TOYOTA ENGINEERING STANDARD

NO.: **TSC1000G**

TITLE: **Test methods for terminals and connectors of low tension cables for automobiles**

CLASS: **C1**

Established/Revised: **Rev. 10 (Oct. 2011)**

This standard has been revised as a result of the review of the Applicable Standards.

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Test methods for terminals and connectors of low tension cables for automobiles

1. Scope

This standard covers the test methods for low tension cable connectors (hereinafter referred to as "connectors") and low tension cable terminals (hereinafter referred to as "terminals") for automobiles.

2. Definitions

2.1 Terminal

A "terminal" is an electrical contact piece to be used as a separate part or as a part of a connector.

2.2 Housing

A "housing" covers the terminals and be used as a part of a connector.

2.3 Connector

A "connector" is an assembly made of terminals and a housing.

3. Measurement Items and Test Items

3.1 Measurement Items

(1) Appearance
(2) Insertion/removal feeling
(3) Inserting force
(4) Separating force
(5) Terminal holding force
(6) Terminal crimping strength
(7) Housing holding force
(8) Tightening torque
(9) Solderability
(10) Voltage drop
(11) Low voltage current resistance
(12) Insulation resistance
(13) Withstand voltage
(14) Temperature rise
(15) Leak current
(16) Sealing ability
(17) Momentary shut-off monitor
(18) Resistance fluctuation monitor
(19) Terminal contact force
(20) Connector fitting sound

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3.2 Test Items

(1) Twisting durability test
(2) High temperature test
(3) Low temperature test
(4) Thermal shock test
(5) Temperature/humidity cycle test
(6) Salt water spray test
(7) Water spray test
(8) High-pressure washing test
(9) Humidity resistance test
(10) Salt-water freezing test
(11) Dust resistance test
(12) Corrosive gas test
(13) Vibration test
(14) Impact test
(15) Overcurrent passing test
(16) Multi-factor environment test
(17) Oil resistance test
(18) Dew formation test

Remark: Test items may be added or deleted upon agreement between the divisions concerened.

4. Test Conditions

(1) Terminals and connectors to be tested shall be randomly sampled.
(2) For testing, attach the cable of maximum size that can be crimped to the terminal or the connector, unless otherwise specified. The cable length is respectively specified for each test.
(3) All the tests shall be conducted at the temperature of 20±15 ℃ and the relative humidity of 65±20 % RH, unless otherwise specified.
(4) All the tests shall be conducted with the terminal or the connector fitted, unless otherwise specified.
(5) Selection of test conditions specified herein shall be in accordance with individual standards.
(6) ±10 % tolerances shall be accepted for test conditions, unless otherwise specified.
(7) Table 1 and Section 5.2 give the required number of specimens.
(8) For multi-pole connectors, conduct test on at least two poles per connector.
(9) Use connection cables equivalent to AEX (AESSX) for Class A, AVX (AVSSX) for Class B, and AVS (AVSS) for Classes C and D.
(10) Test shall be carried out after reviewing test conditions such as passing current and ambient temperature in accordance with conditions and environment where the connectors are used.

5. Construction and Sequence of Test

5.1 Characteristics Tests

Characteristics tests shall be in compliance with Table 1. Details of characteristics tests of each component part of the connector are given in Table 1.

Table 1

<table>
<tr><th rowspan="2">Sequence</th><th colspan="5">Specimen</th></tr>
<tr><th>Terminal</th><th>Housing</th><th>Attachments (rubber plugs, packings, O rings, boots, etc.)</th><th colspan="2">Connector</th></tr>
<tr><td>1</td><td colspan="5">Appearance</td></tr>
<tr><td>2</td><td colspan="2">Inserting force</td><td rowspan="10">---</td><td colspan="2">Inserting force</td></tr>
<tr><td>3</td><td colspan="2">Separating force</td><td colspan="2">Connector fitting sound</td></tr>
<tr><td>4</td><td colspan="2">Insertion/removal feeling</td><td colspan="2">Low voltage current resistance</td></tr>
<tr><td>5</td><td>Terminal holding force</td><td>Housing holding force</td><td colspan="2">Voltage drop</td></tr>
<tr><td>6</td><td>Terminal Crimping strength</td><td>Tightening torque</td><td colspan="2">Temperature rise</td></tr>
<tr><td>7</td><td>Terminal contact force</td><td rowspan="5">---</td><td colspan="2">Insulation resistance</td></tr>
<tr><td>8</td><td rowspan="4">---</td><td colspan="2">Withstand voltage</td></tr>
<tr><td>9</td><td colspan="2">Sealing ability</td></tr>
<tr><td>10</td><td colspan="2">Separating force</td></tr>
<tr><td>11</td><td>Terminal holding force or solderability</td><td>Insertion/removal feeling</td></tr>
</table>

5.2 Durability Tests

Durability tests shall be conducted on items listed and in the sequence given in Fig. 1.　At least 5 units, when using connector as a specimen, and at least 20 units, when using terminal as a specimen, shall be prepared for evaluation.　Items for measurement after each test are as given in Table 2.

