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Electrical System Performance Requirements for Electrical and Electronic Components

Foreword

This joint engineering standard defines the Electrical System performance requirements for electrical and electronic components used in DaimlerChrysler and Mitsubishi Motors vehicles and serves as an acceptance specification for the electrical and electronic components and systems that reference this standard. **This standard shall be used in combination with DC-10613, EMC Performance Requirements – Vehicle and with DC-10614, EMC Performance Requirements – Components.** This document is harmonized to a significant degree with ISO 16750 Parts 1 and 2. These requirements have been developed to assure customer satisfaction and compliance with present and anticipated government regulations regarding the performance of vehicle E/E systems.

Changes

Extensive editing for organization, commonality of terminology and enhanced clarity. Added definitions and informational annexes. Technical changes: hot and cold temperature requirement added to supply voltage range, IOD reduced to 0.1 mA for all components if technically feasible, supply voltage ripple 18 V requirement and requirements above 30 kHz deleted, supply voltage drop out range increased to 2 seconds and ignition switch on-off test deleted, engine cranking low voltage requirement 5 V minimum and clarified as status II below 6 V, 60 second ramp up deleted, hot and cold temperature requirements for supply voltage ramp down deleted, supply voltage offset reduced to 1 V, ground voltage offset reduced to 1 V

NOTE: The English and German version of this jointly developed engineering standard is equivalent. For all other translations, no guarantee can be made as to the accuracy of the technical information.

Chrysler Engineering standard CS-9800 contains general application and subscription information for documents distributed via ADRESS (Automated Document Retrieval and Engineering Standards System). For subscriptions to documents via SIS (Standards Information System) check with your contact at DaimlerChrysler.

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1 Scope

This joint engineering standard defines the electrical performance requirements for electrical and electronic components used in DaimlerChrysler vehicles and applies to all electrical and electronic components designed for 12 V nominal voltage that reference this standard.

1.1 Purpose of the Standard

The purpose of this joint engineering standard is to ensure compatibility between the vehicle electrical power system and the electrical and electronic components in the vehicle. To support this, component requirements and tests are defined in this standard. The purpose of component testing is qualification of

components from the supplier to meet vehicle requirements at a time when representative vehicles are not yet available. Deviations from the requirements contained in this standard are only allowed if agreed to explicitly and documented between the supplier and the appropriate DaimlerChrysler design and release area. The deviations are applicable only to the vehicle line(s) as specified in the individual part standard and/or detail part drawing as released by DaimlerChrysler. Any exceptions to the requirements of this standard shall be reviewed and approved by the DaimlerChrysler releasing engineer. This information shall also be transmitted to the responsible electrical system or powernet group. Satisfactory performance in a vehicle is required for final approval of the vehicle component or system. It is the supplier's responsibility to ensure that the current edition of this standard is used.

1.2 Use of this Standard

The requirements and test methods in this joint engineering standard are based on the international standards referenced in paragraph 2.2, wherever possible. Refer to the definitions in this standard and in the references for clarification of terms. Starter motors, snow plow motors and similar high current motors are not covered by this standard unless they incorporate integral electronics. These devices are subject to evaluation at the vehicle level. Alternators are covered by their own specification, which refers to this specification for electrical requirements and to DC-10614 for EMC requirements. Not all requirements are applicable to all electrical or electronic components; the applicable tests shall be specified in the DUT product specification. For default requirements for particular component types, refer to Annex A. Should a conflict exist between this standard and any of the referenced documents, the requirements of this standard shall prevail, except for regulatory requirements. DaimlerChrysler may change the specific requirements for a given component as a result of testing to this standard.

An electrical or electronic component may provide a single function or a multitude of functions. This standard is intended to define the electrical environment that a component would be connected to when it is integrated into the vehicle electrical system. The operation of specific functions is divided into four groups and one of four responses is allowed as the functional performance status. It is therefore possible that a component could have functions that are in different functional groups with different status requirements. Refer to section 5.4 for functional classification.

This standard is supported by lab procedures, where referenced, that document how the tests are implemented at Chrysler Group (CG) Auburn Hills. They provide additional detail on test equipment, set up and procedures and are an example of the information lab procedures should contain. These CG lab procedures are subject to periodic updates. It is the responsibility of the supplier to maintain current lab procedures as required for their testing.

Questions concerning this standard should be directed to the E/E Architecture and Standards Center of Competence, Department (8590) at CG or to the electrical team at Mercedes-Car-Group (MCG) development. Questions concerning lab procedures and test methods should be directed to Scientific Laboratories, E/E Systems Compatibility Department (5140) at Chrysler Group in Auburn Hills or to the electrical team at Mercedes- Car-Group (MCG) development.

2 References

2.1 General

QS-9000 Quality System Requirements 3rd Edition

PF-8500 General Requirements

UL94 The Standard for Tests for Flammability of Plastic Material for Parts in Devices and Appliances

FMVSS 302 Flammability of Interior Materials

2.2 International Standards

IEC 60050-161 International electrotechnical vocabulary, Chapter 161: Electromagnetic compatibility.

ISO/IEC 17025 1999-12 General requirements for the competence of testing and calibration laboratories

ISO 11452-1 2001-04 Road Vehicles-Component test methods for electrical disturbances from narrow band radiated electromagnetic energy – Part 1: General and definitions.

ISO 16750 Road Vehicles-Environmental conditions and testing for electrical and electronic equipment; Part 1: General, Part 2: Electrical Loads

SAE J1113-2 2002-11 Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components – Part 2: Conducted Immunity

2.3 DaimlerChrysler Standards

DC- 10611, E/E Component Environment Test Specification

DC- 10613, EMC Performance Requirements – Vehicle

DC- 10614, EMC Performance Requirements – Components

2.4 Chrysler Group E/E System Laboratory Procedures

LP-388C-33, Supply Voltage Ripple Test (Low Frequency Conducted Immunity)

LP-388C-XX, Electrical Tests – Part 1: Basic Voltage, Current and Compatibility Tests

LP-388C-YY, Electrical Tests – Part 2: Voltage Dips, Dropouts, Cranking and Load Dump

LP-388C-65, E/E Systems Level Electrical and Electromagnetic Compatibility (EMC) Testing – General Information and Requirements for DCTC, Supplier or Third Party EMC Laboratory

3 Abbreviations, Acronyms, Definitions and Symbols

Refer to IEC 60050-161 and ISO 11452-1 for additional definitions.

ADRESS. An acronym for Automated Document Retrieval and Engineering Standards System.

Anomaly. An effect that represents a deviation from performance as specified in the DUT product standard (see effect).

Battery Voltage Lines. The supply voltage lines to a DUT that are fed directly from the vehicle battery.

Category and subcategory. In this document, electronic modules, electric motors and inductive devices are classified into categories and subcategories, which determine the appropriate test requirements.

