General rules of environmental testing methods for automotive electronic equipment

1. Scope

This standard specifies a uniform test method in order to evaluate the performance of automotive electronic equipment (hereinafter referred to as "equipment") under various environmental conditions, which use a power supply of nominal voltage 12V or 24V system.

Applicable standards :

JIS C 0023 — Basic Environmental Testing Procedures Part 2 : Test-Test Ka : Salt Mist

JIS C 0044 — Basic Environmental Testing Procedures Part 2 : Test-Test Ed: Free Fall

JIS C 0912 — Shock Testing Procedure for Electric Machines and Equipment

JIS C 1102 — Electric Indicating Instruments

JIS D 0203 — Method of Moisture, Rain and Spray Test for Automobile Parts

JIS D 0207 — General Rules of Dust Test for Automobile Parts

JIS D 1601 — Vibration testing method for automobile parts

JIS K 6301 — Physical Testing Methods for Vulcanized Rubber

JIS Z 8703 — Standard Atmospheric Conditions for Testing

JIS Z 8901 — Dusts and aerosols for industrial testing

2. Definitions

Definitions of major terms used in this standard are as follows :

(1) Automotive electronic equipment
The general term for electronic device and system including electric/electronic sensors, control units (or computers), displays, audio-visual devices, etc. having structures and shapes that can be installed on the automobile.

(2) Normal power supply voltage
Power supply voltages within a voltage range in which an equipment should maintain its performance normally.

(3) Abnormal power supply voltage
Any power supply voltage outside of the normal power supply voltage range, which is impressed temporarily on the equipment, due to the reversed connection of battery, failure of voltage regulator, jumper-start under the cold weather, etc. However, voltages that are induced and impressed by transient voltages and electro-magnetic disturbances are not included.

(4) Transient voltage
Any transient voltage that generates in the power supply circuit of the equipment when some change occurs in the electric circuit including the equipment and reaches to steady-state condition, or a voltage that generates in the circuit of the equipment by induction due to the effect of high voltage cable, etc.

(5) Electromagnetic disturbance
A disturbance that causes the deterioration of performance, malfunction, destruction, etc. by direct or indirect interference to the equipment due to the conduction, radiation, etc. under strong electromagnetic environmental conditions.

3. Classification of tests

The classification of tests shall be in accordance with **Table. 1**

4. General requirements

4.1 Atmospheric conditions of testing room

In respect of conditions of the testing room, unless otherwise specified, it shall be at the normal temperature (20 ± 15 ℃) and the normal humidity [(65 ± 20)%] specified in **JIS Z 8703**.

Table 1 Class of tests

Characteristics	Classification of tests	Test item No.
Normal power supply voltage operation	Normal power supply voltage test	5.1
	Test for power supply voltage upon engine starting	5.2
	Power source micro interruption test	5.3
Abnormal power supply voltage resistance	Power supply inverse polarity connection test	5.4
	Over voltage test (A method)	5.5
	Over voltage test (B method)	5.6
Transient voltage immunity	Transient voltage characteristics test	5.7
	Electrostatic test	5.8
Electromagnetic immunity	Conducted electromagnetic test	5.9
	Radiated electromagnetic test	5.10
Low/high temperature resistance	Temperature characteristics test	5.11
	Low temperature maintain test	5.12
	Low temperature operation test	5.13
	High temperature maintain test	5.14
	High temperature operation test	5.15
	Heat cycle test	5.16
	Thermal shock test	5.17
Humidity resistance	Temperature and humidity cycle test	5.18
	Constant high humidity test	5.19
Water resistance	Dew formation test	5.20
	Water resistance test	5.21
Salt water resistance	Salt water spray test	5.22
Vibration resistance	Vibration test	5.23
Shock resistance	Shock resistance test	5.24
Dust resistance	Dust resistance test	5.25
Oil resistance	Oil resistance test	5.26

4.2 Test apparatus

Unless otherwise specified, any apparatus specified as follows.

(1) Ammeter

The accuracy shall be in class equal to or higher than 0.5 in accordance with the **4.1** (Allowable Accuracy) of **JIS C1102**.

(2) Voltmeter

The accuracy shall be in class equal to or higher than 0.5 in accordance with the **4.1** (Allowable Accuracy) of **JIS C1102**.

(3) Power supply device

Power source supply device from which required DC power is stably available (battery and any other similar equipment, the internal impedance of which is so low as same as the battery), the supplied voltage is variable within a range from 8 to 38V, the voltage fluctuation of the power supplied is within a range of ± 0.3V during operation of external equipment.

(4) Input device

Device, its performance is equivalent to the signal generating equipment such as sensors employed on the actual vehicle in connection with the test specimen, but not limited to such sensors.

(5) Loading device

Device, its performance is equivalent to the passive equipment such as actuators employed on the actual vehicle in connection with the test specimen but not limited to such actuators.

Where any imitated load may be employed over such specimen, should any effect be directly given to the result of testing.

4.3 Test specimen

Test specimen shall have been adjusted as required in accordance with the specification in advance before testing as required in accordance with **5.1** of this standard.

4.4 Test voltage and maintenance

Unless otherwise specified, the test shall be carried out at 14V (12V system) and at 28V (24V system), where the voltage shall be monitored after having been set, by means with the voltmeter specified in the **(2)** of **4.2** above, which shall also correctly be maintained during testing.

5. Test methods

5.1 Normal power supply voltage test

5.1.1 Purpose

A test to evaluate the characteristics of the equipment within the range of normal power supply voltage.

5.1.2 Test apparatus

A power supply device, input device(s) and loading device(s).

5.1.3 Operation

After connecting the power supply device, input device and loading devices to the test specimen, and voltage within a range from 10V to 16V (12V system) and 20 to 32V (24V system) shall be applied respectively to the test specimen, the specimen shall be tested for its characteristics respectively at the lowest voltage, highest voltage and any voltage between such highest and lowest voltages within the range, the results obtained from which shall be recorded.

5.2 Test for power supply voltage upon engine starting

5.2.1 Purpose

A test to evaluate the characteristics of the equipment being required to activate at a low supply voltage upon engine starting.

5.2.2 Test apparatus

The power supply system to generate the test voltages specified in **Table 2**, input device(s) and loading device(s).

5.2.3 Operation

After connecting the power supply device, input device and loading devices to the specimen (as shown on **Fig. 1.2** and **Fig. 2.2**), and voltage designated on **Table 2** shall be applied to the test specimen, the specimen shall be tested at the voltage in **Table 2**, the results obtained from which shall be recorded.

Table 2 Test conditions for power supply voltage upon starting

Classifications		Test conditions		
		V_1(V)	V_2(V)	f (Hz)
12V system	Class 1	6	8	1~5
	Class 2	5		
24V system		10	16	

Remark Application of class 1 or Class 2 voltage shall be as follows :
Class 1 : Equipment for a normal specification vehicle
Class 2 : Limited to equipments of special specification vehicles under the agreement between the persons concerned
where, V_1 : Minimum voltage
V_2 : Maximum voltage
f : Frequency of repetition

Fig. 1 Test method (1)

Fig. 1.1 Test voltage waveform

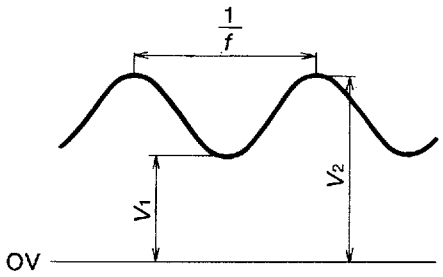


Fig. 1.2 Test arrangement

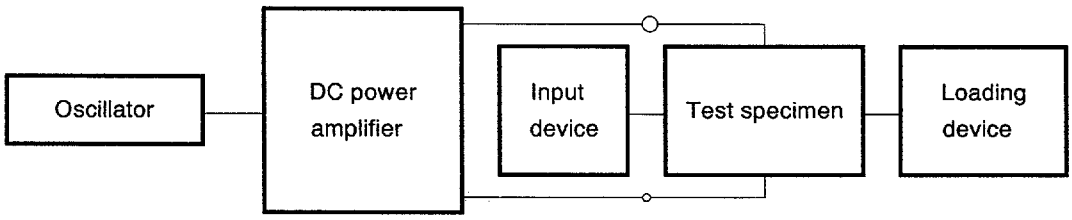


Fig. 2 Test method (2)

Fig. 2.1 Test voltage waveform

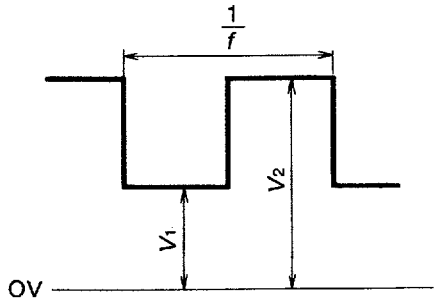
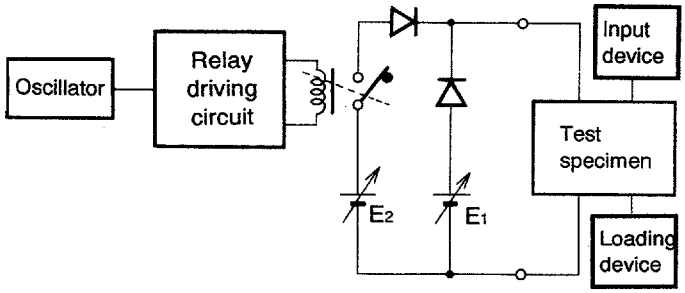


Fig. 2.2 Test arrangement



where, E_1: Power supply device of V_1
E_2: Power supply device of V_2

5.3 Power source micro interruption test

5.3.1 Purpose

The test to evaluate the special behavior of the equipment against any micro interruption of power supply from the source equipment due to any reason attributable to chattering at the contact point(s) on the electric circuit.

5.3.2 Test apparatus

Power source equipment for micro interruption test, the power output of which shall be interrupted for 1 ms. Input device(s) and loading device(s).

5.3.3 Operation

After the power source micro interruption equipment, input device and loading devices having been connected therewith (as shown on **Fig. 3**). The test specimen shall be operated under the test voltage having been applied thereto, after the operation of test specimen is stabilized, output of power source micro interruption equipment shall be micro interrupted and whether any abnormity exist or not of specimen shall be confirmed and recorded.

5.4 Power supply inverse polarity connection test

5.4.1 Purpose

A test to evaluate voltage resistance characteristics of the equipment when the battery was connected with a reverse polarity.

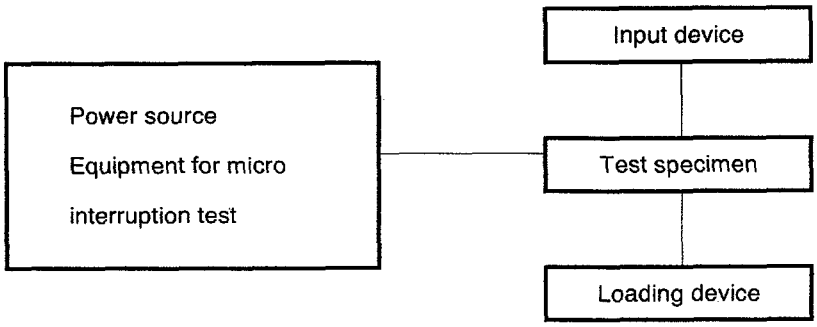
5.4.2 Test apparatus

A power supply device, input device(s) and loading device(s).

5.4.3 Operation

After the input device and loading devices have been connected with the test specimen, and the power supply device shall reversely be connected with the specimen for 1 minute so as for the voltage thus applied to be kept respectively at 13V for the specimen of 12V system and 26V for it of 24V system, then after the power supply device has been disconnected therewith, the test specimen shall be tested for characteristics in accordance with 5.1 of this standard, where the results in respect of the specific performance shall be recorded.

Fig. 3 Arrangement of power source micro interruption test



5.5 Overvoltage test (A method)

5.5.1 Purpose

A test to evaluate the voltage resistance of the equipment when the voltage regulator has failed and an overvoltage is applied to the equipment.

5.5.2 Test apparatus

A power supply device, input device(s) and loading device(s).

5.5.3 Operation

After connecting the power supply device, input device and loading devices to the test specimen, and test specimen shall be so operated respectively at a test voltage of 18V for the 12V system and at 36V for the 24V system that whether any abnormality is available or not be verified. Should any abnormality be detected, the duration of time when the voltage has been kept applied and the conditions thereat shall be recorded. In case where no abnormality is found after applying the test voltage for 60 minutes, record it and the test may be stopped.

5.6 Overvoltage test (B method)

5.6.1 Purpose

A test to evaluate the voltage resistance of the equipment when two batteries of nominal voltage 12V (for 12V system) or three batteries (for 24V system) are connected in series.

5.6.2 Test apparatus

A power supply device, input device(s) and loading device(s).

5.6.3 Operation

After connecting the input and loading devices to the test specimen, apply a test voltage 24V (for 12V system) or 36V (for 24V system) for one minute. Removing the power supply device, carry out the test specified in **5.1** of this standard and record the characteristics of the test specimen.

5.7 Transient voltage characteristics test

5.7.1 Purpose

A test to evaluate characteristics of the equipment when transient voltage is applied.

5.7.2 Test apparatus

An apparatus to generate test voltage prescribed in **Table 3** (refer to **Fig. 4** through **Fig. 10**), a power supply device, input device(s) and loading device(s).

5.7.3 Operation

Connect the input and loading device(s) to the test speciment so that the equipment may operate during the test; connect the assembly to the test apparatus specified in **5.7.2** and activate the equipment under the condition being applied the test voltage specified in Table 3; examine whether there are any abnormalities or not, and record the characteristics of the equipment.

Table 3 Conditions of transient voltage test

Classification	Type of test		Test conditions						Number of pulses	Location of transient voltage impresion
			V_p(V)	τ (μ s)	f(Hz)	R_i(Ω)	Wave-form	Transient voltage generating circuit		
12V system	TypeA	A-1	70	200,000	—	0.8	Fig. 4	Fig. 5 and Fig. 6	1 pulse	Power supply terminal
		A-2	110	2.5	1/30	0.4		Fig.6	10 pulses	
	TypeB	B-1	− 80	60,000		8	Fig. 7	Fig.8	100 pulses	
		B-2	− 260	2,000		80				
	Type C		As agreed between the persons concerned					Fig. 9 and Fig. 10	*	Related terminal
24V system	TypeD	D-1	110	400,000	—	1.5	Fig. 4	Fig. 5, Fig.6	1 pulse	Power supply terminal
		D-2	170	2.5	1/30	0.9		Fig.6	10 pulses	
	Type E		− 320	26,000		210	Fig. 7	Fig.8	100 pulses	
	Type F		As agreed between the persons concerned					Fig.9	*	Related terminal

Note *: As agreed between the persons concerned.

where, Type A and Type D : Exponential function type decaying positive polarity transient voltage

Type B and Type E : Exponentia function type decaying negative polarity transient voltage; however, for the equipment which is always connected to the power supply, the test voltage shall be agreed between the persons concerned.

Type C and Type F : Transient voltage induced by induction

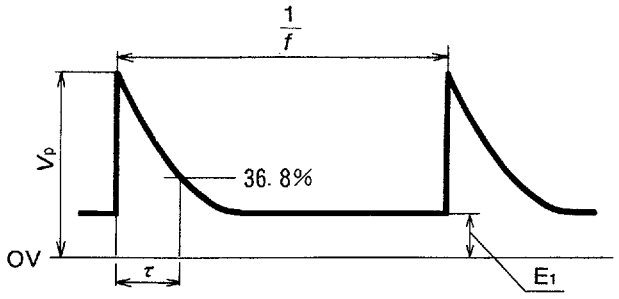
V_p : Maximum value of transient voltage

τ : Decaying time constant (Time required until the voltage decays to 36.8% of the maximum value)

f : Frequency of repetition

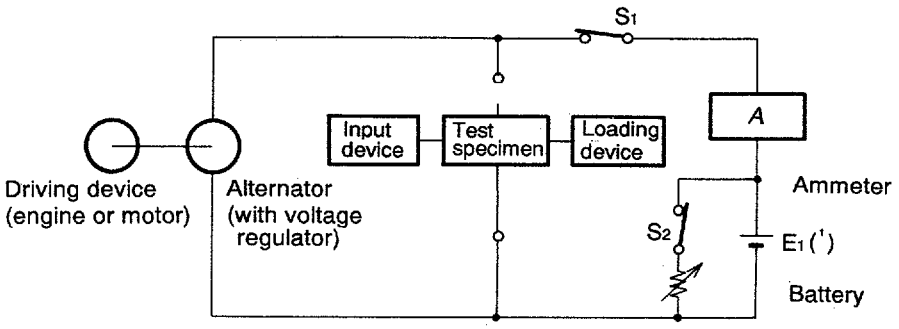
R_i : Output impedance of the test voltage generating circuit

Fig. 4 Voltage waveform for Type A and Type B transient voltage tests



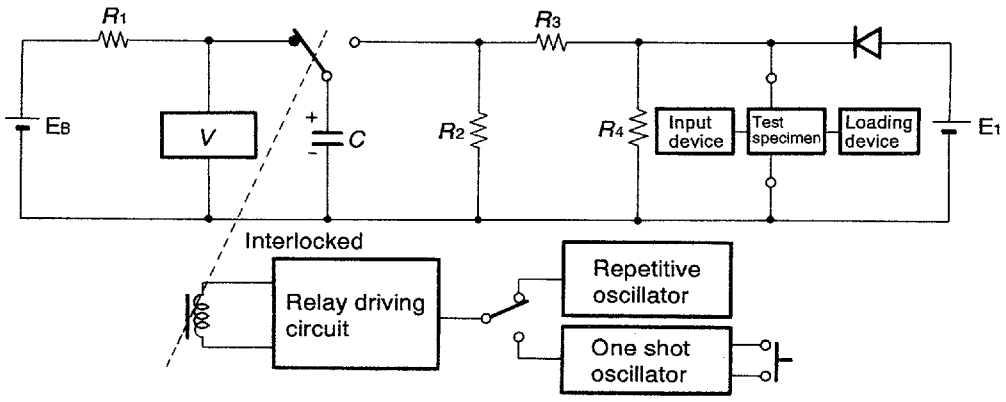
Remark The time to go from 0 (zero) V to V_p (the maximum value of transient voltage) is 1 μs or less.

Fig. 5 Voltage generating circuit for Type A-1 and D-1 transient voltage tests



Note (') : Care must be taken because batteries may explode if sparks are generated near them.
Remarks 1. Set the alternator loading current with both S_1 and S_2 switches turned to "ON" position.
2. A transient voltage will occur when S_1 is turned off.

