BENCH TEST METHOD FOR ELECTRIC NOISE OF AUTOMOTIVE ELECTRONIC DEVICES

1. Scope

This standard covers bench test methods for the electric noise of electronic devices used in automobiles.

2. Definitions

The definitions of major terms used in this standard are as follows:

(1) Automotive electronic devices
"Automotive electronic devices" are mainly the devices containing semiconductor elements used for system control, as well as various detection devices (sensors), electromagnetic devices (actuators), etc. used in combination with such devices.

(2) Service voltage range
"Service voltage range" is a range of power supply voltage that assures normal operation (or performance within the design tolerance) of the devices. Unless otherwise specified, the range shall be 10 to 16 V for 12 V type vehicle devices and 20 to 32 V for 24 V type vehicle devices.

(3) Characteristics
"Characteristics" are numerical values or correlation pertaining to a given device which can be measured or judged quantitatively or qualitatively under a specified condition.

(4) Standard state
"Standard state" is a commonly used testing environment. Unless otherwise specified, this state is a combination of normal temperature (5 to 35 °C) and normal pressure (86 to 106 kPa).

(5) Sample
"Sample" is an electronic device to be used for the test.

(6) Initial measurement
"Initial measurement" is a measurement to be conducted before the test.

(7) Final measurement
"Final measurement" is a measurement to be conducted after the test.

(8) Alternator with Zener diode
"Alternator with Zener diode" is an alternator equipped with a Zener diode in place of rectifier for the purpose of cost reduction by disusing or reducing the weight of surge absorption element inserted into the power supply circuit of ECU. By adopting the Zener diode, the positive pole surge voltage at battery dislocation can be suppressed to a level of 35 V or less.

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3. Test Items

Test items specified in this standard are as follows:

(1) Power supply voltage characteristics test
(2) Field decay test
(3) Floating ground test
(4) Induction noise resistance test
(5) Load dump test
(6) Overvoltage test
(7) Ignition pulse test
(8) Reversed polarity test

4. Test Environment

Unless otherwise specified, each test shall be conducted in the standard state.

Remark:
Vibration, temperature, humidity, atmospheric pressure, salt water, dust, oil, gasoline, exhaust gas, cooling water, windshield washer liquid, etc. are considered as the environmental factors which may affect the automotive electronic devices. If the device to be tested is susceptible to these environmental factors while on the vehicle, it is necessary to take them into account when setting the test conditions.

5. Test Method

5.1 Power Supply Voltage Characteristics Test

5.1.1 Purpose

This section specifies the standard test method for evaluating the characteristics of electronic devices with respect to the fluctuation in the power supply voltage.

5.1.2 Test Conditions

(1) The atmospheric pressure shall be that of the standard state.
(2) The temperature shall be 20±3 ℃, as a rule. However, if the temperature characteristics of the device have been identified and are known to be stable in the normal temperature range (5 to 35 ℃), the test may be conducted at any temperature within this range.

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5.1.3 Test System

The power supply to be used for this test shall be a constant voltage power supply capable of assuring a precision of 0.1 V in the range of 6 to 16 V or 6 to 32 V.

5.1.4 Test Method

(1) Voltage

Unless otherwise specified, the characteristics shall be measured at voltages ranging from the minimum to the maximum of the service voltage range of the sample at 2.0 V intervals, with 14.0 V (for 12 V type vehicles) or 28.0 V (for 24 V type vehicles) taken as the central value. In a voltage range where the characteristics change markedly, however, the measurement shall be conducted at 0.5 or 1.0 V intervals.

(2) Measurement

Measurement shall be conducted at each voltage level as specified in the testing standard for the sample.

5.2 Field Decay Test

5.2.1 Purpose

This section specifies the test method for evaluating the capability of electronic devices to withstand the field decay noise discharged from the field coil of alternator and various types of negative surge discharged from the inductive load.

5.2.2 Initial Characteristics

Measurement shall be conducted as specified in the testing standard for the sample.

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5.2.3 Test

(1) Test system

The test system shown in Fig. 1 shall be used for this test. In this system, the relay contacts are interlocked with the SCR (thyristor) to supply a negative surge to the sample. The relay should be so adjusted that the contact c reaches contact b within 1.0±0.5 ms after being disconnected from contact a, and the voltage of -600 V will be applied from the spark-simulating circuit via resistor of 300±10 Ω within this 1.0±0.5-ms period of time.