Electronic module categories:

- **P:** A passive electrical component or module. Examples: resistor, capacitor, blocking or clamping diode
- **A:** A component or module that contains active electronic devices. Examples: an analog op amp circuit, switching power supply or microprocessor controller.

Electronic module subcategories are in addition to the basic category designation if they apply.

- **B:** An electronic component that has a vehicle battery supply voltage input.

Electric motor categories:

- **BCM:** A brush commutated dc electric motor.

- **ECM:** An electronically controlled or commutated dc electric motor.

Inductive device categories:

- **R:** Relays and solenoids

CCA. Cold Cranking Amps as rated by the Battery Council International.

CG. Chrysler Group (DaimlerChrysler Corp., DaimlerChrysler Canada, DaimlerChrysler de Mexico, etc.).

Component Specification. See Product Specification.

Controlled Manner. Refers to the response of the DUT to an applied stimulus. A response is considered controlled when the operation of the DUT and its system returns to normal after the stimulus is removed (see function performance status, status II).

Damage. A DUT is considered damaged when it no longer performs as specified in the DUT product standard or shows visual evidence (such as discoloration) of electrical or electronic components that have exceeded their ratings.

Device. An electrical or electronic component, module, part or assembly.

Disturbance. Any electrical transient or electromagnetic phenomenon that may affect the proper operation of an electrical or electronic device.

DUT. An acronym for Device(s) Under Test. Any electrical or electronic component, module, motor, filter, etc. Also referred to as EUT or equipment under test.

E/E. Electrical and/or Electronic

Effect. A detectable change in DUT performance due to an applied stimulus.

Engineering Standard. An Engineering Standard contains information that would be too voluminous or repetitive to include in the CAD model or Engineering Graphic Overview. It is a written normative specification that describes material, process, performance, reliability, quality, and/or design requirements for a production part, family of parts, or system. Standards contain common requirements, procedures, processes, acceptance criteria, and/or guidelines. Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, requirements, procedures, processes or definitions of characteristics, to ensure that materials, products, processes, and services are fit for their purpose.

Fail-safe Mode. A predictable operating mode intended to minimize adverse effects by restricting or shutting down operation when a significant stimulus has made operation unreliable. Operation shall be recoverable after the stimulus is removed without permanent loss of function or corruption of stored data or diagnostic information.

Function. The intended operation of an electrical or electronic component for a specific purpose. The component can provide many different functions, which are, defined (functional group and acceptable performance) by the product specification.

Functional Group. Component functions are divided into four groups based on criticality of function. Performance status requirements are appropriate for the functional group - refer to DC-10614, Annex A for Functional Group examples:

- **Group A:** Any function that provides a convenience.

Examples are entertainment systems and nonessential displays.

- **Group B:** Any function that enhances, but is not essential to, the operation and/or control of the vehicle.

Examples are important information displays.

- **Group C:** Any function that controls or affects the essential operation of the vehicle.

Examples are critical engine and transmission control functions, vehicle braking and steering ability.

- **Group D:** Any function that electronically controls the deployment of an electroexplosive device (EED) actuated passive restraint system with the potential for inadvertent deployment. [Refer to definitions and background in MIL-STD-1576 (USAF)]

Function Performance Status. The performance of DUT functions when tested is described by four performance status levels or responses:

- **Status I:** The function operates as designed during and after a test or exposure to a disturbance.
- **Status II:** The function may deviate from designed performance to a specified level as defined in the product specification during a test or exposure to a disturbance; or it may revert to a fail-safe mode of operation as defined in the product specification but shall return to normal operation after the test is done or the disturbance is removed. (See fail-safe mode)
- **Status III:** The function may deviate from designed performance during a test or exposure to a disturbance. Driver action may be required to return the function to normal operation after the test is completed or the disturbance is removed (e.g. ignition off/on).
- **Status IV:** The device/function shall not sustain any permanent damage as a result of a test or exposure to a disturbance. Dealer action may be required to return the function to normal operation after the test is completed or the disturbance is removed (e.g. battery reset).

I/O. Input and output

Ignition Voltage Lines. The supply voltage lines to a DUT that are fed from the vehicle electrical power distribution system through the ignition switch.

Inductive Device. An electromechanical device that stores energy in a magnetic field. Examples are solenoids, relays, buzzers and electromechanical horns.

IOD. Ignition Off Current Draw.

Line. A generic term for a terminal or wire lead of a DUT, which includes all, inputs and outputs.

MCG. Mercedes-Car-Group (Mercedes-Benz, Maybach, smart).

Module. See Device.

NIST. An acronym for National Institute of Science and Technology.

Nominal Voltage. The indicated voltage value used to describe the electrical system of a vehicle.

PF. Performance Standard.

Powernet. Electrical energy supply infrastructure (Bordnetz).

Product Specification. A DaimlerChrysler Performance Standard (PF), Lastenheft (final specification), Pflichtenheft (functional specification), CATIA model or other document used to specify the electrical requirements for a component or system, also referred to as component specification.

PTB. Physikalisch-Technische Bundesanstalt (German National Institute of Natural and Engineering Sciences)

Section. Refers to a major subdivision of this standard or a Laboratory Procedure.

Shall. Denotes a requirement.

Should. Denotes a recommendation.

Sleep Mode. The designed full power down mode of an electronic component where it maintains a minimum current draw but is available to be powered up by a signal input.

Sourced output line. A DUT output line that has its feed source internally connected to or supplied from a feed line into the DUT.

Stability. The condition where the DUT maintains control, within defined limits, of a specific function in the presence of an applied stimulus.

Standby mode. The designed partial power down mode in which the component maintains necessary functions active according to a programmed schedule eventually leading to full power down in the sleep mode.

Stimulus. A change induced in the electrical environment of the DUT. A change may be an applied voltage level, transient, ac signal, or a test pulse used to simulate the electrical environment.

Supply Voltage. The voltage that will be available in the vehicle or as simulated on the bench (test voltage) to power the DUT.

Supply Voltage Lines. The battery and ignition lines and any DUT inputs or outputs sourced from battery or ignition voltage as configured in a DUT's complete system including circuit protection. This includes lines such as voltage sense and illumination also including loads sourced from supply voltage and switched to ground in the DUT. These are lines that connect the vehicle electrical power system through a low impedance path to the DUT.

4 Regulated Substances and Recyclability

All materials, procedures, processes, components, or systems must conform to the current regulatory (governmental) requirements regarding regulated substances and recyclability.

5 Test Requirements and Functional Status

5.1 General

The test laboratory used shall be organized and operated according to ISO 17025. All test equipment used for measurement shall be calibrated in accordance with ISO 17025 (or as defined or recommended by the manufacturer) traceable to NIST, PTB or other equivalent national standard laboratory. The test equipment, test setups and test procedures used shall be documented in lab procedures, especially if they differ from those specified in this standard. DaimlerChrysler reserves the right to inspect the laboratory and the lab procedures. The CG lab procedures (see References) are an example of the information that should be included.