Fig. 6 Voltage generating circuit for Type A and Type D transient voltage tests



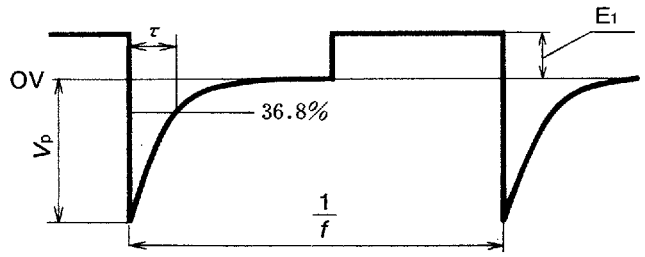
where, E_B : Power source of charge on capacitor C
E_1 : Power supply device for operation of test specimen
Remark The constant of each circuit element shall be as listed **Table 4.**

Table 4 Constants in the voltage generating circuit for Type A and D transient voltage tests

Type of test		Capacitor voltage (V)	Resistor R_1 (Ω)	Resistor R_2 (Ω)	Resistor R_3 (Ω)	Resistor R_4 (Ω)	Capacitor C (μF)	Remarks
Type A	A-1	88	To be determined according to power supply capacity for charging	5(100)	1(100)	4(100)	80000	Select a combination of either conditions
		70		2(100)	0.8(100)	∞	110000	
	A-2	110		0.6(200)	0.4(150)	∞	4.7	–
Type D	D-1	130		22(100)	2(100)	11(100)	50000	Select a combination of either conditions
		110		5.5(100)	1.5(100)	∞	73000	
	D-2	170		1.2(100)	0.9(100)	∞	2.2	–

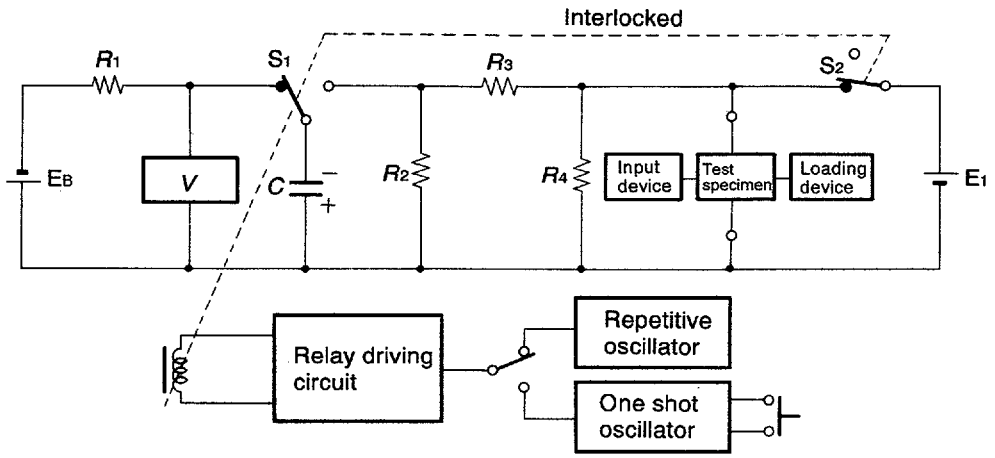
Remarks 1. Values in ( ) are reference values for the resistor power ratings. Unit : W
2. Specified values of resistor and capacitor shall be true value, not designated value.

Fig. 7 Voltage waveform Type B and E transient voltage tests



Remark The time to go from 0 (zero) V to V_p (the maximum value of transient voltage) is 1 μs or less.

Fig. 8 Voltage generating circuit for Type B and Type E transient voltage tests



where, E_B : Power source of charge on capacitor C

E_1 : Power supply device for operation of test specimen

Remarks 1. With the relay "OFF", S_2 is turned on and S_1 is turned to the left and C is charged.

2. With the relay "ON", S_2 is cut off, the power supply voltage which has been impressed on the equipment is cut, and S_1 is turned to the right and C is discharged.

3. Constants of circuit are as listed in **Table 5**.

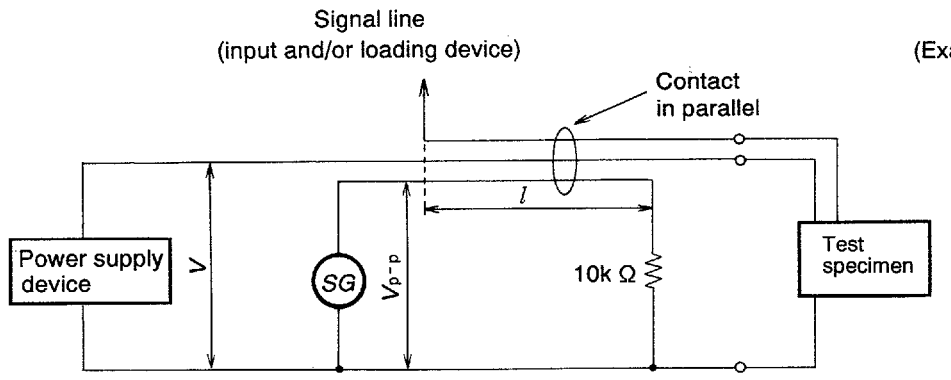
Table 5 Constants in the voltage generating circuit for Type B and E transient voltage tests

Type of test		Capacitor voltage (V)	Resistor R_1 (Ω)	Resistor R_2 (Ω)	Resistor R_3 (Ω)	Resistor R_4 (Ω)	Capacitor C (μF)	Remarks
Type B	B-1	− 100	To be determined according to power supply capacity for charging	50(10)	10(10)	40(10)	2400	Select a combination of either conditions
		− 80		20(10)	8(10)	∞	3000	
	B-2	− 260		60(5)	80 (5)	∞	33	−
Type E		− 457		27(100)	300(10)	700(10)	1000	Select a combination of either conditions
		− 320		13(100)	210(10)	∞	2000	

Remarks 1. Values in ( ) are reference values for the resistor power ratings. Unit : W

2. Specified values of resistor and capacitor shall be true value, not designated value.

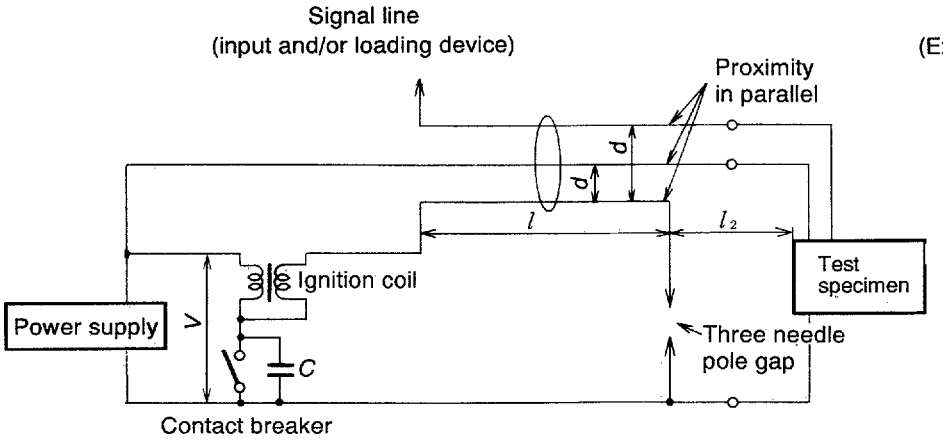
Fig. 9 Voltage generating circuit for Type C and Type F transient voltage tests (SG method)



(Example of conditions)

V : 10 to 15V
(for 12V system)
20 to 30V
(for 24V system)
SG : $V_{(p-p)}$= 100V
f = 1kHz (sine wave)
l : Approx. 1m
(length of parallel wiring)

Fig. 10 Voltage generating circuit for Type C transient voltage test (Pulse method)



(Example of conditions)

V : 10 to 15V
f : Frequency of
repetition = 30Hz
1/2 Li^2 : Primary energy = 60
to 80mJ
l : Approx. 1m
l_2 : Approx. 2m
d : Approx. 50mm
Three needle pole gap:
Approx. 6mm

5.8 Electrostatic test

5.8.1 Purpose

A test to evaluate on the bench the influence of electrical discharge of electro-static charged within human body against the function and operation of an equipment.

5.8.2 Test apparatus

A system as shown on **Fig. 11**, comprising of a high tension DC power source from which the testing voltage specified on **Table 6** is to be generated and the electro-static discharging probe, and the power supply device, input device(s) and loading device(s).

Table 6 Conditions of electrostatic test

Type of test		Test conditions			Number of impression	Location of impression
		Test voltage (kV)	Imprssing cycle times	Impressing circuit		
Type A	A-1	± 0.5	1 sec or more	Fig. 12	3 times or more	Input and output terminals
	A-2	± 1				
Type B	B-1	± 1		Fig. 13		Operating portion
	B-2	± 5				
Type C	C-1	± 5				
	C-2	± 10				
	C-3	± 15				

Remarks : The Type A and Type C shall be applied to destructive test, and the Type B shall be applied to test for mal-operation.

5.8.3 Operation

At test in Type A, the electro-static discharging probe which has already been charged so as that the test voltage specified in **Table 6** is available shall gradually be accessed to the designated portion of the individual test specimen as shown on **Fig. 12** so that electro-static discharge be created. Test in Type B and C, test arrangement shall be so that specimen is connected to power supply device, input device and loading devices shown as in **Fig. 13**, test procedure is same as in case of Type A. It shall be confirmed and recorded whether any abnormity is available or not. Further, should any discharge not be available in air, the discharging probe shall be contacted with the such designated portion.

Fig. 11 Electrostatic test apparatus

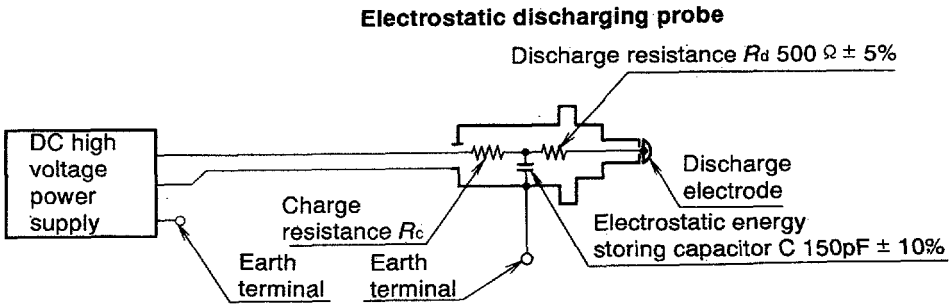


Fig. 12 Type A test method (Impression at terminals)

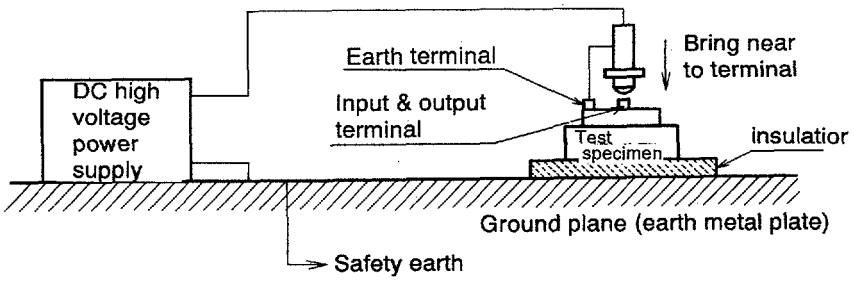
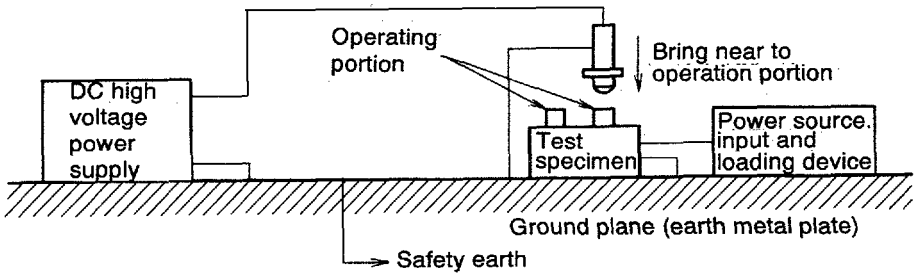


Fig. 13 Type B and Type C test method (Impression at operating portion)



5.9 Conducted electromagnetic test

5.9.1 Purpose

A test to evaluate the effect of interference to the equipment when it has been exposed to the strong electromagnetic field emitted from the systems utilizing low or high frequency electricity, wireless systems, etc. which are outside the vehicle or are installed on the vehicle itself, caused by the interference of the conducted current or wave which are induced through the input or power line terminals.

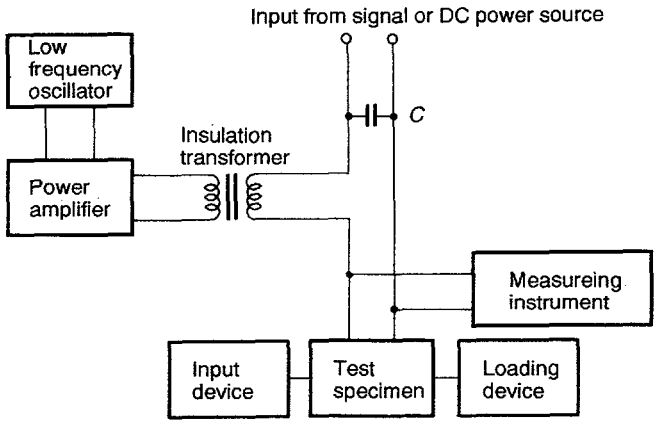
5.9.2 Test apparatus

A power supply device, input device(s), loading device(s) and conducted electro-magnetic test devices as shown in **Fig. 14** and **Fig.15**.

5.9.3 Operation

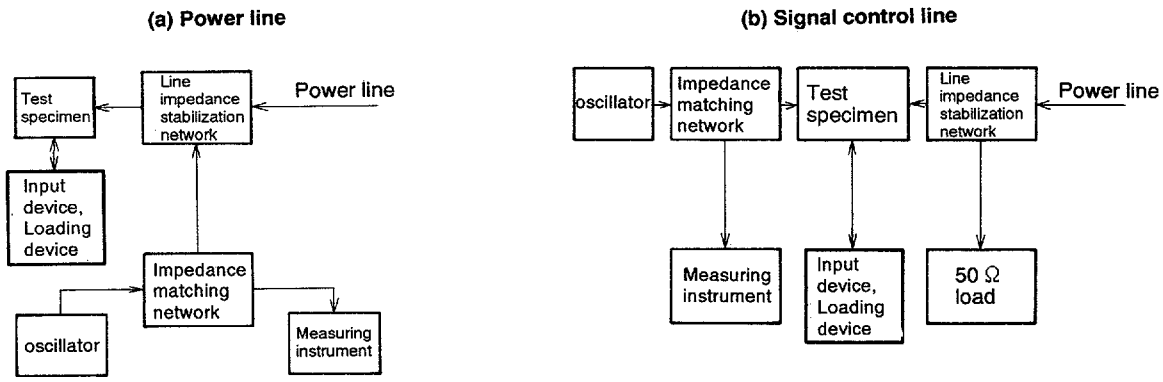
Connect the power supply device, input and loading devices to the test specimen, and confirm the operation of the equipment; then connect the equipment to the test apparatus specified in **5.9.2**, apply the interfering electromagnetic voltage specified between 0.1 to 10V as agreed between the persons concerned under its operating condition, and record the characteristic of the equipment accordingly.

Fig. 14 Conducted electromagnetic test arrangements (30Hz to 50kHz)



where, Low frequency oscillar: 30Hz to 50kHz
Power amplifier : 50W or greater with output impedance equal to, or less than, 2.0 Ω (capable of delivering 50W into a 0.5 Ω resistive load connected across an isolation-transformer secondary).
Measuring instrument : Calibration Oscilloscope, High-frequency volt meter, or EMI Meter.
C : 100 μ F capacitor (shall not used for signal inputs)
Insulation transformer : Core shall not be saturated.

Fig. 15 Conducted electromagnetic test arrangements (50kHz to 100MHz)



where, Oscillator : output impedance 50 Ω , output voltage 100V or greater
Measuring instrument : The same as shown in **Fig. 14**.
Line impedance stabilization network (LISN) : Refer to **Attached Fig. 1**
Impedance matching network : Refer to **Attached Fig. 2**

5.10 Radiated electromagnetic test

5.10.1 Purpose

A test to evaluate the effect of interference to the equipment when it has been exposed to the strong electromagnetic field emitted from the systems utilizing low or high frequency electricity, wireless systems, etc. which are outside the vehicle or are installed on the vehicle itself, caused by the interference of the radiated electromagnetic wave which exposed directly into the equipment.

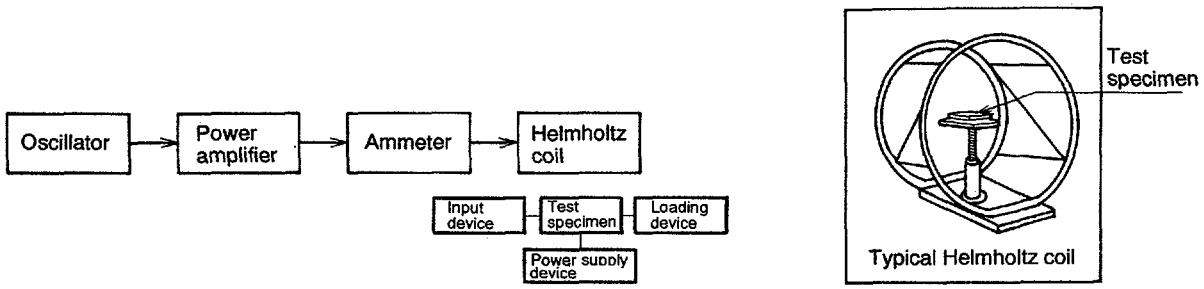
5.10.2 Test apparatus

The electro-magnetic radiation test system as shown on **Fig. 16**, **Fig. 17** and **Fig. 18**. A power supply device, input device(s) and loading device(s).

5.10.3 Operation

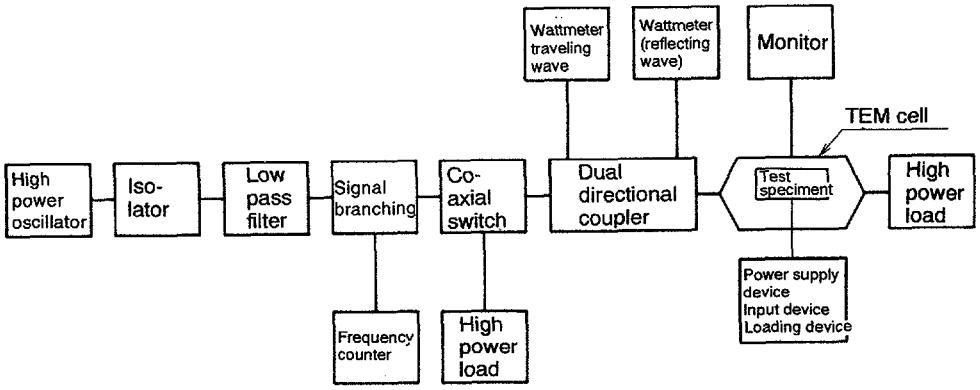
Connect the power supply device, input and loading devices to the test specimen, and confirm the operation of the equipment; connect the equipment to the test apparatus specified in **5.10.2**, apply the interfering electromagnetic field specified between 5 to 100V/m as agreed between the persons concerned to the equipment under its operating condition, and record the characteristics of the equipment accordingly.

Fig. 16 Radiated electromagnetic test arrangements (30Hz to 15kHz Magnetic field)



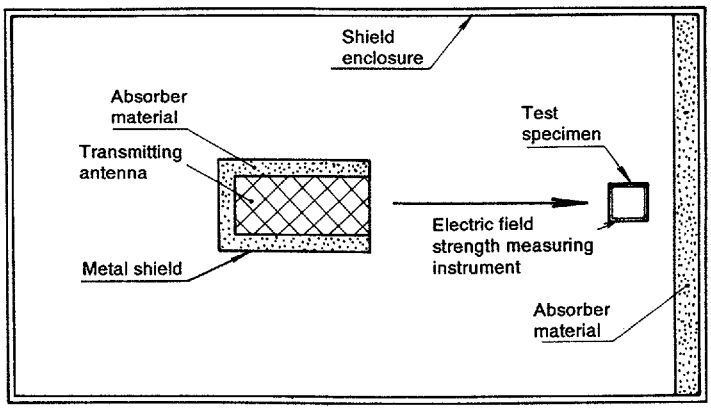
where, Heimholz coil : Diameter 1.8m, spacing 0.9m
Uniform magnetic field (± 10%)
throughout 0.6 m³
Self resonance frequency 15kHz or more
Coil factor 63 μ T/A
Oscillator : 30Hz to 15kHz
Power amplifier : Output impedance 2 Ω or less, output 50W or grater
Ammeter: 0 to 30A, 30Hz to 15kHz

Fig. 17 Radiated electromagnetic test arrangements (1MHz to 200MHz Electric field)



where, High power oscillator : Output 100W
Frequency accuracy within ± 2%
Harmonics and spurious output
ratio -30dB or less
Wattmeter : For measurement of power or voltage, 100W, 1MHz to 200MHz
High power load : 100W, 50 Ω
Frequency counter : Measuring range 200MHz
TEM cell : Refer to **Attached Fig. 3**
Low pass filter : Cutoff frequency 200MHz, attenuation rate -60dB or more at 240MHz
Signal branch : Monitoring device for frequency and high frequency voltage
Monitor : Monitoring for the operation of he test specimen

Fig. 18 Example of radiated electromagnetic test arrangements (200MHz to 1000MHz Electric field)



where, Electric field strength measuring instrument : To measure the electric field strength by installing an EMI meter or spectrum analyzer at the location of the test specimen

Transmitting antenna : Logarithmic conical spiral

Metal shield : Transmitting antenna hood with absorption material An aluminum, cylinder and end plate with 3.2mm thickness, 0.6m diameter × 1.2m height (**Fig.** shows a side view).

