TEST METHOD FOR ANALOG READ-OUT METER

1. Scope

This standard covers test methods for analog read-out meters (hereafter referred to as meter) that are combination meters that indicate, by pointer, information such as vehicle speed, number of engine revolutions, and remaining fuel amount.

2. Definitions

Principal terms used in this standard are defined as follows:

(1) Analog read-out meter
Instruments that indicate various conditions of a vehicle by deflections of the pointer.

(2) Self-illuminating meter
A meter of the type with needle and graduated panel illuminated day and night by cold-cathode tubes and bulbs.

(3) Mechanical speedometer and odometer
A speedometer and an odometer of the type with needle or pointer moved mechanically via speedometer cable.

(4) Electric speedometer and odometer
A speedometer and an odometer of the type with needle or pointer moved mechanically via electric signals input from vehicle speed sensors.

(5) Electronic display odometer
An odometer of the type which displays running distance on an LCD, fluorescent tube or the like electronic display.

(6) Sender
A device to detect the amount of fuel remaining, engine cooling water temperature, engine oil pressure, and the like, converting these into electric resistance, current or voltage.

(7) Crossed coil meter
A device consisting of more than one coil that gives rise to a magnetic field determined by the sender output resistance. The needle is moved by the resultant field of all component fields.

(8) Stepping motor meter
A meter of the type with a needle moved by a stepping motor controlled by a microprocessor (hereinafter referred to as a CPU) or the like.

(9) Bimetal meter
A device consisting of a heat coil, that allows a current determined by the sender output to flow, and the bimetal. The needle is moved by heat generated by the heat coil.

(10) Bimetal constant-voltage device
A device which produces constant voltage by bimetal switching.

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Established/ 7 Revised:
Jul.2001

(11)Hysteresis
The difference in meter reading for the same magnitude of input between when the input is increased by that magnitude and when it is decreased by the same magnitude.
(12)Time lag
The length of time from the moment an input to a meter is changed until the meter reading stabilizes.
(13)Resetting time
The length of time from the moment an input to a meter is turned off until the meter reading returns to zero.
(14)One-way needle meter
A meter whose reading remains unchanged after the meter power is turned off.
(15)LCD odometer
A meter that displays distance and trip readings via LCD.
(16)Multi-display
A device to indicate indicator readings, warning, mean and instant fuel economies, and mean vehicle speed in symbols and letters.
(17)Multiplex communications
Communications receiving signals from sensors and ECUs as serial signals and transmitting them as the same.

3. Test Items and Order
Table 1 shows the test items covered by this standard. Also, Fig. 1 and Table 2 show the test order and number of test pieces, respectively. Numbers in ○ in Fig. 1 are numbers assigned to groups of the test order.

Table 1 Test Items

Classifications	Test items
Initial characteristics	① Initial characteristics
Thermal/voltage characteristics	① Thermal/voltage characteristics
Operation	① Low-temperature operation ② High-temperature operation ③ Humidity operation ④ Low temperature intermittent electric charging ⑤ High temperature intermittent electric charging ⑥ Temperature/voltage composite cycle ⑦ Operation durability ⑧ Lamp indication ⑨ Odometer drive
Environment	① Thermal shock ② Dew condensation ③ Temperature limit ④ Dust resistance ⑤ Light resistance ⑥ Solvent resistance ⑦ Scratch/peeling ⑧ Solder life ⑨ Migration

Established/ 7 Revised:
Jul.2001

Table 1 (Continued)

Classifications	Test items
Radio noise	① Inductive noise ② Electromagnetic interference resistance ③ Static electricity ④ Momentary power interruption ⑤ Power fluctuations ⑥ Overvoltage ⑦ Reverse power connection ⑧ Field decay ⑨ Load dump ⑩ Ignition pulse ⑪ Floating earth ⑫ Radio noise ⑬ W/H(1) open/short-circuit ⑭ Body electronics area network ⑮ Narrow-band emission noise ⑯ Electromagnetic radiation
Mechanical strength, etc.	① Vibration ② Drop ③ Noise

Note (1):
W/H means wiring harness.

