 1 msec
P	24 Vdc	< 1 msec	8 Vdc	50 msec	< 1 msec
Q	24 Vdc	< 1 msec	8 Vdc	38 msec	18 msec
R	24 Vdc	< 1 msec	14 Vdc	170 msec	< 1 msec
S	24 Vdc	< 1 msec	14 Vdc	128 msec	57 msec
T	24 Vdc	< 1 msec	8 Vdc (3 times)	12 msec Every 0.5	< 1 msec
Combined Transient					
U	28.5 Vdc then	< 1 msec < 1 msec	8 Vdc 70 Vdc	10 msec 15 msec	< 1 msec 9 msec
V	24 Vdc then	< 1 msec < 1 msec	8 Vdc 70 Vdc	10 msec 15 msec	< 1 msec 10 msec

TABLE LDC105-III. Test conditions for MIL-STD-704B, C, D, E and F normal voltage transients.

Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Duration at Voltage Transient Level milliseconds	Time From Voltage Transient Level to Steady State Voltage milliseconds
Overvoltage Transients					
AA	29 Vdc	< 1 msec	50 Vdc	12.5 msec	< 1 msec
BB	29 Vdc	< 1 msec	50 Vdc	12.5 msec	70 msec
CC	29 Vdc	< 1 msec	40 Vdc	45 msec	< 1 msec
DD	29 Vdc	< 1 msec	40 Vdc	45 msec	37.5 msec
EE	29 Vdc	< 1 msec	50 Vdc (3 times)	10 msec Every 0.5 msec	< 1 msec
FF	22 Vdc	< 1 msec	50 Vdc	12.5 msec	< 1 msec
GG	22 Vdc	< 1 msec	50 Vdc	12.5 msec	95 msec
HH	22 Vdc	< 1 msec	40 Vdc	45 msec	< 1 msec
II	22 Vdc	< 1 msec	40 Vdc	45 msec	62.5 msec
JJ	22 Vdc	< 1 msec	50 Vdc (3 times)	10 msec Every 0.5 msec	< 1 msec
Undervoltage Transients					
KK	29 Vdc	< 1 msec	18 Vdc	15 msec	< 1 msec
LL	29 Vdc	< 1 msec	18 Vdc	15 msec	234 msec
MM	29 Vdc	< 1 msec	18 Vdc (3 times)	10 msec Every 0.5 sec	< 1 msec
NN	22 Vdc	< 1 msec	18 Vdc	15 msec	< 1 msec
OO	22 Vdc	< 1 msec	18 Vdc	15 msec	85 msec
PP	22 Vdc	< 1 msec	18 Vdc (3 times)	10 msec Every 0.5 sec	< 1 msec
Combined Transient					
QQ	29 Vdc then	< 1 msec < 1 msec	18 Vdc 50Vdc	10 msec 12.5 msec	< 1 msec 70 msec
RR	22 Vdc then	< 1 msec < 1 msec	18 Vdc 50Vdc	10 msec 12.5 msec	< 1 msec 62.5 msec



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC105-1. Normal operation - normal voltage transients.

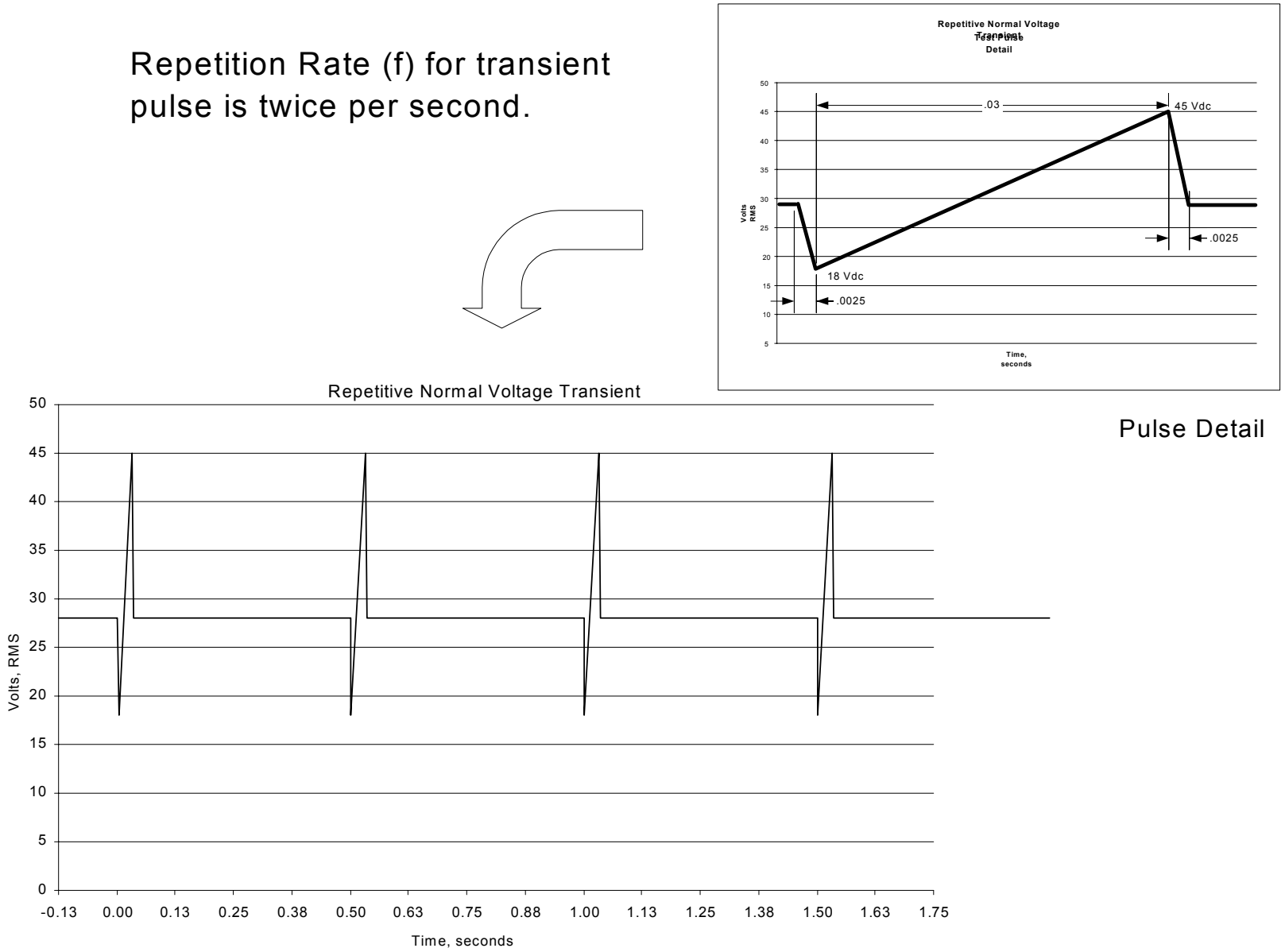


FIGURE LDC105-2. Repetitive normal voltage transient.

TABLE LDC105-IV. Sample data sheet for LDC105 normal voltage transients for MIL-STD-704A.

Test Condition	Parameters								Performance
	Steady State Voltage		Voltage Transient		Time at Voltage Transient Level		Oscilloscope Trace		Pass/Fail
A		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
B		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
C		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
D		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
E		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
F		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
G		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
H		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
I		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
J		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
K		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
L		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
M		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
N		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
O		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
P		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
Q		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
R		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
S		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
T		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
U		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}					
V		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}					

TABLE LDC105-IV. Sample data sheet for LDC105 normal voltage transients for MIL-STD-704A. - Continued

Test Condition	Parameters								Performance
	Steady State Voltage		Voltage Transient		Time at Voltage Transient Level		Oscilloscope Trace		Pass/Fail
Repetitive Transient		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			
	Time Duration At Test Condition								
		min							

TABLE LDC105-V. Sample data sheet for LDC105 normal voltage transients for MIL-STD-704B, C, D, E, & F.

Test Condition	Parameters								Performance
	Steady State Voltage		Voltage Transient		Time at Voltage Transient Level		Oscilloscope Trace		Pass/Fail
AA		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
BB		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
CC		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
DD		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
EE		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
FF		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
GG		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
HH		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
II		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
JJ		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
KK		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
LL		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
MM		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
NN		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
OO		V_{DC}		V_{DC}		msec			
PP		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
QQ		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			
RR		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			

TABLE LDC105-V. Sample data sheet for LDC105 normal voltage transients for MIL-STD-704B, C, D, E, & F. - Continued

Test Condition	Parameters								Performance
	Steady State Voltage		Voltage Transient		Time at Voltage Transient Level		Oscilloscope Trace		Pass/Fail
Repetitive Transient		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			
	Time Duration At Test Condition								
		min							

METHOD LDC201
Power Interrupt

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL
OPERATING CONDITION: Transfer Interrupt

PARAMETER: Power Interrupt

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when subjected to power interrupts as specified in the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for transfer aircraft electrical conditions when subjected to power interrupts as specified by the applicable editions(s) of MIL-STD-704 and as noted in table LDC201-I. The utilization equipment must maintain the specified performance during power interrupts. Unless otherwise specified in the utilization equipment performance specification document, the utilization equipment must automatically return to the performance specified for normal aircraft electrical conditions when the power returns to within normal limits. The utilization equipment must not suffer damage or cause an unsafe condition.

TABLE LDC201-I. MIL-STD-704 power transfer limits.