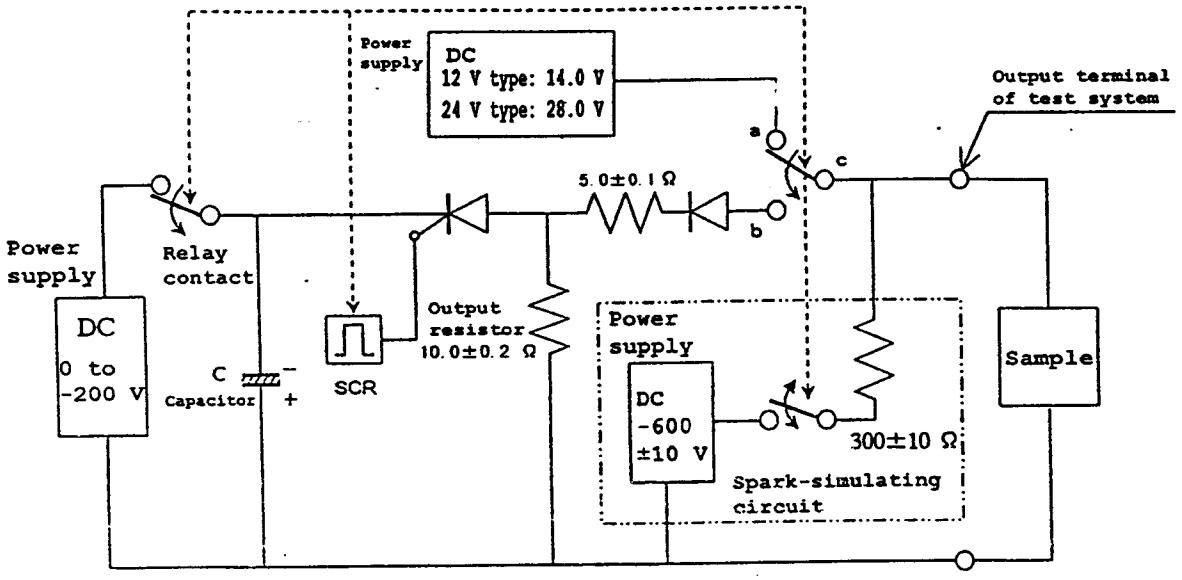

Fig. 1 Field Decay Test System (Example)

(2) Test method

When connecting a resistor of 25.0±0.5 Ω or 1.00±0.02 kΩ to the output terminal of the test system, the sample shall be connected after adjusting the power supply voltage and the capacitor C such that the value of Vp, Vs and τ of the output waveform shown in Fig. 2 shall be as indicated in Table 1.

Table 1 Peak Value for Field Decay Test

Load resistance	When connected with 25.0±0.5 Ω resistor	When connected with 1.00±0.02 kΩ resistor
Vp (V)	-100±2	-120±2
Vs (V)	-46±1	-462±10
τ (s)	0.020±0.001	Not specified

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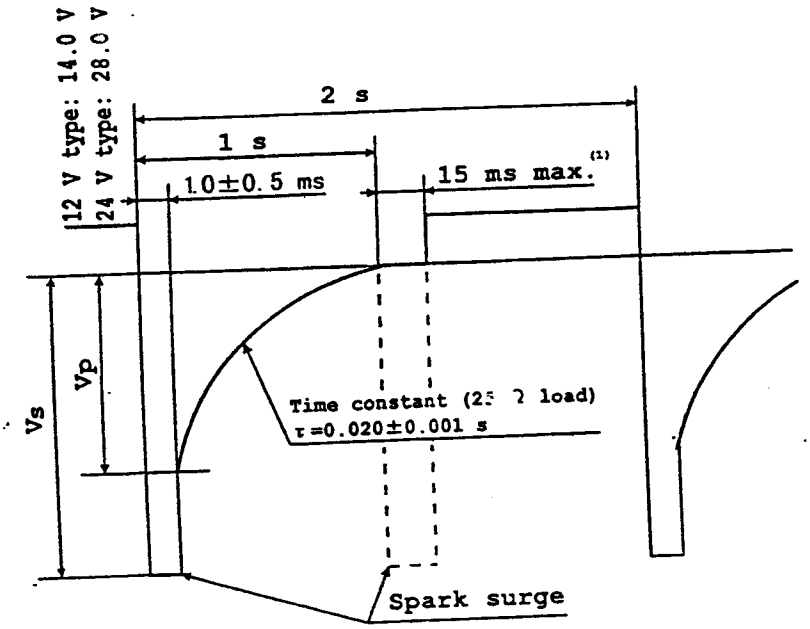

Fig. 2 Field Decay Output Waveform

Note:(1)
0 V is allowable during 15 ms of chattering.

The sample shall be connected to the terminal and checked for proper operation as specified in the testing standard for the sample. The standard number of times of test is 50000 times. In the case of an electronic device having many power input terminals, the test should be performed for each terminal and the combination thereof, unless otherwise specified. Fig. 3 shows some examples for connecting to the terminals.

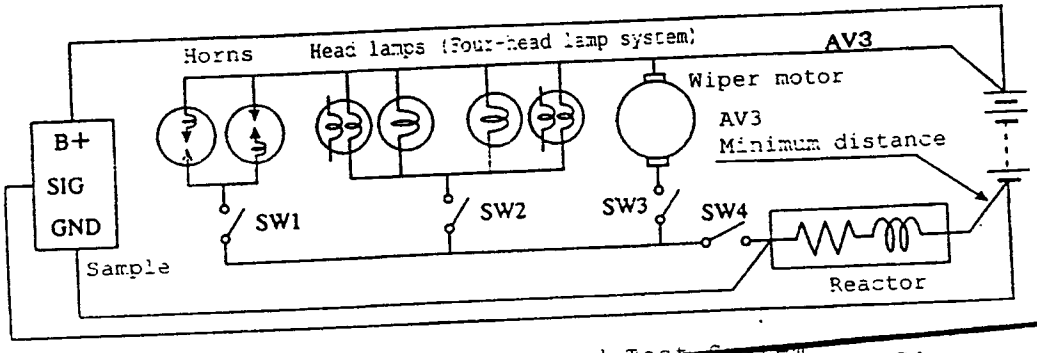

Fig. 3 Floating Ground Test System

5.2.4 Final Measurement

Measurement shall be conducted as specified in the testing standard for the sample.