5.2 Test Conditions and Tolerances

Unless specified otherwise, the tolerances shall be according to Table 1:

Table 1: Permissible Tolerances

Voltage, current, time interval > 1s	± 2 %
Time interval ≤ 1s, length, energy, power	± 5 %
Resistance, capacitance, inductance, impedance	± 10 %
Temperature	± 2 °C

Unless indicated otherwise, the climatic test conditions shall be as defined in Table 2.

Table 2: Climatic Test Conditions

Temperature	23 ± 5 °C (73 ± 9 °F)
Humidity	20 to 80% relative humidity (RH)

Unless stated otherwise, all voltages referenced in this document are direct current referenced to the negative terminal of the power supply or battery.

5.3 Test Plan and Report

Prior to testing, a test plan shall be approved and signed by the appropriate DaimlerChrysler product team electrical engineer. The test plan shall define any required parameters, test conditions, test points and test report information. The test plan shall include the method of monitoring the DUT for effects and/or critical timing and operating parameters that may affect or be effected by the testing. The requirement for a device test plan shall be specified in the product specification. Supplementary and Test Plan Template information for CG is contained in LP-388C-65, E/E Systems Level Electrical and Electromagnetic Compatibility (EMC) Testing.

Three (3) samples of the DUT are required for testing. Significant variation in test results among the three samples tested will require further investigation and possibly additional testing. The DUT test plan shall specify an additional number of samples to be tested and the strategy for testing them based on any anomalies encountered. The DUT shall pass all tests, regardless of the order of the tests. Representative loads or networks are used to simulate the vehicle environment or the in-vehicle configuration. This may be termed a test fixture or a system exerciser or have some other descriptive name for an apparatus used for simulating the appropriate load characteristics, i.e., equivalent resistance, capacitance and inductance within a range as expected in the production vehicle. If the DUT has a data bus line then the test fixture shall also simulate a level of communication consistent with the DUT input/output requirements expected in the vehicle. It shall also be able to operate during testing without affecting the pass/fail result criteria.

On completion of the test, the results shall be submitted to the responsible DaimlerChrysler development department(s) in the form of a test report with reference to the test plan. The test setup shall be documented including but not limited to photographs or images. A statement shall be included in the test report certifying the execution of the tests in accordance with this standard and compliance with its requirements. Any instances of non-compliance shall be detailed in the test report.

5.4 Functional Performance Status Classification

When a DUT is subjected to a stimulus, the required operation of a specific function(s) is determined by the criticality of that function. For the purposes of this standard, the functional performance status is defined by the functional groups listed in Section 3. Refer to DC-10614, Annex A for examples.

Functional Performance Status for E/E Systems is hierarchical. Status I is the highest and Status IV is the minimum. This means that if the response required is Status II then Status I is also acceptable. This applies for components with different functions where the Status II response 'to a specified level', can be used which shall be detailed in the individual component specification or part drawing.

6 Electrical System Operating Environment

Voltage shall be applied to the battery and ignition (or switched) lines and any inputs or outputs sourced from the battery or ignition voltage as configured in the DUT's complete system (supply voltage lines). All input and output lines shall be connected to representative loads or networks to simulate the in-vehicle configuration. If actual wiring or loads cannot be used, or to protect for worst case, the DUT shall operate normally with 5 μ H of series inductance in the supply voltage lines.

6.1 Supply Voltage Range

6.1.1 Requirement

Components shall retain full functionality while performing within the defined voltage range, Functional Performance Status I for all Functional Groups.

6.1.2 Test

This section defines the required operating voltage range by Functional Group for E/E components and systems. The test voltage shall be applied to all supply voltage lines (see definitions). Verify normal DUT operation at minimum and maximum supply voltage starting at the minimum voltage and at integral voltage values in between. The test duration shall be sufficient to verify the specified DUT functions at each voltage level. Refer to LP-388C-XX for CG test procedure.

Group A: 10 to 16 V

Group B: 9 to 16 V

Group C: 6 to 16 V, if operation required during engine cranking.

8 to 16 V, if operation not required during engine cranking.

Group D: 6 to 18 V

The test shall be performed at three different temperatures: -40°C , 23°C and T_{max} , where T_{max} is defined in DC-10611, Section 3, Temperature Classification. This is not intended to be a temperature shock test, so the DUT shall be tested at 23°C between the cold and hot test. The DUT shall be soaked in the temperature environment for sufficient time to stabilize the internal temperature of the DUT at the required temperature. This temperature soak shall be with the DUT unpowered. The five Temperature Classes are listed in Table 3 for convenience, but the temperature ranges of the current revision of DC-10611 shall apply.

Table 3: Temperature Classes

Temperature Class	$T_{\text{max}}^{\circ}\text{C}$
I	85
II	105
III	125
IV	155
V	Actual

6.2 Ignition Off Draw (IOD)

This section applies to any electronic device with battery fed input line or lines. The purpose of these requirements is to control the consumption of electrical power after the ignition switch is turned off. For electric or other non-ignition vehicles, IOD refers to operating key off current draw. Note: Be aware that back feed paths from other circuits connected to the DUT in the vehicle may result in the vehicle design IOD for operating and shipping being exceeded. To preclude premature vehicle battery run down, any exceptions to the requirements of this section shall be reviewed and approved by the DaimlerChrysler releasing engineer. This information shall also be transmitted to the responsible electrical system or powernet group. For CG, this shall be according to the internal document DS-156, Vehicle Level Ignition Off (Current) Draw Calculation.

6.2.1 Standby Battery Energy Draw

6.2.1.1 Requirement

The total allowable energy draw for the standby mode from the vehicle battery input is 0.12 Wh.

6.2.1.2 Test

The total allowable vehicle battery energy draw shall be measured beginning after ignition off and any communication BUS traffic to/from the DUT has ceased and ending when the DUT goes into its sleep mode. Measurement shall be made with 12.6 V applied to the DUT. Record the starting IOD, the magnitude of any interim current draws, the time taken to reach the standby mode and the time to and magnitude of the ending or steady state sleep mode IOD. Refer to LP-388C-XX for CG test procedure.

6.2.2 IOD Sleep Mode

6.2.2.1 Requirement

The average IOD for all DUTs shall be 0.1 mA or less. If technical limitations do not allow achieving this IOD, the product specification shall specify these limitations and the achievable IOD. See the review requirements in section 6.2.

6.2.2.2 Test

Allow sufficient time for the powered down DUT to reach sleep mode before conducting the test. With the DUT in the powered-down state or sleep mode and configured as a part of its complete system, measure the current draw of the DUT. For a DUT that has IOD that varies over time, this measurement shall be time averaged over a minimum of 3 cycles or as defined in the product specification. The supply voltage for this test shall be 12.6 V. Refer to LP-388C-XX for CG test procedure.