Limit	704A	704B	704C	704D	704E	704F
Power Interrupt	50 msec	50 msec	50 msec	50 msec	50 msec	50 msec
Voltage NLSS	24 Vdc	22 Vdc	22 Vdc	22 Vdc	22 Vdc	22 Vdc
Voltage NHSS	28.5 Vdc	29 Vdc	29 Vdc	29 Vdc	29 Vdc	29 Vdc

3. Apparatus. The test equipment should be as follows:

a. Programmable DC power supply
b. True RMS voltmeter
c. Oscilloscope
d. Resistive dummy load

4. Test setup. Configure the test setup as shown in figure LDC201-1. The dummy resistive load placed in parallel to the UUT should be sized to draw three times the steady state current of the UUT up to a maximum 25 kW dummy load. Note: This is done to ensure that the UUT test does

not lose stored energy to other aircraft loads during power interrupts. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

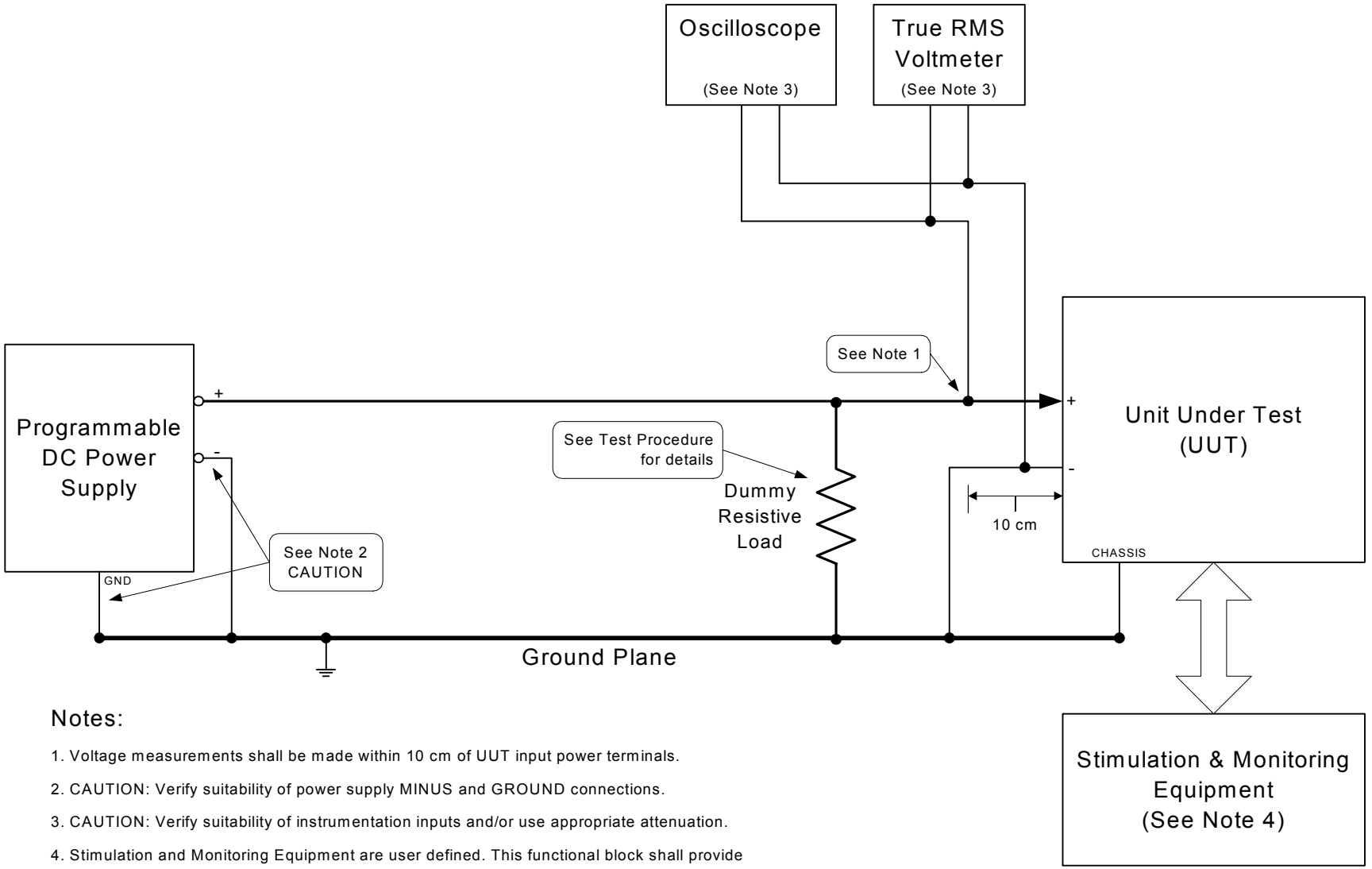
5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC201-1. Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

For each test condition A through K noted in table LDC201-II, adjust the voltage to the steady state voltage listed. Perform a power interrupt (0 V) of the duration listed. The voltage must decrease from the steady state voltage to 0 Volts within 0.25 milliseconds, remain at 0 Volts for the duration listed for the test condition, and return form 0 Volts to the steady state voltage within 0.25 milliseconds. For test condition J, three 50 millisecond power interrupts are performed, separated by 0.5 seconds. For test condition K a normal overvoltage transient follows the power interrupt. The normal voltage transient is 50 Vdc for 12.5 milliseconds and returns to nominal voltage over the next 70 milliseconds. For test condition L a normal undervoltage transient follows the power interrupt. The normal voltage transient is 18 Vdc for 15 milliseconds and returns to nominal voltage over the next 85 milliseconds. For each test condition, monitor the performance of the UUT according to the utilization equipment performance test procedures for power transfer operation to verify that the UUT is providing specified performance for transfer aircraft electrical conditions. After the power returns to normal limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions. Record the steady state voltage, time duration of power interrupt, and the performance of the UUT for each test condition in the data sheet shown in table LDC201-III. Repeat each test condition 5 times. Repeat for each mode of operation of the UUT.

After all test conditions are complete, adjust the voltage to the nominal steady state voltage of 28 VDC. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has not suffered damage and is providing specified performance for normal aircraft electrical conditions.

TABLE LDC201-II. Test conditions for transfer interrupt.

Test Condition	Steady State Voltage	Duration of Interrupt
A	Nominal Voltage	50 msec
B	NLSS Voltage	50 msec
C	NHSS Voltage	50 msec
D	Nominal Voltage	30 msec
E	NLSS Voltage	30 msec
F	NHSS Voltage	30 msec
G	Nominal Voltage	10 msec
H	NLSS Voltage	10 msec
I	NHSS Voltage	10 msec
J	Nominal Voltage	50 msec (repeated 3 times, separated by 0.5 sec)
K	Nominal Voltage	50 msec (followed by a normal voltage transient of 50 Vdc for 12.5 msec and return to steady state voltage in 70 msec)
L	Nominal Voltage	50 msec (followed by a normal voltage transient of 18 Vdc for 15 msec and return to steady state voltage in 85 msec)



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC201-1. Transfer interrupt - power interrupt.

TABLE LDC201-III. Sample data sheet for LDC201 power interrupt.

Test Condition	Parameters				Performance
	Steady State Voltage		Time Duration of Power Interrupt		Pass/Fail
A		V_{DC}		msec	
B		V_{DC}		msec	
C		V_{DC}		msec	
D		V_{DC}		msec	
E		V_{DC}		msec	
F		V_{DC}		msec	
G		V_{DC}		msec	
H		V_{DC}		msec	
I		V_{DC}		msec	
J		V_{DC}		msec	
K		V_{DC}		msec	
	Overvoltage Transient				
	Voltage Transient		Voltage Transient		
		V_{DC}		msec	
L		V_{DC}		msec	
	Overvoltage Transient				
	Voltage Transient		Voltage Transient		
		V_{DC}		msec	

METHOD LDC301
Steady State Limits for Voltage

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL OPERATING CONDITION: Abnormal

PARAMETER: Steady State Limits for Voltage

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when provided power with voltage at that the Abnormal Low Steady State (ALSS) limits and the Abnormal High Steady State (AHSS) limits as specified in the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for abnormal aircraft electrical conditions when supplied input power of voltage at the specified abnormal steady state limits of the applicable editions(s) of MIL-STD-704 and as noted in table LDC301-I. The utilization equipment must maintain specified performance for a length of time that confirms the utilization equipment can continuously operate at the steady state voltage and should be not less than thirty (30) minutes for each of the test conditions. Unless otherwise specified in the utilization equipment performance specification document, the utilization equipment must demonstrate re-start at the abnormal steady state voltage limits. Unless otherwise specified in the utilization equipment performance specification document, the utilization must automatically return to the performance specified for normal aircraft electrical conditions when the power returns to within normal limits. The utilization equipment must not suffer damage or cause an unsafe condition.

TABLE LDC301-I. MIL-STD-704 abnormal limits for steady state voltage.