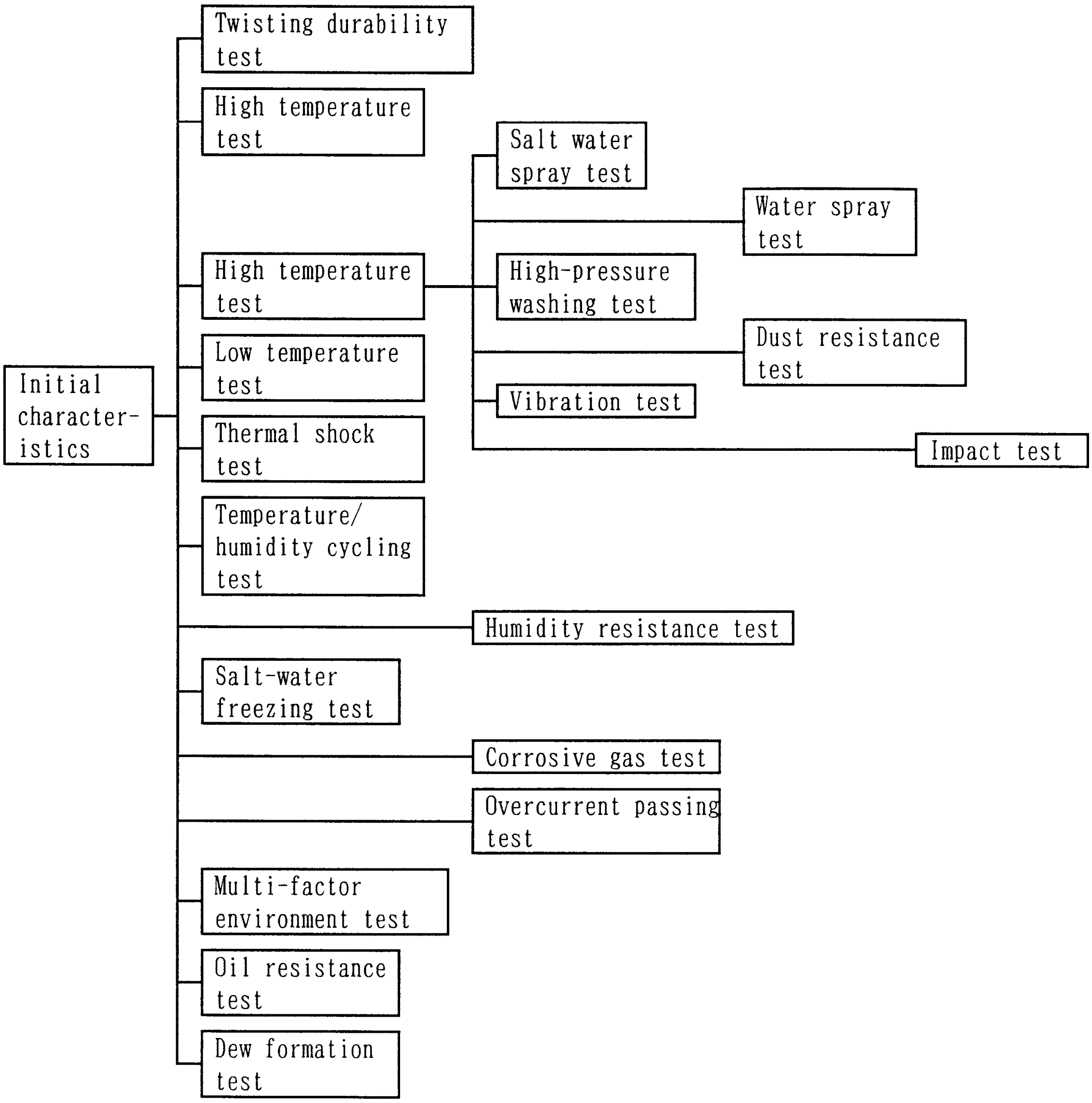

Fig. 1

Table 2

——	Initial char-acter-istic	Twisting durabil-ity test	High tempera-ture test	Low temper-ature test	Thermal shock test	Tempera-ture/ humidity cycling test	Salt water spray test	Water spray test	High-pressure washing test	Humidity resis-tance test	Solt-water freezing test	Dust resis-tance test	Corrosive gas test	Vibra-tion test	Impact test	Over-current passing test	Muti-factor environ-ment test	Oil resis-tance test	Dew forma-tion test
Appearance	○	○	○	○	○	○	◎	◎	◎	○	◎	○	○	○	○	○	○	◎	●
Insertion/removal feeling	○		○	○	○	○													
Inserting force	○																		
Separating force	○																		
Terminal holding force	○		○	○	○	○	◎			○	◎								
Terminal crimping strength	○		○		○								○						
Housing holding force	○		○		○	○				○	◎								
Tightening torque	※		※		※	※													
Solderability	⊕																		
Low voltage current resistance	○	○	○		○	○	◎			●		○	○	○		○	○		
Voltage drop	○	○	○		○	○	◎			●		○	○	○		○	○		
Insulation resistance	○					○	◎	◎	◎	○	◎								●
Withstand voltage	○					○	◎	◎		○	◎								
Temperature rise	○		○														○		
Leak current							◎	◎		●									●
Sealing ability	◎	◎	◎	◎	◎	◎												◎	
Momentary shut-off monitor														○	○		○		
Resistance fluctuation monitor					○	○											○		
Terminal contact force	○	○	○														○		
Connector fitting sound	○																		

Remark: ○: To be conducted for all connectors.
◎: To be conducted for water-proof connectors.
●: To be conducted for non-water-proof connectors.
⊕: To be conducted for the connectors for PCB(1).
※: To be conducted for the screw-fastened type connectors and terminals.

Note (1): Printed Circuit Board (hereinafter referred to as "PCB")

5.3 Test Item Selecting Matrix

Guidelines for required test items at the point of development is given below.

Table 3 Patterns of Development

Pattern	Terminal	Sealing rubber	Housing
A	New development	---	---
B	Material change		
C	---	New development	
D		Material change	
E		---	New development
F			Material change
G			Pole number arrangement

(1) In case more than two patterns should overlap, all corresponding items are to be conducted.
(2) In case none of these patterns applies, decision will be made upon discussion among parties concerned.
(3) When changes concerning test items such as ambient temperature have been made, related test items are to be revaluated.
(4) Test items and confirmation items given in Tables 3, 4 and 5 may be omitted upon discussion among departments and divisions concerned.

Table 4 Durability Test Matrix

Pattern	Initial characteristics	Twisting durability test	High temperature test	Low temperature test	Thermal shock test	Temperature/humidity cycling test	Salt water spray test	Water spray test	High-pressure washing test	Humidity resistance test	Salt-water freezing test	Dust resistance test	Corrosive gas test	Vibration test	Impact test	Multi-factor environment test	Oil resistance test	Over-current passing test	Dew formation test
A	○	○	○		○	○	◎			●		○	○	○	○	○		○	●
B	○	○	○		○		◎			●			○	○	○	○		○	●
C	◎		◎	◎	◎	◎	◎	◎	◎		◎					◎	◎		
D	◎		◎	◎	◎	◎	◎	◎	◎		◎						◎		
E	○	○	○	○	○	○	◎	◎	◎	○	◎	○		○	○	○	◎		●
F	○		○	○	○	○	◎	◎	◎	○	◎						◎		
G	○	○	◎		◎	◎		◎	◎		◎								

Remark: ○: All connectors
◎: Water-proof connectors
●: Non-water-proof connectors

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Table 5　Confirmation Item Matrix

Pattern	Appearance	Insertion/ removal feeling	Inserting force	Separating force	Terminal holding force	Terminal crimping strength	Housing holding force	Tightening torquė	Solderability	Low voltage current resistance	Voltage drop	Insulation resistance	Withstand voltage	Temperature rise	Leak current	Sealing ability	Momentary shut-off monitor	Resistance fluctuation monitor	Terminal contact force	Connector fitting sound
A	○	○	○	○		○			○	○	○			○	○		○	○	○	
B	○	○	○	○		○			○	○	○			○			○	○	○	
C	◎	◎	◎	◎						◎		◎	◎		◎	◎				◎
D	◎	◎	◎	◎						◎		◎	◎		◎	◎				◎
E	○	○	○	○	○		○	○		○	○	○	○	○	○	◎	○	○		○
F	○	○	○	○	○		○	○				○	○		○	◎				○
G	○	○	○	○			○	○				◎	◎		◎	◎				○

Remark: ○: All connectors
◎: Water-proof connectors

6. Test and Measurement Methods

6.1 Measurement Methods

6.1.1 Appearance

Perform visual and tactile inspections.

6.1.2 Insertion/Removal Feeling

Insert and remove the terminal or the connector, while checking the correctness of the insertion/removal feeling.

6.1.3 Inserting Force (Single Piece of Terminal, Housing and Connector)

Measure the load when inserting one end of the connector to its fixed counterpart and pushing the other end at a constant rate of approx. 25 to 100 mm/min in the axial direction.

6.1.4 Separating Force (If a locking mechanism is provided, do not activate this for measurement.)

Measure the load when inserting one end of the connector to its fixed counterpart and pulling the other end at a constant rate of approx. 25 to 100 mm/min in the axial direction.

6.1.5 Terminal Holding Force (between terminal and housing)

Attach an approx. 100-mm cable to a terminal by crimping only or by crimping and soldering.　Secure this terminal into a housing.　Pull the cable in the axial direction at a constant rate of 25 to 100 mm/min.　Measure the load when the terminal breaks off of the housing.　Terminals are to be completely connected when conducting the test.

6.1.6 Terminal Crimping Strength

Attach an approx. 350-mm cable to a terminal by crimping or pressure welding. Secure the terminal to the tester as shown in Fig. 2. Pull the cable in the axial direction at a constant rate of 25 to 100 mm/min. Measure the load when the cable is broken or comes off from the insulation barrel. Unless otherwise specified, do not crimp the insulation barrel.

In principle the cables specified in TSC1114G, TSC1115G, TSC1117G shall be used in the test.

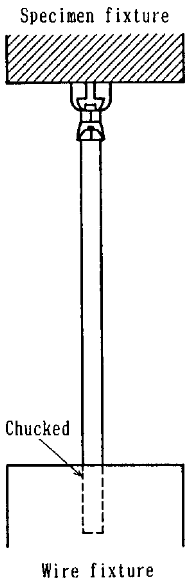

Fig. 2

6.1.7 Housing Holding Force

Fit and lock the connector housing or the terminal. Then measure the load when fixing one side, with the housing or the terminal as locked, and pulling the other in the axial direction at a constant rate of 25 to 100 mm/min.

6.1.8 Tightening Torque

Fix the screw-fastened type connector and the terminal to the case or the mating connector using screws and bolts for actual installation. Check for the breakage and buckling of the housing when tightened to the torque given in Table 6. Check that the screws and bolts are inserted straight.

Table 6

Screw dia.	Tightening torque (N・m)
M3(2)	1.5
M4	2.0
M5	4.0
M6	7.0
M8	16.5

Note (2): When fixing the connectors to the printed circuit board, the tightening torque shall be 0.25 to 0.6 N・m or shall be specified in a drawing.

6.1.9 Solderability

Solderability of PCB connectors (connectors of which terminals are directly attached to the printed circuit board by soldering) shall be tested focusing on the check points as noted in Fig. 3. Install connectors to the printed circuit boards and fix them using screws with the tightening torque given in Table 6 for connectors of the type to be fixed with screw. Dip only the solder surface of the printed circuit board in a solder pot filled with lead solder heated at 245±5 ℃ for 10±1 s, or in a solder pot filled with lead-free solder heated at 260±5 ℃ for 10±1 s, after the lead-free solder is pre-heated at a temperature of 180 ℃ or less for 120±5 s, in a total soldering process consisting of 300 s or less at a temperature of 120 ℃ or more[3]. Then, take them out, leave them in the ordinary temperature environment for at least 30 min, and observe them. If necessary, inspect the section by hardening soldered portion with resin.

Note (3): When the test is conducted for any soldering processes other than above, the test temperature and duration may be changed upon consultation with the departments concerned.