6.3 Supply Voltage Ripple

6.3.1 Requirement

Functional Performance Status I for all Functional Groups

6.3.2 Test

This test verifies immunity to supply voltage ripple. The voltage ripple shall be superimposed on the normal supply voltage of 13.5 V. Use the test set up as shown in SAE J1113-2 and the superimposed alternating voltage ripple as defined in Figure 1 over the frequency ranges indicated. Frequency sweep or steps as defined below may be used. Source impedance is ≤ 0.5 ohms (verify source impedance as described in SAE J1113-2 Appendix B). Refer to LP-388C-33 for CG test procedure.

Frequency sweep time:

15 Hz to 1500 Hz: 2 minutes
1500 Hz to 30 kHz: 4 minutes
30 kHz to 1500 Hz: 4 minutes
1500 Hz to 15 Hz: 2 minutes

Frequency steps:

15 Hz to 145 Hz in 10 Hz steps, 150 Hz to 1500 Hz in 50Hz steps
1500 Hz to 30 kHz with frequency steps less than or equal to 500 Hz linearly decreasing in amplitude in voltage steps less than or equal to $0.071 V_{pp}$ with 4 second minimum dwell time at each step

Voltage ripple open-circuit amplitude:

15 Hz to 1500 Hz: $4.24 V_{pp}$ (or $1.5 VAC_{rms}$)
1500 Hz to 30 kHz: linearly decreasing from $4.24 V_{pp}$ ($1.5 VAC_{rms}$) to $0.212 V_{pp}$ ($75 mVAC_{rms}$)

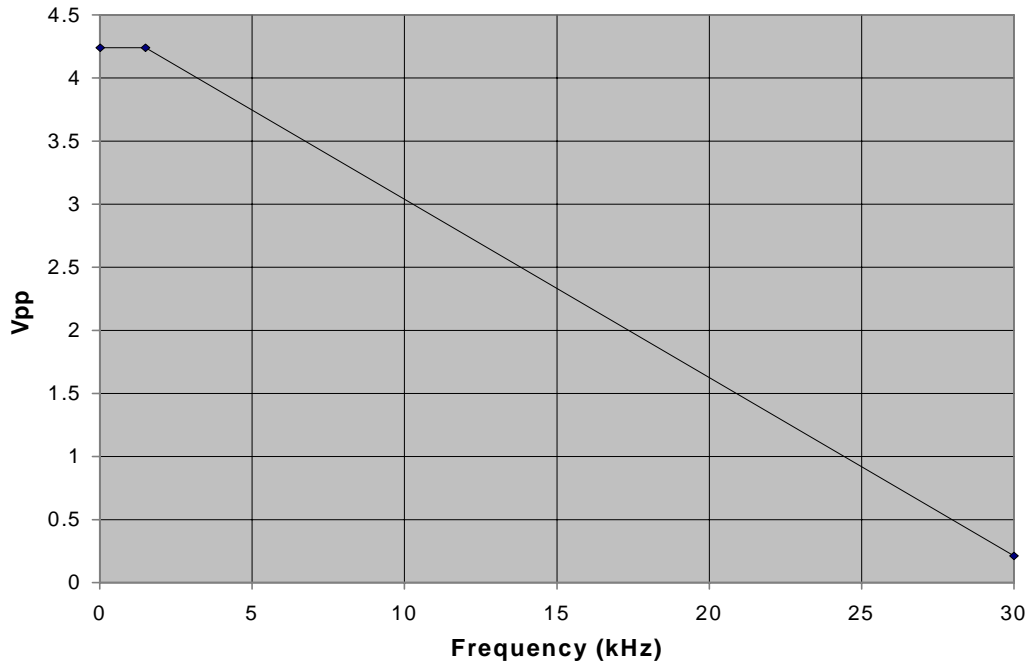


Figure 1: Voltage Ripple Test

7 Supply Voltage Variations

Normal vehicle usage results in the on/off cycling of many electrical and electronic loads. These load changes cause rapid fluctuations of the vehicle supply voltage. These tests verify that the operation of the component is unaffected by dips and dropouts of the supply voltage. If the DUT is utilizing a data bus, no spurious messages shall be transmitted. All DUT inputs and outputs shall be connected to representative loads or networks to simulate the in-vehicle configuration. Functions are to be monitored during the tests to observe effect thresholds.

7.1 Supply Switch Deactivation

These tests validate component behavior when the supply voltage switch is turned to off.

7.1.1 Requirement

When the ignition (or switched) line(s) are turned off, feedback on any non battery input line shall fall to < 1 mA within 1 s max.

7.1.2 Test

A test voltage of 13.5 V shall be applied to the DUT supply voltage lines. Turn the ignition (or switched) line(s) off, and monitor feedback on any non-battery input line(s). Five test cycles are required. Refer to LP-388C-XX for CG test procedure.

7.2 Supply Voltage Drop Out

7.2.1 Requirement

Functional Groups A and B: Functional Performance Status I for drop outs $\leq 100 \mu\text{s}$; Functional Performance Status II for dropouts $> 100 \mu\text{s}$.

Functional Groups C and D: Functional Performance Status I for drop outs $\leq 1 \text{ ms}$; Functional Performance Status II for dropouts $> 1 \text{ ms}$.

No spurious or undesirable active response by the component is allowed.

7.2.2 Test

This test verifies normal operation of the DUT during brief supply voltage interruptions. The supply voltage shall drop out from 11 V to 0 V and return to 11 V. The duration of the drop out increases from 10 μ s to 2 s in increments as shown in Table 4. Test levels are set open circuit (≥ 1 kohm load) with fall time and rise time less than 1.5 μ s each. The DUT operation shall be monitored during the test and the interval time between dropouts shall be sufficient to verify normal DUT operation. Refer to LP-388C-YY for CG test procedure.

Table 4: Drop Out Duration and Increments

Drop Out Duration Range	Increment
10 μ s to 100 μ s	10 μ s
100 μ s to 1 ms	100 μ s
1 ms to 10 ms	1 ms
10 ms to 100 ms	10 ms
100 ms to 2 s	100 ms

7.3 Supply Voltage Dips

7.3.1 Requirement

Functional Groups A and B: Functional Performance Status I for dips ≤ 100 μ s; Functional Performance Status II for dips > 100 μ s.

Functional Groups C and D: Functional Performance Status I for dips ≤ 1 ms; Functional Performance Status II for dips > 1 ms.

No spurious or undesirable active response by the component is allowed.

7.3.2 Test

During the normal course of vehicle usage, many electrical and electronic devices are user activated, automatically controlled or are automatically controlling other loads in the electrical system. These load variations, or fuse activation, can result in rapid fluctuations of the supply voltage.