Abnormal Limit	704A	704B	704C	704D	704E	704F
Voltage NLSS	22.5 Vdc	20.0 Vdc	20.0 Vdc	20.0 Vdc	20.0 Vdc	20.0 Vdc
Voltage NHSS	30.0 Vdc	31.5 Vdc	31.5 Vdc	31.5 Vdc	31.5 Vdc	31.5 Vdc

3. Apparatus. The test equipment should be as follows:

a. Adjustable DC power supply
b. True RMS voltmeter

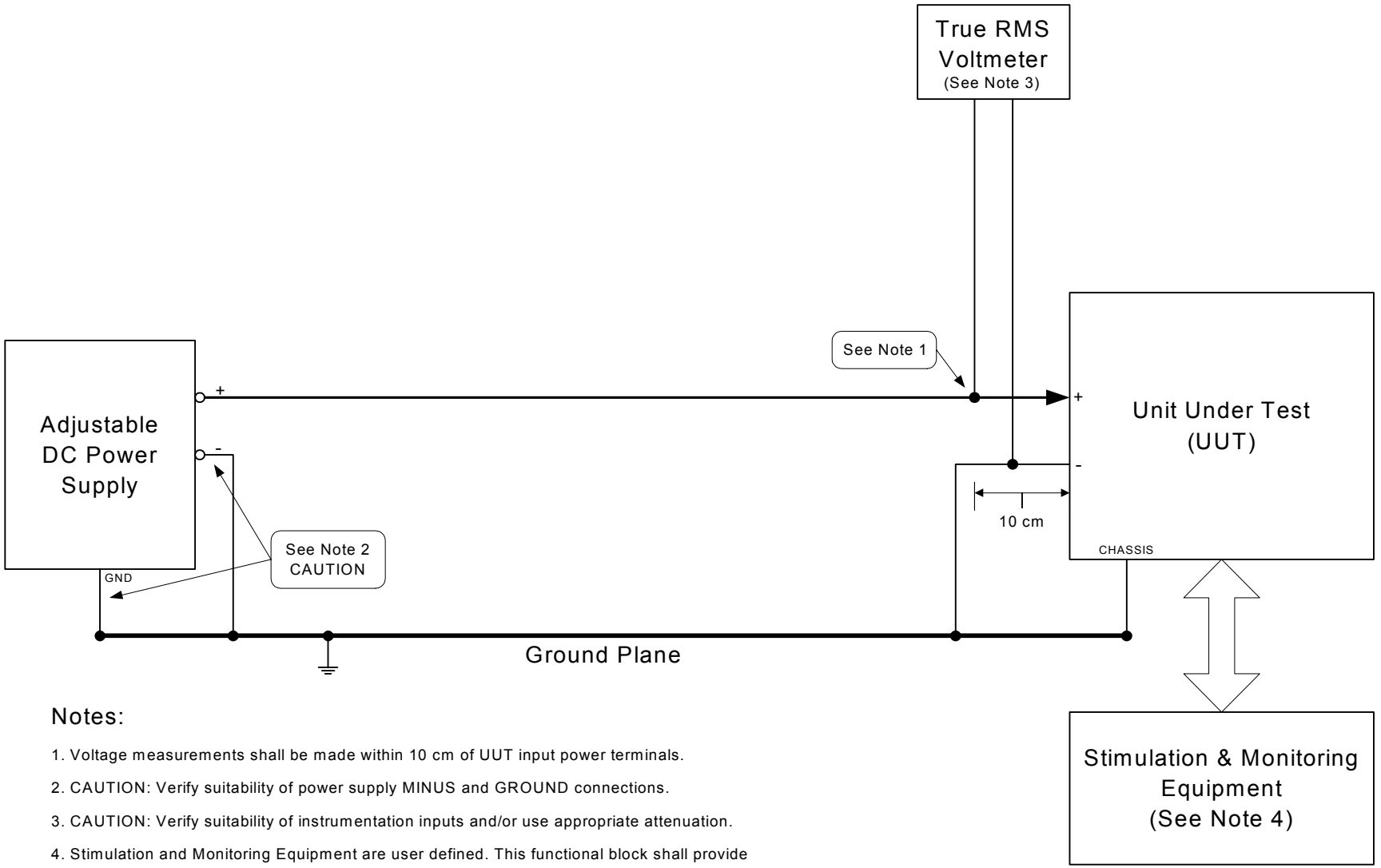
4. Test setup. Configure the test setup as shown in figure LDC301-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC301-1. Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

For each test condition A and B noted in table LDC301-II, the UUT must remain for a length of time that confirms the utilization equipment can perform as specified at the abnormal steady state voltage limits and should be not less than thirty (30) minutes. At each test condition conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for abnormal aircraft electrical conditions. For each test condition shutdown the UUT and verify that the UUT can be re-started. After re-start conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for abnormal aircraft electrical conditions. Adjust the voltage to the nominal steady state voltage of 28 VDC. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has automatically returned to the performance specified for normal aircraft electrical conditions, and has not suffered damage. Record the voltage, time duration at test condition, successful/unsuccessful re-start and the performance of the UUT for each test condition in the data sheet shown in table LDC301-III. Repeat for each mode of operation of the UUT.

TABLE LDC301-II. Test conditions for abnormal steady state limits of DC voltage.

Test Condition	Voltage
A	ALSS Voltage
B	AHSS Voltage



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC301-1. Abnormal operation - steady state limits for voltage.

TABLE LDC301-III. Sample data sheet for LDC301 abnormal steady state limits for voltage.

Test Condition	Parameters					Performance
	Voltage		Time Duration at Test Condition		Re-Start (Yes/No)	Pass/Fail
A		V_{DC}		min		
B		V_{DC}		min		

METHOD LDC302
Abnormal Voltage Transients

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL OPERATING CONDITION: Abnormal

PARAMETER: Abnormal Voltage Transients

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when subjected to abnormal voltage transients as specified in the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for abnormal aircraft electrical conditions when subjected to voltage transients within the abnormal limits of the applicable editions(s) of MIL-STD-704 and as noted in table LDC302-I. Unless otherwise specified in the utilization equipment performance specification document, the utilization equipment must automatically return to the performance specified for normal aircraft electrical conditions when the power returns to within normal limits. The utilization equipment must not suffer damage or cause an unsafe condition.

TABLE LDC302-I. MIL-STD-704 limits for abnormal voltage transients.

Limit	704A	704B	704C	704D	704E	704F
Abnormal Voltage Transients	Figure 9 MIL-STD-704A Locus of Equivalent Step Function Curves 1 and 4	Figure 8 MIL-STD-704B	Figure 12 MIL-STD-704C	Figure 12 MIL-STD-704D	Figure 11 MIL-STD-704E	Figure 14 MIL-STD-704F

3. Apparatus. The test equipment should be as follows:

a. Programmable DC power supply
b. True RMS voltmeter
c. Oscilloscope

4. Test setup. Configure the test setup as shown in figure LDC302-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC302-1. Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

5.1 Compliance test for MIL-STD-704A. The UUT must be subjected to the voltage transients for each test condition A through V noted in table LDC302-II. The voltage must increase or decrease from steady state voltage as noted in table LDC302-II to the voltage transient level within 1 milliseconds. The voltage must remain at the voltage transient level for the duration noted in table LDC302-II. The voltage must return to steady state over the time duration noted in table LDC302-II. For test condition E and J, three over-voltage transients of 80 Vdc for 12 milliseconds are performed, separated by 0.5 second. For test condition O and T, three under-voltage transients of 6 Vdc for 12 milliseconds are performed, separated by 0.5 second. For test condition U and V, an under-voltage transient of 6 Vdc for 10 milliseconds is immediately followed by an overvoltage transient of 80 Vdc for 50 milliseconds and the voltage returns to steady state over the time duration noted. For each test condition, monitor the performance of the UUT during the voltage transient according to the equipment performance test procedures to verify that the UUT is providing specified performance for abnormal aircraft electrical conditions. Repeat each test condition 5 times. After the power returns to normal limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT automatically returns to specified performance for normal aircraft electrical conditions when the power returns to within normal limits. Record the steady state voltage, voltage transient (oscilloscope trace), and the performance of the UUT for each test condition in the data sheet shown in table LDC302-V. Repeat for each mode of operation of the UUT.

5.2 Compliance test for MIL-STD-704B, C, & D. The UUT must be subjected to the voltage transients for each test condition AA through NN noted in table LDC302-III. The voltage must increase or decrease from steady state voltage as noted in table LDC302-III to the voltage transient level within 1 milliseconds. The voltage must remain at the voltage transient level for the duration noted in table LDC302-III. The voltage must return to steady state over the time duration noted in table LDC302-III. For test condition CC and FF, three over-voltage transients of 50 Vdc for 45 milliseconds are performed, separated by 0.5 second. For test condition LDC302-II and LL, three under-voltage transients of 7 Vdc for 45 milliseconds are performed, separated by 0.5 second. For test condition MM and NN, an under-voltage transient of 7 Vdc for 10 milliseconds is immediately followed by an over-voltage transient of 50 Vdc for 45 milliseconds and the voltage returns to steady state over the time duration noted. For each test condition, monitor the performance of the UUT during the voltage transient according to the equipment performance test procedures to verify that the UUT is providing specified performance for abnormal aircraft electrical conditions. Repeat each test condition 5 times. After the power returns to normal limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT automatically returns to specified performance for normal aircraft electrical conditions when the power returns to within normal limits. Record the steady state voltage, voltage transient (oscilloscope trace), and

the performance of the UUT for each test condition in the data sheet shown in table VI. Repeat for each mode of operation of the UUT.

5.3 Compliance test for MIL-STD-704E & F. The UUT must be subjected to the voltage transients for each test condition AAA through NNN noted in table LDC302-IV. The voltage must increase or decrease from steady state voltage as noted in table LDC302-IV to the voltage transient level within 1 millisecond. The voltage must remain at the voltage transient level for the duration noted in table LDC302-IV. The voltage must return to steady state over the time duration noted in table LDC302-IV. For test condition CCC and FFF, three over-voltage transients of 50 Vdc for 50 milliseconds are performed, separated by 0.5 second. For test condition LDC302-III and LLL, three under-voltage transients of 7 Vdc for 50 milliseconds are performed, separated by 0.5 second. For test condition MMM and NNN, an under-voltage transient of 7 Vdc for 10 milliseconds is immediately followed by an over-voltage transient of 50 Vdc for 50 milliseconds and the voltage returns to steady state over the time duration noted. For each test condition, monitor the performance of the UUT during the voltage transient according to the equipment performance test procedures to verify that the UUT is providing specified performance for abnormal aircraft electrical conditions. Repeat each test condition 5 times. After the power returns to normal limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT automatically returns to specified performance for normal aircraft electrical conditions when the power returns to within normal limits. Record the steady state voltage, voltage transient (oscilloscope trace), and the performance of the UUT for each test condition in the data sheet shown in table VII. Repeat for each mode of operation of the UUT.