Established/ 7 Revised:
Jul.2001

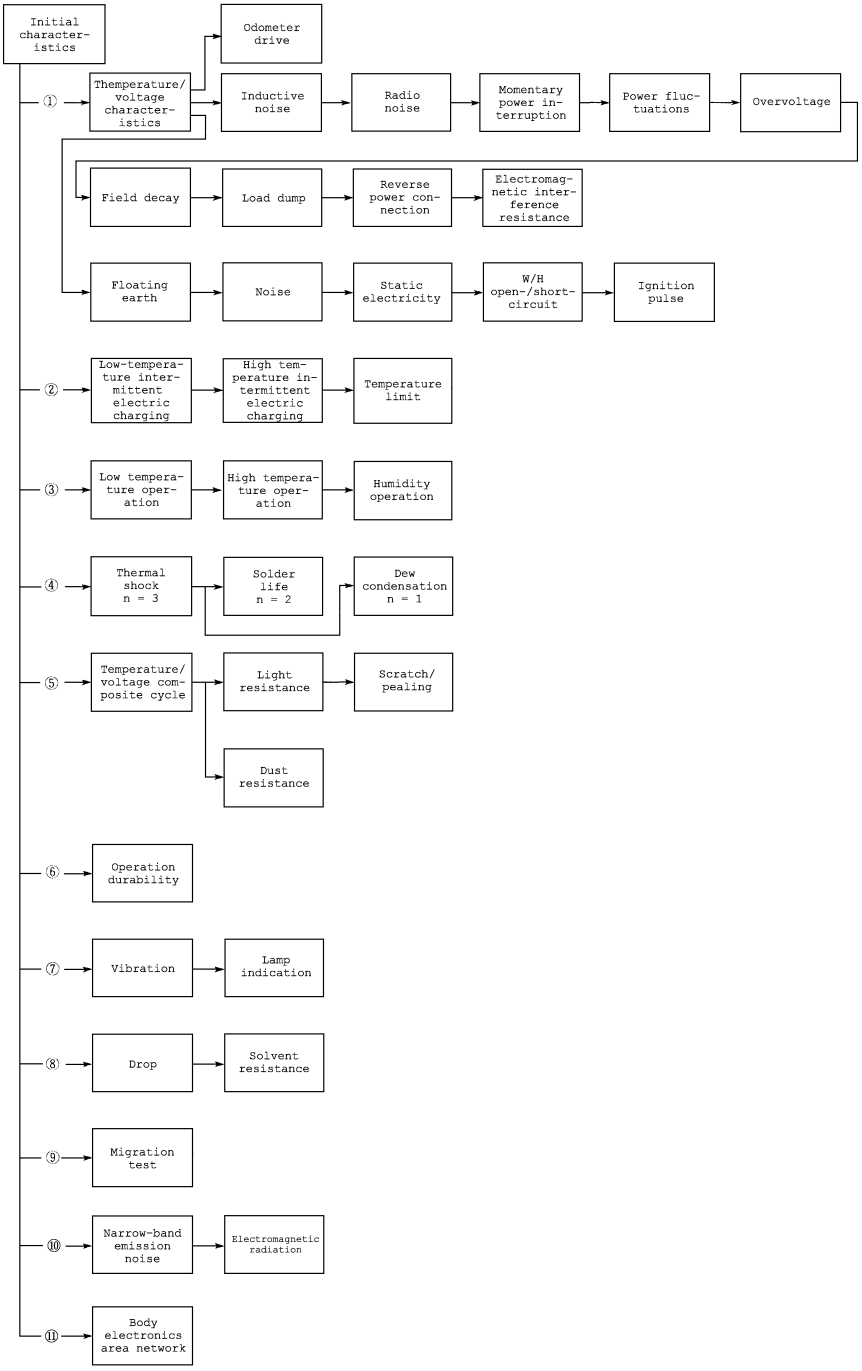


Fig. 1 Test Order

Established/ 7 Revised: Jul.2001

Table 2 Number of Test Pieces for Each Test

Development steps	Ranks			
	A	B	C	D
FS	For each test in ① to ③, ⑤ to ⑥, N = 2. (Only temperature/voltage composite cycle test for ⑤) For each test in ④ and ⑨, N = 3. ⑪		For the initial test, N = 2.	----
Pilot production sample	For each test in ①, ⑧, N = 2. For each test in ② to ⑦, N = 3. For each test in ⑨, N = 4. ⑩ and ⑪	For each test in ① to ③, ⑤ to ⑥, N = 2. For each test in ④, N = 3. For each test in ⑨, N = 4. ⑩ and ⑪		

Remark:
When deciding number of test pieces shown in Table 2, note the following:
(1) The numbers in ○ correspond to the group number of the test order in Fig. 1.
(2) The number of test pieces is the minimum number required. If an error occurs during the test, continue the test with a substitute, however, for the test time and cycles for the durability test, restart the test.
(3) For development ranges and evaluation ranks about the ranks, see Table 3.
(4) For a vehicle type developed employing many meter variations, classify meters in the basic and derived types. Carry out all test items for the basic type. For the derived type, carry out tests in regard with the altered sections and the items agreed among departments concerned.
(5) Ranking, applicable test items, number of test pieces are determined by an agreement among departments concerned.