Absorbing material : To be covered on inside surfaces of the metal shield and one side surface (right side in **Fig.**) of the shield chamber.

Remarks1. Any high power oscillator supplied to transmission antenna from which the power required for the test shall have frequency accuracy within a range of ± 2%, the sprias output ratio of which shall be equal to or less than-30dB.

2. Any test specimen shall be operated after the power supply device, input device and loading devices have been connected therewith, the operation of which shall be monitored by means with a proper monitoring equipment.

5.11 Temperature characteristic test

5.11.1 Purpose

A test to evaluate the characteristics of the equipment under various temperature conditions ranging from low to high temperatures.

5.11.2 Test apparatus

A power supply device, input device(s), loading device(s) and a constant temperature chamber capable to maintain the temperature within the allowable range shown in **Table 8** regarding each setting temperature specified in **Table 7** shall be used.

Further, the constant temperature chamber shall be so constructed that the test specimen does not receive the heat radiation directly from the heat source. This test, however, shall not be applied to the case of a chamber of 200 ℃ or more.

Table 7 Setting temperatures

Unit: ℃

Classification of equipment	Setting temperatures
Class 1	− 30, − 5, 25, 65, 80
Class 2	− 30, − 5, 25, 65, 80
Class 3	− 30, − 5, 25, 65, 100, (125)
Class 4	As agreed between the persons concerned

Remarks 1. The classifications of the equipments shall be as follows:
Class 1 : Equipment installed in the vehicle compartment and the trunk room, other than class 4.
Class 2 : Equipment installed outside the vehicle other than class 4.
Class 3 : Equipment installed inside the engine room other than class 4.
Class 4 : Equipment to be installed at or near the high temperature portion or other special portion.
2. The (125) of class 3 carry out according to necessary condition.

Table 8 Allowable temperature difference

Unit: ℃

Setting temperature	Allowable temperature difference
− 40 or higher and lower than 200	± 2
200 or higher	As agreed between the persons concerned

5.11.3 Operation

Place the test specimen in the constant temperature chamber specified in **5.11.2** under room temperature, and connect the power supply device, input and loading devices to the outside of the chamber so that the test specimen may be operated. Make the temperature in the chamber gradually approached to a setting temperature specified in **Table 7**; and when the temperature has reached to the setting temperature, keep the specimen under the temperature during 1 ± 0.5h; afterwards, operate the specimen and record its characteristic. Then, make the temperature gradually approached to other temperature and record in like manner. The test order of setting temperature is not particularly specified.

5.12 Low temperature maintain test

5.12.1 Purpose

A test to evaluate the characteristics of the equipment after the equipment has been exposed to a low temperature atmosphere.

5.12.2 Test apparatus

A constant temperature chamber capable of maintaining the temperature at − 40 ± 2 ℃.

5.12.3 Operation

Place the test specimen in the constant temperature chamber specified in **5.12.2** under room temperature, lower the temperature gradually, when the temperature has reached to − 40 ℃, keep the equipment for 70 ± 2 hours under the temperature.

Take the test specimen out of the chamber, remove water drops from ist surface, if any, then keep it for 2 hours or more under room temper-

ature, test it according to **5.1** of this standard, and record the characteristic of the equipment.

5.13 Low temperature operation test

5.13.1 Purpose

A test to evaluate the characteristics of the equipment after operating it in a low temperature atmosphere.

5.13.2 Test apparatus

A constant temperature chamber capable to maintain at a temperature within − 30 ± 2 ℃ , a power supply device, input device(s) and loading device(s).

5.13.3 Operation

Place the test specimen in the constant temperature chamber specified in **5.13.2.** under room temperature, and connect the power supply device, input and loading devices to the outside of the chamber so that the test specimen may be operated.

Lower the temperature gradually, when the temperature has reached to − 30 ℃ , keep the equipment for 1 ± 0.5 hours.

Further, operate the test specimen for 70 ± 2 hours under the temperature. Take the specimen out of the chamber, remove water drops from its surface, if any, then keep it for 2 hours or more under room temperature, test it according to **5.1** of this standard, and record the characteristics of the equipment.

5.14 High temperature maintain test

5.14.1 Purpose

A test to evaluate the characteristics of the equipment after the equipment has been exposed to a high temperature atmosphere.

5.14.2 Test apparatus

A constant temperature chamber capable to maintain the temperature within the allowable range shown in **Table 8** regarding each setting temperature specified in **Table 9**.

Further, the constant temperature chamber shall be so constructed that the chamber does not receive the heat radiation directly from the heat source of the test specimen, however, shall not be applied to the case of a chamber of 200 ℃ or more.

5.14.3 Operation

Place the test specimen in the constant temperature chamber specified in **5.14.2** under room temperature, raise the temperature gradually, when the temperature has reached to the temperature specified in **Table 9**, keep the test specimen for 94 ± 2 hours under the temperature. Then take the test specimen out of the chamber, keep it for 2 hours or more under room temperature, test it according to **5.1** of this standard, and record the characteristics of the equipment.

Table 9 Setting temperature

Unit: ℃

Classification of equipment	Setting temperature
Class 1	85
Class 2	75
Class 3	120 (135)
Class 4	As agreed between the persons concerned

Remarks 1. Classification of the equipments shall be as shown in **Table 7**.

2. The (135) of class 3 carry out according to necessary conditions.

Table 10 Setting temperature

Unit: ℃

Classification of equipment	Setting temperature
Class 1	75
Class 2	65
Class 3	100 (125)
Class 4	As agreed between the persons concerned

Remarks 1. Classification of the equipments shall be as shown in **Table 7.**
2. The (125) of class 3 carry out according to necessary conditions.

5.15 High temperature operation test

5.15.1 Purpose

A test to evaluate the characteristics of the equipment after operating it in a high temperature ambient atmosphere.

5.15.2 Test apparatus

A constant temperature chamber capable to maintain the temperature with in the allowable range shown in **Table 8** regarding each setting temperature specified in **Table 10**, a power supply device, input device(s) and loading device (s).
Further, the constant temperature chamber shall be so constructed that the chamber does not receive the heat radiation directly from the heat source of the test specimen.

5.15.3 Operation

Place the test specimen in the constant temperature chamber specified in **5.15.2** under room temperature, and connect the power supply device, inputs and loading devices to the outside of the chamber so that the test specimen may be operated.
Raise the temperature inside the chamber gradually, when it has reached to the temperature specified in **Table 10**, keep the equipment for 1 ± 0.5 hours under the temperature. Further, operate the test specimen for 118 ± 2 hours under the specified temperature. Take the test specimen out of the chamber, then keep it for 2 hours or more under room temperature, test it according to **5.1** of this standard, and record the characteristics of the equipment.

5.16 Heat cycle test

5.16.1 Purpose

A test to evaluate the characteristics of the equipment after operating it in an ambient atmosphere of which the temperature changes repeatedly.

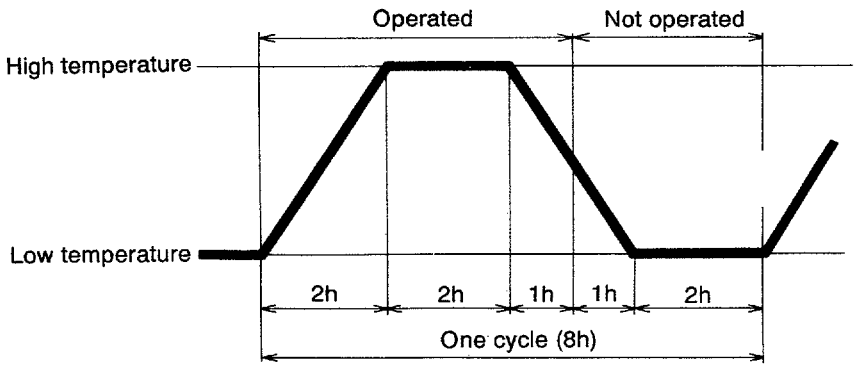
5.16.2 Test apparatus

Constant temperature chamber shall have the function possible to raise and lower the temperature as specified in **Fig. 19**, a power supply device, input device(s) and loading device(s).

5.16.3 Operation

Place the test specimen in the constant temperature chamber specified in **5.16.2** under room temperature, and connect the power supply device, input and loading devices to the outside of the chamber so that the test specimen may be operated.
Lower the temperature inside the chamber gradually, when it has reached to − 30 ℃ , keep the equipment for 1 ± 0.5 hours.
Further, carry out the test pattern specified in **Fig. 19** and **Table 11** by 30 cycles, and operate the test specimen for the specified time. Take the test specimen out of the chamber and keep it for 2 hours or more under room temperature, test it according to **5.1** of this standard, and record the characteristics of the equipment.

Fig. 19 Test pattern



Remark Al though the temgerature rate is not specified, it is desiralb to vary it as linearly as.

Table 11 Setting temperature

Unit: ℃

Classification of equipment	Setting temperature	
	High temperature	Low temperature
Class 1	75	− 30
Class 2	65	
Class 3	100 (125)	
Class 4	As agreed between the persons concerned	

Remarks 1. Classification of the equipments shall be as shown in **Table 7.**
2. The (125) of class 3 carry out according to necessary conditions.

5.17 Thermal shock test

5.17.1 Purpose

A test to evaluate the characteristics of the equipment after applying rapid temperature changes.

5.17.2 Test apparatus

Constant temperature chambers capable of re-suming the setting temperature specified in **Table 12** within 5 minutes from placing the test specimen therein, and following two kinds of them sholl be used.

(1) Low constant temperature chamber
As specified in **5.12.2.**

(2) High constant temperature chamber
As specified in **5.14.2.**

5.17.3 Operation

Place the test specimen in the low constant temperature chamber of preset to − 40 ℃ , and keep it for 2 ± 0.5 hours. Then take the test specimen out of the chamber, place it immediately in the constant temperature chamber adjusted to the high temperature specified in **Table**

12, keep it in the chamber for the time specified in **Table 13**. Regarding above operations as one cycle (refer to **Fig. 20**), repeat it 6 times continuously, take the test specimen out of the chamber and keep it for 2 hours or more under room temperature. Then carry out the test according to **5.1** and record the characteristics of the equipment.

Fig. 20 Test pattern

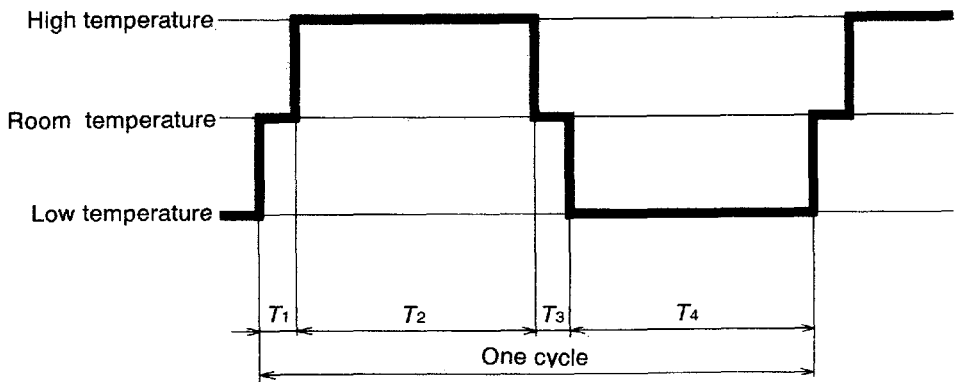


Table 12 Setting Temperature

Unit: ℃

Classification of equipment	Setting temperature	
	High temperature	Low temperature
Class 1	85	− 40
Class 2	75	
Class 3	120	
Class 4	As agreed between the persons concerned	

Remark Classification of the equipments shall be as shown in **Table 7**.

Table 13 Keeping hours at each setting temperature

Mass of equipment (kg)	T_2, T_4		T_1, T_3(²)
less than 0.2	1h	+15min 0	1 min or less
0.2 or more and less than 0.8	2h	+15min 0	
0.8 or more and less than 1.5	3h	+15min 0	
1.5 or more	4h	+15min 0	

Note(²): Test specimen transition times T_1 and T_3 are for reference only, but are desirable to be as short as possible.

5.18 Temperature and humidity cycle test

5.18.1 Purpose

A test to evaluate the characteristics of the equipment after operating it in an ambient atmosphere of which the high humidity and the temperature changes repeatedly.

5.18.2 Test apparatus

A constant temperature and humidity chamber which is capable of maintaining the temperatures and humidities specified in **Fig. 21**, and is so constructed that the test specimen does not receive the heat radiation directly from the heat source. A power supply device, input device(s) and loading devices(s).

5.18.3 Operation

Place the test specimen in the constant temperature and humidity chamber, and connect the power supply device, input(s) and loading devices(s) at the outside of the chamber in such a manner that the test specimen may be operated.

Adjusted the chamber inside temperature to 23 ± 5 ℃ and the humidity to (60 ± 15)%. Keep the test specimen under the conditions for 2.5 ± 0.5 hours. Carry out the test pattern shown in **Fig. 21** by 10 cycles, and operate the test specimen for the specified time.

Subsequent operations shall be as follows:

(1) After keeping the test specimen for 1.5 ± 0.5 hours under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)%, carry out the test immediately according to **5.1**, and record the characteristics of the equipment.

Appearance and other conditions of the test equipment at that time shall also be confirmed.

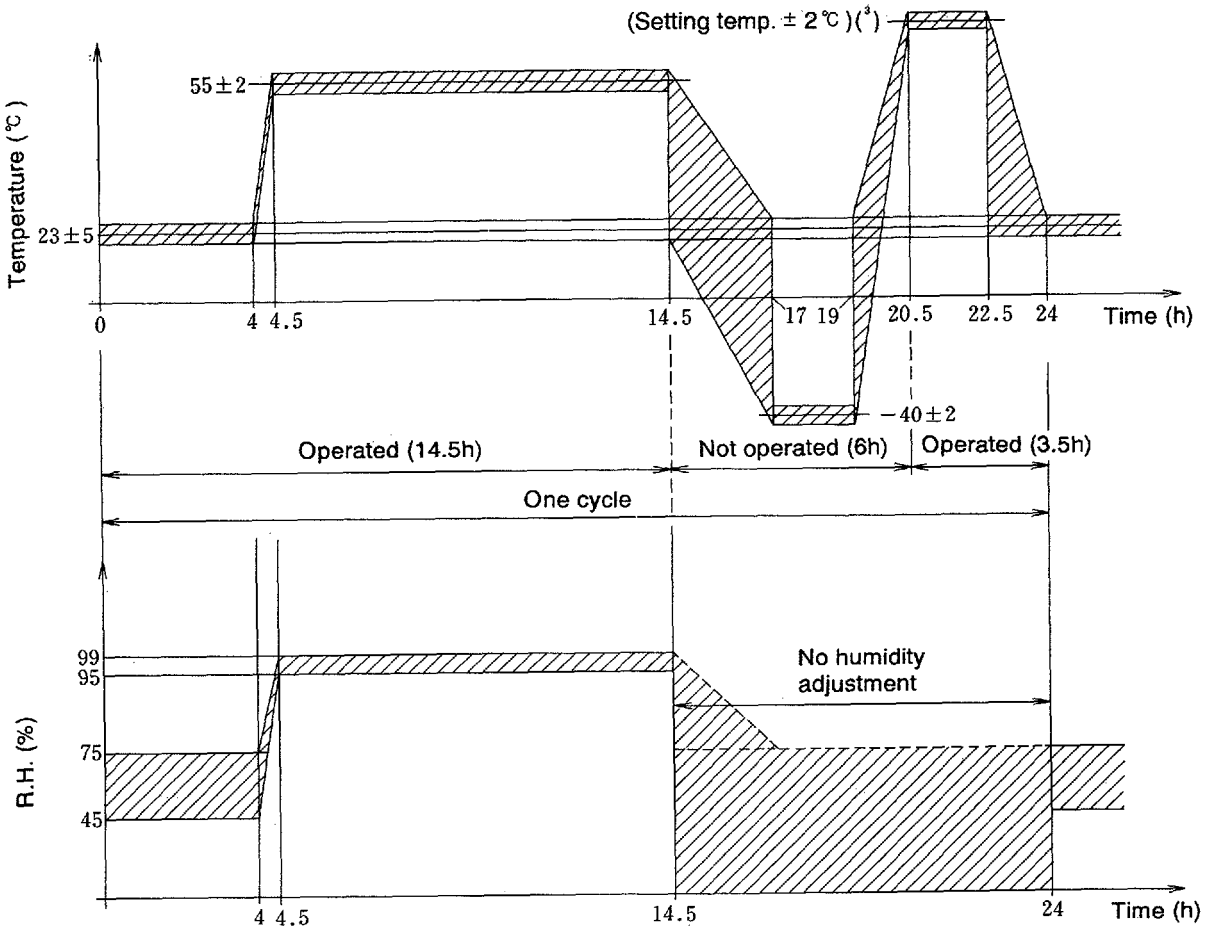
(2) Further, if necessary, carry out the test according to **5.1** immediately after keeping the test specimen under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)% for 22 ± 2 hours. Record the characteristics of the equipment accordingly.

Confirm the appearance, etc. of the equipment at that time.

(3) Furthermore, if the characteristics immediately after the temperature and humidity cycle test are particularly required, carry out the test immediately according to **5.1** under the same condition (without removing water drops from the surface), and record the characteristics of the equipment. Thereafter, successively record the characteristics of the equipment, according to above mentioned **(1)** or **(2)**.

Confirm also the appearance, etc. of the equipment at that time.

Fig. 21 Test pattern



Note(3): Setting temperature shall be as shown in **Table 10**.

5.19 Constant high humidity test

5.19.1 Purpose

A test to evaluate the characteristics of the equipment after operating it in a high humidity atmosphere.

5.19.2 Test apparatus

A constant temperature and humidity chamber which is capable of maintaining the temperature at 55 ± 2 ℃ and the humidity at (95 ± 5)%. A power supply device, input device(s) and loading device(s).

5.19.3 Operation

Connect the power supply device, input and loading devices at the outside of the chamber so that the test specimen may be operated. Place the test specimen in the constant temperature and humidity chamber, raise gradually the temperature and humidity in the chamber. When the temperature and humidity have reached to 55 ± 2 ℃ and (95 ± 5)% respectively, keep the test specimen under that condition for 1 ± 0.5 hours. Then operate the test specimen under the same condition for 94 ± 2 hours. Subsequent operations shall be as follows:

(1) After keeping the test specimen for 1.5 ± 0.5 hours under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)%, carry out the test immediately according to 5.1 of this standard, and record the characteristics of the equipment.

Appearance and other conditions of the equipment at that time shall also be confirmed.

(2) Further, if necessary, carry out the test according to **5.1** immediately after keeping the test specimen under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)% for 22 ± 2 hours.
Record the characteristics of the equipment accordingly.
Confirm the appearance, etc. of the equipment at that time.