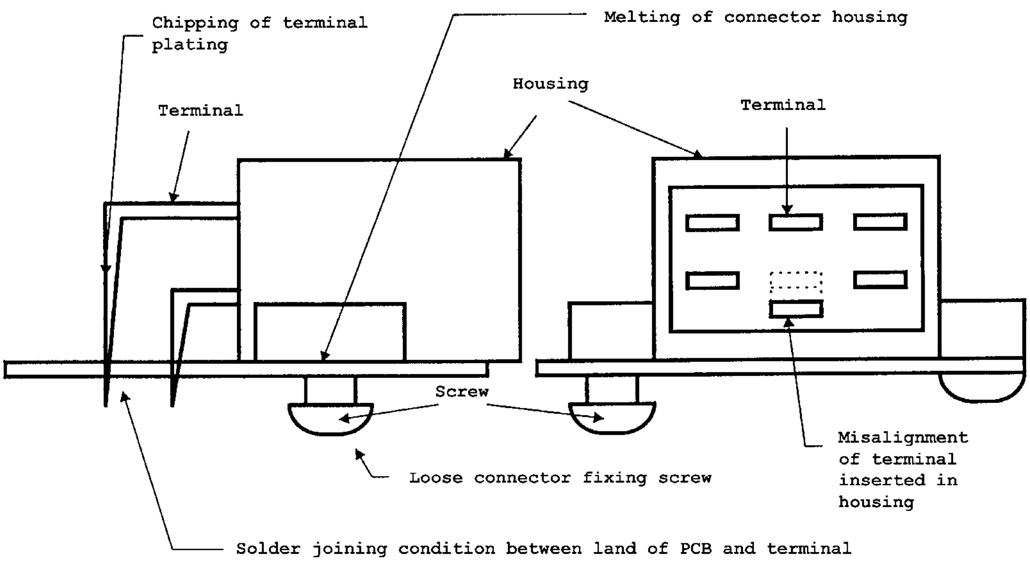

Fig. 3　Solderability Check Points

6.1.10 Voltage Drop

Apply 12±1 V to the connector or the terminal when open-circuited, and 1±0.05 A when short-circuited.　When the temperature at the terminal fitting has stabilized, measure the voltage drop between two points; a point 75 mm or 100 mm away from the crimped section of the conductor on each side of the connector.　Fig. 4 shows examples.　Subtract from this value the voltage drop due to cables or that due to the lead sections for connectors for printed circuit boards (refer to Table 7 or use actual measurement for cable resistances).　Use cables of the maximum size that can be crimped, and conduct testing for each pole separately.　When the barrel shape differs depending on the cables used, conduct testing separately on each shape.　Tightening torque for vis-fastened terminals are as given in Table 6.

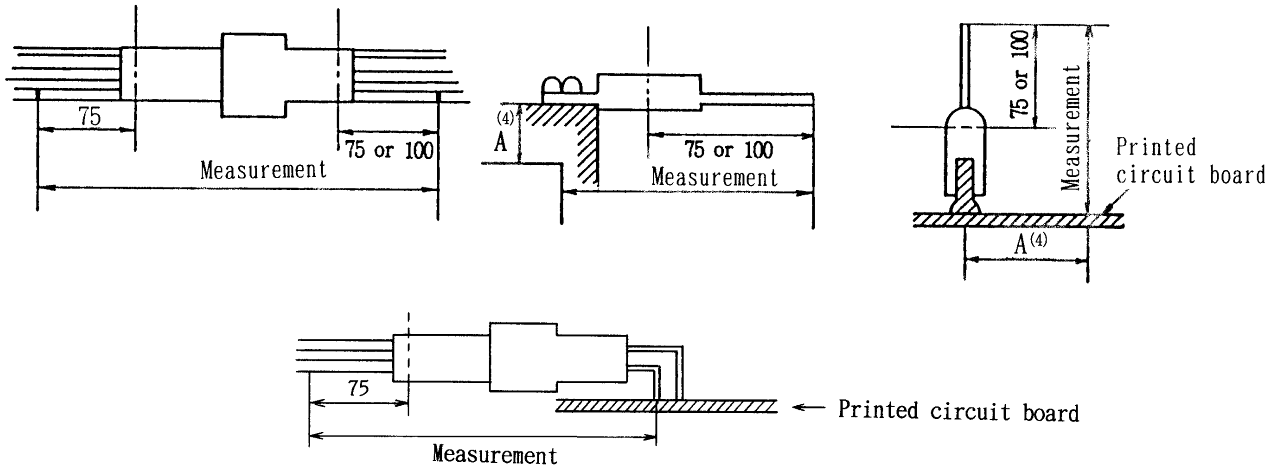

Fig. 4　(Unit: mm)

Note (4): Dimension A shall be less than 100 mm, and the voltage drop between the fixed portion and dimension A shall be subtracted.

Table 7　Copper Cable Resistance (at 20 ℃)

Copper cable size (mm^2)	Resistance (mΩ/75 mm)	Resistance (mΩ/100 mm)
0.13 Alloy	18.2	24.2
0.13 Annealed copper	10.2	13.6
0.22	6.4	8.5
0.3	3.77	5.02
0.35	4.1	5.5
0.5 JIS	2.45	3.27
0.5 ISO	2.8	3.8
0.75	1.77	2.36
0.85	1.56	2.08
1.0	1.4	1.9
1.25	1.07	1.43
1.5	1.0	1.3
2.0	0.66	0.88
3.0	0.42	0.56
5.0	0.26	0.35
8.0	0.17	0.23
9.0	0.16	0.21
10.0	0.15	0.20
12.0	0.11	0.15
15.0	0.10	0.14

6.1.11 Low Voltage Current Resistance

Apply 20±5 mV to the connector or the terminal when open-circuited, and 10±0.5 mA when short-circuited.　Measure the voltage drop between two points; a point 75 mm or 100 mm away from the crimped section on each side of the connector.　Subtract from this value the voltage drop due to the cables or that due to the lead sections for connectors for printed circuit boards.　Cable resistance shall be those specified in Table 7 or measured value.

6.1.12 Insulation Resistance

Fit the connector, and measure the insulation resistance between adjacent terminals and between terminals and the ground as shown in Fig. 5, using a 500 V DC insulation resistance meter.

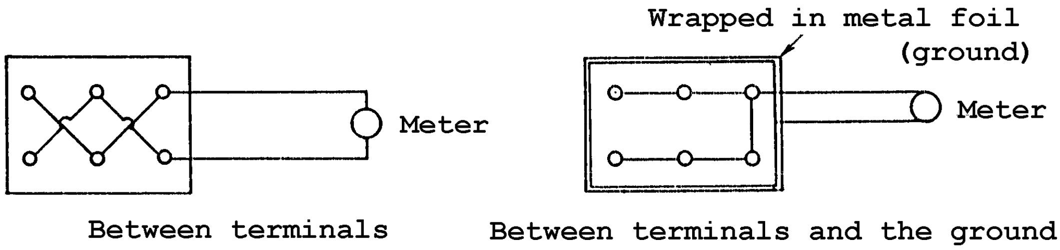

Fig. 5

6.1.13 Withstand Voltage

Fit the connector, and apply 1000 V AC of commercial frequency for one min between adjacent terminals and between terminals and the ground as shown in Fig. 5.

6.1.14 Temperature Rise

Measure the surface temperature of the crimped section of terminal after the temperature has stabilized under the two conditions mentioned below.　Temperature should be kept at ordinary temperature and there should be no draft during the test.

(1) Supply the current "*I max*" given in Table 8 to any one pole of the connector.

(2) Supply the current obtained by multiplying "*I max*" given in Table 8 by the reduction coefficient "*Kd*" given in Table 9 to all poles of the connector.

Table 8　Maximum Allowance Current[5] (*I max*)

Copper cable size (mm^2)	Current (A)
0.13	3
0.22	5
0.3	7
0.35	
0.5	11
0.75	14
0.85	15
1.0	16
1.25	19
1.5	21
2.0	25
3.0	34
5.0	46
8.0	60
9.0	73
10.0	78
12.0	82
15.0	95

Note (5): If the maximum allowable current value is specified for each connector, that value shall be satisfied.

Table 9　Reduction Coefficient (*Kd*)

Poles	Reduction coefficient
1	1
2 to 3	0.75
4 to 5	0.6
6 to 8	0.55
9 to 12	0.5
13 to 20	0.4
21 to 30	0.3
>30	0.2

6.1.15 Leak Current

Apply the voltage as given in Table 10 to the circuit shown in Fig. 6.　Measure the peak value of leak current.