Established/ 7 Revised:
Jul.2001

Table 3 Development Scales and Evaluation Ranks of Meter

<table>
<tr><td></td><td colspan="2">Ranks</td><td colspan="3">I_1 I_2 I_3</td><td colspan="2">II_1 II_2</td><td>III</td></tr>
<tr><td rowspan="2">Ranks</td><td colspan="2">Exterior/ design
Internal mechanism</td><td colspan="3">New design</td><td colspan="2">Sectional change</td><td rowspan="2">No change</td></tr>
<tr><td>Mechanical sections</td><td>Electric sections</td><td>New structure</td><td>Integration/ installation change</td><td>Form change</td><td>Partial change in form</td><td>Surface treatment change</td></tr>
<tr><td>A_1
A_2</td><td>New mechanism</td><td rowspan="2">New circuit</td><td colspan="3" rowspan="2">A-I</td><td colspan="2" rowspan="2">A-II</td><td>—</td></tr>
<tr><td rowspan="2">Movement characteristics change</td><td>—</td></tr>
<tr><td>B_1
B_2</td><td>Circuit change</td><td colspan="3" rowspan="2">B-I</td><td colspan="2" rowspan="2">B-II</td><td rowspan="2">B-III</td></tr>
<tr><td>Printed board pattern change</td></tr>
<tr><td>C_1</td><td>Pointer change</td><td rowspan="3">No change</td><td colspan="3" rowspan="2">C-I</td><td colspan="2">C-II</td><td>C-III</td></tr>
<tr><td>C_2</td><td>Installation change</td><td colspan="2">—</td><td></td></tr>
<tr><td>D</td><td>No change</td><td colspan="3">D-I</td><td colspan="2">D-II</td><td>D-III</td></tr>
</table>

4. Characteristics Measuring Items and Timings

Table 4 summarizes the characteristics measuring items and timings for the evaluation ranks. The initial characteristics are items that are measured before the test. The temperature/voltage characteristics are those that are measured during the temperature/voltage characteristics test. Also, durability includes those that are measured at the intermediate (if specified) and the ending moments of the individual tests contained in each group of the tests shown in Fig. 1.

Established/ 7 Revised:
Jul.2001

Table 4 Characteristics Measuring Items and Timing

Classification	Characteristics measuring items	Sorts in characteristics measurement and evaluation ranks												Remarks
		Initial				Temperature/ voltage				Durability				
		A	B	C	D	A	B	C	D	A	B	C	D	
(1) Speedometer indicating characteristics	(a) Indication accuracy	○	○	○	○	○	○	○	○	○	○	○	○	
	(b) Pointer deflection	○	○			○	○			○	○			
	(c) Chime operation characteristics	○	○			○	○			○	○			
	(d) Indication response	○	○			○				○	○			(c) is for domestic and Saudi Arabian market.
	(e) Speed sensor output characteristics	○	○	○	○	○	○	○	○	○	○	○	○	
	(f) Driving torque	○	○			○	○			○	○			
	(g) Actuation	○	○			○	○			○	○			
	(h) Resetting	○	○			○	○			○	○			
	(i) Hysteresis characteristics	○	○			○	○			○	○			
(2) Odometer and trip meter indicating characteristics (mechanical and electric)	(a) Indication accuracy	○	○			○	○			○	○			
	(b) Trip meter resetting characteristics	○	○			○	○			○	○			
	(c) T belt warning accuracy	○	○			○	○			○	○			(c) is for diesel only.
	(d) Driving torque	○	○			○	○			○	○			
	(e) Indicating characteristics	○	○			○	○			○	○			
(electronic indication)	(a) Indication accuracy	○	○			○	○			○	○			
	(b) Trip meter resetting characteristics	○	○			○	○			○	○			
	(c) T belt warning accuracy	○	○			○	○			○	○			(c) is for diesel only.
	(d) Indicating characteristics	○	○			○	○			○	○			
	(e) Odometer indication storage	○	○			○	○			○	○			
(3) Tachometer indicating characteristics	(a) Input signal detecting characteristics	○	○	○	○	○	○	○	○	○	○	○	○	
	(b) Indication accuracy	○	○	○	○	○	○	○	○	○	○	○	○	
	(c) Pointer deflection	○	○			○	○			○	○			
	(d) Actuation	○	○			○	○			○	○			
	(e) Indication response	○	○			○				○	○			
	(f) Pointer deflection when electrically charged	○	○											
	(g) Hysteresis characteristics	○	○			○	○			○	○			