Voltage shall be applied to the supply voltage lines. A dip is from 11 V to the dip voltage for the specified duration and then back to 11 V. The dip voltages are: 5.5 V, 5.0 V, 4.5 V, 4.0 V, 3.5 V and 3.0 V. Dips to each voltage level are for 100 μ s, 1 ms, 10 ms and 500 ms durations. The DUT operation shall be monitored during the dip test and the interval time between dips shall be sufficient to verify normal DUT operation. At each dip voltage, run through the range of dip durations. Refer to LP-388C-YY for CG test procedure.

Each supply voltage line shall be dipped individually and as a grouping of all of the supply lines together.

7.4 Engine Cranking Low Voltage

7.4.1 Requirement

Functional Group A and B – Functional Performance Status II during the test

Functional Group C (operation required during start) – Functional Performance Status II during the time of the ramp below 6.0 V, Functional Performance Status I at and above 6.0 V

Functional Group C for operation not required during start – Functional Performance Status II

Functional Group D – Functional Performance Status II during the time of the ramp below 6.0 V, Functional Performance Status I at and above 6.0 V

There shall be no loss or corruption of the initialized or stored data.

7.4.2 Test

During starting (cranking of the engine) the battery voltage will fall to a low voltage for a short time period and then rise slightly. Most components will be briefly energized just prior to cranking and some will be deactivated during the crank and subsequently re-energized after the start when the engine is running. This test verifies normal operation under these conditions. All inputs and outputs shall be connected to representative loads or networks to simulate the in-vehicle configuration.

The test pulse simulates the voltage dip during the start operation and is defined by Figure 2 and Table 5. If the DUT has stored initialization data or memory data in volatile storage then initialize and/or store data before beginning the test. With the run only and accessory lines at 0 V, subject the DUT to the Engine Cranking Test Pulse in Figure 2 on battery, run/start and start lines simultaneously. The DUT operation shall be monitored during the test. Return all DUT supply voltage lines to V_B and confirm normal functioning after each test. This is one (1) cycle; five (5) test cycles are required. Refer to LP-388C-YY for CG test procedure.

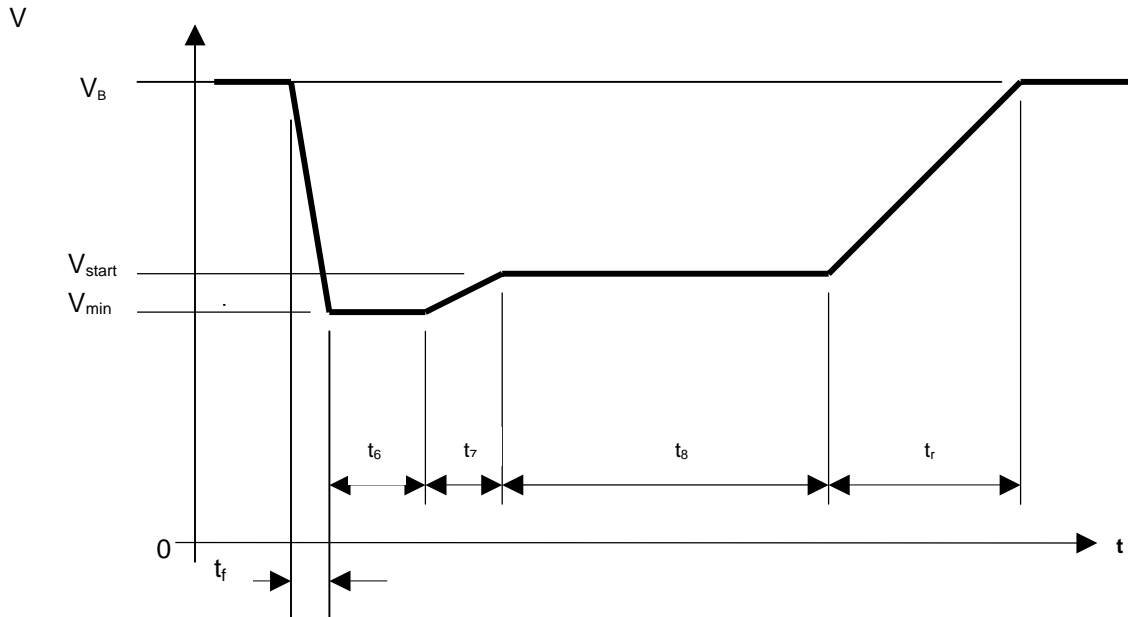


Figure 2: Engine Cranking Test Pulse

Table 5: Engine Cranking Test Pulse Parameters

Parameter	Value
V_B in V	12.6
V_{start} in V	6.5
V_{min} in V	5
t_f in ms	5
t_6 in ms	15
t_7 in ms	50

Parameter	Value
t_g in s	10
t_r in ms	100
R_i in Ω	0.01
Test pulses	5

7.5 Supply Voltage Ramp Up

7.5.1 Requirement

Within the normal operating voltage range: Function Performance Status I for all Functional Groups.
 Outside the normal operating voltage range: Function Performance Status II for all Functional Groups.
 No spurious or undesirable action or response on the part of the component is allowed regardless of voltage progression.

7.5.2 Test

The purpose of this test is to verify that the component power up sequence is not adversely affected by a slow supply voltage ramp up. The test shall be performed at three different temperatures: -40°C , 23°C and T_{max} , where T_{max} is defined in DC-10611, Section 3, Temperature Classification (see also section 6.1.2 and Table 3). This is not intended to be a temperature shock test, so the DUT shall be tested at 23°C between the cold and hot test. The DUT shall be soaked in the temperature environment for sufficient time to stabilize the internal temperature of the DUT at the required temperature. This temperature soak shall be with the DUT unpowered. Apply test voltage to the DUT supply voltage lines linearly increasing (maximum steps of 50 millivolts) from 0 V dc to 13.5 V and, without interruption of this supply voltage, test the DUT functions. Confirm normal functioning after each test interval. Repeat this procedure five times for each ramp up interval with a minimum 10 seconds power down time between power-up cycles. The time intervals for the supply voltage ramp up are: 100, 200, 500 and 1600 milliseconds. Test duration, t_3 as required to evaluate DUT functions. Refer to Figure 3 for waveform and LP-388C-XX for CG test procedure.