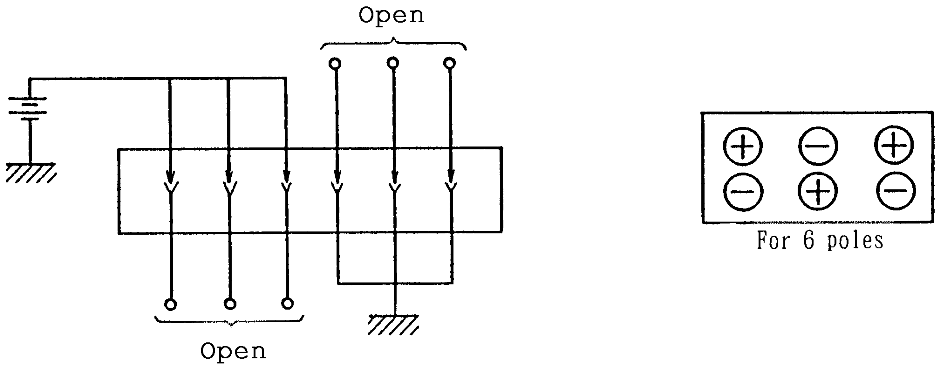

Fig. 6

Table 10　(Unit: V)

Connector	Voltage
General connector	14.0±0.1
Connector for multi-power source	42.0±0.1

6.1.16 Sealing Ability

Drill a hole in the connector housing, or pass a plastic tube through one of the connector cavities. Supply compressed air through the hole or the plastic tube, and check the connector sealing ability. Lead cables must be prepared in one of the following methods: solder the cable ends and seal them with an adhesive (Fig. 7) or use cables of appropriate lengths (250^{+30}_{0} mm) to form loops for sealing. Fix the cable to the connector horizontally without load or with the cable inclined by 30 ° with a tensile load of 30 N (Fig. 8) and perform the measurement.　When testing initial characteristics, load shall be applied in three directions (from above, below and side) and durability test (high temperature test (uncoupled), salt water spray test, and water spray test) shall be conducted in a loading orientation of the worst condition.　Lead cable itself should be fixed on the jig with a load applied to the cable during the durability test.　Immerse the connector into water, and supply compressed air of 10.0 kPa for 30 s.　If there is no air leak during this 30 s, increase the pressure in steps of 10.0 kPa.

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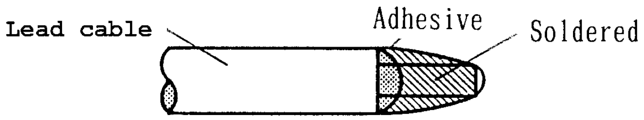


Fig. 7

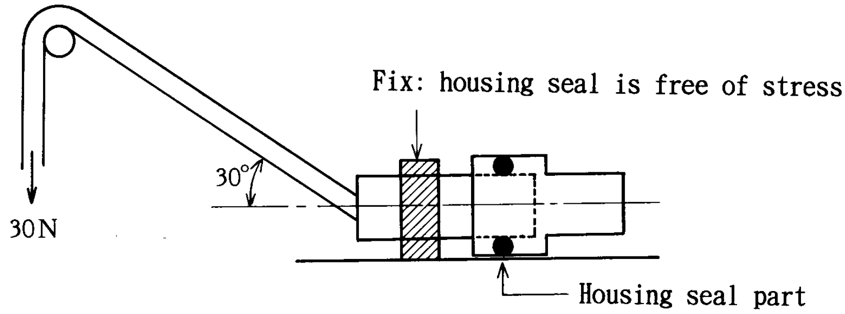


Fig. 8　Orientation of Connector Installation

6.1.17 Momentary Shut-off Monitor

Connect all the poles of the connectors in series and pass the specified current.　Check for momentary shut-off using a frequency counter or a waveform recorder (Fig. 9).

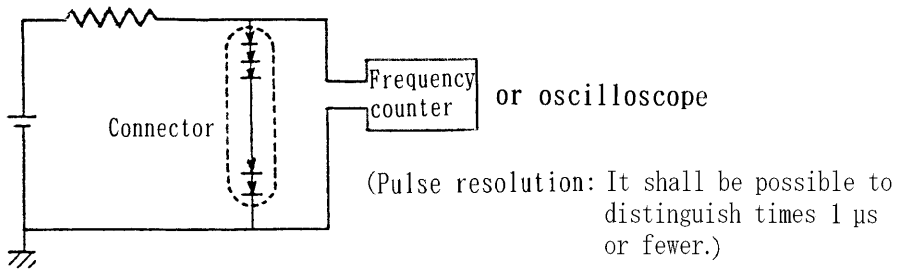


Fig. 9

6.1.18 Resistance Fluctuation Monitor

Connect all the poles of the connectors in series and pass the specified current.　Monitor the fluctuation of resistance using a pen recorder, etc.

6.1.19 Terminal Contact Force

(1) Obtain the contact force between the female terminal and the male terminal by the method described below.

(a) Measure the clearance of the engaging part of the female terminal by inserting 0.01 mm thickness gages into the clearance or by using a projector.

(b) Push down (pull up) the contact spring part of the female terminal by a flat jig and obtain the relationship between displacement and force (spring characteristics) by measuring them with a displacement meter and a load cell (Fig. 10).

(i) Displacement speed: 0.3 to 3 mm/min

(ii) Measuring accuracy: Displacement meter 0.01 mm min., load cell 0.1 N min.

(c) Obtain the force (male tab thickness-clearance) at insertion from the displacement-load curve obtained from steps (a) and (b) (Fig. 11).

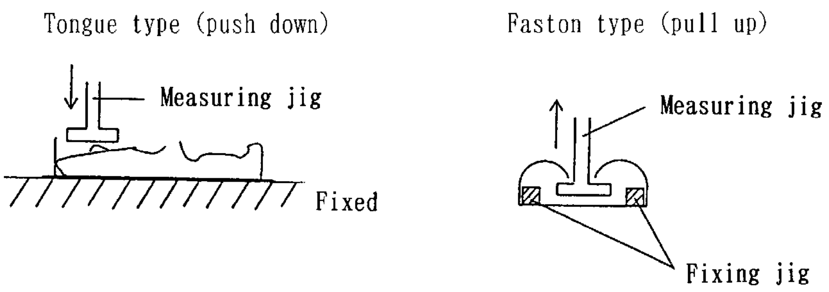


Fig. 10

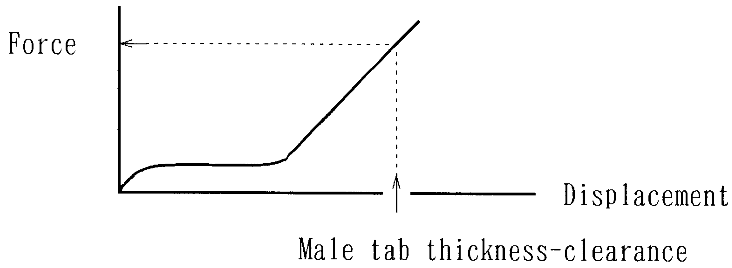


Fig. 11

(2) Outline of the measuring device

Basically, measure the displacement of the load cell itself and take into consideration the correction of distortion, deformation, etc. Fig. 12 shows a typical configuration of the measuring device.

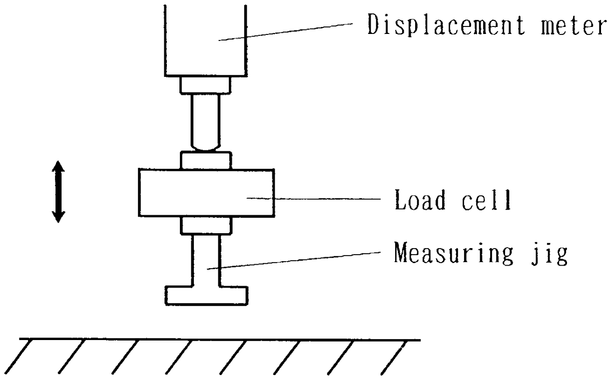


Fig. 12

6.1.20 Connector Fitting Sound

Using a sound level meter, measure the sound generated when fitting a connector, and analyze it with a frequency analyzer (FFT). The frequency correction characteristics of the sound level meter shall be A weighted sound pressure level. The measurement frequency range shall be 10 Hz to 20 kHz. Measure the connector fitting sound in a room in which the ambient noise is 5 kHz or more and the peak value is 50 dB or less. Sound insulating material such as a carpet shall be placed under the connector fitting position. As shown in Fig. 13, face the lock of the connector toward the sound level meter, and fit the connector at the position 60^{+6}_{-0} cm apart from the sound level meter. For measuring the fitting sound, use the sound level meter that is calibrated before each measurement. The connector fitting sound measurements shall be made 4 times, using the same specimen and applying a load in the 3 directions shown in Fig. 14. In the 4th measurement, the connector fitting sound shall be measured applying the load in the same direction as that in the first measurement. However, direction of measurement and the number of measurements may be changed after discussion among the departments concerned. When fitting the connector, hold the connecter with gloved hand to prevent fingertips contacting the connector lock. As for the PCB connector, measurement shall be made with it installed in a dummy substrate and the substrate fixed in place. As for the lever type connector, measurement shall be made only in a horizontal direction.