5.3 Floating Ground Test

5.3.1 Purpose

The ground terminal of electronic device is in many cases grounded to the vehicle body by means of a wiring harness which also connects other electrical parts, and is not necessarily of the same electric potential as the vehicle body while the power is on due to the resistive inductance at the portion where the wiring harness is grounded. This test is conducted for the purpose of confirming roper operation of the electronic device in the case where the electric potential of the ground terminal of the device fluctuates.

5.3.2 Initial Characteristics

Measurement shall be conducted as specified in the testing standard for the sample.

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5.3.3 Test

(1) Test system

The test system shown in Fig. 4 shall be used for this test.

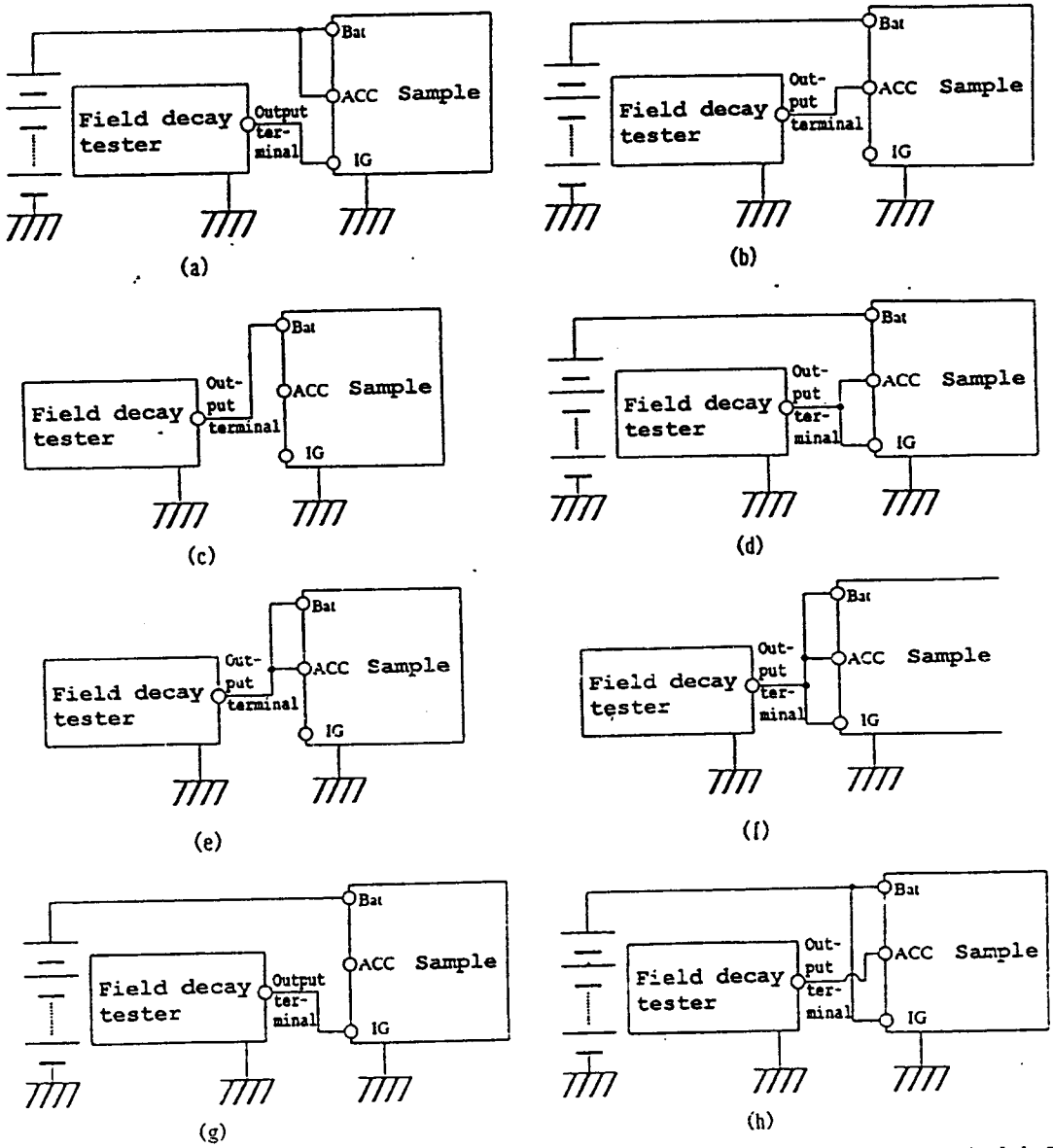

Fig. 4 Combination of Terminals When Negative Surge Is Applied in Field Decay Test (Example)