(3) Furthermore, if the characteristics immediately after the constant humidity test are particularly required, carry out the test immediately according to **5.1** under the same condition as before the test specimen being taken out from the chamber (without removing water drops from the surface), and record the characteristics of the equipment.
Thereafter, successively record the characteristics of the equipment, according to above mentioned **(1)** or **(2)**. Confirm also the appearance, etc. of the equipment at that time.

5.20 Dew formation test

5.20.1 Purpose

A test to evaluate the performance under the conditions of dew attached on the equipment because of quickly heating after exposure in an atmosphere at low temperature.

5.20.2 Test apparatus

Following two kinds of constant temperature chamber;

(1) Low constand temperature chamber
The inside temperature can be controlled so as to be kept at temperature within a range of − 5 ± 2 ℃.

(2) Constant temperature and humidity chamber
The inside temperature can be controlled so as to be kpet at temperature within a range of 35 ± 2 ℃, and the relative humidity inside which can be controlled so as to be kept at any value within a range of (85 ± 5)%.

5.20.3 Operation

Before testing, the constant temperature and humidity chamber shall be set respectively so as to be kept at temperature within a range of 35 ± 2 ℃ and relative humidity within a range of (85 ± 5)%. The test specimen at room temperature shall be put in the low constant temperature chamber, the temperature at which shall then be gradually dropped to − 5 ℃, which shall be moved to the constant temperature and humidity chamber after having been kept for duration of time within a range of 2 ± 0.5 hours at such low temperature after it has been reached thereat.
The test specimen thus moved shall then be tested as it is without any dew being wiped out, in accordance with **5.1** of this standard, as soon as possible after having been taken out from the constant temperature and humidity chamber, after having been kept for 10 minutes therein, where the performance through this test shall be recorded.
In addition, any conditions including but not limited to the visual appearance shall also be verified.

5.21 Water resistance test

5.21.1 Purpose

A test to evaluate the water resistance of the equipment.

5.21.2 Test apparatus

A testing apparatus as specified in the **remark 1** of **Table 2 in 3.** (test method) of **JIS D 0203.**

5.21.3 Operation

Any test specimen shall be tested in accordance with the **Table 14** below, prescribed by **JIS D 0203**, after having been installed on the testing equipment so as to be kept nearly equal to what is to be made at the practical installation, which shall be operated as specified hereunder.:

(1) After keeping the test specimen for 1.5 ± 0.5 hours under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)%, carry out the test immediately according to **5.1**, and record the characteristics of the equipment.
Appearance and other conditions of the equipment at that time shall also be confirmed.

(2) Further, if necessary, carry out the test according to **5.1** of this standard immediately after keeping the test specimen under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)% FOR 22 ± 2 hours.
Record the characteristics of the equipment accordingly.
Confirm the appearance, etc. of the equipment at that time.

(3) Furthermore, if the characteristics immediately after the water resistance test are particularly required, carry out the test immediately according to **5.1** under the same condition as before the test specimen being taken out from the chamber (with out removing water drops from the surface), and record the characteristics of the equipment. Thereafter, successively record the characteristics of the equipment, according to above mentioned **(1)** or **(2)**. Confirm also the appearance, etc. of the equipment at that time.

5.22 Salt water spray test

5.22.1 Purpose

A test to evaluate the resistance of the equipment against salt water.

5.22.2 Test apparatus and salt water

The testing apparatus and salt water shall be as follows;

(1) Test apparatus

A test apparatus specified in **3.** (Test equipment) of **JIS C 0023** or any other equipment, the performance of which are equivalent thereto.

(2) Salt water solution

Any salt water solution specified in **4.1** (Salt water solution) of **JIS C 0023**.

5.22.3 Operation

The test specimen shall be installed on test apparatus so as to be arranged nearly equal to it at the practical installation, over which the salt water solution at temperature within a range of 25 ± 10 ℃ shall then be sprayed under an atmosphere inside testing chamber at temperature within a range of 35 ± 2 ℃ for duration of time within a range of 96 ± 2 hours. The additional operations shall be carried out subsequent thereto as specified hereunder.:

Table 14 Conditions at water resistance test

Classification of equipment	Kind of test to be performed
Class 1	As agreed between the persons concerned(4)
Class 2	S1 or S2
Class 3	R1 or R2
Class 4	As agreed between the persons concerned(5)

Notes (4) : The constant humidity test of 5.19 or the test of *R*1 shall preferably be carried out.
(5) : It is recommended to carry out the test for either Class 2 or 3 depending on flooding conditions due to the place where the equipment have been installed.

Remarks 1. Classification of the equipments shall be as shown in **Table 7.**
2. The code symbol applicable to kind of the test to be performed shall be in accordance with 2. (Kind of test and code symbol) of **JIS D 0203**.

(1) After the test above, the test specimen shall be carefully taken out from the chamber, which shall then be dried with the air under a pressure at approximately 250 kPa by being fed over it, after the surface thereof having perfectly been rinsed with the fresh water at temperature equal to or lower than 38 ℃ as high by being sprayed over it, which shall then be tested in accordance with the provisions of the **5.1** of this rule, where the specific performance obtained through the test above shall be recorded and in addition, the conditions of the equipment including but not limited to the visual appearance shall also be verified.

(2) Should any treatment after having been taken out from the chamber have been agreed by between the persons concerned, the test specimen shall be tested in accordance with the provisions **5.1** after having been treated as required in accordance with the agreement, where the specific performance obtained from the equipment devices under test through the test shall be verified.

5.23 Vibration test

5.23.1 Purpose

A test to evaluate the resistance of the equipment under test against vibration.

5.23.2 Test apparatus

A vibrator conforming to the vibrating conditions specified in the **Table 15**.

5.23.3 Operation

The test specimen shall be installed on the vibrator so as to be arranged nearly equal to it at the actual installation, which shall then be tested as required in accordance with the provisions **5.1** after having been tested under conditions specified in the **Table 15**, where the performance obtained from the equipment through this test shall be recorded and in addition, the conditions thereof including but not limited to the visual appearance shall also be verified.

5.24 Shock resistance test

5.24.1 Purpose

A test to evaluate the resistance of the equipment under test against shock.

5.24.2 Test apparatus

A test machine and acceleration measuring equipment specified in **5.** (Test Method 2) of **JIS C 0912** or the plywood board of a thickness equal to approximately 50mm and size so large as equal to or more than 1,500 × 1,500mm.

5.24.3 Operation

Shock shall be applied over the test specimen as required in accordance with **5.** (test method 2) of **JIS C 0912**, where the peak value of the acceleration available from the pulse of the shock applied shall be equal to 981m/s^2, and the test shall be carried out in accordance with the provisions **5.1** after 3 times of shock having continuously been applied from the direction of each of the 3 axes selected so as to be mutually at right angle on the test specimen (9 times in total), where the performance obtained from the equipment through this test shall be recorded and in addition, the conditions thereof including but not limited to the visual appearance shall also be verified.

However, the test may be carried out by means of the method as specified hereunder.:

Shock shall be applied to the specimen in accordance with **2.** (Method 1 for Natural Drop) of **JIS C 0044**, where the height of drop shall be so high as within a range of 1,000 ± 50mm and the test shall be carried out as required in accordance with the provisions **5.1** after 3 times of shock having continuously been applied from each direction of the 3 axes which had been selected on the test specimen so so to be mutually at right angle, (9 times in total) over the plywood placed on the surface of floor made of concrete, where the performance obtained from the equipment through this test shall be recorded and in addition, the conditions thereof including but not limited to a visual appearance shall also be verified.

5.25 Dust resistance test

5.25.1 Purpose

A to test evaluate the dust proofness and dust resistance of equipment.

(2) Further, if necessary, carry out the test according to **5.1** immediately after keeping the test specimen under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)% for 22 ± 2 hours.
Record the characteristics of the equipment accordingly.
Confirm the appearance, etc. of the equipment at that time.

(3) Furthermore, if the characteristics immediately after the constant humidity test are particularly required, carry out the test immediately according to **5.1** under the same condition as before the test specimen being taken out from the chamber (without removing water drops from the surface), and record the characteristics of the equipment.
Thereafter, successively record the characteristics of the equipment, according to above mentioned **(1)** or **(2)**. Confirm also the appearance, etc. of the equipment at that time.

5.20 Dew formation test

5.20.1 Purpose

A test to evaluate the performance under the conditions of dew attached on the equipment because of quickly heating after exposure in an atmosphere at low temperature.

5.20.2 Test apparatus

Following two kinds of constant temperature chamber;

(1) Low constand temperature chamber
The inside temperature can be controlled so as to be kept at temperature within a range of − 5 ± 2 ℃.

(2) Constant temperature and humidity chamber
The inside temperature can be controlled so as to be kpet at temperature within a range of 35 ± 2 ℃, and the relative humidity inside which can be controlled so as to be kept at any value within a range of (85 ± 5)%.

5.20.3 Operation

Before testing, the constant temperature and humidity chamber shall be set respectively so as to be kept at temperature within a range of 35 ± 2 ℃ and relative humidity within a range of (85 ± 5)%. The test specimen at room temperature shall be put in the low constant temperature chamber, the temperature at which shall then be gradually dropped to − 5 ℃, which shall be moved to the constant temperature and humidity chamber after having been kept for duration of time within a range of 2 ± 0.5 hours at such low temperature after it has been reached thereat.
The test specimen thus moved shall then be tested as it is without any dew being wiped out, in accordance with **5.1** of this standard, as soon as possible after having been taken out from the constant temperature and humidity chamber, after having been kept for 10 minutes therein, where the performance through this test shall be recorded.
In addition, any conditions including but not limited to the visual appearance shall also be verified.

5.21 Water resistance test

5.21.1 Purpose

A test to evaluate the water resistance of the equipment.

5.21.2 Test apparatus

A testing apparatus as specified in the **remark 1** of **Table 2 in 3.** (test method) of **JIS D 0203.**

5.21.3 Operation

Any test specimen shall be tested in accordance with the **Table 14** below, prescribed by **JIS D 0203**, after having been installed on the testing equipment so as to be kept nearly equal to what is to be made at the practical installation, which shall be operated as specified hereunder.:

(1) After keeping the test specimen for 1.5 ± 0.5 hours under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)%, carry out the test immediately according to **5.1**, and record the characteristics of the equipment.
Appearance and other conditions of the equipment at that time shall also be confirmed.

(2) Further, if necessary, carry out the test according to **5.1** of this standard immediately after keeping the test specimen under the condition of temperature 25 ± 5 ℃ and humidity (65 ± 20)% FOR 22 ± 2 hours.
Record the characteristics of the equipment accordingly.
Confirm the appearance, etc. of the equipment at that time.

(3) Furthermore, if the characteristics immediately after the water resistance test are particularly required, carry out the test immediately according to **5.1** under the same condition as before the test specimen being taken out from the chamber (with out removing water drops from the surface), and record the characteristics of the equipment. Thereafter, successively record the characteristics of the equipment, according to above mentioned **(1)** or **(2)**. Confirm also the appearance, etc. of the equipment at that time.

5.22 Salt water spray test

5.22.1 Purpose

A test to evaluate the resistance of the equipment against salt water.

5.22.2 Test apparatus and salt water

The testing apparatus and salt water shall be as follows;

(1) Test apparatus

A test apparatus specified in **3.** (Test equipment) of **JIS C 0023** or any other equipment, the performance of which are equivalent thereto.

(2) Salt water solution

Any salt water solution specified in **4.1** (Salt water solution) of **JIS C 0023**.

5.22.3 Operation

The test specimen shall be installed on test apparatus so as to be arranged nearly equal to it at the practical installation, over which the salt water solution at temperature within a range of 25 ± 10 ℃ shall then be sprayed under an atmosphere inside testing chamber at temperature within a range of 35 ± 2 ℃ for duration of time within a range of 96 ± 2 hours. The additional operations shall be carried out subsequent thereto as specified hereunder.:

Table 14 Conditions at water resistance test

Classification of equipment	Kind of test to be performed
Class 1	As agreed between the persons concerned(4)
Class 2	S1 or S2
Class 3	R1 or R2
Class 4	As agreed between the persons concerned(5)

Notes (4) : The constant humidity test of 5.19 or the test of *R*1 shall preferably be carried out.
(5) : It is recommended to carry out the test for either Class 2 or 3 depending on flooding conditions due to the place where the equipment have been installed.

Remarks 1. Classification of the equipments shall be as shown in **Table 7.**
2. The code symbol applicable to kind of the test to be performed shall be in accordance with 2. (Kind of test and code symbol) of **JIS D 0203**.

(1) After the test above, the test specimen shall be carefully taken out from the chamber, which shall then be dried with the air under a pressure at approximately 250 kPa by being fed over it, after the surface thereof having perfectly been rinsed with the fresh water at temperature equal to or lower than 38 ℃ as high by being sprayed over it, which shall then be tested in accordance with the provisions of the **5.1** of this rule, where the specific performance obtained through the test above shall be recorded and in addition, the conditions of the equipment including but not limited to the visual appearance shall also be verified.

(2) Should any treatment after having been taken out from the chamber have been agreed by between the persons concerned, the test specimen shall be tested in accordance with the provisions **5.1** after having been treated as required in accordance with the agreement, where the specific performance obtained from the equipment devices under test through the test shall be verified.

5.23 Vibration test

5.23.1 Purpose

A test to evaluate the resistance of the equipment under test against vibration.

5.23.2 Test apparatus

A vibrator conforming to the vibrating conditions specified in the **Table 15**.

5.23.3 Operation

The test specimen shall be installed on the vibrator so as to be arranged nearly equal to it at the actual installation, which shall then be tested as required in accordance with the provisions **5.1** after having been tested under conditions specified in the **Table 15**, where the performance obtained from the equipment through this test shall be recorded and in addition, the conditions thereof including but not limited to the visual appearance shall also be verified.

5.24 Shock resistance test

5.24.1 Purpose

A test to evaluate the resistance of the equipment under test against shock.

5.24.2 Test apparatus

A test machine and acceleration measuring equipment specified in **5.** (Test Method 2) of **JIS C 0912** or the plywood board of a thickness equal to approximately 50mm and size so large as equal to or more than 1,500 × 1,500mm.

5.24.3 Operation

Shock shall be applied over the test specimen as required in accordance with **5.** (test method 2) of **JIS C 0912**, where the peak value of the acceleration available from the pulse of the shock applied shall be equal to 981m/s^2, and the test shall be carried out in accordance with the provisions **5.1** after 3 times of shock having continuously been applied from the direction of each of the 3 axes selected so as to be mutually at right angle on the test specimen (9 times in total), where the performance obtained from the equipment through this test shall be recorded and in addition, the conditions thereof including but not limited to the visual appearance shall also be verified.

However, the test may be carried out by means of the method as specified hereunder.:

Shock shall be applied to the specimen in accordance with **2.** (Method 1 for Natural Drop) of **JIS C 0044**, where the height of drop shall be so high as within a range of 1,000 ± 50mm and the test shall be carried out as required in accordance with the provisions **5.1** after 3 times of shock having continuously been applied from each direction of the 3 axes which had been selected on the test specimen so so to be mutually at right angle, (9 times in total) over the plywood placed on the surface of floor made of concrete, where the performance obtained from the equipment through this test shall be recorded and in addition, the conditions thereof including but not limited to a visual appearance shall also be verified.

5.25 Dust resistance test

5.25.1 Purpose

A to test evaluate the dust proofness and dust resistance of equipment.

Table 15 Conditions at vibration test

Classification of Equipment	Vibration range	Cycle (6)	Acceleration	Amplitude	Testing time(7) (h)		
	Hz	min	m/s^2	mm	Direction from upper to lower	Direction from right to left	Direction from front to rear
Class A	5~200	10	29.4	(8)	4	2	2
Class B	5~200	10	44.1	(8)	4	2	2
Class C	5~200	10	68.6	(8)	4	2	2
Class D	5~200	10	(9)	(9)	4	2	2

Notes (6) Sweeping shall be carried out so as to be continuously increased or decreased within a range of vibration times per second (frequencies) with an uniform ratio.
(7) To be carried out 8 hours in total on 3 directions.
(8) Within a range of the vibrations, the amplitude is more than 10mm, the test shall be carried out at a constant amplitude equal to 10mm.
(9) as required in accordance with agreement between the persons concerned.

Remarks: 1. The classification of equipment shall be as follows:
Class A : Any equipment installed on body or the spring of suspension system, the vibration of which is relatively low.
Class B : Any equipment installed on body or the spring of suspension system, the vibration of which is relatively high.
Class C : Any equipment installed on engine, the vibration of which is relatively low.
Class D : Any equipment installed under the spring of suspension system and any equipment installed on engine, the vibration of which is relatively high.
2. Should there any resonance be available, the test shall be carried out in accordance with "(2) In case of occur in pesonance vibration" of 5.3 (Methods of vibration endurance test) of **JIS D 1601**.

5.25.2 Test apparatus

An apparatus as shown on the **reference fig. 1** (Floatation Test Equipment) or the **reference fig. 2** (Air Flow Test Equipment) in **JIS D 0207** or any other apparatus equivalent or similar thereto.

5.25.3 Operation

The test specimen shall be installed on test apparatus so as to be arranged nearly equal to it at the practical installation, the test of the F2 or C1 specified in **4.** (Test method) of **JIS D 0207** shall be carried out by means with the dust for test of the **class 8** or the **class 6** specified in **3.** (Kind of dust) of **JIS Z 8901**, subject to selection of kind of the test to be carried out being made in accordance with the agreement made by and between the persons concerned. After the test above, the test in **5.1** shall be additionally carried out, where the performance obtained from the equipment through this test shall be recorded and in addition, the conditions thereof including but not limited to the visual appearance shall also be verified.

5.26 Oil resistance test

5.26.1 Purpose

A test to evaluate the oil resistance of the equipment.

5.26.2 Testing vessel and oil

The vessel and the oil used for this testing shall be as specified hereunder.:

(1) Vessel

Any vessel, the containing capacity is sufficiently large enough with a rise of the oil level when the test specimen has been put therein having been taken into consid-

eration, the material of which will not be eroded from the oil.

(2) Oil

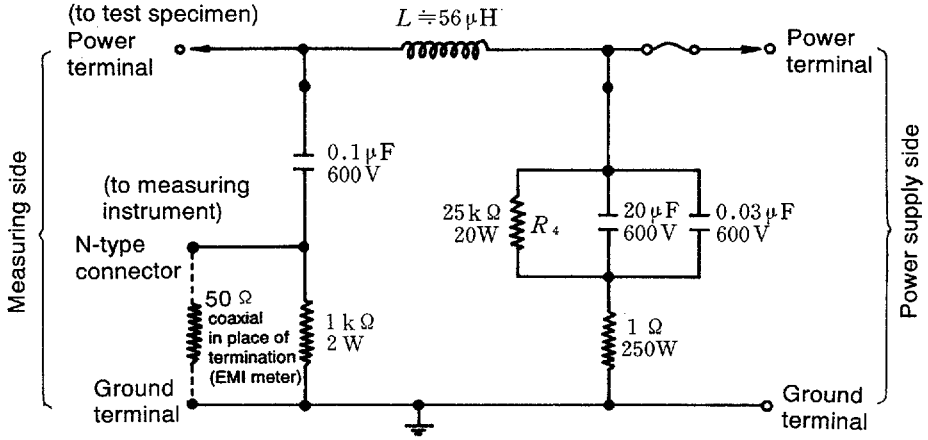
The **No.1 oil** listed in the **Table 4** and the **C oil** listed in the **Table 5** of **12.3.1** (testing oil) of **JIS K 6301**.