Established/ 7 Revised: Jul.2001

Table 4 (Continued)

Classification	Characteristics measuring items	Sorts in characteristics measurement and evaluation ranks												Remarks
		Initial				Temperature/ voltage				Durability				
		A	B	C	D	A	B	C	D	A	B	C	D	
(4) Fuel gage indicating characteristics	(a) Indication accuracy	○	○	○	○	○	○	○	○	○	○	○	○	(c) is for cross coil type only. (e)(f)(g) are for bimetal type only.
	(b) Indication response	○	○	○	○	○	○			○	○	○	○	
	(c) Pointer stay-in characteristics	○	○	○	○	○	○			○	○			
	(d) Hysteresis characteristics	○	○	○	○	○	○			○	○			
	(e) Voltage characteristics	○	○	○	○	○	○			○	○			
	(f) Bimetal temperature characteristics	○	○			○	○			○	○			
	(g) Bimetal contact point characteristics	○	○			○	○			○	○			
(5) Temperature gage indicating characteristics	(a) Indication accuracy	○	○	○	○	○	○	○	○	○	○	○	○	(c) is for center stable type only. (d) is for bimetal type only.
	(b) Indication response	○	○			○				○	○			
	(c) Intermediate stability	○	○	○	○	○	○	○	○	○	○	○	○	
	(d) Bimetal temperature/contact point characteristics	○	○			○	○			○	○			
	(e) Pointer deflection when electrically charged	○	○											
	(f) Hysteresis characteristics	○	○			○				○	○			
(6) Oil pressure gage indicating characteristics	(a) Indication accuracy	○	○	○	○	○	○	○	○	○	○	○	○	(f) is for bimetal type only.
	(b) Indication response	○	○	○		○				○	○			
	(c) Actuation	○	○	○		○				○	○	○	○	
	(d) Resetting	○	○	○		○				○	○	○	○	
	(e) Pointer deflection	○	○	○		○				○				
	(f) Bimetal temperature characteristics	○	○			○				○				
	(g) Hysteresis characteristics	○	○	○		○				○	○			
(7) Turbo gage indicating characteristics	(a) Indication accuracy	○	○	○	○	○	○	○		○	○	○	○	
	(b) Indication response	○	○	○		○				○				
(8) Voltmeter indicating characteristics	(a) Indication accuracy	○	○	○	○	○	○	○	○	○	○	○	○	
	(b) Indication response	○	○	○		○				○				
(9) Indicators/warning lamps display characteristics	(a) Checking indicating functions	○	○	○		○				○	○			(b) is for turbo/ED monitor, etc.
	(b) Indication response	○	○	○		○				○	○			

Established/ 7 Revised: Jul.2001

Table 4 (Continued)

Classification	Characteristics measuring items	Sorts in characteristics measurement and evaluation ranks												Remarks
		Initial				Temperature/ voltage				Durability				
		A	B	C	D	A	B	C	D	A	B	C	D	
(10) Optical characteristics	(a) Luminance/ chromaticity of indicators and warning lamps	○	○	○		○				○	○			
	(b) Luminance/ chromaticity of dial and pointer	○	○	○		○				○	○			
	(c) Chromaticity of dial	○	○	○		○				○	○			
	(d) Light control characteristics	○	○	○		○				○				
	(e) External illumination characteristics	○	○	○		○				○				
(11) Visibility	(a) Visibility of odometer/trip meter	○	○	○		○				○				
	(b) Visibility of illuminated meters	○	○	○		○				○				
(12) Multiplex communications	(a) Transmitting and receiving characteristics	○	○			○	○			○	○			
	(b) Indication accuracy	○	○			○	○			○	○			
	(c) Indication response	○	○			○	○			○	○			

Established/ 7 Revised:
Jul.2001

5. Instruments for Characteristics Measurement

Table 5 shows instruments for the characteristics measurement.