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The battery shall be fully charged. A reactor with a direct current resistance of R=50±2 mΩ and an inductance of L=10±1 μH shall be used for the dummy ground. The electric horn of part No.86510-33160 shall be used for the Hi-tone and of part No.86520-33100 for the Low-tone, and connected in parallel with the polarity of each of them reversed. For switching ON and OFF of the horns, horn relay of part No.90987-02012 shall be used. For head lamps, two lamps of part No.90080-81041 and 90080-81040 shall be used as connected in parallel. For switching ON and OFF of the head lamps, head lamp relay of part No.90987-02016 shall be used. The wiper motor of part No.85110-42110 shall be used in a locked state. For switching ON and OFF of the wiper motor, combination switch of part No.84652-52010 shall be used. When testing the electronic devices for 24 V type vehicles, the electric horns, head lamps, wiper motor and the relays and switches that are mounted on the vehicle model for which the concerned electronic devices will be adopted or equivalent parts shall be used.

(2) Test method

(a) SW4 shall be turned ON and OFF 10 times under each of the 7 load conditions by setting SW1, SW2 and/or SW3 ON and OFF.

(b) SW4 shall be kept ON for 1 s and then OFF for 5 s minimum under each load condition.

(c) If the battery voltage drops to 11.0 V or below (22.0 V or below in the case of devices for 24 V type vehicles), test shall be suspended and the battery shall be charged.

(d) The terminal of sample shall be connected and the sample checked for proper operation as specified in the testing standard for the sample.

5.3.4 Final Measurement

Measurement shall be conducted as specified in the testing standard for the sample.

5.4 Induction Noise Resistance Test

5.4.1 Purpose

It is possible for the electronic devices to malfunction or to cause self-oscillation by picking up the surge noise generated by the electronic devices. This test combines the representative sources of electrical noise that can occur on vehicle.

5.4.2 Initial Characteristics

Measurement shall be conducted as specified in the testing standard for the sample.

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5.4.3 Test

(1) Test system

The test system shown in Fig. 5 shall be used for this test. The 10 m-long wiring harness is a bundle of three AV3 and three AV0.5 wires wrapped with tape. A fully charged battery shall be used.

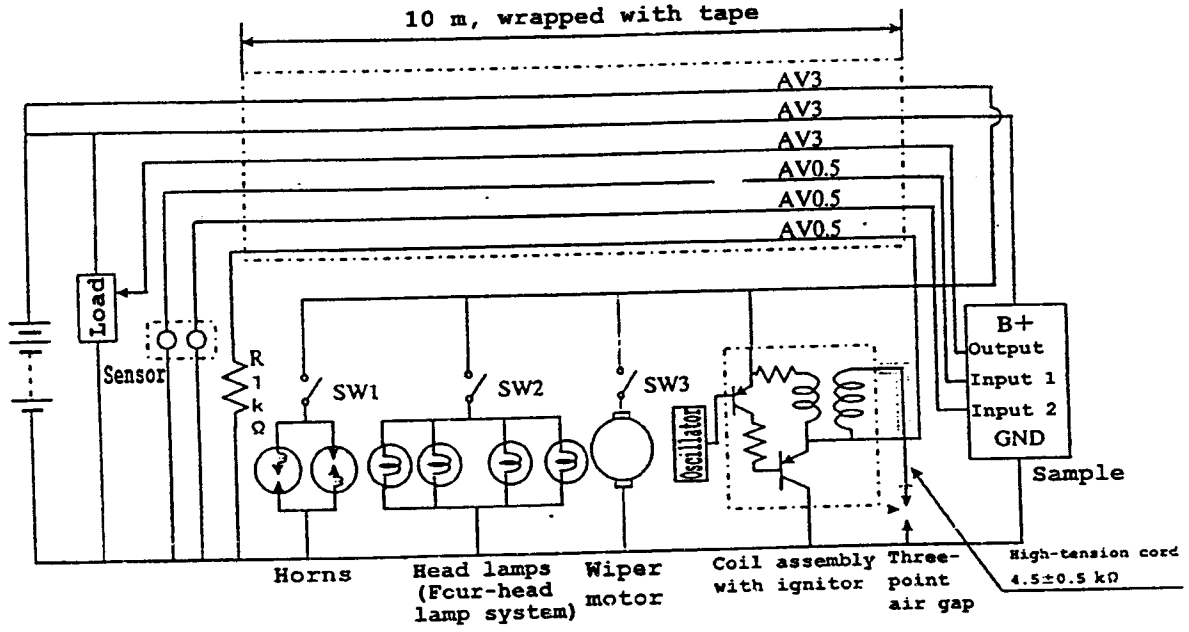


Fig. 5 Induction Noise Resistance Test System

The electric horn of part No.86510-33160 shall be used for the Hi-tone and of 86520-33100 for the Low-tone, and connected in parallel with the polarity of each of them reversed. For switching ON and OFF of the horns, horn relay of part No.90987-02012 shall be used. For head lamps, two lamps of part No.90080-81041 and 90080-81040 shall be used as connected in parallel. For switching ON and OFF of the headlamps, headlamp relay of part No.90987-02016 shall be used. The wiper motor of part No.85110-42110 shall be used in a lock state. For switching ON and OFF of the wiper motor, combination switch of part No.84652-52010 shall be used. The coil assembly with ignitor of parts No.89620-40030 and 90919-02106 shall be used in combination, or a TYPE III-equivalent shall be used. The three-point air gap shall be configured as shown in Fig. 6 and shall be so adjusted that a discharge voltage of 22.5± 5.0 kV is generated. A high-tension cord with a resistance value of 4.5± 0.5 kΩ shall be used for connecting the ignition coil and the three-point air gap. An example of the output waveform of the oscillator is shown in Fig. 7. When testing the electronic devices for 24 V type vehicles, the electric horns, headlamps, wiper motor and the relays and switches that are mounted on the vehicle model or equivalent parts shall be used.