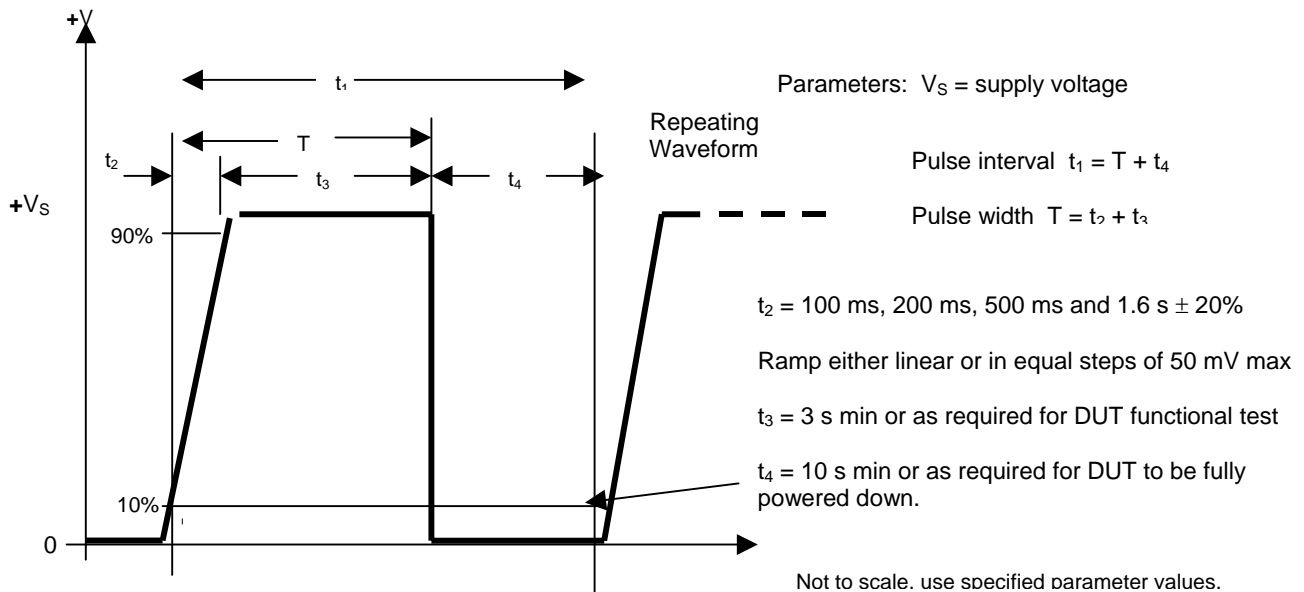


Figure 3: Supply Voltage Ramp Up Test

7.6 Supply Voltage Ramp Down

7.6.1 Requirement

Within the normal operating voltage range: Function Performance Status I for all Functional Groups.
Outside the normal operating voltage range: Function Performance Status II for all Functional Groups.
No spurious or undesirable action or response on the part of the component is allowed regardless of voltage progression. No spurious BUS messages shall be transmitted.

7.6.2 Test

This test simulates a slow reduction in supply voltage due to loss of charging capability and is aimed at detecting spurious and undesirable responses and the thresholds at which malfunctions begin.

Power up the DUT at the minimum voltage for its group and verify normal operation. Monitor the DUT for effects and linearly ramp down the voltage from the minimum operating voltage to 0 V or use 50 mV max steps, over a 10 minute interval, hold for 10 s minimum or as long as is required to confirm DUT is fully powered down. Return the supply voltage to minimum operating voltage and confirm normal operation. This is one (1) cycle; five (5) cycles are required. Refer to LP-388C-XX for CG test procedure.

8 Supply Over Voltage and Reverse Voltage

These requirements are to verify DUT immunity to higher than normal operating voltages and surges that may occur during a jump-start or certain failure modes of other components in the vehicle electrical system. All inputs and outputs shall be connected to representative loads or networks to simulate the in-vehicle configuration. Confirm normal functioning of the DUT at 13.5 V before and after each test. None of the DUT's components may exceed their power ratings. The DUT may shut down for protection outside its specified operating voltage range.

8.1 Defective Regulation (Full-Fielded Alternator)

8.1.1 Requirement

Functional Performance Status II for Functional Groups A, B and C.
Functional Performance Status I for Functional Group D

8.1.2 Test

Confirm normal functioning of the DUT at 13.5 V. Apply 18 V to all supply voltage lines for 60 minutes and monitor functioning of the DUT. Return the DUT to 13.5 V and confirm normal functioning. Refer to LP-388C-XX for CG test procedure.

8.2 Jump Start

8.2.1 Requirement

Functional Performance Status II for all Functional Groups

8.2.2 Test

Confirm normal functioning of the DUT at 13.5 V. Apply 27 V to all DUT supply voltage lines for 1 minute. Return the DUT to 13.5 V and confirm normal operation. Refer to LP-388C-XX for CG test procedure.

8.3 Load Dump

8.3.1 Requirement

Functional Performance Status II for all Functional Groups. No spurious or undesirable action or response on the part of the DUT is allowed.

8.3.2 Test

The DUT shall be subjected to the load dump voltage transient test pulse illustrated in Figure 4 simultaneously on each supply voltage input. The test pulse defined in Figure 4 and Table 6 represents alternators or generators with integral load dump protection. The DUT operation shall be monitored during the test. Return the DUT to 13.5 V and confirm normal functioning after each test pulse. The test shall consist of 5 pulses a minimum of 2 minutes apart. Refer to LP-388C-YY for CG test procedure.

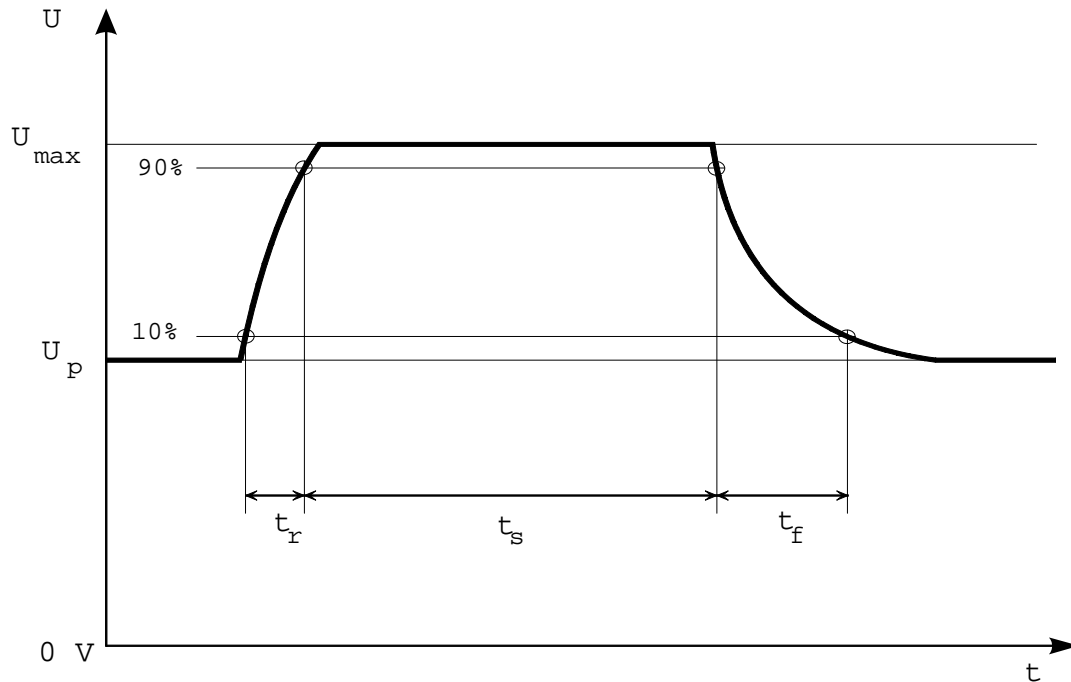


Figure 4: Load Dump Test Pulse

Table 6: Load Dump Test Pulse Parameters

Parameter	Value
U_p in V	13.5
U_{max} in V	32
t_r in ms	≤ 10
t_s in ms	400
t_f in ms	≤ 50
R_l in Ω	0.5
Test pulses	5