5.26.3 Operation

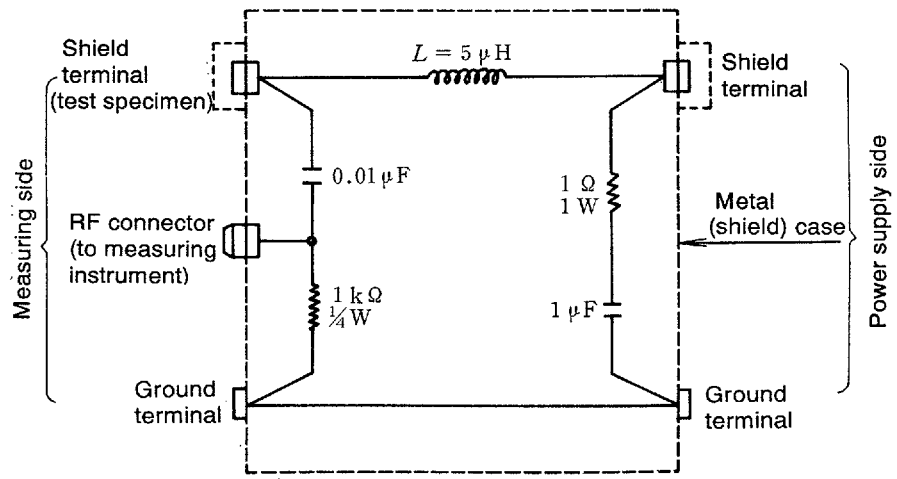
The test specimen shall be immersed and then kept there for 1 minutes in the oil for testing inside the vessel at temperature within a range of 25 ± 3 ℃ after the vessel having been filled with such oil, which shall then be tested in accordance with **5.1** after having been kept at the atmosphere at temperature within a range of 25 ± 5 ℃ under relative humidity within a range of (65 ± 20)% for 22 ± 2 hours, after having been taken out from the oil, where the performance obtained from the equipment through this test shall be recorded and in addition, the conditions thereof including but not limited to the visual appearance shall also be verified.

Attached Fig. 1 Line impedance stabilization network (LISN)

(a) 50kHz – 5MHz

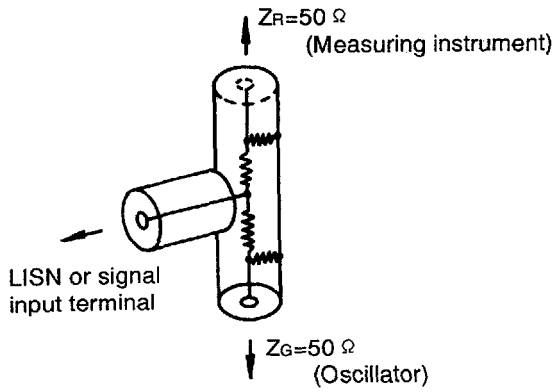


(b) 5MHz – 100MHz



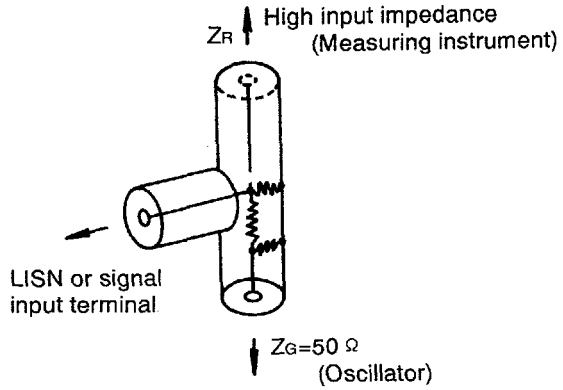
Attached Fig. 2 Impedance matching device

(a) $Z_G=Z_R=50\ \Omega$



Note 1 All resistance 70.7 Ω
2 Add 10.7 dB to instrument meter reading to obtain Voltage injected into LISN.

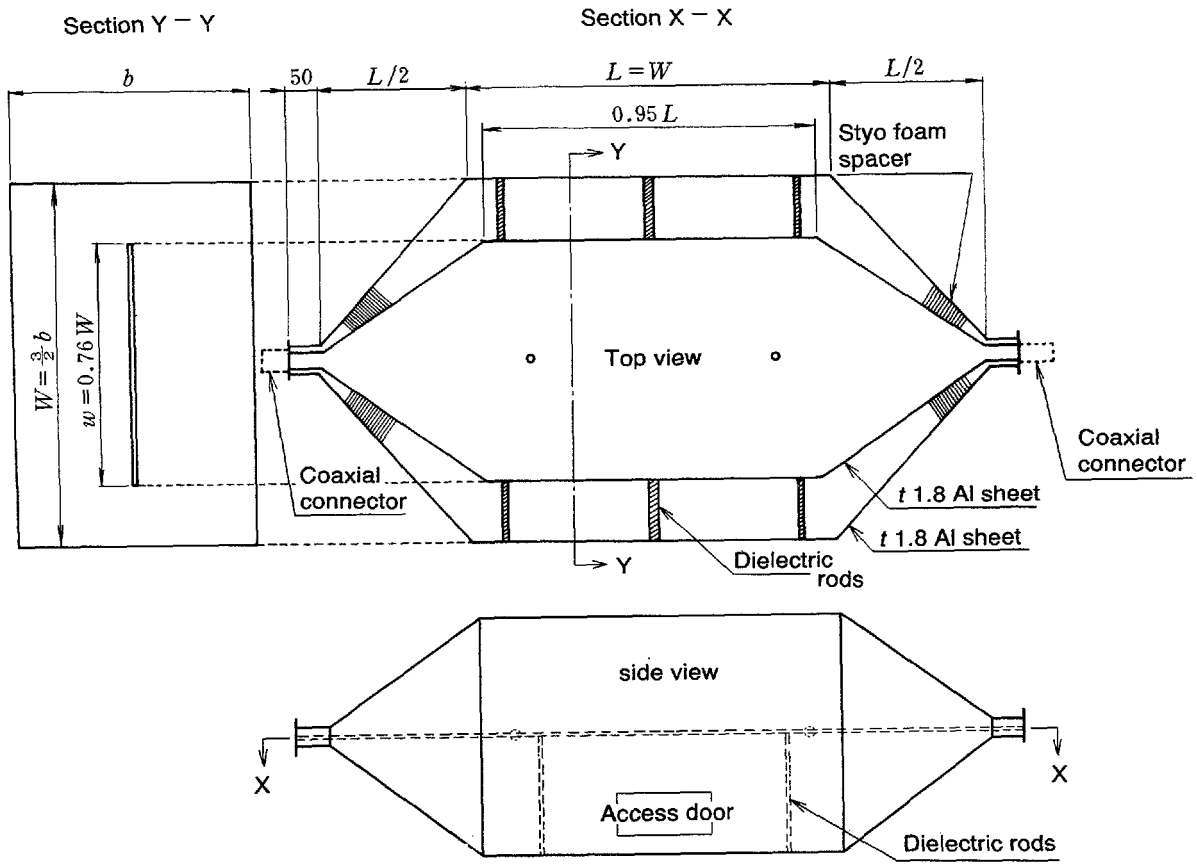
(b) $Z_G=50\ \Omega$, $Z_R \geqq 50\ \Omega$



Note 1 All resistance 86.6 Ω (6dB PAD)
2 Instrument reads directly voltage injected into LISN.

Attached Fig. 3 Example of TEM cell

Unit : mm



Explanatory note on JASO D 001-94 General rules of environmental testing methods for automotive electronic equipment

This explanatory note has been issued for a purpose to explain the matters specified in the Text of this standard and any matter relating thereto, which shall not be any part of this standard.

1. Purpose

This standard aims to establish a unified test method in order to evaluate the performance of automotive electronic equipment under various environmental conditions.

2. Major portions revised and matters discussed as problem at committee meeting

The revisions on this time were made based on the results of review of testing items covering the general requirements for environment and efforts to make the format and style of this standard in better order so as to make it in accordance with **JIS Z 8301** as well as the modification made as the results of comparison with the similar international standards. Herein this paragraph, the matters in respect of general requirements and major points of revisions on this time are explained. Any supplemental explanations of the individual items are made on the paragraph 3 hereof.

(1) Basic stance

The investigation to be offered for reference to the revision of this **JASO D 001** made by the committee in respect of applications of the standards through questions and answers showed the result that a share of the persons who answered not applied was nearly equal to a level a bit lower than 30%. From this result, it was recognized that wide revisions were not required, with the achievements accomplished since the time when enacted being taken into consideration. Accordingly, the revisions on this time were carried out mainly over the matters centered on a coordination with any other domestic and international rules relating thereto.

(2) Testing items removed

The Method of transient voltage withstanding test was newly enacted in 1994 by the **JASO**. In order to avoid a duplication of the provisions, this test was removed from this **D 001**. Before this revision, according to the conditions of the Type B-1 and Type B-2 (12V system), and Type E (24V system) specified in **Table 3** of **5.7** of the Text, the duration of time for the test had been specified to be any time period so long as within a range of 94 $\pm$ 2 hours.

(3) Testing items added

(a) Power source micro interruption test

Since should any power source be instantly interrupted due to chattering at contacts of electrical circuit, any adverse effect shall be given to a normal operation of the equipment, this item has newly been added for a purpose to verify no any possibility of such interruption.

(b) Dew formation test

Water resistance test is the provision to specify a requirement to examine any adverse effect given from the water outside the equipment. Since should the equipment under chilled conditions be quickly heated by the heat from engine and/or heater, etc., dew could internally be created, this item has been newly added so as to require to perform examination of such effect.

(4) Description of provision for testing operations

According to the previous standard, the provision of test operations at each test for vibration, shock, water resistance, salt water, dust or oil resistance had been specified only so as to be performed in accordance with **JIS** C (or **D**) ○○○○. Which conditions in the referred standard or rule to be applied was not clear. Therefore, for the each, the general method to be applicable to electronic equipment for automobile has been specified as a representative requirement.

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(5) Combination of voltage and temperature

There was an opinion offered at the committee meeting, under which the conditions for voltage and temperature should be combined by specifying the normal voltage test to be carried out at high temperature and low temperature, or to make the operational voltage of equipment varied at heat cycle test.

Since there had been no any problem on the method under which any one selected among the voltage and temperature shall be kept constant, such opinion was not accepted mainly due to a reason that it is not favourable to make the test requirements so complex.

(6) Provisions for multi-purpose testing

There was an opinion offered at the committee meeting, under which the provisions on multi-purpose testing including but not limited to combination of temperature and humidity cycle test and vibration test and combination of the test for behavior at low and high temperature and examination for the behavior due to the transient voltage should be added. From a reason that it is better to be optionally combined by user subject to the basic requirements for testing having been set out, such opinion was not accepted.

(7) Unification of heat cycle test, temperature and humidity cycle test, and constant high humidity test

There was an opinion offered at the committee meeting there, under which should the temperature and humidity cycle test be there specified, the heat cycle test and constant high humidity test should not be required. Supposed that those tests are required to evaluate any reliability, only the temperature and humidity test should be required. However, supposed that those tests are required to examine the changed behavior of the equipment due to change of the environmental conditions only by temperature and humidity cycle test, it is not possible to identify due to which the behavior available has been changed, either temperature change or humidity change. Accordingly, from a reason that those test items may be optionally applied after selection by user, case by case, it was concluded for these items to be kept on this standard as they were.

3. Points revised of individual provision and supplemental explanation thereof

3.1 Scope (1. of the Text)

The standard of the environmental testing method for automotive electronic equipment has been enacted mainly considering four wheeled automobiles with nominal 12V and 24V systems as electric power sources. This standard is desirable to be applied to motorcycles, if possible, although the environmental conditions of motorcycles are not always the same as four wheelers.

Further, the car radio, audio players and TVs may be automotive electric equipments, but they have few necessary to meet severe environmental immunity as in the case of control electronic equipments. Such devices, therefore, may be excluded from this standard, but it is desirable that the test methods specified in this standard are applied to those equipments.

3.2 Definitions (2. of the Text)

As for the definitions of automotive electronic equipments (hereafter referred to as "equipments"), only terms peculiar to the equipments are defined in this standard.

3.3 Kind of test (3 of the Text)

It is preferable to specify those including but not limited to sequence of tests and number of the specimens to be used for each test, from point of view with the efficiency and economic factor at or for performing test by being taken into consideration.

However, due lack of practical experiences and actual applications, it was decided not to be specified.

3.4 Power supply device (4.2.(3) of the Text)

Since it is essential to employ any power supply device for testing the equipment under operation, the provisions were decided to be newly added in this standard. Because it is not favourable for the voltage from the power supply device to be widely fluctuated due to operation of the equipment during test, the allowable range of such fluctuation has been revised so as to be a little bit severer.

3.5 Testing voltage (4.4 of the Text)

The testing voltage to be applied was accepted to be specified as the general requirement to be representatively applied to the engine circuit specified in **JIS D 5005**. A study had been carried out so as to obtain allowable range of the testing voltage.

However, since there was not any testing specified in this standard, the minor deviation of testing voltage at which is important, it was decided to provide a provision to specify that the testing voltage shall be applied, which shall be monitored so as to be correct by means with any voltmeter of accuracy in the class of 0.5.

3.6 Normal power supply voltage test (5.1 of the Text)

A test to evaluate the characteristics of the equipment against the power supply voltage excluding the case of engine starting, when the power supply system is normal, and is desirable to be carried out for every kind of equipments. Numerical values of test voltages are specified considering the results of the survey with questionaires sent to the companies concerned, as well as the values recommended by **SAE**, etc. Three points test voltages including both extreme values shall at least be performed, and more points are left to the agreement between the persons concerned.

3.7 Test for power supply voltage upon engine starting (5.2 of the Text)

A test to evaluate the characteristics of equipment against the power supply voltage drop when the starter motor is operated to start the engine (particularly in cold weather), and to evaluate the resistance not to cause abnormalities in the characteristics before and after the engine starting. The test shall be carried out for following equipments:

(1) Equipments which shall operate even at the time of engine starting
e.g. Electronic fuel injection system, electronic ignition control system, etc.

(2) Electronic equipments having memories which need continuous power supply
e.g. Clocks, navigation device, etc.

For 12V system, two kinds of voltages, 6V (class 1) and 5V (class 2), are selected as the minimum voltage V_1.

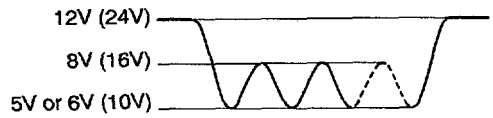
Most of the equipments will not cause any trouble with the class 1 test voltage for the normal and cold area specifications, but the class 2 voltage shall be used under the agreement between the persons concerned when the effect of engine frictions, etc. is necessary to be considered.

Although it is desirable that the test apparatus shown in **Fig. 1** of the **Text** is applied as much as possible, the test apparatus shown in **Fig. 2** of the **Text** may be substituted if it is judged that no effect will particularly be resulted.

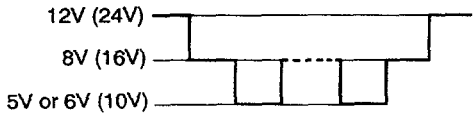
In case of evaluating the variation of characteristics or the degree of effect on characteristics (whether any abnormalities exist or not) of the equipment during "before starting-while cranking-after starting", voltages shall be varied as shown in **Explanatory Fig.1** or **2** while the measurement for 12V systems, and values in parentheses in those figures are for 24V systems.

Although these test apparatuses are desirable to be used in low temperature atmosphere, they may be used under room temperature if it is considered acceptable according to the agreement between the persons concerned.

Explanatory Fig. 1
Test voltage waveform (1)



Explanatory Fig. 2
Test voltage waveform (2)



3.8 Power supply micro interruption test (5.3 of the Text)

When there is an instant release available happened on electric circuit, only a slight change in voltage is expected, based upon the input circuit constant as shown on **Explanatory Fig. 3-b**, if a capacitor have been connected with the terminal circuit for the input equipped inside the specimen as shown on **Explanatory Fig. 3-a**. Accordingly, connection of test specimen when micro-interruption is operated it was decided to confirm whether or not any abnormity be happened.

3.9 Overvoltage test (A method) (5.5 of the Text)

There are following cases of abnormalities that the alternator terminal voltages exceed normal range of source voltage:

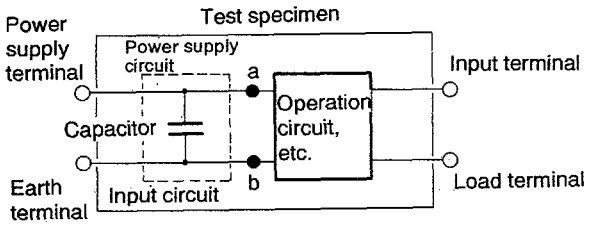
(1) When the voltage regulator failed
(2) When the contact failure occurred in the wiring of alternator of the system to control the generated voltage by detecting the terminal voltage of battery
(3) When the harness from the alternator to battery came off at the battery terminal

Among these, the voltage generated by failure of the regulator like case **(1)** leads to the most severe condition. If the electric current of exciting circuit of the alternator becomes not to be controlled by failure of the alternator, generated voltage becomes higher in proportion to the rotating speed of the alternator, and the battery will be overcharged.
The voltage, however, will be kept at about 18V while the electrolyte remains. The A method is set considering this situation.

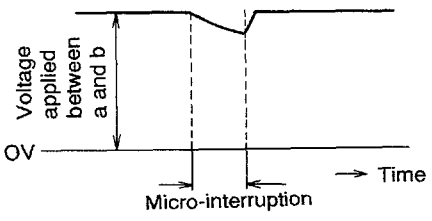
3.10 Overvoltage test (B method) (5.6 of the Text)

It is reported by **SAE**, etc. that some users connect two batteries of nominal 12V in series (12V system), or three such batteries (24V system), in order to make up for the deficiency of battery and make engine starting easier in cold weather, etc. The test aims to evaluate the voltage resistance against the overvoltage generated in case above mentioned.
This is a test to evaluate the resistance against the over- voltage supplied in the case mentioned above, the objective equipment to which are same as those mentioned in the paragraph **5.7** of those explanations.

Explanatory Fig. 3-a
Construction of system on test specimen



Explanatory Fig. 3-b
Wave form of voltage on test specimen



Further, this test is desirable to be carried out under low temperature condition as same as **5.2**, but now obtained data are not sufficient to specify the numerical values of the temperature, therefore the temperature condition shall be decided under the agreement between the persons concerned, and it may be carried out under room temperature unless otherwise specified. Moreover, in case of the equipment in 24V system, two different kinds of the testing circuits on which the voltage shall be applied for a duration of time so long as equal to 60 times shall be constructed, subject to the voltage condition being same as it of **5.5**.
Regardless of this provision, this test may not be carried out subject to the test required under 5.5 being performed.

3.11 Transient voltage characteristics test (5.7 of the Text)

This is a test to evaluate the characteristics of an equipment against transient voltages that may be generated by other electric and electronic devices installed on the vehicle.
Main transient voltages on vehicles may be classified as follows:

(1) Transient voltages generated upon load damping (Type A and Type D)
(2) Transient voltages generated when ignitions are switched off (Type B-1)
(3) Transient voltages generated when a diesel engine vehicle battery are switched off, etc. (Type E)
(4) Transient voltages generated when various inductive loads (relay, solenoid, etc.) are switched off (Type B-2)
(5) Transient voltages generated by the inductive/capacitive combinations caused by the activation of various electric/ electronic devices (ignition system, etc.) (Type C and Type F)
(6) High frequency oscillatory transient voltages following spark discharges generated by "ON" and "OFF" operations of the contact points in various electric circuits on the vehicles.

Of above mentioned transient voltages, test methods are specified in this standard for **(1)** through **(5)**.