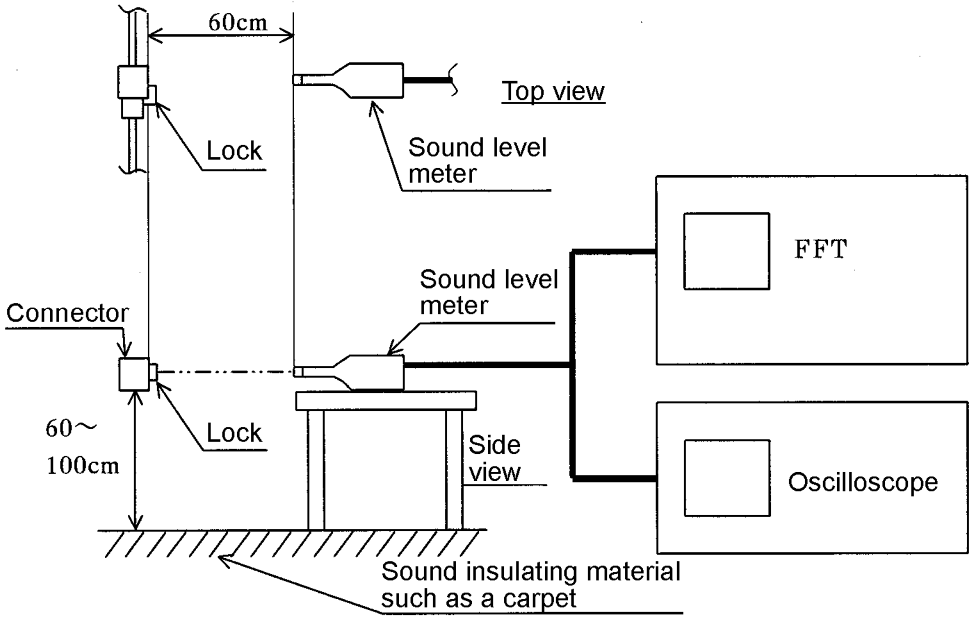


Fig. 13　Example of Connector Fitting Sound Measurement Method

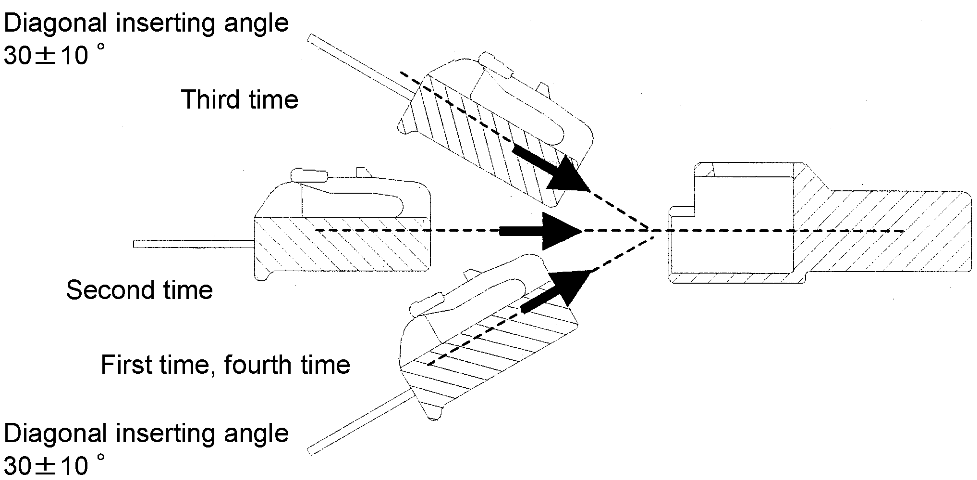


Fig. 14　Connector Fitting Directions

6.2 Test Methods

Classification of each test shall comply with the classification given in Table 11.

Table 11　(Unit: ℃)

Class	Connector location
A	Connectors fixed directly to the engine body and in proximity of heat source (prolonged duration, 120)
B	Connectors fixed directly to the engine body (prolonged duration, 100)
C	Connectors used in the engine compartment but fixed directly to the body (prolonged duration, 80)
D	Connectors used in the interior (prolonged duration, 60)

6.2.1 Twisting Durability Test

Repeat inserting and removing the connector 10 times while twisting it upward, downward, to the right and the left by hands.

6.2.2 High Temperature Test

Place the connector in a thermostatic chamber for 120 h.　Take it out and leave it until it is cooled down to room temperature.　Refer to Table 12 for temperatures inside the thermostatic chamber.

Table 12　(Unit: ℃)

Class	Temperature
A	160±5
B	140±5
C	120±3
D	100±3

6.2.3 Low Temperature Test

Place the connector in a thermostatic chamber for 120 h.　Take it out and immediately repeat coupling and uncoupling the connector 5 times and leave it until it is cooled down to room temperature. Conduct the measurement after it has cooled down to room temperature.　Refer to Table 13 for temperatures in the thermostatic chamber.

Table 13　(Unit: ℃)

Class	Temperature
A	-40±3
B	
C	
D	-30±3

6.2.4 Thermal Shock Test

Place the connector in a thermostatic chamber.　Repeat the thermal cycle shown in Fig. 15 for 1000 cycles.　Take it out and leave it at room temperature for 2 h or more.

Control the temperature in the thermostatic chamber to that given in Table 14.　During the test, pass a specified current (10 mA unless otherwise specified) to the connector, and monitor the fluctuation of resistance.

Standing duration may be shortened if the specimen temperature has reached the test temperature(6).

Note (6): Standing duration may be reduced if the specimen temperature measured at its center has reached the test temperature.

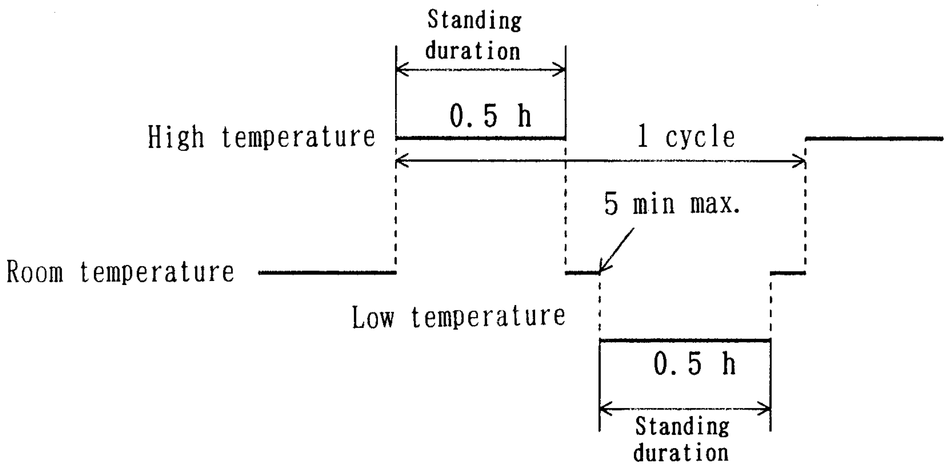


Fig. 15

Table 14　(Unit: ℃)

Class	High temperature	Low temperature
A	120±3	-40±3
B	100±3	
C	80±3	
D		-30±3

6.2.5 Temperature/Humidity Cycle Test

Place the connector in a thermostatic chamber.　Expose it to the temperature/humidity cycle pattern as shown in Fig. 16 for 10 cycles, and leave it at room temperature for 2 h or more.　During the test, pass a specified current (10 mA unless otherwise specified) to the connector, and monitor the fluctuation of resistance.