After all test conditions are complete, adjust the voltage to the nominal steady state voltage of 28 VDC. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has not suffered damage and is providing specified performance for normal aircraft electrical conditions.

TABLE LDC302-II. Test conditions for MIL-STD-704A abnormal voltage transients.

Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Duration at Voltage Transient Level	Time From Voltage Transient Level to Steady State Voltage milliseconds
Overvoltage Transients					
A	28.5 Vdc	< 1 msec	80 Vdc	50 msec	< 1 msec
B	28.5 Vdc	< 1 msec	80 Vdc	37.5 msec	24 msec
C	28.5 Vdc	< 1 msec	60 Vdc	550 msec	< 1 msec
D	28.5 Vdc	< 1 msec	60 Vdc	410 msec	280 msec
E	28.5 Vdc	< 1 msec	80 Vdc (3 times)	12 msec Every 0.5 sec	< 1 msec
F	24 Vdc	< 1 msec	80 Vdc	50 msec	< 1 msec
G	24 Vdc	< 1 msec	80 Vdc	37.5 msec	26 msec
H	24 Vdc	< 1 msec	60 Vdc	550 msec	< 1 msec
I	24 Vdc	< 1 msec	60 Vdc	410 msec	320 msec
J	24 Vdc	< 1 msec	80 Vdc (3 times)	12 msec Every 0.5 sec	< 1 msec
Undervoltage Transients					
K	28.5 Vdc	< 1 msec	6 Vdc	50 msec	< 1 msec
L	28.5 Vdc	< 1 msec	6 Vdc	37.5 msec	26 msec
M	28.5 Vdc	< 1 msec	12 Vdc	550 msec	< 1 msec
N	28.5 Vdc	< 1 msec	12 Vdc	410 msec	320 msec
O	28.5 Vdc	< 1 msec	6 Vdc (3 times)	12 msec Every 0.5 sec	< 1 msec
P	24 Vdc	< 1 msec	6 Vdc	50 msec	< 1 msec
Q	24 Vdc	< 1 msec	6 Vdc	37.5 msec	24 msec
R	24 Vdc	< 1 msec	12 Vdc	550 msec	< 1 msec
S	24 Vdc	< 1 msec	12 Vdc	410 msec	280 msec
T	24 Vdc	< 1 msec	6 Vdc (3 times)	12 msec Every 0.5 sec	< 1 msec
Combined Transient					
U	28.5 Vdc then	< 1 msec < 1 msec	6 Vdc 80 Vdc	10 msec 50 msec	< 1 msec 24 msec
V	24 Vdc then	< 1 msec < 1 msec	6 Vdc 80 Vdc	10 msec 50 msec	< 1 msec 24 msec

TABLE LDC302-III. Test conditions for MIL-STD-704B, C, and D abnormal voltage transients.

Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Duration at Voltage Transient Level	Time From Voltage Transient Level to Steady State Voltage or Next Voltage Level
Overvoltage Transients					
AA	29 Vdc	< 1 msec	50 Vdc	45 msec	< 1 msec
BB	29 Vdc	< 1 msec	50 Vdc	45 msec	15 msec
		then	45 Vdc	decreasing	30 msec
		then	40 Vdc	decreasing	60 msec
		then	35 Vdc	decreasing	4.85 sec
		then	30 Vdc	decreasing	1 sec
		then	29 Vdc		
CC	29 Vdc	< 1 msec	50 Vdc (3 times)	45 msec Every 0.5 sec	< 1 msec
DD	22 Vdc	< 1 msec	50 Vdc	45 msec	< 1 msec
EE	22 Vdc	< 1 msec	50 Vdc	45 msec	15 msec
		then	45 Vdc	decreasing	30 msec
		then	40 Vdc	decreasing	60 msec
		then	35 Vdc	decreasing	4.85 sec
		then	30 Vdc	decreasing	8 sec
		then	22 Vdc		
FF	22 Vdc	< 1 msec	50 Vdc (3 times)	45 msec Every 0.5 sec	< 1 msec
Undervoltage Transients					
GG	29 Vdc	< 1 msec	7 Vdc	45 msec	< 1 msec
HH	29 Vdc	< 1 msec	7 Vdc	45 msec	15 msec
		then	12 Vdc	increasing	30 msec
		then	17 Vdc	increasing	60 msec
		then	22 Vdc	increasing	4.85 sec
		then	28 Vdc	increasing	1 sec
		then	29 Vdc		
II	29 Vdc	< 1 msec	7 Vdc (3 times)	45 msec Every 0.5 sec	< 1 msec
JJ	22 Vdc	< 1 msec	7 Vdc	45 msec	< 1 msec
KK	22 Vdc	< 1 msec	7 Vdc	45 msec	15 msec
		then	12 Vdc	increasing	30 msec
		then	17 Vdc	increasing	60 msec
		then	22 Vdc		
LL	22 Vdc	< 1 msec	7 Vdc (3 times)	45 msec Every 0.5 sec	< 1 msec

TABLE LDC302-III. Test conditions for MIL-STD-704B, C, and D abnormal voltage transients. - Continued

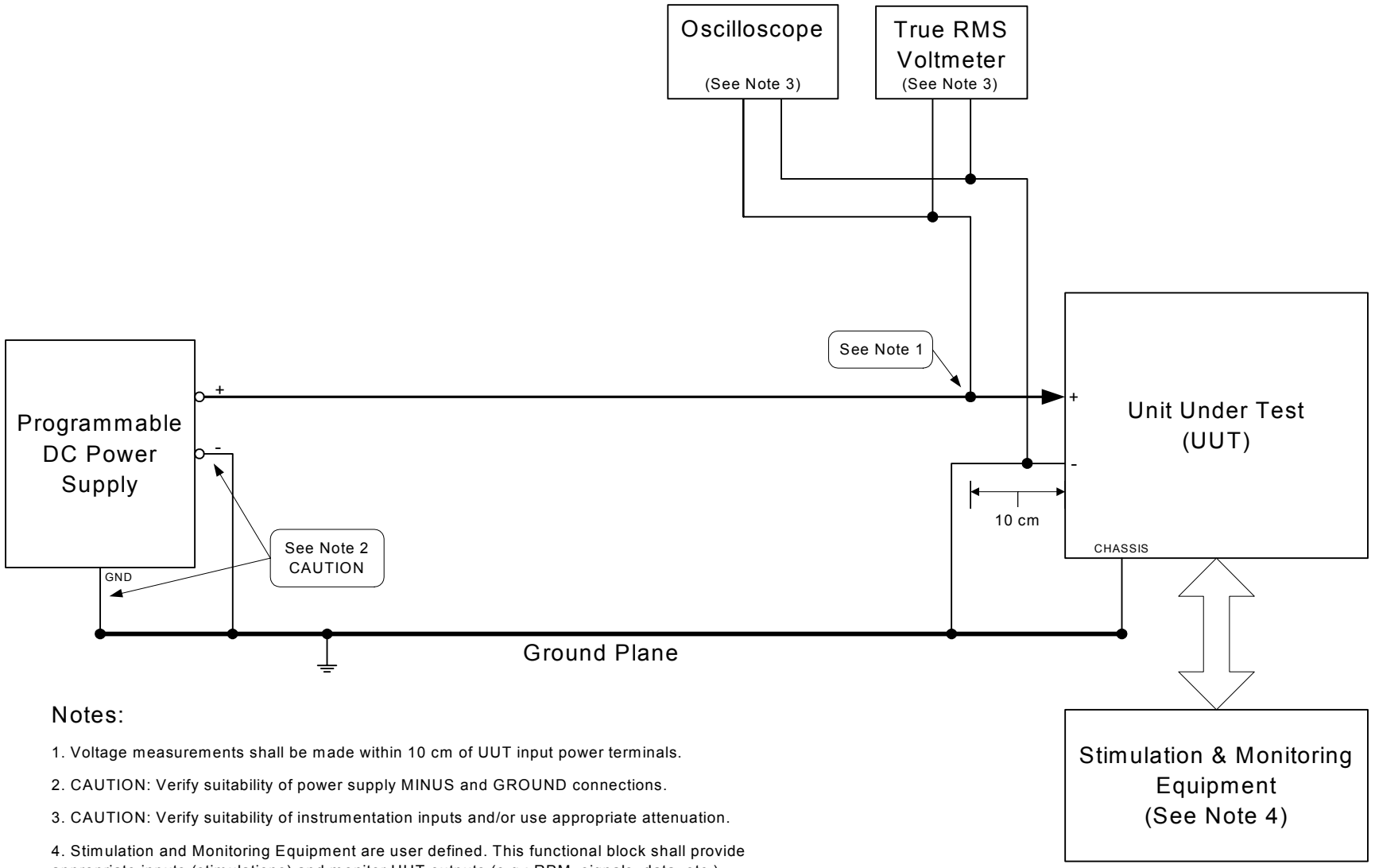
Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Duration at Voltage Transient Level	Time From Voltage Transient Level to Steady State Voltage or Next Voltage Level
Combined Transient					
MM	29 Vdc	< 1 msec < 1 msec	7 Vdc then 50Vdc	10 msec 45 msec	< 1 msec 15 msec
		then	45 Vdc	decreasing	30 msec
		then	40 Vdc	decreasing	60 msec
		then	35 Vdc	decreasing	4.85 sec
		then	30 Vdc	decreasing	1 sec
		then	29 Vdc		
NN	22 Vdc	< 1 msec < 1 msec	7 Vdc then 50Vdc	10 msec 45 msec	< 1 msec 15 msec
		then	45 Vdc	decreasing	30 msec
		then	40 Vdc	decreasing	60 msec
		then	35 Vdc	decreasing	4.85 sec
		then	30 Vdc	decreasing	8 sec
		then	22 Vdc		

TABLE LDC302-IV. Test condition for MIL-STD-704E and F abnormal voltage transients.

Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Duration at Voltage Transient Level	Time From Voltage Transient Level to Steady State Voltage or Next Voltage Level
Overvoltage Transients					
AAA	29 Vdc	< 1 msec	50 Vdc	50 msec	< 1 msec
BBB	29 Vdc	< 1 msec	50 Vdc	50 msec	15 msec
		then	45 Vdc	decreasing	30 msec
		then	40 Vdc	decreasing	60 msec
		then	35 Vdc	decreasing	4.85 sec
		then	30 Vdc	decreasing	1 sec
		then	29 Vdc		
CCC	29 Vdc	< 1 msec	50 Vdc (3 times)	50 msec Every 0.5 sec	< 1 msec
DDD	22 Vdc	< 1 msec	50 Vdc	50 msec	< 1 msec
EEE	22 Vdc	< 1 msec	50 Vdc	50 msec	15 msec
		then	45 Vdc	decreasing	30 msec
		then	40 Vdc	decreasing	60 msec
		then	35 Vdc	decreasing	4.85 sec
		then	30 Vdc	decreasing	8 sec
		then	22 Vdc		
FFF	22 Vdc	< 1 msec	50 Vdc (3 times)	50 msec Every 0.5 sec	< 1 msec
Undervoltage Transients					
GGG	29 Vdc	< 1 msec	7 Vdc	50 msec	< 1 msec
HHH	29 Vdc	< 1 msec	7 Vdc	50 msec	15 msec
		then	12 Vdc	increasing	30 msec
		then	17 Vdc	increasing	60 msec
		then	22 Vdc	increasing	4.85 sec
		then	28 Vdc	increasing	1 sec
		then	29 Vdc		
III	29 Vdc	< 1 msec	7 Vdc (3 times)	50 msec Every 0.5 sec	< 1 msec
JJJ	22 Vdc	< 1 msec	7 Vdc	50 msec	< 1 msec
KKK	22 Vdc	< 1 msec	7 Vdc	50 msec	15 msec
		then	12 Vdc	increasing	30 msec
		then	17 Vdc	increasing	60 msec
		then	22 Vdc		
LLL	22 Vdc	< 1 msec	7 Vdc (3 times)	50 msec Every 0.5 sec	< 1 msec

TABLE LDC302-IV. Test conditions for ML-STD-704E & F abnormal voltage transients. - Continued

Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Duration at Voltage Transient Level	Time From Voltage Transient Level to Steady State Voltage or Next Voltage Level
Combined Transient					
MMM	29 Vdc	< 1 msec < 1 msec	7 Vdc then 50Vdc	10 msec 50 msec	< 1 msec 15 msec
		then	45 Vdc	decreasing	30 msec
		then	40 Vdc	decreasing	60 msec
		then	35 Vdc	decreasing	4.85 sec
		then	30 Vdc	decreasing	1 sec
		then	29 Vdc		
NNN	22 Vdc	< 1 msec < 1 msec	7 Vdc then 50Vdc	10 msec 50 msec	< 1 msec 15 msec
		then	45 Vdc	decreasing	30 msec
		then	40 Vdc	decreasing	60 msec
		then	35 Vdc	decreasing	4.85 sec
		then	30 Vdc	decreasing	8 sec
		then	22 Vdc		



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC302-1. Abnormal operation - abnormal voltage transients.

TABLE LDC302-V. Sample data sheet for LDC302 abnormal transients for MIL-STD-704A.

Test Condition	Parameters								Performance
	Steady State Voltage		Voltage Transient		Time at Voltage Transient Level		Oscilloscope Trace		Pass/Fail
A		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
B		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
C		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
D		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
E		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
F		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
G		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
H		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
I		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
J		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
K		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
L		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
M		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
N		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
O		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
P		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
Q		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
R		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
S		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
T		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
U		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			
V		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			

TABLE LDC302-VI. Sample data sheet for LDC302 abnormal voltage transients for MIL-STD-704B, C, & D.

Test Condition	Parameters								Performance
	Steady State Voltage		Voltage Transient		Time at Voltage Transient Level		Oscilloscope Trace		Pass/Fail
AA		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
BB		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
CC		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
DD		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
EE		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
FF		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
GG		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
HH		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
II		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
JJ		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
KK		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
LL		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
MM		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			
NN		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			

TABLE LDC302-VII. Sample data sheet for LDC302 abnormal voltage transients for MIL-STD-704E, & F.

Test Condition	Parameters								Performance
	Steady State Voltage		Voltage Transient		Time at Voltage Transient Level		Oscilloscope Trace		Pass/Fail
AAA		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
BBB		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
CCC		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
DDD		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
EEE		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
FFF		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
GGG		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
HHH		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
III		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
JJJ		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
KKK		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
LLL		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
MMM		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			
NNN		V_{DC}		V_{DC}		msec	Attach Trace	V_{DC} vs Time	
				V_{DC}		msec			

METHOD LDC401
Steady State Limits for Voltage

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL OPERATING CONDITION: Emergency

PARAMETER: Steady State Limits for Voltage

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when provided power with voltage at that the Emergency Low Steady State (ELSS) limits and the Emergency High Steady State (EHSS) limits as specified in the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for emergency aircraft electrical conditions when supplied input power of voltage at the specified emergency steady state limits of the applicable editions(s) of MIL-STD-704 and as noted in table LDC401-I. The utilization equipment must maintain specified performance for a length of time that confirms the utilization equipment can continuously operate at the steady state voltage and should be not less than thirty (30) minutes for each of the test conditions. Unless otherwise specified in the utilization equipment performance specification document, the utilization equipment must demonstrate re-start at the emergency steady state voltage limits. Unless otherwise specified in the utilization equipment performance specification document, the utilization must automatically return to the performance specified for normal aircraft electrical conditions when the power returns to within normal limits. The utilization equipment must not suffer damage or cause an unsafe condition.

TABLE LDC401-I. MIL-STD-704 emergency limits for steady state voltage.

Emergency Limit	704A	704B	704C	704D	704E	704F
Voltage ELSS	16.0 Vdc	18.0 Vdc	16.0 Vdc	16.0 Vdc	18.0 Vdc	18.0 Vdc
Voltage EHSS	24.0 Vdc	29.0 Vdc	30.0 Vdc	29.0 Vdc	29.0 Vdc	29.0 Vdc

3. Apparatus. The test equipment should be as follows:

a. Adjustable DC power supply
b. True RMS voltmeter

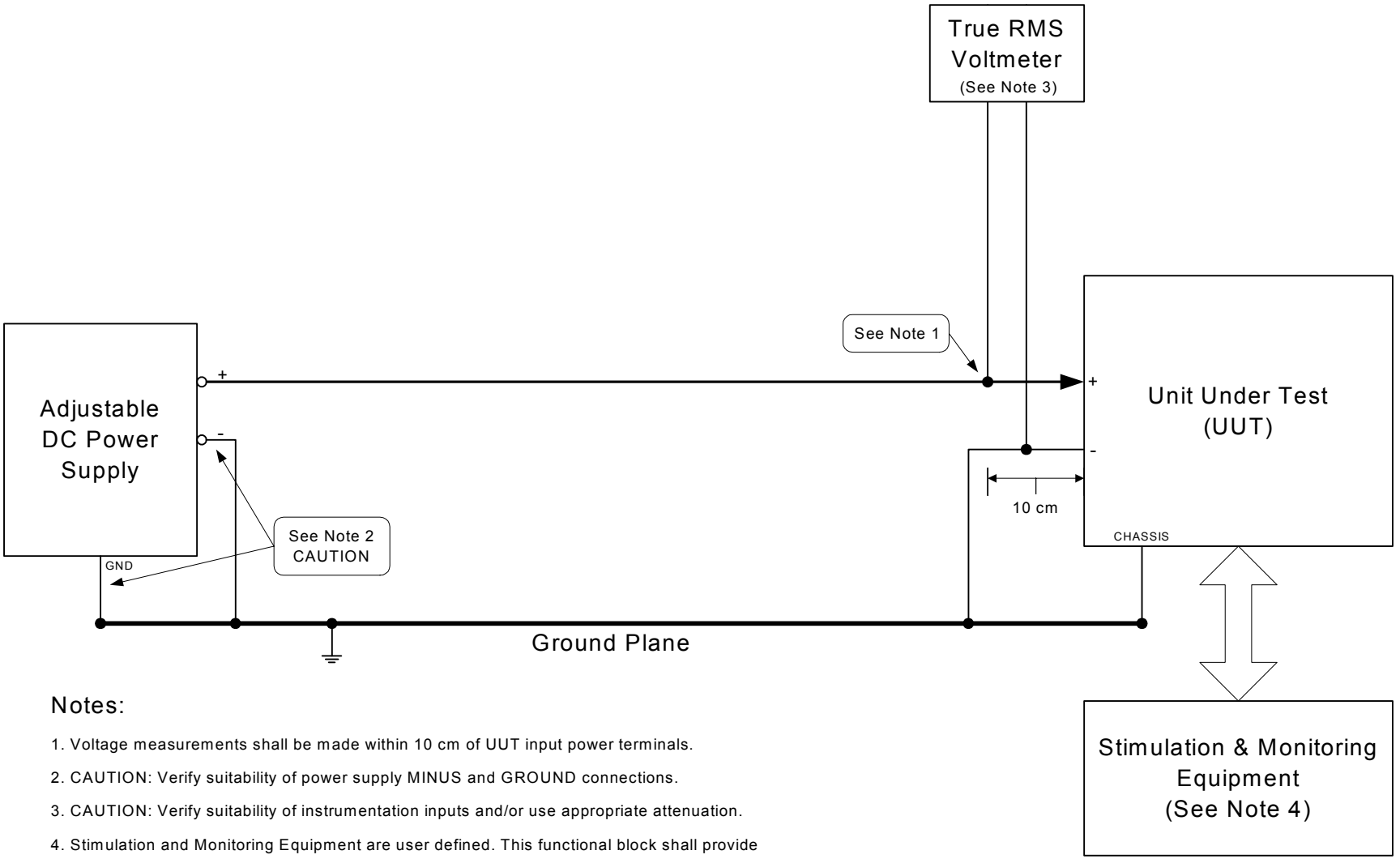
4. Test setup. Configure the test setup as shown in figure LDC401-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC401-1. Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