Type A and Type D
These are the tests which assume the transient voltages generated upon load damping classified in **(1)** above.
Of load dampings, A-1 and D-1 are the tests for transient voltages caused by the delayed response in field coil.
For, setting of the test conditions of 12V system, it is appropriate to set the condition of alternator that may occur generally as 60% cut-off of the rated current at 7000 rpm, based on test results accumulated by the companies concerned and referring to **SAE J 1113a**. Typical values of transient voltages under the above mentioned conditions are as follows,

Load resistance :	∞ Ω	2 Ω
Maximum value of transient voltage :	70V	50V
Duration of transient voltage :	400ms	240ms
Decaying time constant of transient voltage :	200ms	120ms

Next, for setting of test conditions of 24V system, it is appropriate to set the condition of load damping that may occur generally as 60% cut-off of the rated current at 5000 rpm of alternator revolution, because the engine revolution is ordinarily lower than the 12V system. Typical values of transient voltages under the above mentioned conditions are as follows, based on test results accumulated by the companies concerned, constants of parts of the test circuit are specified based on them :

Load resistance :	∞ Ω	4 Ω
Maximum value of transient voltage :	110V	80V
Duration of transient voltage :	800ms	400ms
Decaying time constant of transient voltage :	400ms	200ms

Two kinds of value are given so that the test may be done either circuits (Refer to **Table 4** in the **Text**).
Of load dampings, A-2 and D-2 are the tests for transient voltages caused by the inverse electromotive force of the stator coil. As was the case of A-1 and D-1, the test conditions (the test circuit and the constants of its parts) are specified based on the test results under the same operating conditions for alternator with A-1 and D-1. (**Table 4** in the **Text**)
Values specified on **Table 4** and **Table 5** of the Text are the actual values of related circuit parts, therefore care must be taken, for condensers in

particular, since the indicated and actual capacities of condensers are qpttodiffer each other.

Type B and Type E

Of major transient voltages classified in the foregoing, these tests are based on the assumption of **(2)**, **(3)** and **(4)** above; that is to say, these transient voltages of negative polarity, that generate when inductive loads connected to the vehicle electric circuit are cut off, are assumed.

B-1 is a test against the transient voltage discharged from the field coil to the loading side when the ignition switch is opened in the 12V system.

When establishing the provision for the standard, only open circuit was assumed, because the duration of transient voltage tends to prolong significantly when the ignition circuit is opened as compared with the case where the circuit is closed.

Typical values of the former are as follows, and constants of parts of the test circuit are specified based on them.

Load resistance :	40 Ω	8 Ω
Maximum value of transient voltage :	− 80V	− 40V
Duration of transient voltage :	140ms	200ms
Decaying time constant of transient voltage :	40ms	60ms

Two kinds of values are given so that the test may be done either circuits (Refer to **Table 5** in the **Text**).

Values specified on **Table 5** of the **Text** are the actual values of related circuit, therefore care must be taken, for condensers in particular, since the indicated and actual capacities of condensers are different.

When the ignition circuit is opened by the ignition switch, transient voltage tends to differ according to the arc discharge generated by the switch. Some test results indicate, if a noise suppressor condenser is installed in parallel to the power supply circuit, it will constitute the major electrostatic capacity of the power supply circuit, and will affect on the generation of arc discharge.

It is also expected that the voltage may rise near to the primary inductive voltage at the time when the breaker is connected, according to the condition of arc discharge suppression.

Foregoing results are, however, obtained on bench assembled tests, and it was confirmed that only the lower transient voltage would occur on vehicle tests as compared with bench tests.

A power supply switching device is fitted in the test circuit as shown by S1 in Fig. 8 of the Text, because it was considered that the electric potential variation of the power supply line would affect on the transient voltage resistance due to the succession of discharge caused by the electrostatic capacity included in the equipment just after opening the ignition switch.

B-2 is a test against the transient voltage which generates when the induction loads (relay, solenoid, etc.) other than the field coil are cut off in 12V system.

The test conditions are specified through practical measurements of the transient voltage of each inductive load, and relatively large transient voltages among these measurements are given as typical values. (Refer to **Table 5** in the **Text**)

Type E is the test against the transient voltages that occur at the loading side when the battery switch is opened on 24V system vehicle (diesel engine vehicle). Typical values of the former are as follows, and constants of parts of the test circuit are specified based on them :

Load resistance :	∞ Ω	150 Ω	30 Ω
Maximum value of transient voltage :	−320V	−170V	−40V
Duration of transient voltage :	8ms	35ms	90ms
Decaying time constant of transient voltage :	1.7ms	10ms	25ms

Two kinds of values are given so that the test may be done either circuit (Refer to **Table 5** in the **Text**).

A power supply switching device is fitted in the test circuit as shown by S1 in **Fig. 8** of the **Text**, because it is considerable that the electric potential variation of the power supply line will affect on the transient voltage resistance due to the succession of discharge caused by the electrostatic capacity included in the equipment just after opening the battery switch, etc.

In respect of voltage application at the test in Type B and Type E, since the frequency of occurrence thereof is remarkably high as compared with the load damp subject to Type A and Type D, the opinion offered was accepted, under which it should be necessary for voltage to be applied more frequently to a considerable high extent. 100 times of voltage application was

decided to be specified from a point of view with the purpose of this provision to require the examination of any influence over performance of the equipment by being taken into consideration. Should it be essentially required, the frequency of voltage application are recommended to be increased in accordance with the agreement made between the persons concerned.

Type C and Type F

Of above classified various transient voltages, the tests cover **(5)**; that is, the resistance against mutual interference caused by inductive and capacitive combination between loading lines that are loaded in an operation of equipment, radiated electric noise interference from the magnetic inductive interference caused by alternator, ignition systems (high tension codes, spark plug etc.) alternator, etc. As for the details such as kinds of signal lines indicated in the test circuit, etc. they are left to the agreement between the persons concerned.

According to the previous provision, a resistance of 2 ohms or diode had been required to be inserted in the transient voltage generating circuit of the power supply system (between the power source and the test specimen). Since under such condition, the generation of transient voltage is limited to be kept so low that the test condition be made more relaxed, the resistance has been decided to be specified so to be directly connected with the power source and the test specimen. (See **Fig. 9** and **Fig. 10** in the **Text**)

Type C and Type F test conditions and the high frequency transient voltage, etc. accompanying the contact electrode aprk discharge classified in **(6)** in the foregoing are not specified in the current standard, but it is desirable to specify them in future amendments of the standard. (For the latter, however, the conducted electromagnetic test method given in **5.9** will serve the purpose to a certain extent).

Equipment subject to transient voltage test

Although kinds of equipment subject to Type A through Type F transient voltage tests are basically left to the agreement of the parties concerned, some examples are given below for the reference taking account of the degree of effects of kinds of devices on the vehicle when some abnormalities have occurred **(Explanatory Table 1)**.

Explanatory Table 1 Examples of equipment subject to tests

Classifications of equipment			Types of transient voltage test				
		12V system	A-1	A-2	B-1	B-2	C
		24V system	D-1	D-2	E	–	F
Class a	Those impair the safety of vehicle by the failure of defective operation		○	○	○	○	○
Class b	Those hinder the running function of vehicle by the failure or defective operation		○	○	○	○	○
Class c	Those relating to vehicle functions, excluding those listed in Class a or b			○	○	○	○
Class d	Those without direct relation to vehicle functions				○		

Remark Individual examples of the equipment
Class a : Skid control device, air bag
Class b : Electronic ignitor, electronic fuel injection
Class c : Indicators such as speedometer, alternator
Class d : Car radio, automobile telephone, air conditioner

3.12 Electrostatic test (5.8 of the Text)

This is a test to evaluate on the table the resistance against the defective operation and burn-out damage caused by electrostatic discharge.

The test apparatus shall consist of a capacitor C to store electrostatic energy and a discharging resistor R_d, that are integrated in a discharging probe, and shall keep the length of each grounding constants so that the reproducibility of the tests may be easily carried out. The length of the grounding is desirable to keep constant within the range of 30 – 70cm.

Capacity 150pF of the capacitor C and value of resistance 500 Ω are specified based on the electrostatic discharge equivalent circuit of the human body and conformity with ISO standard.

Then the value of the charging resistor R_c is appropriate to be 100M Ω ± 10% in accordance with the charging time constant and leakage current.

Impressing method of voltage is specified to simulate a practical electrostatic discharge case that the electrode of the probe shall slowly approach to the impressing point so that the discharge within the air occurs. Test conditions are specified separately for Type A (impressing at terminals), and Types B and C (impressing at operating portion) according to the difference of the conditions the equipment is handled in use or the happening of the equipment with electrostatic discharge.

Type A (Impressing at terminals) test

This is a test assuming the case that electrostatic discharge occurs at the terminal of an equipment while handling it on the production line and the equipment is broken.

Results of the study on charged electrostatic voltages of line workers of the automobile manufacturer in winter (**Fig. 1** of **Explanatory Reference 1**) shows that the voltages are almost all 1kV or less with very few exception of 5kV and greater part of them are 0.5kV or less. Therefore, the test voltages are specified as ± 0.5kV (A-1) and ± 1kV (A-2). Number of impressions is specified as 3 times or more, but about 10 times are desirable. Impressing may be done not only between the earth terminal and all other terminals but also, if necessary, between each terminal and the case, and in particular case test conditions (test voltage, applying period, number of impressions) may otherwise be specified under agreement between the persons concerned.

Type B and Type C (Impressing at operating portion) tests

These are the tests assuming the case that electrostatic discharge occurs a manual operating portion where the driver may have frequently to touch and the equipment malfunctions and burn out damage. Progressed with a great variety of electronic devices in recent years, such equipments have increased that give and receive information with drivers through switches, keyboards or visual displays. This test should be specially applied against the liquid crystal displays, etc.

Results of the study on electrostatic charged voltages of passenger car drivers in winter (**Fig. 2** and **Table 1** of **Explanatory Reference 1**) shows that high voltage of 8kV is measured just after getting off the car, but in the car room the voltages are 1kV against the car body in most cases.

Based on the results of these studies, the test voltages are specified as ± 1kV (B-1), ± 5kV (B-2) against the malfunction, ± 5kV (C-1), ± 10kV (C-2), ± 15kV (C-3) against the burn out damage. Number of impressions is specified as 3 times or more, but about 10 times are desirable.

As in particular case, when the vehicles for foreign dry lands are applied, test conditions (test voltage, applying period, number of impressions) may otherwise be specified under agreement between the persons concerned, as making the test voltage 20kV or 25kV.

In addition, grounding of whole test devices is necessary in order to the stabilization of reference potential and the safety during tests.

Equipment subject to electrostatic test

Although kinds of equipment subject to Type A through Type C electrostatic tests are basically left to the agreement between the perties concerned, some examples are given in **Explanatory Table 2** for reference taking account of the degree of effects on the vehicle when the equipment have occurred abnormalities.

Explanatory Table 2 Examples of equipment subject to tests

Classifications of equipment		Types of transient voltage test						
		A-1	A-2	B-1	B-2	C-1	C-2	-3C
Class a	Those miss the safety of vehicle by the failure of defective operation		○		○			○
Class b	Those spoil the running function of vehicle by the failure or defective operation		○		○		○	
Class c	Those relating to vehicle functions, excluding those listed in Class a or b	○		○		○		
Class d	Those without direct relation to vehicle functions	○		○		○		

Remark Individual examples of the equipment shall be pursuant to **Explanatory Table 1**.

3.13 Conducted electromagnetic test and radiated electromagnetic test (5.9 and 5.10 of the Text)

Electromagnetic troubles of the equipment are sometimes caused by the radiation, induction, conduction, etc. from the devices, such as electromagnetic wave applied equipments, electric facilities, radio communication facilities, etc.

Particularly, strong electromagnetic fields that occur near radio transmission facilities represented by broadcasting stations, those which generated around the vehicle body by the operation on board radio of transmitter represented by transceiver, and troubles caused by interferences resulted from high frequency voltages, etc. induced at the vehicle wiring systems will exhibit problems such as error or defect operations, deterioration or destruction of such devices. This test, therefore, aims to evaluate the electromagnetic environmental resistance by way of the design standard to protect equipment and to ensure functions of equipment from such troubles.

Although every type of electromagnetic wave should be included in the applicable frequency range, the provision is established mainly for the frequency band from MF (medium frequency) band to UHF (ultra high frequency) band that have the great effect in daily operation.

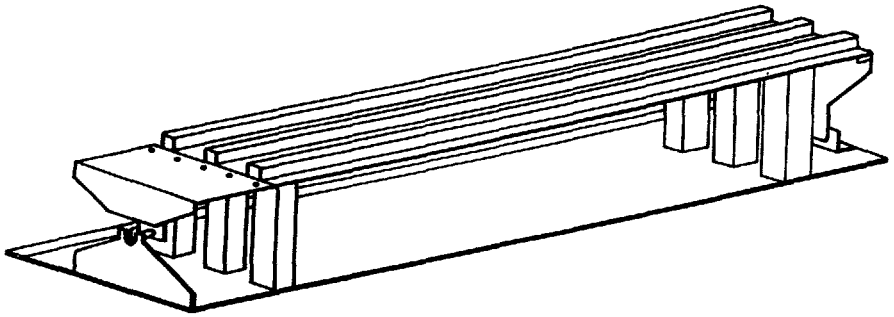
Type of tests are classified into conducted and radiated electromagnetic environments according to the propagation paths against troubles such as interferences, etc. caused by electromagnetic waves of high frequency sine waves other than steep peak transient voltage interferences, based on the classification adopted in **SAE J 1113a** and **MIL-STD-462** Notice 3 (EL).

Conducted electromagnetic tests are divided into two frequency bands of 30Hz to 50Hz and 50kHz to 100MHz, while the radiated electromagnetic tests are divided into three tests, test by magnetic field of 30Hz to 15kHz and tests by electric fields of 1MHz to 200MHz and 200MHz to 1000MHz.

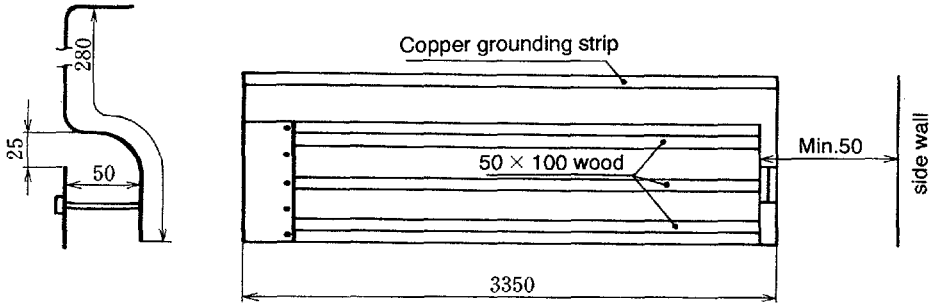
In addition, the test apparatus for 14kHz to 30MHz frequency range electric fields may be the parallel strip line (**Explanatory Fig. 4**) method proposed in **MIL-STD-462** instead of the TEM (Transverse Electromagnetic) cell shown in **Fig. 17** of the **Text**.

Further, measuring accuracy and reproducibility of TEM cell test method using the reference sample, that careful consideration is necessary on the following points:

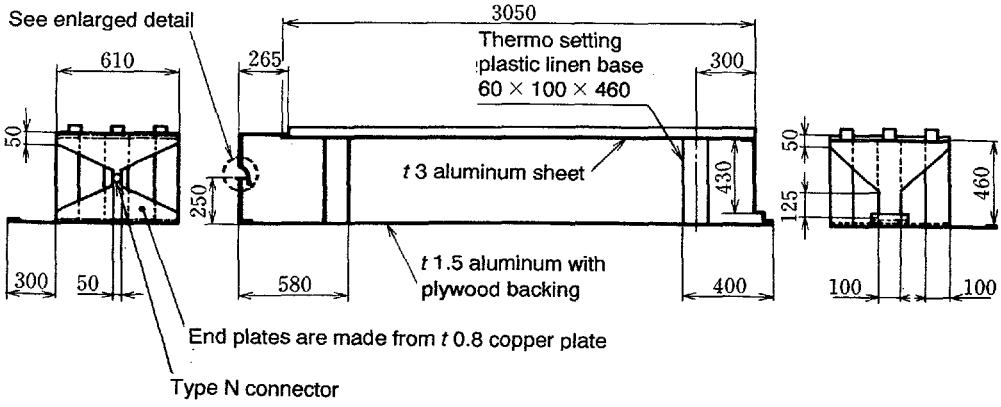
Explanatory Fig. 4 Parallel strip line for radiated electromagnetic tests



Enlarged detail **Top view** **Unit**: mm



Input end **Side view** **Load end**



(1) Accuracy of electric field strength in the TEM cell

(a) Although the set strength of electric field in the TEM cell varies according to the test conditions, such as location in the TEM cell, and difference among TEM cells themselves other than the frequency characteristics, and accuracy of signal generator, signal level meter, etc., it was confirmed that the deviation of the set strength of electric field in the TEM cell was within 3dB under the same test conditions. This deviation may be increased about 8dB by variation of the test conditions.

(b) In order to ensure the accuracy of the set electric field strength, the spurious suppression for the signal fed to the TEM cell and maintenance of accuracy of level measurement shall particularly be cared.

(2) Fitting method of test specimen

It is necessary to make the fitting conditions constant, when the test specimen is fitted in TEM cell, to ensure the reproducibility of the

test. Particularly the impressing direction of electric field, the fitting direction of the test specimen (for instance, the surface to be faced toward the ground of a specimen shall be faced to the outer conductive surface of the TEM cell), etc. shall be cared.

(3) Effect of lead Wire from test specimen on inner electromagnetic field

(a) The electromagnetic field in the TEM cell sharply varies under the effect of resonance phenomena by the lead wire of the test specimen to the outside, accordingly the electromagnetic resisting characteristics happen to vary steeply at peculiar frequency (actual measurement example showed a deflection of 20dB or more); and in such case, reproducibility of the test is low.

(b) The effect of resonance phenomena by lead wire may be suppressed within 6 - 12dB by means of connection of the lead wire through ferrite tube of large high frequency loss.

(c) The existence of abnormal electromagnetic field in TEM cell and its suppressing effect may be detected by simultaneous measurement of reflection coefficient in case of the measurement of signal level (electric power) fed to TEM cell.

(4) Test of the specimen accompanying lead wire connecting outside

(a) When the lead wire is shielded

Tests including lead wire may be carried out within allowable variation range of 6 - 12 dB using ferrite tube shown in **(b)** of **(3)**.

(b) When the lead wire is not shielded

It has been confirmed that the test results vary 30dB or more by the interaction between interferences of conduction and radiation caused by intrusion of electric voltage induced in the lead wire by impressed electromagnetic field.

(Refer to **Fig. 1** through **4** in **Explanatory Reference 2** for the test reference samples and practical measurement examples. The test results are proper to the set test conditions, and it is difficult to evaluate as normal characteristics of a specimen.)

From the results above mentioned, this electromagnetic resisting characteristics test using TEM cell is useful as a test method to evaluate the operation of an electronic equipment unit under specific condition of lead wire connection, but conducted electromagnetic test that examine the effects of connecting lead wire, wiring, etc. is necessary to be also carried out to evaluate as an electronic control system. Further, for comprehensive evaluation of the equipment including the effects of wiring and grounding when it is fitted on a vehicle, a test impressing electromagnetic field directly is sometimes necessary as the technical report of **SAE J 1338** for instance.

As for the intensity of interference electromagnetic field to be impressed in the test, the numerical values of 0.1 to 10V for interference voltage and 5 to 100V/m for interference electric field has been specified referring to **Table 1** to **3** of **Explanatory Reference 3**, etc.

Further, as for the intensity of interference magnetic field for tests by means of magnetic fields, the test method alone is specified due to the lack of adequate data to establish a standard. Impression duration for applying electromagnetic trouble factors and other test conditions (conditions that may affect on troubles according to the modulation method for interfering electromagnetic waves, degree of modulation, modulation frequency, etc,) and other environmental conditions are not particularly specified in this standard, but it is recommendable to carry out the tests by selecting appropriate test durations and conditions which best fit to each object.

Other details of the tests are left to the agreement between parties.