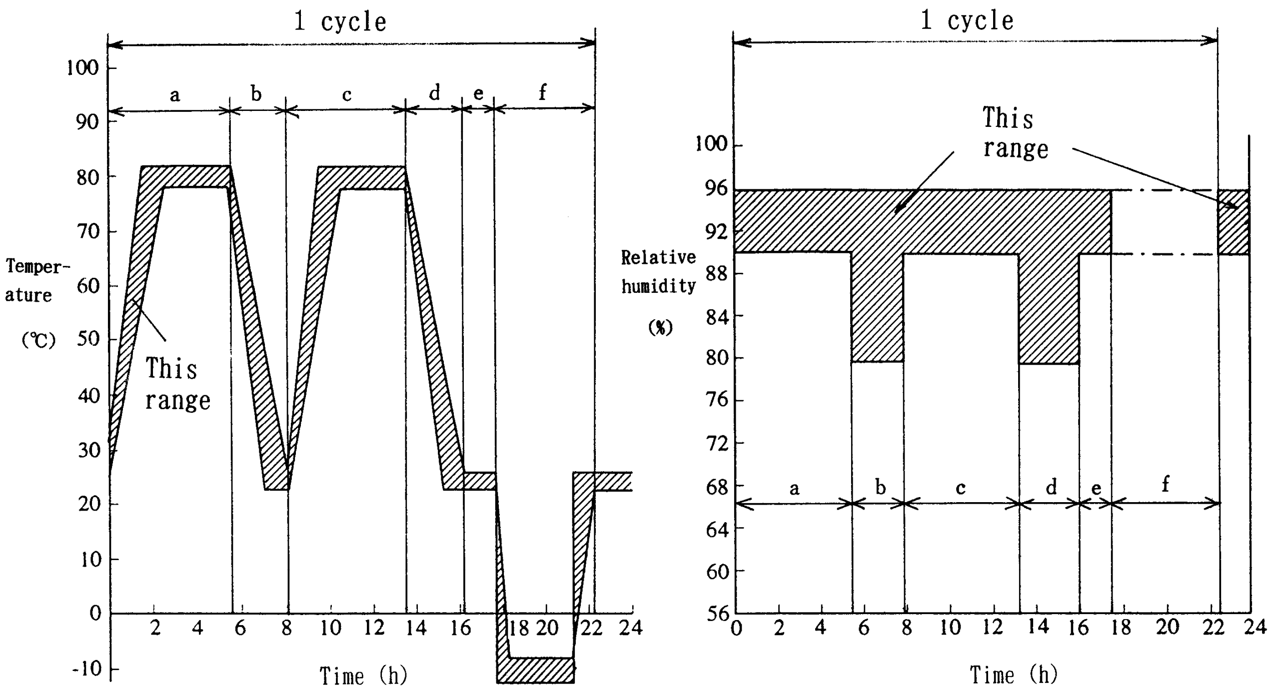


Fig. 16　Temperature/Humidity Cycle Pattern

6.2.6 Salt Water Spray Test

Hang the connector in a closed tank.　Spray salt water (concentration: 5±1 mass %; specific gravity: 1.0268 to 1.0413; pH: 6.5 to 7.2) at 35±5 ℃ with a 68.6 to 176.5 kPa pressure for 96 h.　Then, hang the connector in a humidity cabinet and leave at a temperature of 80±5 ℃ and a relative humidity of 90 to 95 % of RH for 96 h.　Dry it at room temperature, and then make necessary measurements. During the salt water spraying apply to each pole the voltages given in Table 10 in the circuit shown in Fig. 6.　Conduct testing with the waterproof connector and the cable horizontally placed without load, or as inclined by 30° with a load of 30 N (see Fig. 8).　Load shall be applied to the cable which is stretched and fixed to the jig and successively to the previous high temperature test.

6.2.7 Water Spray Test

Hang the connectors in a spray test chamber and heat them for 40 min. Then, immediately spray with water of ordinary temperature (25 ℃) for 20 min. Repeat this cycle for 48 times. The spraying conditions are as given in Table 16. During the test, apply the voltages given in Table 10 to each pole of the connector in the circuit shown in Fig. 6. Be sure to seal the end of the lead cable with an adhesive and extend it out of the test chamber. Refer to Table 15 for temperatures inside the test chamber. Conduct testing with the connector and the cable horizontally placed without load, or as inclined by 30° with a load of 30 N (see Fig. 8). Load shall be applied to the cable which is stretched and fixed to the jig and successively to the previous high temperature test.

Table 15 (Unit: ℃)

Class	Temperature of test chamber
A	120±3
B	100±3
C・D	80±3

Table 16

Water pressure (gage) at the nozzle (MPa)	Nozzle dimensions (mm)	Number of nozzles	Total water discharge (L/min) (min.)	Water temperature (℃)	Operation
0.098	φ1.2	40	24.5	Ordinary temperature	See "Remark"

Remark: Set the specimen about 400 mm away from the water discharge tube with nozzles as shown in Fig. 17. Rotate the water discharge tube at about 23 r/min about the XX axis.
Rotate the specimen at about 17 r/min about on its vertical axis.

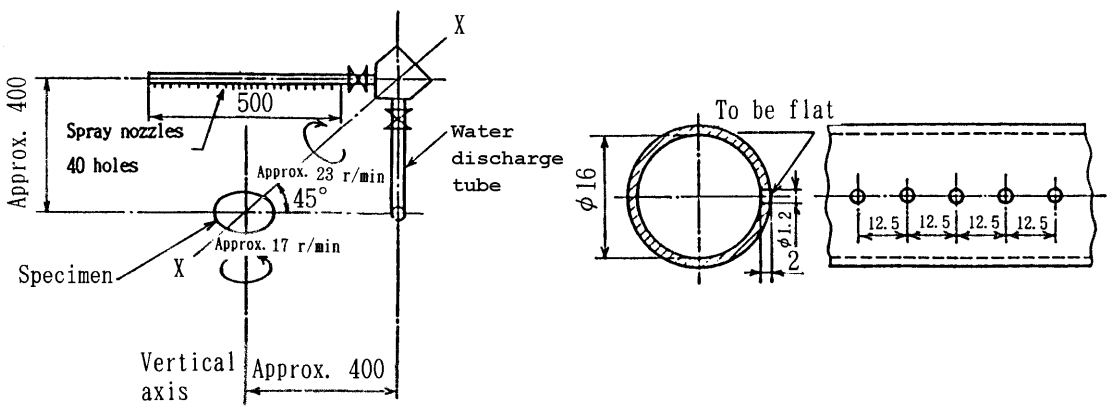


Fig. 17 Spray Nozzles (Nozzle shape and dimensions) (Unit: mm)

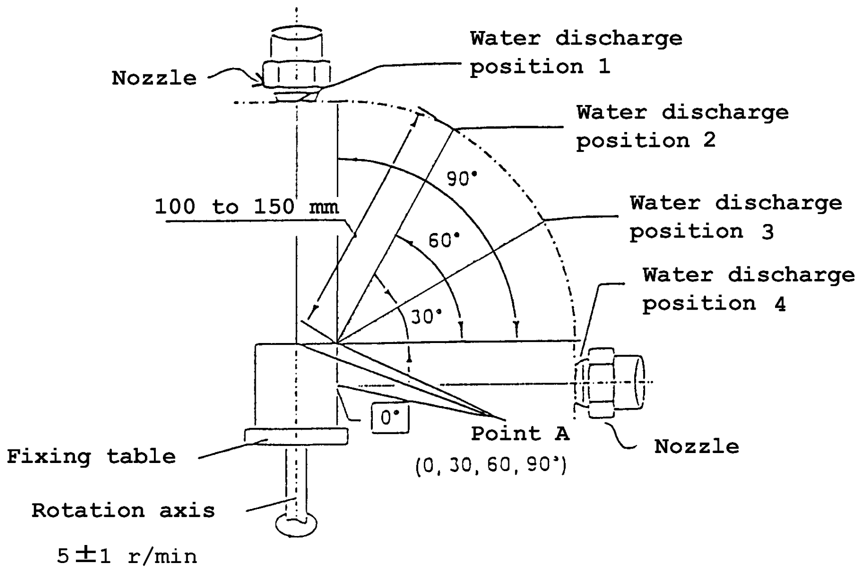
6.2.8 High-Pressure Washing Test

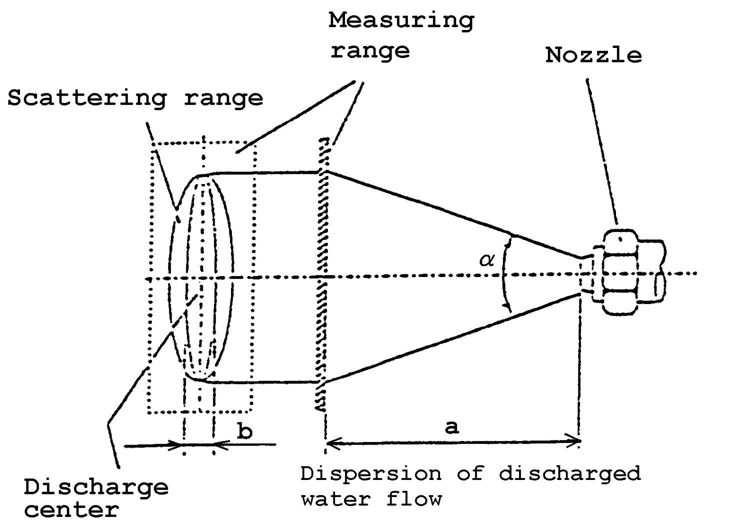
Place the connector in a thermostatic chamber and heat it for 1 h under the conditions given in Table 15.　Then, within 5 min after the heating, subject the connector to high pressure washing for 30 s from each of the water discharge positions 1 to 4 shown in Fig. 18 under the conditions given in Table 17.　Fix the specimen horizontally and rotate the fixing table at a speed of 5±1 r/min.