8.4 Reverse Supply Voltage

8.4.1 Requirement

Functional Performance Status I for all Functional Groups after the test and reset or replacement of any fuse protection

8.4.2 Test

There shall be no damage to the DUT and it shall operate as specified, without effect on stored data, after being subjected to a reverse voltage test of -16 V for 1 minute. None of the DUT's components may exceed their power ratings. This reverse voltage is applied to the DUT supply voltage lines. Loss of vehicle battery powered memory is allowed. For DUT integrated in a vehicle that provides reverse voltage isolation for the DUT external to the DUT (e.g. powered through relay isolated circuits or protected using a reverse diode/fuse for non-critical functions) this test does not apply. Return the DUT to 13.5 V and confirm normal operation. The power supply shall be capable of providing at least 100 A of current. Refer to LP-388C-XX for CG test procedure.

9 Electrical System Compatibility Requirements

These tests verify the DUT's immunity to short circuits in the 12 V vehicle electrical system where it is feasible that a short circuit can occur in the wiring or at the DUT lines. The tests are performed on the supply voltage lines, all output lines, signal I/O lines and input lines. All inputs and outputs shall be connected to representative loads or networks to simulate the in-vehicle configuration. A short circuit to ground in any of the supply input circuit(s) shall not permanently or adversely affect the DUT. A protective response mechanism in the DUT may be triggered. The power supply for the short circuit tests shall be capable of maintaining between 13.5 V and 14.5 V during the test while supplying at least 100 A. A low ripple 50 A minimum power supply may be used in parallel with a fully charged automotive battery. Battery chargers are not an acceptable alternative. If technical limitations do not allow some of these requirements to be met, the product specification shall specify these limitations and the achievable survivability. See the deviation requirements in section 1.1.

9.1 Immunity to Short Circuits in the Supply Voltage Input and Load Output Lines

9.1.1 Requirement

Functional Performance Status II for all Functional Groups with automatic reset of the protective mechanism

Functional Performance Status IV for all Functional Groups with manual resetting of the protective mechanism

9.1.2 Test

With a supply voltage of 13.5 V, verify normal operation. All supply voltage lines (including sourced output lines) where technically feasible are to individually survive connection to 13.5 V and/or a short to ground. Disconnect the power supply and connect the DUT supply input line to ground for 5 s. Remove the short to ground and return 13.5 V to confirm normal operation. Refer to LP-388C-XX for CG test procedure.

9.2 Immunity to Short Circuits in I/O Signal Lines

9.2.1 Requirement

Functional Performance Status II for all Functional Groups. Individual short-circuit currents shall not exceed 200 mA in a steady state condition without approval from the releasing engineer, refer to section 1.1.

9.2.2 Test

This test verifies the DUT's immunity to short circuits in control and bus signal lines as well as in signal I/O lines. All signal input and output lines shall be tested by short circuiting the individual lines to ground

and to 13.5 V. The individual short-circuit currents shall be recorded. Signal lines shall remain permanently resistant to short circuits. Paired control/bus signal lines shall remain permanently resistant to mutual short circuits as well as shorts to supply voltage and ground. Refer to LP-388C-XX for CG test procedure.

9.3 Resistance to Overload

This requirement applies only if specifically called out in the product specification and the appropriate circuit protection is defined. All inputs and outputs shall be connected to representative loads or networks to simulate the in-vehicle configuration. All E/E component supply voltage lines shall survive short circuits on their outputs that can occur with certain failure modes. If an incorrect oversize fuse is used in the field or a current limiting mechanism becomes non-responsive, the output circuits of the DUT shall survive short-circuiting to ground. Destruction of the device is permissible under certain circumstances if and only if flammability class V0 per UL 94 (or FMVSS 302) is complied with, is demonstrated and is so documented in the part standard and in the test report.

9.3.1 Melting Fuse, Fusible (Wire) Link, Circuit Breakers

9.3.1.1 Requirement

Functional Performance Status IV for all Functional Groups. The test shall not lead to destruction of the output circuits, and the E/E component shall revert to full and unimpaired functionality following termination of the test.

9.3.1.2 Test

This test verifies overload resistance for a short circuit to ground at the output lines. The output lines shall withstand the currents commensurate with the circuit protection rating as shown in the following Table 7 and labeled "Max". The test times are calculated from the circuit protection device response curve, based on the upper tolerance limit plus 10%. All current protected output lines shall be tested for overload in activated and non-activated states. Refer to LP-388C-XX for CG test procedure.

Table 7: Parameters for Overload Resistance

Name	Symbol	Min	Typical	Max	Unit
Protective Device design rated current	I_{NS}		100		%
Test current as a % of design rated current	I_P	135	200	350	%
Test duration	t_P	Protective device 'blow time' + 10%			minutes

If a circuit protection device is not used between the DUT and the vehicle battery or in the DUT itself, then the DUT shall withstand a test current limited only by battery and circuit capacity for 5 minutes without damage. The current shall be supplied by a fully charged 12 V automotive battery of at least 500 CCA (Group 34, H6 or equivalent) in parallel with a low ripple 50 A power supply.

9.3.2 Electronic Fuse

9.3.2.1 Requirement

Functional Performance Status IV for all Functional Groups

9.3.2.2 Test

The term 'Electronic Fuse' refers to solid state protective devices that have controlled resetability, e.g. PTC's, high side drivers with output overload protection. The short circuit and overload cut-off occurs

separately for each load output stage. If not otherwise defined, the final stages shall be reactivated 30 s after switching off. With a continuously present short-circuit, activation shall be conducted 10 times (if not otherwise defined). On the 11th attempt with a short-circuit still present, the respective output line should be switched off until the next driving cycle ignition off/on. This shall lead to an entry in the fault memory. Recognition criteria and recognition time for the DUT shall be as described in the devices component specification. All current protected output lines shall be tested for short circuit/overload in the activated state. Refer to LP-388C-XX for CG test procedure.