As for the high output transmitter for the test, it is considered convenient to use the transmitters with frequency bands for amatures (1.9, 3.5, 7, 10, 14, 21, 28, 50, 144, 430, 1200MHz, etc. in Japan) in view of availability, performance, easiness in handling, and generating frequency, etc. It will be necessary, however, to make sure that no resonance phenomena exist in particular frequency

ranges against interferences, and that no illegal electric wave radiation to outside environments when carrying out the tests.

3.14 Temperature characteristics test (5.11 of the Text)

3.14.1 Testing temperature at temperature characteristic test and allowable deviation (Tolerance)

In respect of the setting temperature of 20 ℃ specified in the standard previously mentioned, since as the condition required for verification after the those tests including but not limited to temperature and humidity cycle test, dew formation test and water resistance test, 25 ℃ had been specified, it was coordinated with it. In addition, a range of − 20 ℃ and − 30 ℃ has been specified. Since the range specified is considered too narrow, it was revised so as to be equal to − 5℃ , which is located nearly at the center between the range of − 30 ℃ and 25 ℃ . In respect of any of those in the **Class 3**, since the specified 65℃ , 80℃ and 100℃ are situated in a relatively narrow zone, the 80 ℃ was omitted. Since it should be equal to 125 ℃ as high a long the recent trend of the **ISO**'s standards relating to automotive parts, this trend was introduced in the parts enclosed with ( ) so as to be able to be applied, should it be essentially required. In addition, in respect of the allowable range of temperatures, it was unified so as to be equal to ± 2 ℃ as high in accordance with the relating international standard, after the performance available from the existing constant temperature chamber in the market having been investigated.

3.14.2 Equipment on a high temperature portion

As for the **Class 4** equipments to be installed at or near high temperature generating units or other special portions (equipments installed on the exhaust manifold surface, inside the exhaust pipe, in engine oil etc.), it is difficult to unify temperature setting due to the significant differences in high temperature conditions according to the kind of vehicle, installation location, installing method, etc. Therefore, such details are left to the agreement between the persons concerned. Further, the test apparatus and allowable temperature difference are also left to the agreement between the parties concerned when the set temperature is 200 ℃ or higher. Even equipments installed in the vehicle room are subject to severe temperature conditions if they are so located as exposed to direct rays of sunshine when the vehicle is parked at a high temperature ares. Thus such equipments shall be handled as **Class 3** or **Class 4** equipments. Some examples are given below for reference of temperature setting for these equipment.

Upper portion of the instrument panel :	110 ℃
Upper portion of rear shelf :	110 ℃
Engine cooling water :	120 ℃
Engine oil :	150 ℃
Transmission oil :	150 ℃
Intake manifold surface :	120 ℃
Exhaust manifold surface :	650 ℃
Dash panel surface :	140 ℃
Alternator intake air :	130 ℃
Distributer surface :	135 ℃
Disk brake pad :	500 ℃

3.14.3 Operation (5.11.3 of the Text)

It is not particularly necessary to specify the temperature time gradient when setting the ambient temperature (around the test specimen, but the method to vary the temperature) in the chamber gradually after the test specimen was placed in the chamber and bring the temperature to the specified value has been adopted, since sudden thermal change will result if it is put into the constant temperature bath for which the temperature is previously set.

3.15 Operation of the high temperature operation test (5.15.3 of the Text)

Three kinds of test durations of 94 ± 2h, 118 ± 2h and 238 ± 2h where considered at first taking account of situations when carrying out high temperature operation test, but due to the difficulty in selecting an appropriate test duration clearly according to the kind of equipment, the duration of 118 ± 2h has been adopted for the time being. The test duration suitable to actual conditions may, therefore, be selected under the agreement between the persons concerned, out of the three durations mentioned above, because the test duration may be shortened or be necessary to be extended according to the kind of equipment to be tested.

3.16 Temperature and humidity cycle test (5.18 of the Text)

3.16.1 Purpose of test

This test is to be carried out for a purpose to evaluate the performance quickly in shorter time, in case when the equipment is to be operated or to be kept under a relatively high humidity, subject to change of the temperature within a range from high to low level, within which the acceleration test is to be carried out, under the testing condition which is severer than the conditions for actual service at vehicle.
Therefore, to the applicable testing conditions, the **ISO**'s recent standards in respect of electric and electronic equipment for automobile were referred.

3.16.2 Test operations (5.18.3 of the Text)

The conditions for the operation and non-operation under temperature and humidity cycle were specified so as to be suitable to the provision of temperature and humidity cycle test set out in the previous JASO D 001. In respect of method of treatment for measurement of performance after the temperature and humidity cycle test, the three conditions as listed hereunder were specified.:

(1) Water on surface to be dried,
(2) Overall sections to be dried, and
(3) Surface to be kept as it is, should water in drop be kept attached thereon.

Among them, the **(3)** was especially specified, by being supposed the situation of the equipment (sensor, actuator etc.) to be installed inside engine room or under suspension spring, otherwise, to which any operation under very high humidity is required. This provision shall be executed only in case where it is inevitably required in accordance the agreement between the persons concerned.

3.17 Dew formation test (5.20 of the Text)

Should the equipment in low temperature environment at temperature equal to or less than 0 °C as low be exposed under the ambient condition at high temperature and under high humidity, dew would essentially be created. Should so wide range of difference of temperatures be specified, it would be regarded as a kind of thermal shock test. However, though should it be exposed in the ambient conditions which is on lower side, dew would be created, depending on the heat mass of the equipment, a high fluctuations could be available in the periods of time required for a change from frost to dew. Therefore, the time required of release was specified so as to be equal to 10 minutes to the maximum value as long after such maximum value on the condition at normal room temperature and under normal room humidity had been deciced to be used. Experimentally, it has been verified that under such condition, almost all the equipment has come to be dewed from the state of frost. In case of the equipment, the heat mass of which are utmost high, the duration of time for holding at low temperature and the time required of release in constant temperature and humidity chamber may be optionally fixed in accordance with the agreement made between the persons concerned.

3.18 Salt water spray test (5.22 of the Text)

This test is to evaluate a resistance of the equipment which has been installed mainly on the external section of vehicle against salt water. In respect of the method of salt water spray test for automotive parts, since there had been no any suitable provisions in **JIS** and **JASO**, in the previous **JASO D 001**, **JIS C 5028** had been referred. However, since the **JIS C 5028** was abolished after the **JIS C 0023** and **C 0024** coordinated with IEC and had been enacted, it was decided to review the standards and code to be referred therein and to describe the operations required of the test concretely.
The differences between the **JIS C 0023** and **JIS C 0024** are that the former is a test in which mist is continuously sprayed, while the latter is a cycle test in which mist spraying and stopping it are altertively repeated. For the provision for the old **JIS C 5028**, it was decided to refer the **JIS C 0023**. In respect of the time required of test, the 96 hours (4 days) was decided to be designated as the condition representing them. It was also decided that should it be essentially required to do so, the testing conditions (testing time, cycling etc.) may be designated in accordance with the agreement made between the persons concerned.

3.19 Vibration test (5.23 of the Text)

This test is to be carried out to evaluate the resistance of the equipment against the vibration

given by rotation of engine and operation of vehicle, which was decided so as to be performed in accordance the **JIS D 1601** which had already been enacted. However, since according to the provision of the **JIS D 1601** applicable thereto, the user's wide selection shall be allowed, herein this standard, a common condition to 4 wheel automobile was decided to be spefi-cied as the condition representing it, where should it be essentially required, the testing conditions (Range of vibration frequency, accelelation of vibration, constant frequency vibration, etc.) may be designated in accordance with the agreement made between the persons concerned.

3.20 Shock resistance test (5.24 of the Text)
This is the test to evaluate the resistance of the equipment aginst the severe shock expected given thereto from the handling and transportation at the process until having been assembled on vehicle after completion of all the product inspections or at the process until being shipped as the parts for repair.
Since it had specially been no problem available until now for the **JIS C 0912** to be refered in **JASO D 001**, the same standard was decided to be used. However, since according to the provision of the **JIS C 0912** applicable thereto, the user's wide selection shall be allowed, herein this standard, the 981 m/s^2 which is specified in **the method 2** therein as the severity to shock was designated to be speficied as the condition representing it. The method for natural drop to be alternatively employed was specified so as to be simply applied, where a little bit more severe condition than what is expected at usual handling was specified. In the necessary case, the testing conditions (severity of the shock, height of drop, etc.) may be designated in accordance with the agreement made between the persons concerned.

3.21 Dust resistance test (5.25 of the Text)
This is a test to evaluate the resistance of the equipment against dust when they are kept installed mainly in externally exposed on vehicle, which was decided to be specified so as to follow the applicable provisions of the **JIS D 0207** which had been enacted to be applied to automobile parts. In case of the **JIS D 0207**, since depending on the place of the parts where to be installed, the applicable testing condition shall be selected, should the place have already been known, the test may be carried out in accordance with **JIS D 0207**. Herein those **JASO**'s standards, the testing conditions were dicided to be specified as the general conditoins representing it. Should it be essentially required, the testing conditions (condense of the dust, duration of test, etc.) may be designated in accordance with the agreement made between the persons concerned.

3.22 Oil resistance test (5.26 of the Text)
This test is to be carried out to evaluate the resistance of the equipment against contact with chemical solutions or the similar matter, when they are kept installed mainly in externally exposed on vehicle, for which it was decided to be applicable only the oils which have until now been specified in the previous **JASO D 001**, because too many kinds of chemical solutions (brake fluid, washer fluid, anti-freezing solution, etc.) to be used for automobile are available so that it is too complex to cope with the all as well as it was considered not necessary to do so. However, since **JIS K 6301** is the standard to specify the testing the physical properties of sulfurized rubber, only the provision for testing oil was referred in those standards and in respect of the method of testing, a unique method newly developped to judge whether the test shall be required or not and the testing conditions were specified. It is considered not necessary for the equipment to be installed inside car room to be immmersed in oil. Therefore, should it be essentially required to do so, whether such test is required or not, the testing conditions (kind of oil, method of contact of the equipment with oil, etc.) may be designated in accordance with the agreement made between the persons concerned.

Explanatory reference 1
Example of Result of Measurement of Potential Created by Electro-Static Charging

This **explanatory reference 1** is the result of investigation which had been carried out for a purpose to set out the potential voltage to be applied for the electro-static test specified in **5.8** of the Text.

The **Fig. 1 of Explanatory reference1** in this information shows the result of the investigation which had been carried out to know the potential voltages actually charged in winter season to the workers of automobile manufacturers working on actual production line.

The **Fig. 2 of Explanatory reference 1** and **Table 1** in this information show the result of the investigation which had been carried out to know the voltages actually charged in winter season to the passenger car drivers.

Fig.1 of Explanatory reference 1
Study results on charged voltages of line workers (Japan, in winter)

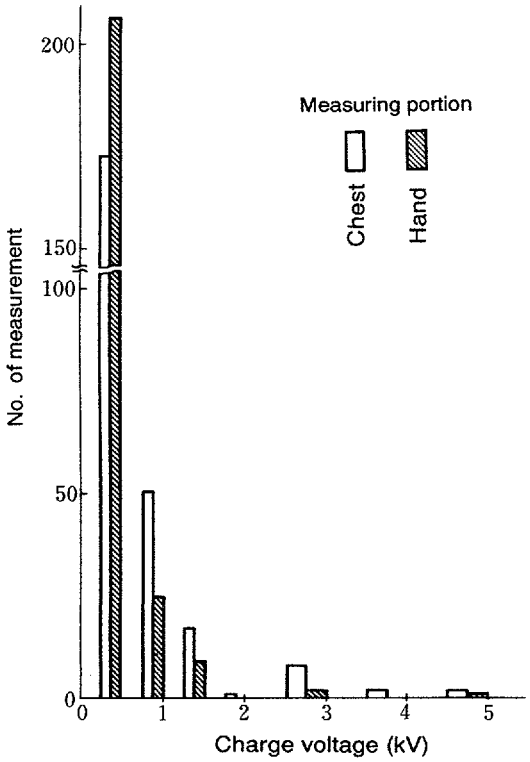


Fig. 2 of Explanatory reference 1
Study results on charged voltages of passenger car drivers(Japan, in winter)

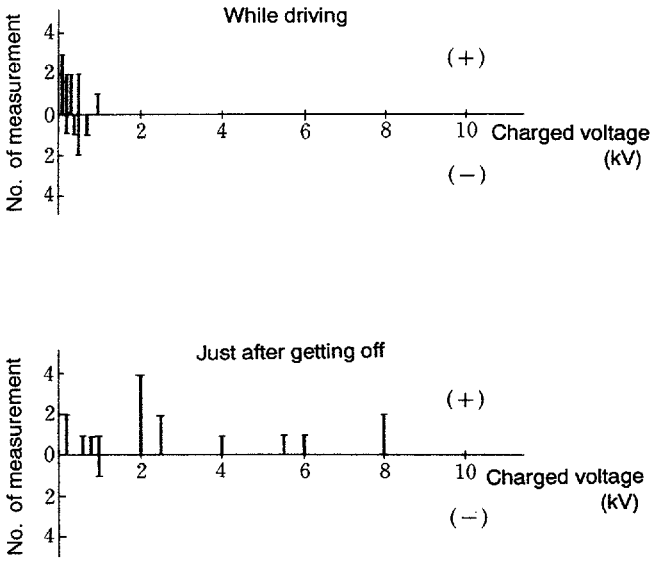


Table 1 of Explanatory reference 1
Study result on charged voltages of passenger car drivers (Japan, in winter)

Weather		Vehicle condition			State of measured person			Measuring condition	Electrostatic Voltage (kV)
Temperature (℃)	Humidity (%)	Floor mat	Seat	Steering	Coat	Underwear	Shoes		
7	40	Acryl	Synthetic clothing	Resin	Cotton, Synthetic clothing	Cotton	–	Just after aboard While driving	0.8 to 1.0 – 0.4 to 0
–	40	–	Vinyl	–	–	Wool	Sports shoes	While driving Friction at leaving seat Just after getting off	0.3 0.3 to 0.8 1 to 2
2	40	Rubber	Moquette	Resin (Urethane)	Sweater	–	Leather	While driving Just after getting off	0.1 to 0.2 8
2	40	Rubber	Moquette	Resin (Urethane)	Vinyl	Cotton	Rubber	While driving Just after getting off	0 to 0.1 7 to 8
2	40	Vinyl	Synthetic clothing	Resin	Wool	–	Leather	While driving Just after getting off	0.2 to 1 2 to 4
2	40	Wool	Synthetic clothing	Resin (Urethane)	Cotton	Wool	–	While driving Just after getting off	– 0.2 – 0.2
Fair, abnormal dryness warning		–	Synthetic clothing	Resin	Cotton, Polyester, mixture	Cotton	Rubber	Wile driving Just after getting off	0.05 to 0.1 0.7 to 0.8
Fair, abnormal dryness warning		Rubber	Synthetic clothing	Resin	Wool	Wool	–	While driving Just after getting off	0.2 to 0.3 2

Explanatory reference 2
Example of measurement at TEM cell test

This **explanatory reference 2** shows the distribution in potential field inside the TEM cell (of Sample A), the resonance phenomena on conductor wire and counter-measure and effect against it and examples of the measurement (of Sample B) made without shield over the conductor wire, when studied is carried out for testing method used TEM cell showed in **Fig. 17** concerning radiated electromagnetic test specified in **5.10** of the **Text.**

Fig. 1 of Explanatory reference 2
Reference measuring device for the test

(1) Sample A
Frequency range : 20 to 200MHz
Electric field strength
when LED is it : 146 ± 1dB (μV/m)

(2) Sample B
Frequency range : 20 to 200MHz
Electric field strength
when LED is it : 152 ± 1dB (μV/m)

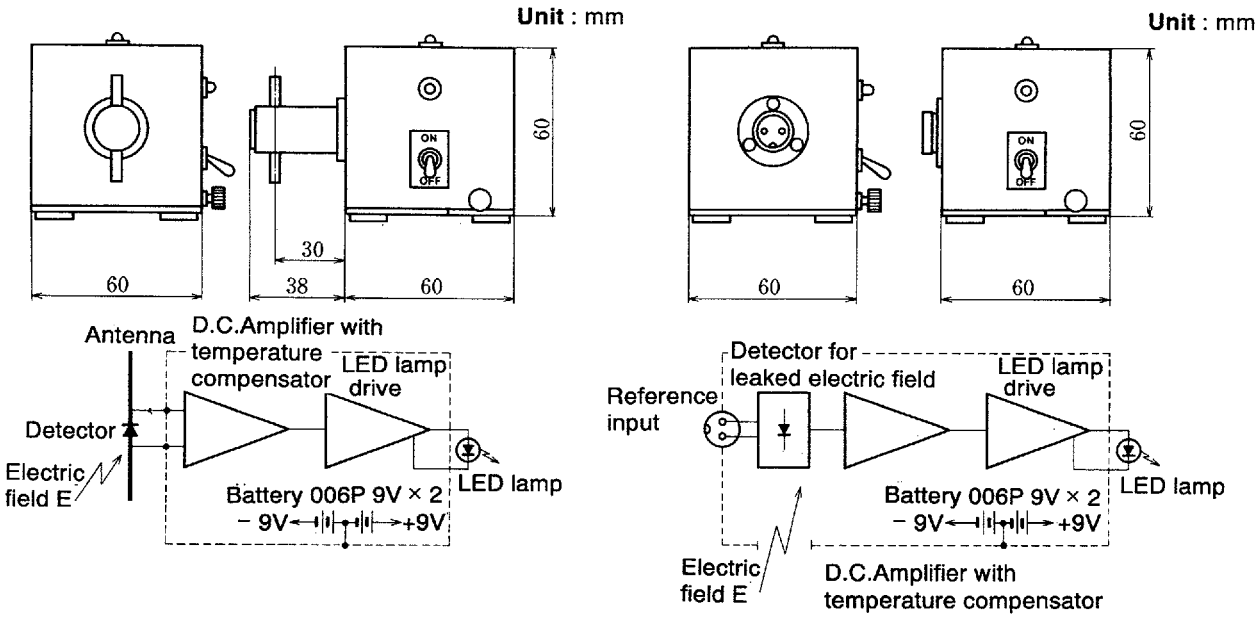
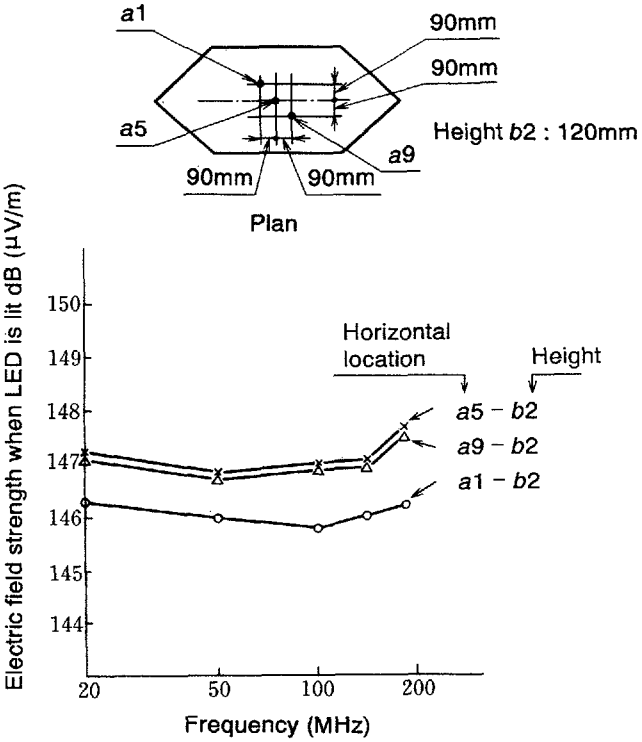


Fig. 2 of Explanatory reference 2 : Examples of measurement of distribution of electric field strength in TEM cell

(1) Location of the test reference measuring device is varied in horizontal direction



(2) Location of the test reference measuring device is varied in vertical direction