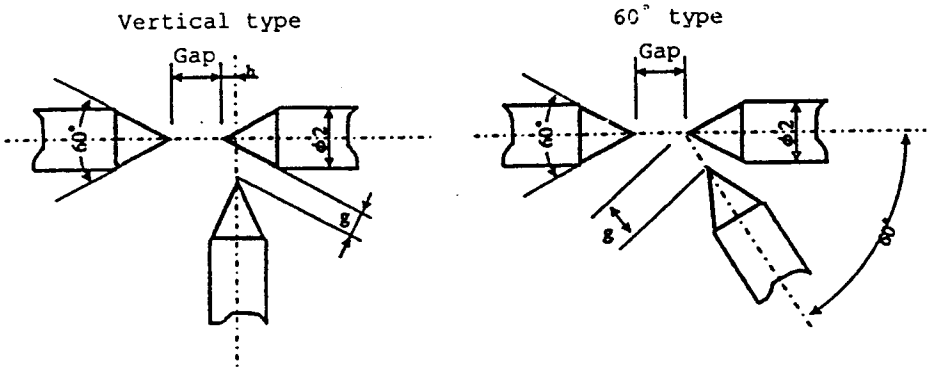
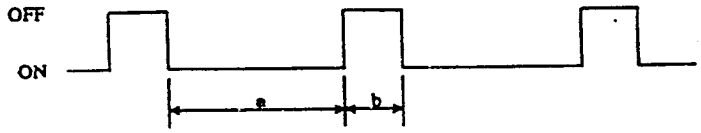


Fig. 6 Three-Point Air Gap

Remark 1:
With vertical type, h shall be adjusted to fall within the range of 0 to 2 mm and g within the range of 0.2 to 1 mm. With 60° type, g shall be adjusted to fall within the range of 0.2 to 1 mm.
Remark 2:
The tip of electrodes shall be sharpened.



Example

Assumed revolution speed	a	b
2000 r/min	4 ms	1 ms
666 r/min	20 ms	10 ms

Fig. 7 Output Waveform of Oscillator

(2) Test method
(a) Turn ON and OFF SW1 in Fig. 5 10 times minimum with SW2 and SW3 OFF. Test also SW2 and SW3 similarly.
(b) The switch shall be kept ON for 1 s and then OFF for 5 s minimum after the 10 switching operations.
(c) If the battery voltage drops to 11.0 V or below (22.0 V or below in the case of devices for 24 V type vehicles), test shall be suspended and the battery shall be charged.
(d) The terminal of sample shall be connected and the sample checked for proper operation as specified in the testing standard for the sample.

5.4.4 Final Measurement
Measurement shall be conducted as specified in the testing standard for the sample.

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5.5 Load Dump Test

5.5.1 Purpose

This test is conducted to evaluate the resistance of electronic devices with respect to the positive high-voltage pulse generated due to the dislocation of battery terminals. The positive high-voltage pulse generated on the vehicle is a summation of high-repeating pulse (ignition noise) and giant pulse (positive pole surge) voltage. The giant pulse voltage is generated upon rapid reduction in the load on the alternator. The high voltage pulse is generated at such instances as the dislocation of battery terminals during the charging of battery with large current by the alternator operating at high speed or the rapid reduction in other electrical loads while the battery terminals are disconnected.

5.5.2 Initial Characteristics

Measurement shall be conducted as specified in the testing standard for the sample.

5.5.3 Test 1

(1) Test system

The test system shown in Fig. 8 shall be used for this test. A 30 A high-speed diode (equivalent to NEC30RH4S) shall be used.

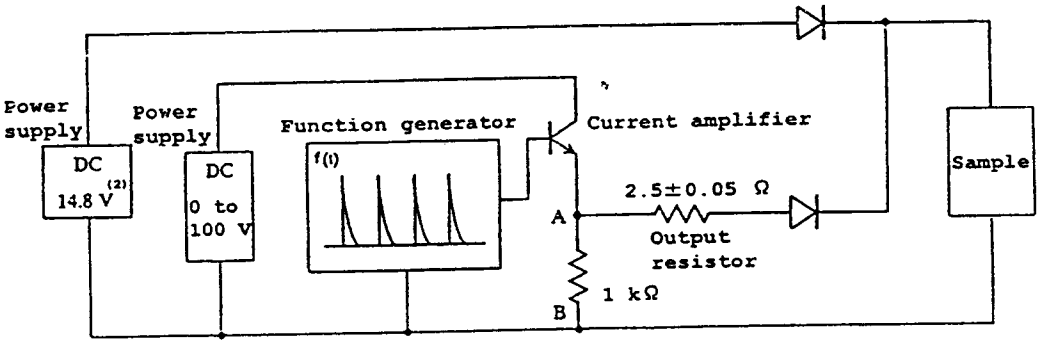

Fig. 8 Load Dump Test System 1

Note: (2)
29.6 V for 24 V type vehicles

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(2) Test method

Connect the sample to the load dump test system 1 shown in Fig. 8. Adjust the test system so that the waveform of the high-repeating pulse voltage between A and B, V_{AB}, meets the requirements given in Fig. 9. The pulse peak voltage V_{IP} shown in Fig. 9 is 80±2 V. Set the sample in its normal operating conditions. The standard test time is 10 min.