Table 17

Item	Condition 1	Condition 2(7)
Water discharge pressure (MPa)	8.0	10.0
Nozzle distance (mm)	125±25	
Water discharge duration (s)	30	
Water discharge rate (L/min)	14 to 16	
Temperature (℃)	25±5 (80±5)(7)	

Note (7): Test with water at a temperature of 80 ℃ under the Condition 2 shall be conducted as required upon consultation with the related departments.





Dimensions of nozzle and discharged water flow

Dimension relation of high hydraulic pressure discharge

α (°)	a (mm)	b (mm)
30±5	100	8±2
	150	10±2

Fig. 18　Orientation of Connector Installation and Direction of Washing

6.2.9 Humidity Resistance Test

Hang the connector in a humidity cabinet in such a manner that no dew falls on them. Leave it at a temperature of 60±5 ℃ for non-waterproof connector or 85±5 ℃ for waterproof connector, and at a relative humidity of 90 to 95 % for 96 h. During the test, apply the voltages given in Table 10 to each pole of the connector in the circuit shown in Fig. 6. If a material change has taken place, standing duration shall be 1000 h. If resin material change has taken place, standing duration shall be 1000 h. During the test, pull out the connector and insert it again after 300 h, 500 h, and 700 h have passed, respectively. The standing duration shall be decided upon deliberation among the divisions concerned.

6.2.10 Salt-Water Freezing Test

Place the connector in a thermostatic chamber and leave it at -30 ℃ for 50 min. Then, leave it at 80 ℃ for 50 min and immerse into the salt water (concentration: 10±1 mass %) of ordinary temperature for 10 min. Repeat this cycle for 40 times and then take it out of the salt water and leave it for 2 h or more. Transition from one condition to the other shall be performed within 5 min. Test may be discontinued for a given period of time if continual performance up to 40 cycles is impracticable. In such an instance, however, connectors must be maintained in an atmosphere of 80 ℃.

6.2.11 Dust Resistance Test

Hang the connector in a closed tank of 900 to 1200-mm length, width and height. Blow compressed air for 10 s every 15 min, and stir to uniformly scatter 1.5 kg of Kanto loam powder or Portland cement using a fan, etc. Repeat this for cycle 8 times. Insert and remove the connector once after every 2 cycles.

6.2.12 Corrosive Gas Test

Expose the connector to sulfur dioxide gas (SO_2) (concentration: 25±5 ppm; humidity: 75 % RH or above) of ordinary temperature for 96 h. Connectors shall not be fitted during the test. After testing, fit them for measurement.

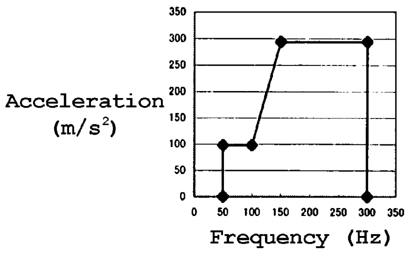
6.2.13 Vibration Test

Install the connector or the terminal on a vibration table as shown in Figs. 19 to 21. Vibrate it while applying a current, and check if momentary shut-off occurs. Vibration shall be applied in three directions with respect to the terminal; back and forth, left and right, upward and downward. Tables 18 and 19 give other vibrating conditions.

For testing, all the poles must be connected in series.

Testing may be conducted in on-vehicle conditions if actual vibration level exceeds that given as testing conditions. Classification of the vibration class shall comply with Table 20.

Table 18

<table>
<tr><th>Class</th><th>Acceleration (m/s^2)</th><th>Vibrating time</th><th>Vibration frequency</th><th>Open-circuit voltage</th><th>Short-circuit current</th></tr>
<tr><td rowspan="2">I</td><td rowspan="2">98 to 294</td><td rowspan="6">3 h each for samples of 3 different directions</td><td rowspan="2">50 to 100 Hz (98 m/s^2 constant)
100 to 150 Hz (98 m/s^2 to 294 m/s^2)
150 to 300 Hz (294 m/s^2 constant)
Sweep time: 3 min (one cycle)

</td><td>12 V</td><td>$I\,max \times Kd$</td></tr>
<tr><td>20 mV max.</td><td>10 mA max.</td></tr>
<tr><td rowspan="2">II</td><td rowspan="2">88</td><td rowspan="4">20 to 200 Hz (Acceleration constant)
Sweep time: 3 min (one cycle)</td><td>12 V</td><td>$I\,max \times Kd$</td></tr>
<tr><td>20 mV max.</td><td>10 mA max.</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">44</td><td>12 V</td><td>$I\,max \times Kd$</td></tr>
<tr><td>20 mV max.</td><td>10 mA max.</td></tr>
</table>

Remark: See Table 8 for $I\,max$, and Table 9 for *Kd*.

Table 19

Open-circuit voltage	Short-circuit current	Condition
12 V	$I\,max \times Kd$	Heavy-current terminal(8)
		All terminals except heavy-current terminal (conduct the test for both voltages using separate samples)
20 mV max.	10 mA max.	Gold plated terminals

Note (8): Heavy-current terminal, the width of the male terminal shall be 4 mm min.

Table 20

Class	Condition
I	Connectors or terminals fixed directly to the engine body
II	Connectors or terminals fixed indirectly to the body and cause noticeable resonance
III	Connectors or terminals fixed directly to the body or interior

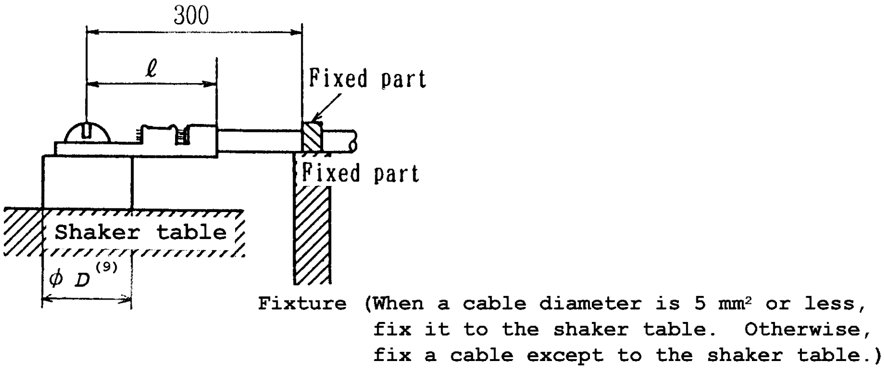


Fig. 19 For Round and Spade Terminals (Unit: mm)

Note (9): "*D*" should be greater than the outside diameter of the terminal and smaller than "ℓ".

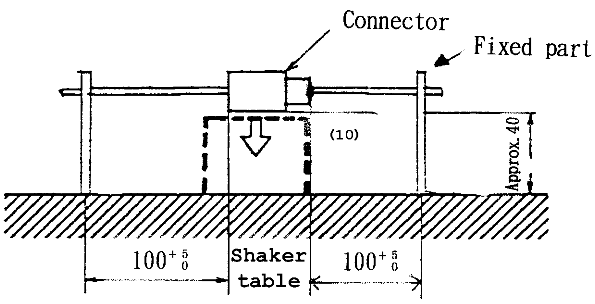


Fig. 20 For Wire to Wire Connectors (Unit: mm)

Note (10): The broken line indicates clamping.

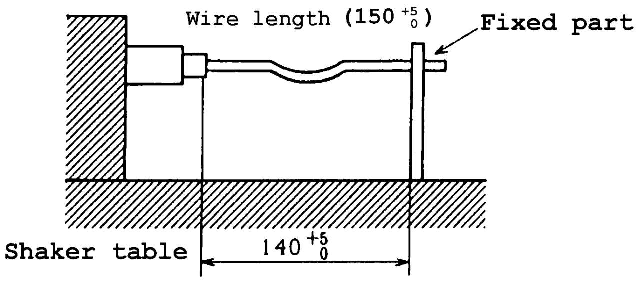


Fig. 21 For Connectors for Direct Mounting on PCB (Unit: mm)

6.2.14 Impact Test

Attach the connector to the impact testing table, and give impacts while checking for momentary shut-off (Fig. 22).　Refer to Table 21 for test conditions.