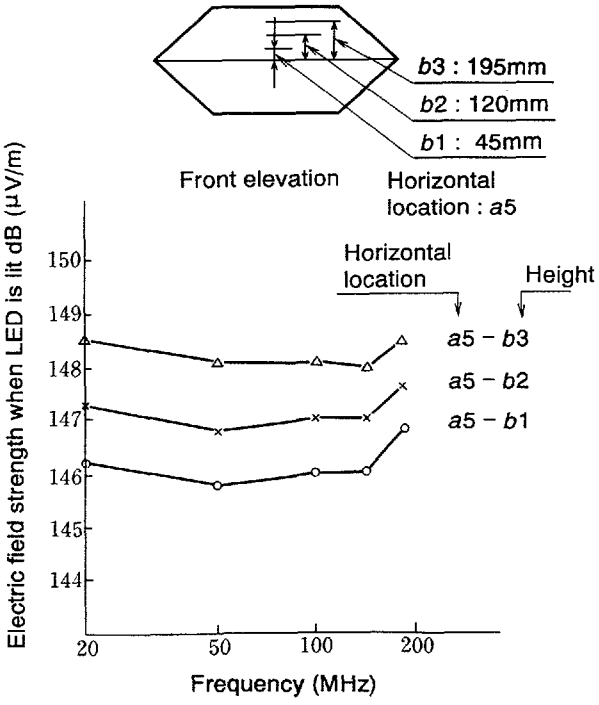


Fig. 3 of Explanatory reference 2 : Examples of resonance phenomena by connecting lead wire (Coaxial cable) and the effect of the improvement

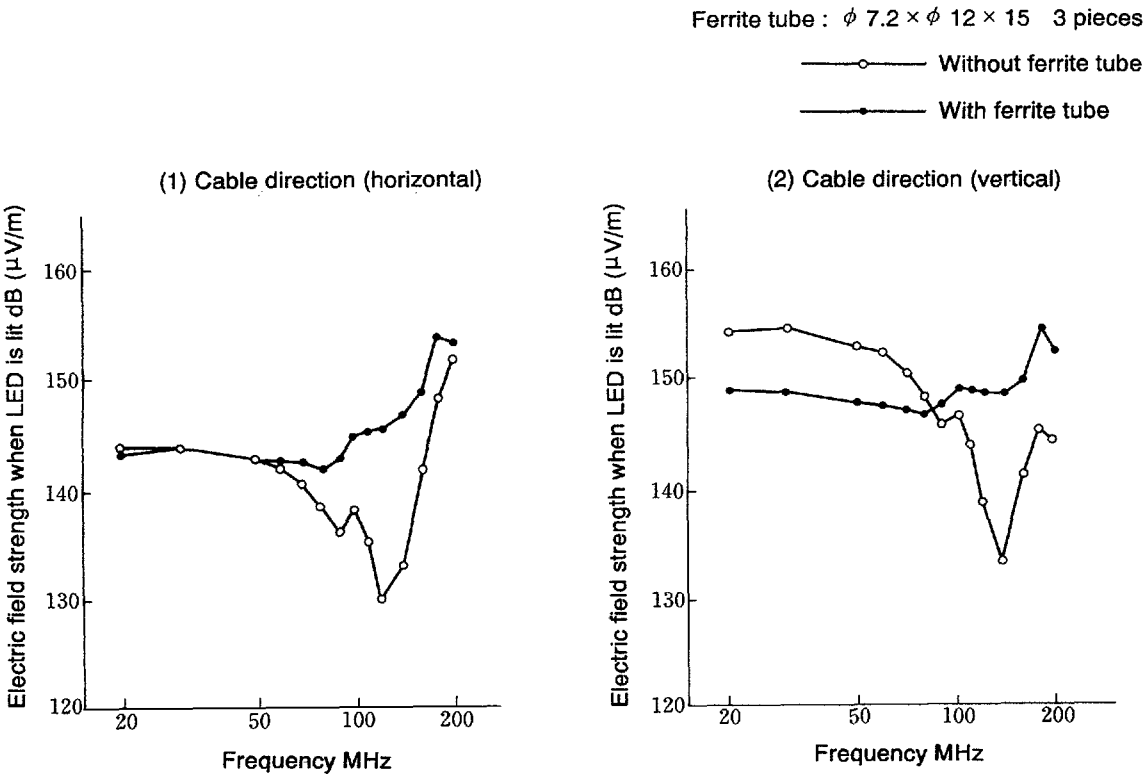
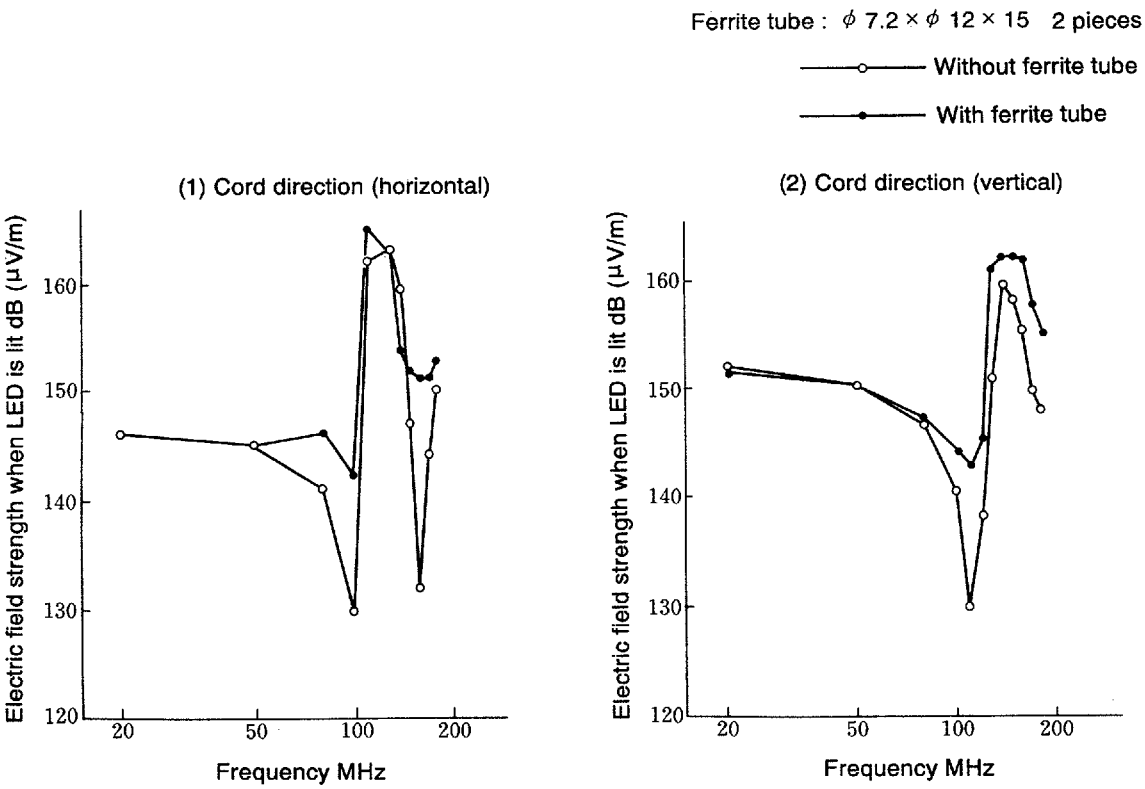


Fig. 4 of Explanatory reference 2 : Example of material measurement of samples having connecting lead wire (Twin cord) without shield



Explanatory reference 3
Example of measuring result and related data on electromagnetic conduction and radiation

This **explanatory reference 3** are given to assist as decision in specifying values of electromagnetic disturbance inputs to te impressed on test circuits specified in **5.9.3** and **5.10.3** of the **Text.**

Some of them are already published data on electromagnetic environments and some others are summaries of test results obtained to establish this standard.

Measured values are those obtained by using mean value detectors, excluding "Peak" (peak value) and "QP" (quasi peak value) particularly indicated in the column of "Conditions or remarks".

The indication of "cigar lighter" for the inductive voltage of wiring means in **Table 1** and **2** of **Explanatory reference 3**, that the measurement of voltage disturbance induced at the power supply cable was done at the cigar lighter terminal for convenience.

Further, "D" in the tables shows the distance between the transmitting station antenna and measuring point, "Ⓗ Ⓥ" indicate that the received polarized wave plane is horizontal or vertical polarization, while "f_p" indicates the TV video frequency and "f_s" shows the measured value at the TV sound frequency. As for the measuring devices and methods, those which are generally used for measurement of electric field strength are used. Some measurements are done, however, by inserting a fixed attenuator between the input terminal and the antenna, and some other measurements are done by using the roop antenna in place of dipole antenna when the accessory antenna of the measuring device is used and for the measurement of electric field around a vehicle body in VHF band, etc. Measured values around transmitting station or upon transmitting of transceiver include those obtained through combination of measuring conditions of distance and received polarized wave, etc., but the maximum values only are shown for convenience.

In addition, those values are the examples of readings.

Table 1 of Explanatory reference 3: Induced voltage of wirings

(a) Induced voltages of wirings near transmission station

Frequency (kHz)	Output (kW)	Induced voltage at battery line (mV)	Conditions or remarks
590	100	94	D = 10m Cigar lighter
690	300	178	D = 200m Cigar lighter
950	100	5	D = 10m Cigar lighter

Remark Measurement done by Automotive Electronics Research Committeeof JSAE

(b) Induced voltages of wirings upon transmitting of onboard transceiver

Frequency (MHz)	Output (W)	Induced voltage at battery line (mV)	Conditions or remarks
7	8	631	Ant, Rear Peak
21	10	50	Ant, Rear Cigar lighter
	72	89	Ant, Rear Cigar lighter
28	5	14.1	Ant, Rear Peak between battery and body
	10	199	Ant, Rear Cigar lighter
	80	1000	Ant, Rear Cigar lighter
50	7	631	Ant, Rear Cigar lighter
144	13	562	Ant, Rear Cigar lighter
430	7	32	Ant, Rear Cigar lighter

Remark Measurement done by Automotive Electronics Research Committee of JSAE

Table 2 of Explanatory reference 3: Example of electric field strength

(a) Example of electric field strength measurement near transmission station

Frequency band	Frequency (MHz)	Output (kW)	Maximum electric field strength (V/m)	Conditions or remarks
Long wave	0.017		35.1	D = 1m Ⓥ
Medium wave broadcasting	0.59	100	84.1	D = 0 Ⓥ
	0.69	300	10	D = 200m Ⓥ
	0.87	500	1259	D = 5m Ⓥ
	1.0	1	12.6	D = 7m Ⓥ
Short wave broadcasting	11.96	200	100	D = 0
	15.31	200	63.1	D = 0
	15.325	100	31.6	D = 0
FM broadcasting	80.0	10	2.3	D = 200m Ⓗ
	84.2	0.1	0.684	D = 60m Ⓗ
VHF-TV broadcasting	175.75	0.25	0.224	f_S D = 0 Ⓗ
	193.25	1	0.2	f_P Ⓗ
	217.75	50	5.15	f_P D = 100m QP Ⓗ
	221.75	12.5	3.09	f_S D = 100m QP Ⓥ
UHF-TV broadcasting	692 - 698	0.1	12.4	D = 17m Ⓗ

Remark Measurement done by Automotive Electronics Research Committeeof JSAE

(b) Example of actual measurement of electric field strength around vehicle body near transmission station (maximum value)

Frequency (kHz)	Output (kW)	Measured strength ( ) (V/m)	Conditions or remarks
590	100	70.8	D = 100m Ⓗ
690	300	5	D = 200m Ⓥ
950	100	5	D = 50m Ⓥ

Note(1) Measuring location-Under the instrument cluster
Remark Measurement done by Automotive Electronics Research Committee of JSAE

(c)-1 Example of actual measurement of electric field strength around vehicle body upon transmitting of vehicle transceiver (maximum value)

Frequency (MHz)	Output (W)	Measured strength (V/m)			Conditions or remarks
		Engine room(2)	Under instrument cluster(2)	Luggage room(2)	
21	10	8.9	12.6	6.3	Ant, Base Loading
	72	22.4	10	22.4	Ant, Base Loading
28	10	1.58	8.9	12.6	Ant, Base Loading
	120	31.6	12.6	20	Ant, Base Loading
50	7	35	11.2	2.0	Ant, Roof
144	13	3.5	11.2	15.8	Ant, Roof
430	7	0.501	2.2	2.2	Ant, Roof

Note(2) Measuring location
Remark Measurement done by Automotive Electronics Research Committeeof JSAE

(c)-2 Example of actual measurement of electric field strength around vehicle body upon transmitting of vehicle transceiver (maximum value)

Frequency (MHz)	Output (W)	Measured strength (V/m)				
		In front of front seat (3)	Engine room (3)	Luggage room (3)	Above transceiver (35)	Other max. values
7	8	1.26	1.78	10	7.08	35
28	5	44.7	39.8	56.2	20	50.1

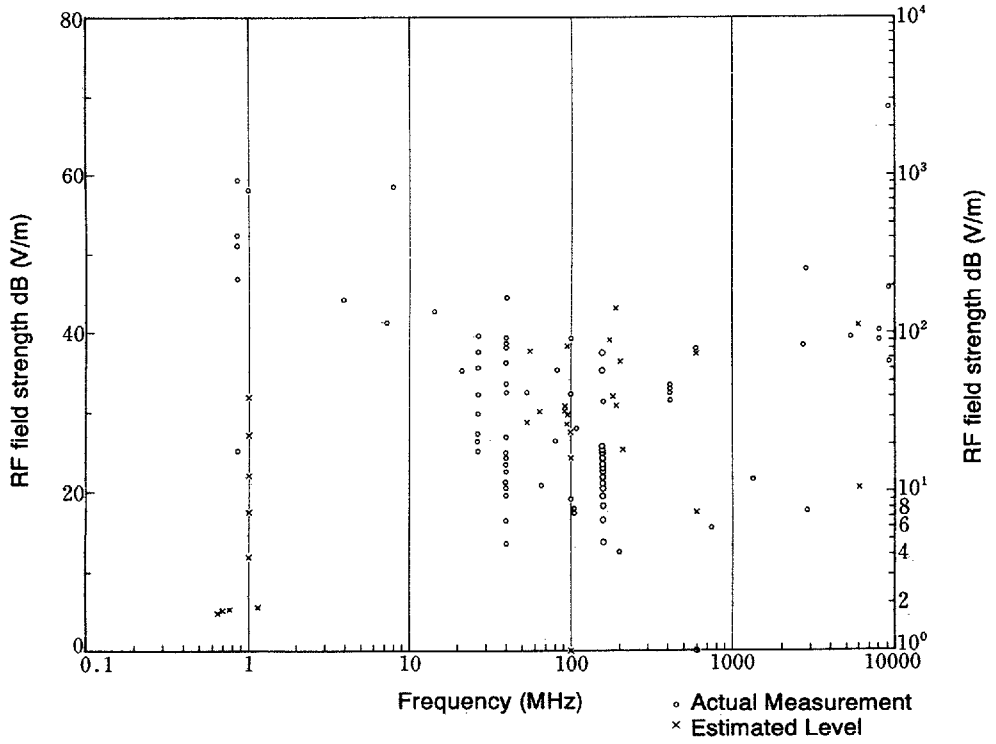
Note(3) Measuring location
Remark Measurement done by Automotive Electronics Research Committeeof JSAE

(d)-1 Example of actual measuring of field intensity level (1)

Antenna	Transceiver	RF output (W)	Frequency (MHz)	Field intensity (V/m)	
				Enclosure	Outside
41" rod	NCX-3 (International)	100	14	-	20(4)
Citizens band rod	Lab power supply	100	28	10(4)	-
Omunistub	CMCA-N2F (RCA)	100	151	200(5)	55(5)
Omunistub	6MVA (RCA)	60	467	800(4)	22(4)

Note(4) Measuring distance is 3 feet.
(5) Measuring distance is 5 feet.
Remark According to Robert B, Cowdell, Collins Radio, "Susceptibility on the freeways" IEEE Int. Sympo EMC July 13-15, 1976

(d)-2 Example of actual measuring of electric field strength (2)



Remark According to **CISPR/D (USA) 16** "SQ87/1 Man-made Electromagnetic Environment- Partial Response of the USA regarding the Environment in Which Vehicle Must Operate" August 1985.

Table 3 of Explanatory reference 3 : Other's electric field strength data

(a) Allowable limit of radiation field According to MIL-STD-461B 1 April 1980

Frequency range	Electric field strength (horizontal, vertical polarized wave) V/m
14kHz to 30MHz	10
30MHz to 10GHz	5
10GHz to 40GHz	20

Remark According to MIL-STD-461B April 1980

(b) Summary on the maximum allowable limit for human body

Country or organization	Frequency band	Max. allowable value	(V/m)	ons or remarks
U. S. A	10MHz – 100GHz	10mW/cm²	194	0.1 hour
		1mW/cm²		Average of 1 hour or more
U. S. Army & Air Force		10mW/cm²	194	Continuously
		10 to 100mW/cm²	194 – 614	Allowable hour (minute) is 6000W ² per 1 hour (W is the max. allowable value mW/cm²)
		100mW/cm²	614	Unstayable
U. K.	30MHz – 30GHz	10mW/cm²	194	Average of continuous 8 hours
NATO (1956)		0.5mW/cm²	43	
Canada	10MHz – 100GHz	1mW/cm²		Average of 0.1 hour or more
		10mW/cm²	194	0.1 hour
Poland	300MHz	10 μW/cm²	6.1	8 hours/day
		100 μW/cm²	19.4	2 – 3 hours/day
		1mW/cm²	61	15 – 20min/day
Germany		10mW/cm²	194	
USSR	0.1 – 1.5MHz	20V/m 5amp/m		A. C. magnetic field
	1.5 – 30MHz	20V/m		
	30 – 300MHz	5V/m		
	300MHz	10 μW/cm²	6.1	6 hours/day
		100 μW/cm²	19	2 hours/day
		1mW/cm²	61	15 min/day
Czecho	0.01 – 300MHz	10V/m		8 hours/day
	300MHz	25 μW/cm²	97	8 hours/day CW
		10 μW/cm²	6.1	8 hours/day Pulse

Remark According to Richard A. Tell, U.S. Environmental Protection Agency "Broad cast radiation how safe is safe?" IEEE Spectrum, August 1972

(c) Remarks for electromagnetic environment immunity limits for industrial systems

Limit	Distance (m)	Comment
FCC Maximum Power	1	Limits of 86 to 172 volts/meter are very high. It would be difficult to get test gear.
	3	Limits between 29 and 59 volts per meter are still very difficult to test unless the sample is small and parallel plates could be used.
	7	The 12 to 24 volts/meter range would be limited by available test gear, although most commercial labs could do the test.
Maximum Available Power	1	57 volts/meter matches that of measured data using the same antennas.
	3	The 18 volts/meter limit is probably the most realistic for typical equipment.
	7	All commercial systems with critical functional requirements should at least be qualified to the 8 volt/meter level.

Remark According to Robert B. Cowdell, Collins Radio, "Susceptibility on the freeways" IEEE 1976 EMC Symposium

(d) Measured results of capability of large scale computers to suppress disturbing waves

Disturbance frequency (MHz)	Electric field strength of disturbance (V/m)	Operating conditions of computer
5	0.71	Normal
10	0.45	Normal
10	1.58	Error has occurred in the magnetic tape
10	5.62	Error has occurred in the magnetic disc

Remark According to Automobile radio disturbance prevention study Committee, JARI Data "Example of capability to suppress disturbing wave for communications" (1973)

In the event of any doubt, the original
standards in Japanese should be referred.

SI : THIRD PHASED STANDARD
(The standard where SI units and newly values are given and do not using customary units, but it is excepted that the standards are represented in only accustomed metric units as m, A, Hz etc.)

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