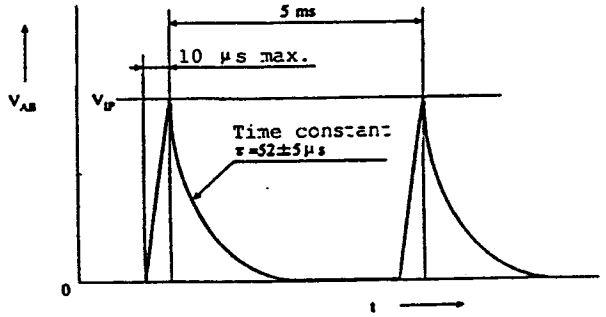

Fig. 9 High-Repeating Pulse Voltages Waveform V_{AB}

5.5.4 Test 2

(1) Test system

The test system shown in Fig. 10 shall be used for this test. A 30 A high-speed diode (equivalent to NEC30RH4S) shall be used.

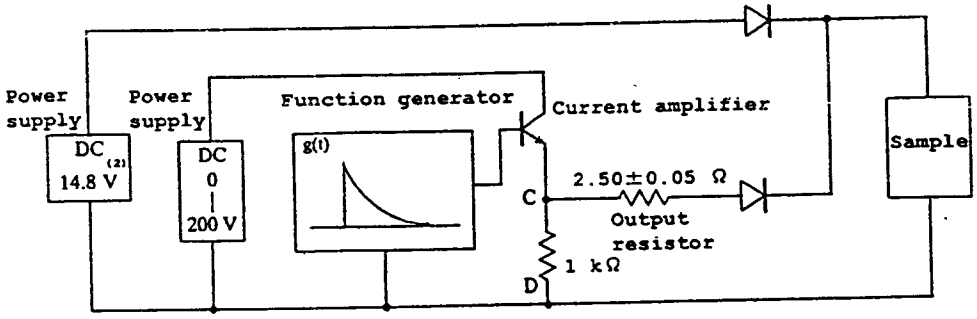

Fig. 10 Load Dump Test System 2

(2) Test method

Connect the sample to the load dump test system 2 shown in Fig. 10. Adjust the test system so that the waveform of the giant pulse voltage between C and D, V_{CD}, meets the requirements given in Fig. 11. The pulse peak voltage V_{GP} shown in Fig. 11 is classified into three levels (levels A, B and C) as shown in Table 2. The standard test method is to continuously apply the giant pulse voltage 10 times at 1 min intervals to the sample in its normal operating conditions.

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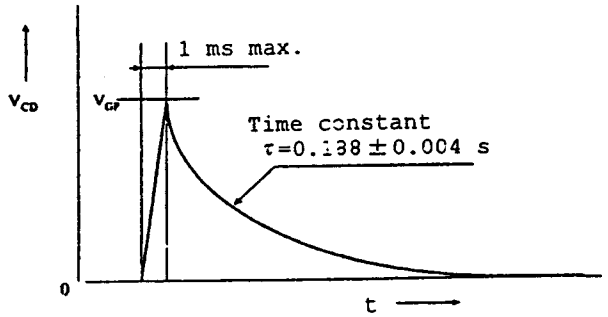

Fig. 11 Giant Pulse Voltage Waveform V_{CD}

Table 2 Classification of Load Dump Test 2

Level	Peak voltage V_{GP} (V)
A	50±2
B	80±2
C	110±2

5.5.5 Test 3

(1) Test system

The test system shown in Fig. 12 shall be used for this test. A 30 A high-speed diode (equivalent to NEC30RH4S) shall be used. A 30 V power supply shall have sufficient output current capacity so that no voltage drop will be caused even when the sample is connected. Although the switching speed of the switch (SW) is not specified, a switch which does not develop chattering (such as thyristor) shall be used.