For each test condition A and B noted in table LDC401-II, the UUT must remain for a length of time that confirms the utilization equipment can perform as specified at the emergency steady state voltage limits and should be not less than thirty (30) minutes. At each test condition conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for emergency aircraft electrical conditions. For each test condition shutdown the UUT and verify that the UUT can be re-started. After re-start conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for emergency aircraft electrical conditions. Adjust the voltage to the nominal steady state voltage of 28 VDC. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has automatically returned to the performance specified for normal aircraft electrical conditions, and has not suffered damage. Record the voltage, time duration at test condition, and the performance of the UUT for each test condition in the data sheet shown in table LDC401-III. Repeat for each mode of operation of the UUT.

TABLE LDC401-II. Test conditions for emergency steady state limits for DC voltage.

Test Condition	Voltage
A	ELSS Voltage
B	EHSS Voltage



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC401-1. Emergency operation - steady state limits for voltage.

TABLE LDC401-III. Sample data sheet for LDC401 emergency steady state limits for voltage and frequency.

Test Condition	Parameters				Performance
	Voltage		Time Duration at Test Condition		Pass/Fail
A		V_{DC}		min	
B		V_{DC}		min	

METHOD LDC501
Starting Voltage Transients

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL OPERATING CONDITION: Starting

PARAMETER: Starting Voltage Transients

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when subjected to starting voltage transients as specified in the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for starting aircraft electrical conditions when subjected to starting voltage transients for the applicable editions(s) of MIL-STD-704 and as noted in table LDC501-I. Unless otherwise specified in the utilization equipment performance specification document, the utilization equipment must automatically return to the performance specified for normal aircraft electrical conditions when the power returns to within normal limits. The utilization equipment must not suffer damage or cause an unsafe condition.

TABLE LDC501-I. MIL-STD-704 limits for starting voltage transients.

Limit	704A	704B	704C	704D	704E	704F
Starting Voltage Transients	16.0 Vdc to 28.5 Vdc	Use Limits of 704 C	16.0 Vdc to 30.0 Vdc	12.0 Vdc to 29.0 Vdc	12.0 Vdc to 29.0 Vdc	12.0 Vdc to 29.0 Vdc

3. Apparatus. The test equipment should be as follows:

a. Programmable DC power supply
b. True RMS voltmeter
c. Oscilloscope

4. Test setup. Configure the test setup as shown in figure 1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC501-1. Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

5.1 Compliance test for MIL-STD-704A, B and C. The UUT must be subjected to the starting voltage transients described in table LDC501-II (test condition A). The voltage must decrease from steady state voltage to the 16 Vdc within 1 millisecond. The voltage must return to steady state at a constant rate over 30 seconds. Monitor the performance of the UUT during the starting voltage transient according to the equipment performance test procedures to verify that the UUT is providing specified performance for starting aircraft electrical conditions. Repeat the test condition 5 times. After the power returns to normal limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT automatically returns to specified performance for normal aircraft electrical conditions when the power returns to within normal limits. Record the steady state voltage, voltage transient (oscilloscope trace), and the performance of the UUT in the data sheet shown in table LDC501-IV. Repeat for each mode of operation of the UUT.

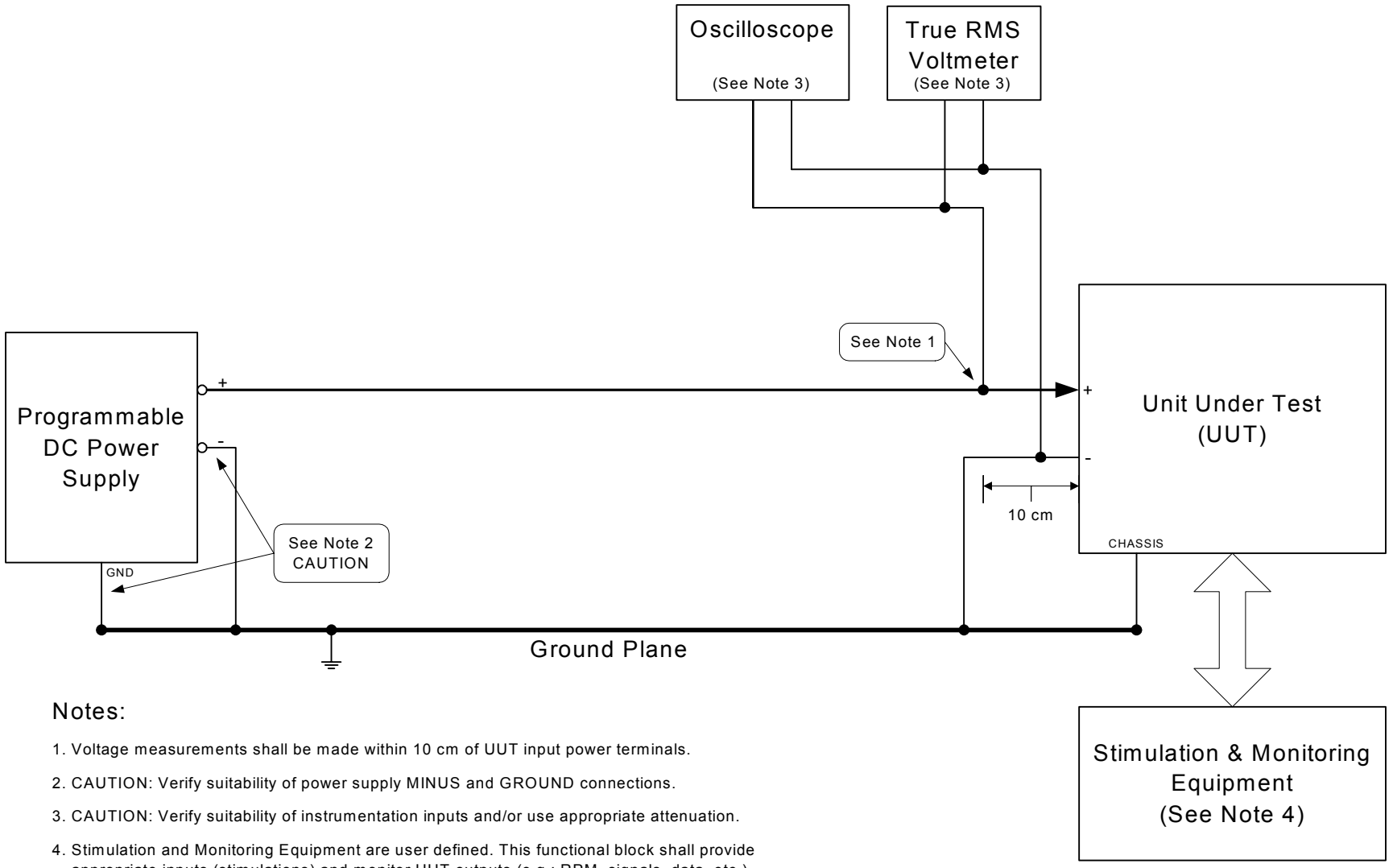
5.2 Compliance test for MIL-STD-704D, E, & F. The UUT must be subjected to the starting voltage transients described in table LDC501-III (test condition AA). The voltage must decrease from steady state voltage to the 12 Vdc within 1 millisecond. The voltage must return to steady state at a constant rate over 30 seconds. Monitor the performance of the UUT during the starting voltage transient according to the equipment performance test procedures to verify that the UUT is providing specified performance for starting aircraft electrical conditions. Repeat the test condition 5 times. After the power returns to normal limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT automatically returns to specified performance for normal aircraft electrical conditions when the power returns to within normal limits. Record the steady state voltage, voltage transient (oscilloscope trace), and the performance of the UUT in the data sheet shown in table LDC501-IV. Repeat for each mode of operation of the UUT.

TABLE LDC501-II. Test conditions for MIL-STD-704A, B and C starting voltage transients.

Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Time From Voltage Transient Level to Steady State Voltage
A	28.5 Vdc	< 1 msec	16 Vdc	30 sec

TABLE LDC501-III. Test conditions for MIL-STD-704D, E and F starting voltage transients.

Test Condition	Steady State Voltage Vdc	Time From Steady State Voltage to Voltage Transient Level milliseconds	Voltage Transient Level Vdc	Time From Voltage Transient Level to Steady State Voltage
AA	29 Vdc	< 1 msec	12 Vdc	30 sec



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC501-1. Starting operation - starting voltage transients.