9.4 Supply Voltage Offset

The primary purpose of the voltage offset test is to verify compatibility with different electrical potentials at the power-supply input lines if two (2) or more inputs in the normal run condition are being supplied by different circuits. For instance, an "ignition on" supply line and a standby/IOD supply on a different supply line to an E/E component. Note: Data integrity for communications is not covered by this test. The voltages shall be measured at the DUT.

9.4.1 Requirement

Functional Performance Status I for all Functional Groups - There shall be no malfunction or latch up of the DUT.

9.4.2 Test

All input and output lines shall be connected to representative loads or networks to simulate the in-vehicle configuration. Using 13.5 V for supply voltage confirm normal operation. Test by setting up another supply line for ± 1 V offset (1 volt maximum offset relative to 13.5 V). The test duration is as long as it takes to confirm normal DUT operation. Repeat for each battery and switched ignition line until all combinations are tested. This is one (1) cycle; three (3) cycles are required. Refer to LP-388C-XX for CG test procedure.

9.5 Ground Reference Offset

The ground reference offset test serves to verify reliable operation of a component when two (2) or more ground paths exist. For instance a component may have a power ground and a signal ground that are outputs on different circuits; or there may be a hard wired ground and a case ground. Note: Data integrity for communications is not covered by this test.

9.5.1 Requirement

Functional Performance Status I for all Functional Groups - There shall be no malfunction or latch up of the DUT.

9.5.2 Test

All inputs and outputs shall be connected to representative loads or networks to simulate the in-vehicle configuration. Apply 13.5 V supply voltage to the DUT and confirm normal operation. Establish a voltage difference between the ground points of the DUT equal to ± 1 V ground offset (maximum 1 volt ground to ground offset). The voltages shall be measured at the DUT. The test duration is as long as it takes to confirm normal operation. Repeat for each ground path and combinations of ground paths until all combinations are tested. This is one (1) cycle; three (3) cycles are required. Refer to LP-388C-XX for CG test procedure.

10 Specific Requirements for Motors and Inductive Devices

This section applies to motors and inductive devices including solenoids, electromechanical relays, buzzers and horns unless otherwise defined in a DaimlerChrysler product specification. It applies to brush commutated and electronically controlled or commutated dc electric motors without integral

electronics and/or solid state components other than for RF or transient voltage suppression or self-protection. The motor/inductive device shall be loaded to approximate the in-vehicle operating conditions, where practical, for all tests. If technical limitations do not allow some of these requirements to be met, the product specification shall specify these limitations and the achievable operation and survivability. See the deviation requirements in section 1.1.

10.1 Operating and Voltage Stress

10.1.1 Requirement

DUTs without an internal protection device: Functional Performance Status I for all Functional Groups.
DUTs with an internal protection device: Functional Performance Status II for all Functional Groups.

10.1.2 Test

This is a continuously running test. Test the motor/inductive device in the following sequence: operate at the minimum voltage for its Functional Group for 10 minutes, then step up the supply voltage in 1 volt increments operating for 1 minute at each increment up to 12 V, then at 13.5 V for 5 minutes, then at the maximum voltage for its Functional Group for 10 minutes. Within 1 minute, ramp up to 18 V and run for 10 minutes and then within 1 minute ramp up to 27 V and run for 1 minute. Within 1 minute, ramp down to 13.5 V and run for 10 minutes. Verify that there is no degradation of the motor/inductive device and that it performs as specified. Refer to LP-388C-XX for CG test procedure.

10.2 Stall

10.2.1 Requirement

DUTs without an internal protection device: Functional Performance Status I for all Functional Groups.
DUTs with an internal protection device: Functional Performance Status II for all Functional Groups.

10.2.2 Test

This test simulates a locked rotor or solenoid armature failure mode and only applies to motors and solenoids. A protective response mechanism may be triggered.

The power supply for this test shall be capable of maintaining the voltage between 12.4 V and 12.8 V during the test while supplying at least 100 A. A low ripple 50 A minimum power supply may be used in parallel with a fully charged automotive battery. Battery chargers are not an acceptable alternative.

Firmly mount the device housing so it cannot move. Lock the moveable part of the DUT so it cannot move or rotate. Supply 12.6 V to the feed line(s) of the DUT. Maintain this stall (or locked) condition for one (1) hour. Remove the supply voltage and return the DUT to a normal operating mode. If an internal protective device has been activated record the time for it to reset. Apply normal supply voltage and verify that there is no degradation of the motor or solenoid and that it performs as specified. Refer to LP-388C-XX for CG test procedure.

End of Main Document

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Annex A (informative)

RECOMMENDATION FOR APPLYING THIS STANDARD TO COMPONENT TYPES

The releasing department, in cooperation with the appropriate product team electrical engineer, should define the following information when referencing this joint engineering standard in the product specification(s):

- CATEGORY (and sub-category, if applicable) of the electrical or electronic component (see definitions)
- DUT FUNCTIONS and their FUNCTIONAL GROUP (affects test levels, see definitions and DC-10614, Appendix A)
- ACCEPTABLE PERFORMANCE LIMITS for these functions (to establish criteria for Function Performance Status I, II or III)
- DUT INFORMATION such as battery feed or circuit protection requirements

Table A-1: Electrical Test Selection Matrix Example

TEST	COMPONENT CATEGORIES					
	Passive Component	Active Component	Active Component with Battery Input	Electronic Motor	Brush Motor	Inductive Device
	P	A	A/B	ECM	BCM	R
Operating Environment						
Supply Voltage Range (6.1)	X	X	X			
IOD (6.2)			X			
Supply Voltage Ripple (6.3)		X	X			
Supply Voltage Variations						
Supply Deactivation (7.1)		X	X	X		
Supply Drop Out (7.2)		X	X			
Supply Dips (7.3)		X	X			
Engine Cranking (7.4)		X	X			
Supply Ramp Up (7.5)		X	X	X		
Supply Ramp Down (7.6)		X	X	X		
Supply Over Voltage						
Full-Fielded Alternator (8.1)	X	X	X	X	X	X
Jump Start (8.2)	X	X	X	X	X	X
Load Dump (8.3)	X	X	X	X	X	X
Reverse Supply Voltage (8.4)	X	X	X	X	X	X
System Compatibility						
Short Circuit – Supply (9.1)		X	X			
Short Circuit – I/O (9.2)		option	option			
Overload (9.3)		option	option			
Supply Voltage Offset (9.4)		X	X			
Ground Offset (9.5)		X	X			
Motors and Inductive Devices						
Operating and Stress (10.1)				X	X	X
Stall (10.2)				X	X	

End of Annex A
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Annex B (informative)

ADDITIONAL INFORMATION

Related DaimlerChrysler Standard

DS-108, Vehicle Grounding Requirements for Electrical and Electronic Systems

End of Annex B
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