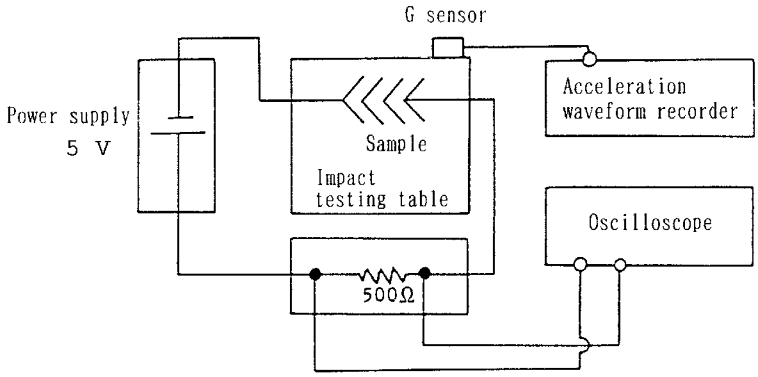
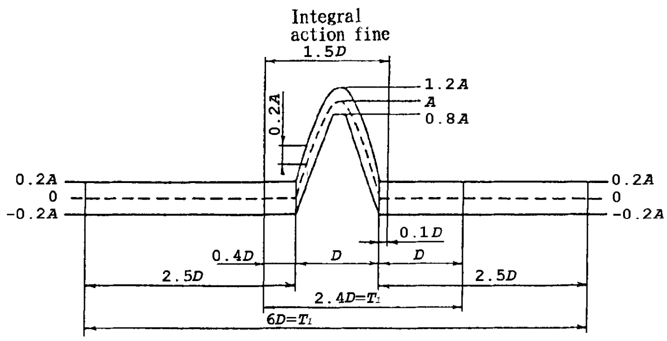


Fig. 22　Impact Confirmation Method

Table 21　Impact Test Conditions

Item	Test condition
Peak acceleration (m/s^2)	981
Operation time (ms)	6
Pulse wave (Sinusoidal half-wave)	 where, ---- Ideal pulse —— Acceptable limit D: Active period of ideal pulse A: Peak acceleration of ideal pulse T_1: Minimum impact-monitoring duration in the case of ordinary impact tester T_2: Minimum impact-monitoring duration in the case of vibration tester
Direction of vibration application	6 directions with respect to the connector terminal: upward,　downward, right, left, back and forth
Number of vibration application	3 times in each direction

6.2.15 Overcurrent Passing Test

Supply a current to a connector held horizontally in a place shielded from draft. For multi-pole connectors, supply a current through only one circuit to be arbitrarily selected. Refer to Table 22 for the passing current and duration.

Table 22

Copper cable dia. (mm^2)	Sample No.	Current (A)	Time	Copper cable dia. (mm^2)	Sample No.	Current (A)	Time
0.13	1	5.5	60 min	2	1	40.5	60 min
	2	6.75	5 s		2	45.0	500 s
	3	7.5	2 s		3	60.0	70 s
	4	10.0	0.5 s		4	90.0	7 s
	---				5	150.0	1 s
0.22	1	8.2	60 min	3	1	54.0	60 min
	2	10.1	20 s		2	60.0	500 s
	3	11.3	5 s		3	80.0	80 s
	4	15.0	0.5 s		4	120.0	10 s
	---				5	200.0	1 s
0.3 0.35	1	11.0	60 min	5	1	67.5	60 min
	2	13.5	10 s		2	75.0	1000 s
	3	15.0	5 s		3	100.0	70 s
	4	20.0	1 s		4	150.0	10 s
	---				5	250.0	1 s
0.5	1	16.5	60 min	8	1	108.0	400 s
	2	20.2	200 s		2	120.0	200 s
	3	22.5	5 s		3	180.0	20 s
	4	30.0	1 s		4	240.0	7 s
	---				5	400.0	1 s
0.75 0.85 1.0	1	22.0	60 min	9 10	1	162.0	400 s
	2	27.0	100 s		2	180.0	150 s
	3	30.0	10 s		3	240.0	30 s
	4	40.0	1 s		4	360.0	5 s
	---				5	600.0	1 s
1.25 1.5	1	33.0	60 min	12 15	1	202.5	2000 s
	2	40.5	100 s		2	225.0	300 s
	3	45.0	10 s		3	300.0	15 s
	4	60.0	2 s		4	450.0	2 s
	---				---		

6.2.16 Multi-factor Environment Test

Attach the connector to the shaker table as shown in Figs. 19 to 21. Supply the current calculated by multiplying the current "Ｉ*max*" given in Table 23 by the reduction coefficient "*Kd*" given in Table 9. Supply the current in on-vehicle condition in the case of Class A and Class B connectors for exclusive use. Amount of current to be supplied is set separately for each connector. Supply this current to all the poles for 45 min, and stop for 15 min. Repeat this cycle 300 times. Conduct testing under the vibration conditions given in Tables 18 and 19 without draft as much as practicable. Vibrate it in three directions with respect to the direction of connector installation; upward and downward, back and forth, right and left. This test shall be conducted with one sample in each testing direction (3 specimens in total).

Testing temperatures are given in Table 24. Measure temperatures at the terminal and monitor the fluctuation of circuit resistance.

After testing, conduct the vibration test as given in Section 6.2.13 in three directions for 1 h respectively, and check for momentary shut-off.

Remarks:

1. Passing current = *Kd*・Ｉ*max* (Refer to Tables 23 and 9)

Table 23 Maximum Allowable Current (Ｉ*max*)

Copper cable size (mm^2)	Current (A)
0.13	2
0.22	3
0.3	4
0.35	4
0.5	6
0.75	7
0.85	8
1.0	9
1.25	10
1.5	11
2.0	14
3.0	19
5.0	26
8.0	34
9.0	36
10.0	38
12.0	44
15.0	46

Table 24 Ambient Temperature for Testing (Unit: ℃)

Class	Temperature
A・B	120±3
C	100±3
D	80±3

Remarks:

2. If the cable crimping area of a specimen satisfies any of the following 4 conditions, use the specimen whose cable is crimped under the conditions that the C/H (crimp height) is management upper limit, management median, and management lower limit:
   (1) terminal wire barrel is newly developed or changed (material and thickness of terminal, wire barrel shape, plating material, film thickness, etc),
   (2) type of cable (diameter of conductor, composition of element wire) is added or changed (as a combination of crimp),
   (3) crimp applicator (crimper, anvil, etc.) is newly developed or changed, or
   (4) crimping conditions (C/W, C/H management values) are changed.
   In addition, resistance values at the crimped terminal shall be measured before and after the test in accordance with Section 5.1.5 or 5.1.6 in TSC1229G.

6.2.17 Oil Resistance Test

(1) Use torque converter oil, transmission oil, engine oil, clutch oil or brake oil of 85±2 ℃, and conduct testing as follows:
   (a) Torque converter oil: Immerse for 1 h → Leave to stand under the atmosphere of ordinary temperature for 24 h
   (b) Transmission oil: Immerse for 1 h → Leave to stand under the atmosphere of ordinary temperature for 24 h
   (c) Engine oil: Immerse for 1 h → Leave to stand under the atmosphere of ordinary temperature for 24 h
   (d) Clutch oil or brake oil: Immerse for 1 h → Leave to stand under the ordinary temperature for 24 h

(2) Use other specimens and a windshield washer liquid (concentration: 30 %) of 50±2 ℃ and engine coolant (concentration: 30 %) of 118±5 ℃, and conduct testing as follows:
   (a) Windshield washer liquid: Immerse for 1 h → Leave to stand under the atmosphere of ordinary temperature for 24 h
   (b) Engine coolant: Immerse for 1 h → Leave to stand under the atmosphere of ordinary temperature for 24 h

(3) Immerse other specimens in gasoline, gas oil, or battery liquid of 23±5 ℃ for 1 h respectively and leave to stand under the ordinary temperature for 24 h.

6.2.18 Dew Formation Test

Conduct 48 cycles of dew formation test of the sample (connector) at separate test tanks with different atmospheres (low temperature, high temperature and high humidity) with the pattern shown in Fig. 23 as 1 cycle.　Apply the voltage shown in Table 10 to the circuit shown in Fig. 6 and measure the peak value of the leak current for each cycle.

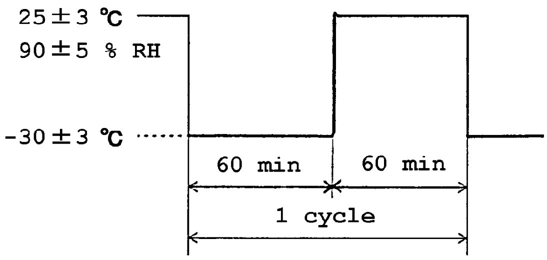


Fig. 23　Test Pattern

Leaving the sample in the thermostatic chamber of -30±3 ℃ for 60 min, then immediately after that left in the thermostatic chamber with the temperature of 25±3 ℃ and the humidity of 90±5 % RH for 60 min shall be one cycle.

Applicable Standards

TSC1114G	Cables for electric vehicles
TSC1115G	Cables with fluoro rubber insulator for electric vehicles
TSC1117G	Low-voltage cables for automobiles
TSC1229G	Test methods for connection at crimped terminals