TABLE LDC501-IV. Sample data sheet for LDC501 starting voltage transients for MIL-STD-704A, B, C, D, E & F.

Test Condition	Parameters								Performance
	Steady State Voltage		Voltage Transient		Time to Return to Steady State Voltage		Oscilloscope Trace		Pass/Fail
		V_{DC}		V_{DC}		sec	Attach Trace	V_{DC} vs Time	

METHOD LDC601
Power Failure

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL
OPERATING CONDITION: Power Failure

PARAMETER: Power Failure

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment operates and maintains specified performance when subjected to Power Failures as specified in the applicable editions(s) of MIL-STD-704.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment operates and maintains performance as specified in the utilization equipment performance specification document for power failure aircraft electrical conditions when subjected to power failures as specified by the applicable editions(s) of MIL-STD-704 and as noted in table LDC601-I. The utilization equipment must maintain the specified performance during power failures. Unless otherwise specified in the utilization equipment performance specification document, the utilization equipment must automatically return to the performance specified for normal aircraft electrical conditions when the power returns to within normal limits. The utilization equipment must not suffer damage or cause an unsafe condition.

TABLE LDC601-I. MIL-STD-704 power failure limits.

Limit	704A	704B	704C	704D	704E	704F
Power Failure	7 sec Figure 9 Curve 4 MIL-STD-704B	7 sec Figure 8 MIL-STD-704B	7 sec Figure 12 MIL-STD-704C	7 sec Figure 12 MIL-STD-704D	7 sec Figure 11 MIL-STD-704E	7 sec Figure 14 MIL-STD-704F

3. Apparatus. The test equipment should be as follows:

a. Programmable DC power supply
b. True RMS voltmeter
c. Oscilloscope

4. Test setup. Configure the test setup as shown in figure LDC601-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

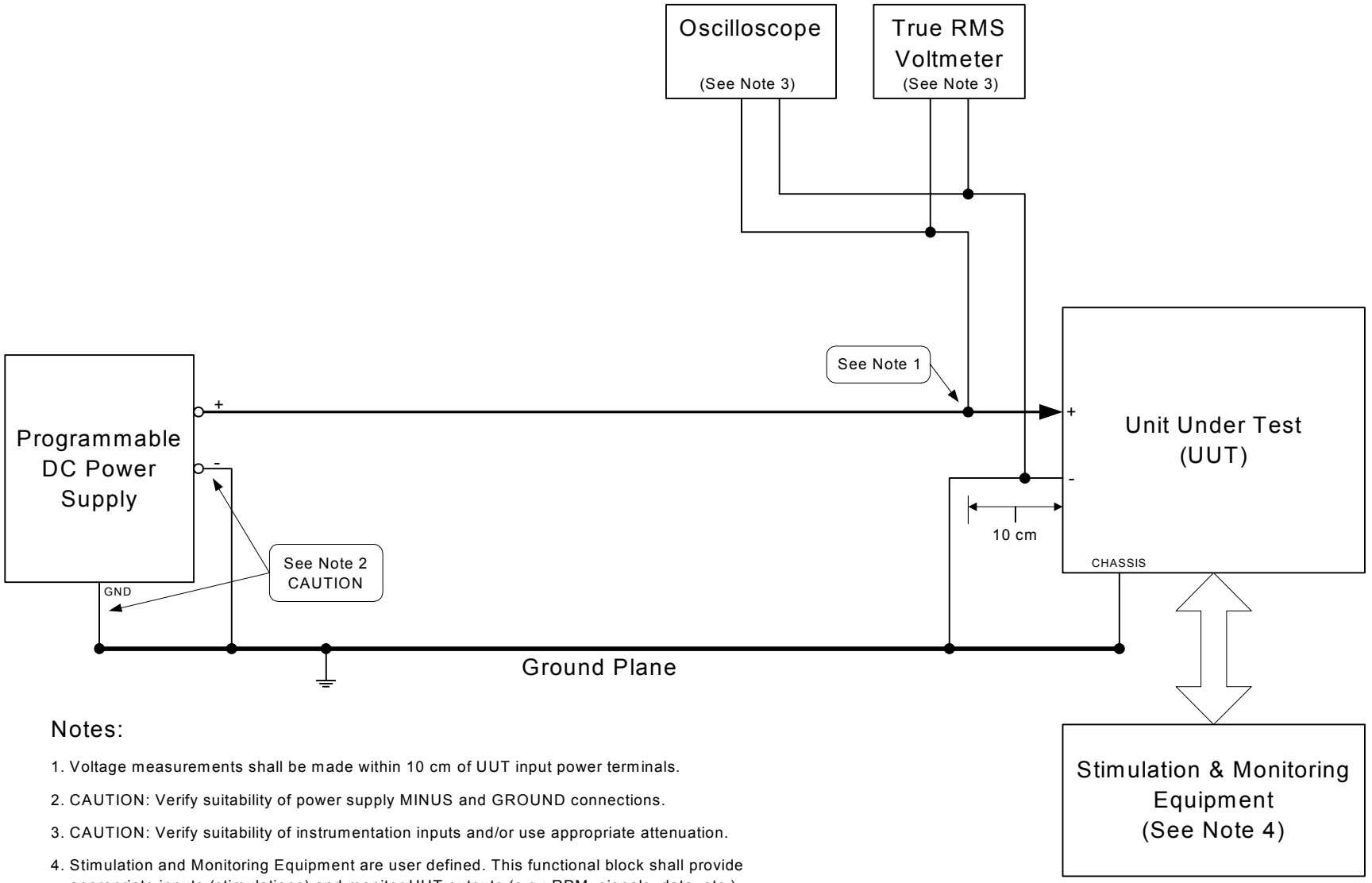
5. Compliance test. With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC601-1. Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. Allow sufficient time for the UUT to warm up. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to verify that the UUT is providing specified performance for normal aircraft electrical conditions.

For each test condition A through D noted in table LDC601-II, perform a power failure (0 V) of the duration listed. The voltage must decrease from the steady state voltage to 0 Volts within 0.25 milliseconds, remain at 0 volts for the duration listed for the test condition, and return from 0 Volts to the steady state voltage within 0.25 milliseconds. For each test condition, monitor the performance of the UUT according to the utilization equipment performance test procedures for power failure operation to verify that the UUT is providing specified performance for power failure aircraft electrical conditions. After the power returns to normal limits, conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has automatically returned to the performance specified for normal aircraft electrical conditions, and has not suffered damage. Record the steady state voltage, time duration of power failure, and the performance of the UUT for each test condition in the data sheet shown in table LDC601-III. Repeat each test condition 5 times. Repeat for each mode of operation of the UUT.

After all test conditions are complete, adjust the voltage to the nominal steady state voltage of 28 VDC. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has not suffered damage and is providing specified performance for normal aircraft electrical conditions.

TABLE LDC601-II. Test conditions for power failures.

Test Condition	Duration of Power Failure
A	100 msec
B	500 msec
C	3 seconds
D	7 seconds



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC601-1. Power failure - power failure.

TABLE LDC601-III. Sample data sheet for LDC601 power failure.

Test Condition	Parameters				Performance
	Voltage		Time Duration of Power Failure		Pass/Fail
A		V_{DC}		msec	
B		V_{DC}		msec	
C		V_{DC}		sec	
D		V_{DC}		sec	

METHOD LDC602
Phase Reversal

POWER GROUP: 28 Volt DC

AIRCRAFT ELECTRICAL
OPERATING CONDITION: Power Failure

PARAMETER: Phase Reversal

1. Scope.

1.1 Purpose. This test procedure is used to verify that 28 volt DC power utilization equipment is not damaged by phase reversal or a positive physical means is employed to prevent phase reversal.

2. Validation criteria. The utilization equipment is considered to have passed if the utilization equipment is not damaged and does not cause an unsafe condition when the positive and negative connection are reversed for the applicable editions(s) of MIL-STD-704 and as noted in table LDC602-I. A positive physical means to prevent phase reversal may be used to fulfill this requirement.

TABLE LDC602-I. MIL-STD-704 phase reversal requirement.

Limit	704A	704B	704C	704D	704E	704F
Phase Reversal	N/A	N/A	N/A	N/A	N/A	Phase Reversal Does not Cause Damage