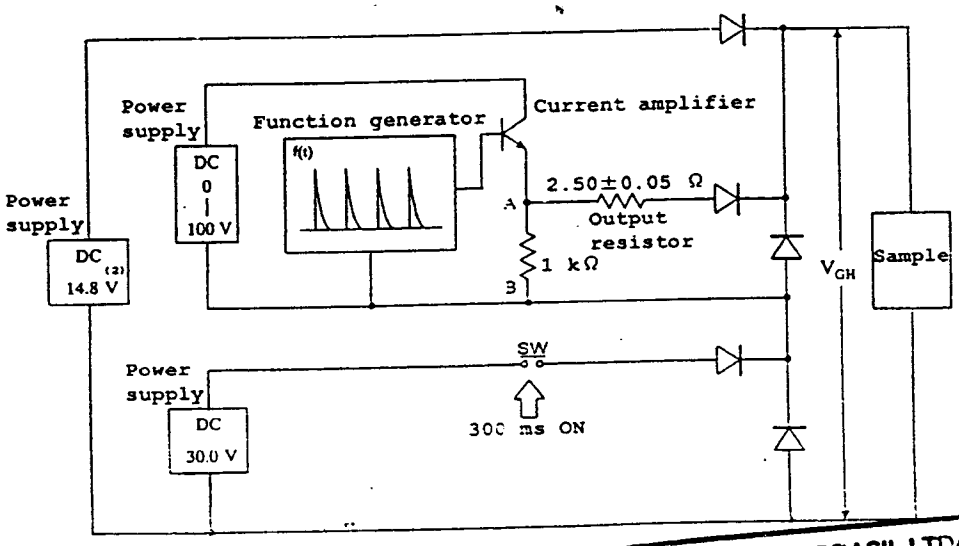

Fig. 12 Load Dump Test System 2

(2) Test method

Connect the sample to the load dump test system 3 shown in Fig. 12. Adjust the test system so that the waveform of the high-repeating pulse voltage between A and B, V_{AB}, meets the requirements given in Fig. 9. The pulse peak voltage V_{IP} shown in Fig. 9 is 80±2 V. Adjust the test system so that the waveform of the positive pole surge voltage, V_{GH}, meets the requirements given in Fig. 13. The surge voltage V_{SP} shown in Fig. 13 is 30^{+0}_{-1} V. The standard test method is to apply the high-repeating pulse continuously and the positive pole surge 10 times at 1-min interval to the sample set in its normal operating conditions.

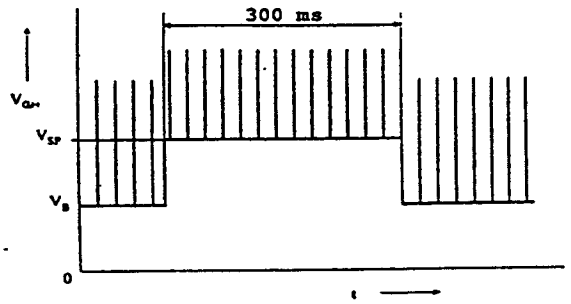

Fig. 13 Positive Pole Surge Voltage Waveform V_{GH}

5.5.6 Final Measurement

Measurement shall be conducted as specified in the testing standard for the sample.

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5.5.7 Application

The appropriate test method shall be selected from the test 1 to test 3 specified in Section 5.5.3 to Section 5.5.5 in accordance with the testing standard for the concerned electronic device. Given below in Table 3 is the guideline to the selection of appropriate test.

Table 3 Guideline to Selection of Load Dump Test

Classification	Both test 1 specified in Section 5.5.3 and test 2 specified in Section 5.5.4	Only test 3 specified in Section 5.5.5
Electronic devices to be used only on the vehicle adopting alternator with Zener diode	△	○
Electronic devices to be used on both the vehicle adopting alternator with Zener diode and the vehicle adopting alternator without Zener diode	○	×
Electronic devices to be used only on the vehicle adopting alternator without Zener diode	○	×

Remark:
○; To be performed
△; May be selected
×; Must not be selected

5.6 Overvoltage Test

5.6.1 Purpose

This test is conducted to evaluate the resistance of electronic devices against the overvoltage occurring at the time of so-called "jump start", by cranking with two 12 V batteries (for 12 V type vehicles) or four 12 V batteries (for 24 V type vehicles) connected in series.

5.6.2 Initial Characteristics

Measurement shall be conducted as specified in the testing standard for the sample.

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5.6.3 Test

The overvoltage specified in the testing standard for the sample shall be applied for the time specified to the sample set in its normal operating conditions at the time of vehicle start-up. If no such overvoltage is specified, 24.0±0.5 V shall be applied for 12 V type vehicles and 48.0±0.5 V shall be applied for 24 V type vehicles for $1.0^{+0.5}_{-0.0}$ min, respectively.

5.6.4 Final Measurement

Measurement shall be conducted as specified in the testing standard for the sample.

5.7 Ignition Pulse Test

5.7.1 Purpose

This test is conducted to evaluate the resistance of electronic devices with respect to the ignition pulse in the cases where the electronic devices are subject to the ignition pulse. This test is applicable only to the electronic devices which will be mounted in the engine compartment or those subject to possible application of ignition pulse via wire harness in the engine compartment. Carry out test 1 or 2 according to types of D-TDI ignition systems that are ignited by positive and negative spark discharges. Carry out test 1 for a device to be mounted on a vehicle adopting a twin-tower type ignition system, and test 2 for a device to be mounted on a vehicle adopting other one. If the ignition system to be mounted cannot be specified, carry out both test 1 and test 2.

5.7.2 Initial Characteristics

Measurement shall be conducted as specified in the testing standard for the sample.