3. Apparatus. The test equipment should be as follows:

a. Adjustable DC power supply
b. True RMS voltmeter

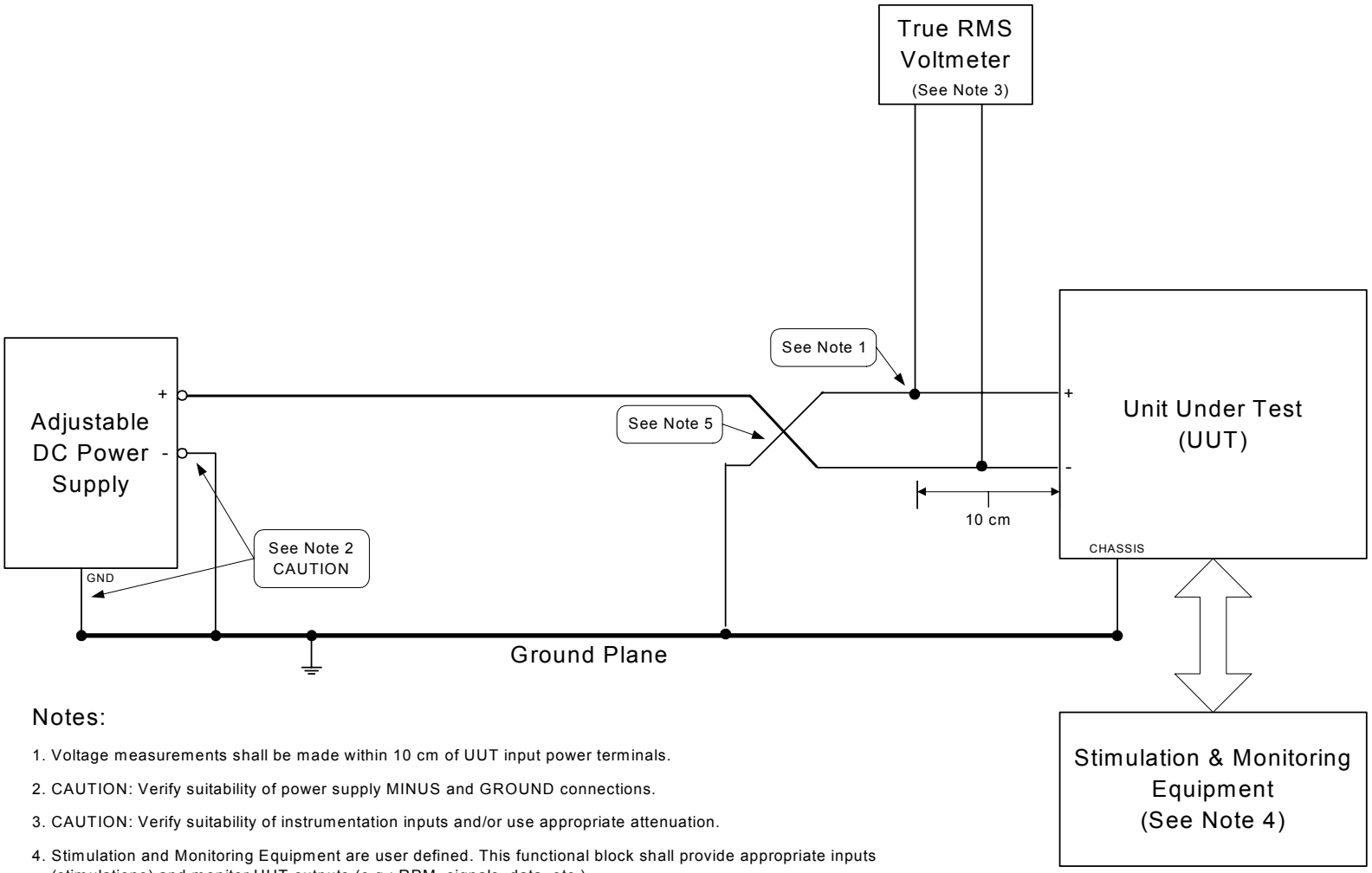
4. Test setup. Configure the test setup as shown in figure LDC602-1. Measurements, except current, must be made within 10 cm of the input power terminals of the UUT.

5. Compliance test. If a positive physical means is employed to prevent phase reversal, confirm that the positive and negative conductors cannot be reversed.

If the positive and negative conductors can be reversed, with the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC602-1 (positive and negative conductors reversed). Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. The UUT must remain for a length of time that confirms the utilization equipment is not damaged and does not cause an

unsafe condition due to phase reversal and should be not less than thirty (30) minutes. Record the steady state voltage, time duration at phase reversal test condition, and the performance of the UUT in the data sheet shown in table LDC602-II. Repeat for each mode of operation of the UUT.

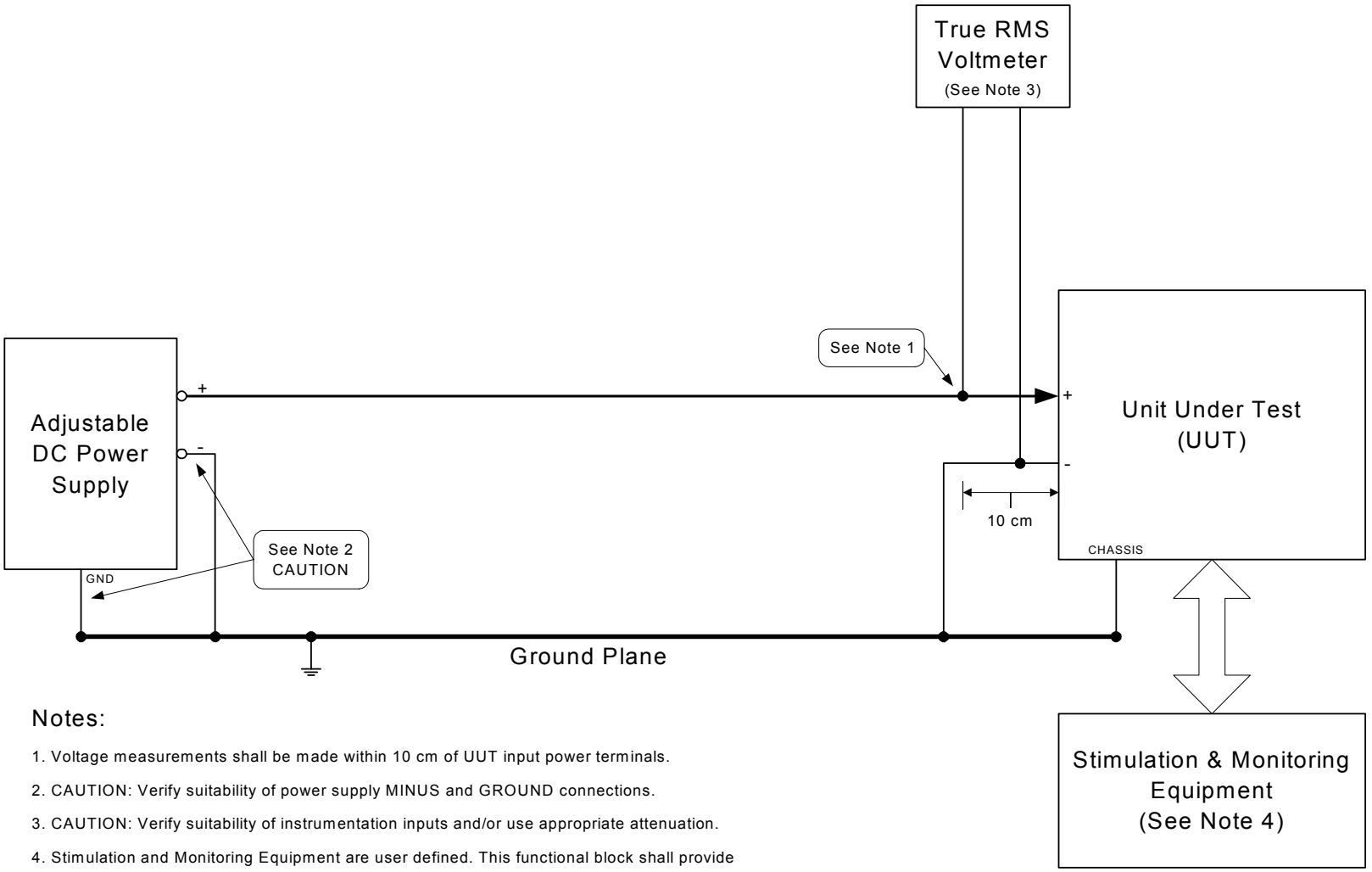
With the power source off, install the UUT and the stimulation and monitoring equipment into the test setup of figure LDC602-2 (positive and negative conductors connected properly). Turn on the power source and adjust the voltage to the nominal steady state voltage of 28 VDC. Energize the UUT. The UUT must remain for a length of time that confirms the utilization equipment was not damaged and does not cause an unsafe condition after the phase reversal and should be not less than thirty (30) minutes. Conduct a performance test of the UUT according to the utilization equipment performance test procedures to confirm that the UUT has returned to the performance specified for normal aircraft electrical conditions and has not suffered damage. Record the steady state voltage, time duration at test condition, and the performance of the UUT in the data sheet shown in table LDC602-II. Repeat for each mode of operation of the UUT.



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)
5. Phase Polarity is reversed.

FIGURE LDC602-1. Phase reversal.



Notes:

1. Voltage measurements shall be made within 10 cm of UUT input power terminals.
2. CAUTION: Verify suitability of power supply MINUS and GROUND connections.
3. CAUTION: Verify suitability of instrumentation inputs and/or use appropriate attenuation.
4. Stimulation and Monitoring Equipment are user defined. This functional block shall provide appropriate inputs (stimulations) and monitor UUT outputs (e.g.: RPM, signals, data, etc.)

FIGURE LDC602-2. Correct phase connection.

TABLE LDC602-II. Sample data sheet for LDC602 phase reversal.

Test Condition	Parameters				Performance
					Yes/No
Phase Reversal Prevented by Positive Physical Means					
If No					
	Voltage		Time Duration at Condition		Pass/Fail
Phase Reversal		V_{dc}		min	
Correct Phase Connection		V_{dc}		min	

6. NOTES

6.1 Intended use. This handbook should be used as guidance when establishing test requirements, for inclusion in performance specifications developed for the procurement of utilization equipment, to ensure compliance with the aircraft electrical power characteristics as specified by MIL-STD-704.

6.2 Subject term (keyword) listing.

Aircraft, electrical power
Aircraft, electrical test
Electrical operating areas
Equipment, utilization
Power groups
Specification, utilization equipment

CONCLUDING MATERIAL

Custodians:
Army - AV
Navy - AS
Air Force - 11

Preparing Activity:
Navy - AS

(Project No. SESS-0054)

Review Activities:
Army - CR, MI, TE
Navy - EC, MC, SA, SH, YD

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