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5.7.3 Test 1

(1) Test system

The system shown in Fig. 14 shall be used for this test. The coil assembly with ignitor of part No.90919-02217 or a TYPE III-equivalent shall be used. Should the type of coil assembly with ignitor be limited for use on vehicle, however, the appropriate type of coil assembly specified for the concerned application shall be used. The three-point air gap shall be configured as shown in Fig. 6 and shall be so adjusted that a discharge voltage of 12.5± 5.0 kV is generated. The oscillator shall generate the output waveform shown in Fig. 7.

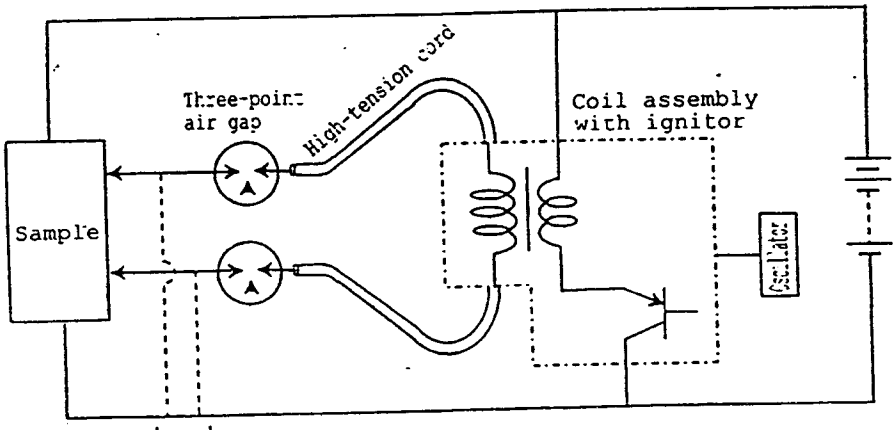

Fig. 14 Ignition Pulse Test System 1

(2) Test method

The sample shall be set in the operating conditions as specified in its testing standard and the three-point air gap shall be connected to the terminal as specified in its testing standard. Then, discharge at the three-point air gap for 30 s. Carry out the test for following cases, respectively.

① Apply positive pole discharge
② Apply negative pole discharge
③ Apply bipolar discharge combined with each terminal

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5.7.4 Test 2

(1) Test system

The system shown in Fig. 15 shall be used for this test. The coil assembly with ignitor of parts No.89620-40030 and 90919-02106 shall be used in combination, or a TYPE III-equivalent shall be used. Should the type of coil assembly with ignitor be limited for use on vehicle, however, the appropriate type of coil assembly specified for the concerned application shall be used. The three-point air gap shall be configured as shown in Fig. 6 and shall be so adjusted that a discharge voltage of 22.5±5.0 kV is generated. An example of the output waveform of the oscillator is shown in Fig. 7. A high-tension cord of part No.90919-13296 shall be used.

(2) Test method

The sample shall be set in the operating conditions as specified in its testing standard and the three-point air gap shall be connected to the terminal as specified in its testing standard. Then, discharge at the three-point air gap for 30 s.

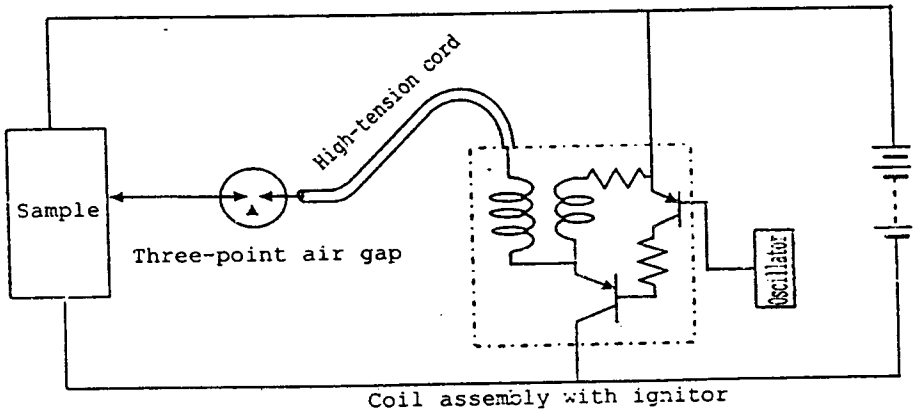

Fig. 15 Ignition Pulse Test System 2

5.7.5 Final Measurement

Measurement shall be conducted as specified in the testing standard for the sample.

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5.8 Reversed Polarity Test

5.8.1 Purpose

This test is conducted to investigate the behavior of electronic devices in the event the polarity of battery has been mistaken in its connection, targeting mainly at preventing the smoking of electronic devices and/or the burning damage of wire harness.

5.8.2 Initial Characteristics

Measurement shall be conducted as specified in the testing standard for the sample.

5.8.3 Test

The sample shall be connected in reverse polarity in the standard state and let stand for 30 s as energized. For the power supply, 1 fully charged lead acid battery (55D23-equivalent) shall be used for 12 V type vehicles and 2 batteries connected in series shall be used for 24 V type vehicles. The parts for the wiring (fusible links, wiring harness, fuses, connectors) and the wiring conditions shall be the same as those for actual vehicle.

5.8.4 Final Measurement

Measurement shall be conducted as specified in the testing standard for the sample. Unless otherwise specified, the sample shall be checked for its appearance and internal conditions, particularly for flame resistance.

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