Table 5 Instrument List

Items	Specification	Quantity
Constant-voltage power supply	Rated output: 0 to 40 V, 10 A min.	1
Oscilloscope	Frequency characteristics: 50 MHz min. Sensitivity: 10 mV to 5 V/div, with storage	
Voltage probe for oscilloscope	Frequency characteristics: 50 MHz min. Potential dividing ratio: 10:1 Withstand voltage: 500 V min.	2
Digital voltmeter	Measuring range: Voltage: 0 to 40 V Current: 0 to 10 A Accuracy: within ±0.5%	
Frequency counter	Measuring range: 0.1 to 5 MHz Input sensitivity: 100 mV rms	1
Stopwatch	Measuring range: 0 to 1 h Accuracy: within ±0.5 s	
Luminance meter	Tokyo Optical Co., Ltd., BM-5 equivalent	
Speedometer cable driver	Driving speed range: 0 to 300 km/h Accuracy: within ±0.1 km/h	
High-speed camera or video recorder	Feed rate: 100 frame/s	
Torque meter		
Tachometer/gage driver		
Standard resistor	Substitute resistor for fuel and temperature gages	2
Sound level meter		1
FFT or 1/3 octave analyzer	Shall be able to analyze each 1/3 octave of 50 Hz to 10 kHZ	

6. Test Methods

6.1 Initial Characteristics Test

Measure the initial characteristics of meters (hereafter referred to as characteristics) prior to each test. For test pieces, use always those passed the shipping inspection. If a meter does not function as required in the specification, replace it with a substitute, also, inspect the cause of malfunctioning. Unless otherwise specified, applied voltage to a meter IG ⊕, when measuring characteristics, should be 13.5 ± 0.1 V, as shown in Fig. 2. Here, measure the applied voltage in such a manner that the length from the meter may be 10 cm or less, that is, ℓ = 10 cm max. In addition, temperature at the characteristics measurement should be normal temperature (20 ± 5℃).

Established/ 7 Revised:
Jul.2001

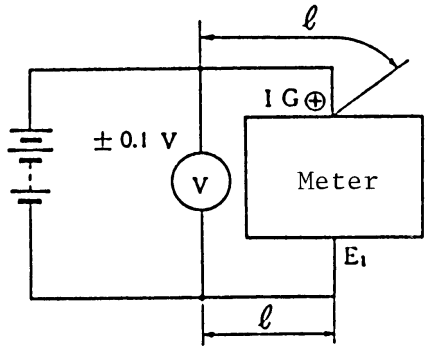


Fig. 2 Applied Voltage Measuring Device at the Characteristics Measurement

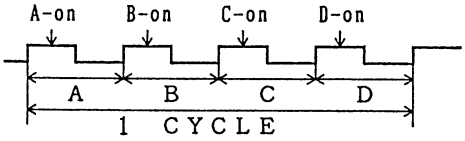
The following paragraphs describe measurement methods for the characteristics measuring items shown in Table 4.

(1) Speedometer indicating characteristics

The speedometer characteristics measuring items include 9 items, which are indication accuracy, deflection, chime operation characteristics, indication response, vehicle speed sensor output characteristics, driving torque, actuation, resetting, and hysteresis characteristics. Measure these items following procedures specified in Table 6.

Established/ 7 Revised:
Jul.2001

Table 6 Speedometer Indicating Characteristics Measuring Methods

<table>
<tr><th>Items</th><th>Characteristics measuring conditions</th><th>Remarks</th></tr>
<tr><td>(a) Indication accuracy</td><td>Sweep vehicle speed from 0 to the maximum speed for one cycle. Here, measure readings at the following speeds in the accelerating direction.
<table>
<tr><th></th><th>Measuring speeds</th><th>Measuring unit</th></tr>
<tr><td>km/h scale</td><td>every 20 km/h</td><td>1/10 of the minimum division</td></tr>
<tr><td>mph scale</td><td>every 20 mph</td><td>1/10 of the minimum division</td></tr>
</table></td><td>Measure with tapping.</td></tr>
<tr><td>(b) Pointer deflection</td><td>① Cable type speedometer
Measure deflecting amount of the pointer in the same condition as that in the indication accuracy. (Mean value of 10 times, measurement unit: 1/10 deg.)
② Electric speedometer
Input the vehicle speed input signal every 4 pulses repeatedly as shown below and measure the deflecting amount of the pointer. (Mean value of 10 times, measurement unit: 1/10 deg.)
 

(1) DUTY = 50%
A = 1.1B = 1.1C = 1.1D
(2) DUTY = 50%
A = B = 1.1C = 1.1D
(3) A = B = C = D
A-on/A = C-on/C = 0.4
B-on/B = D-on/D = 0.6
<table>
<tr><th></th><th>(1)</th><th>(2)</th><th>(3)</th></tr>
<tr><td>20 km/h</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>40 km/h</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>60 km/h</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>80 km/h</td><td>○</td><td>○</td><td>○</td></tr>
</table>
Remark: ○-Mark: Carry out the measurement.</td><td></td></tr>
</table>

Established/ 7 Revised: Jul.2001

Table 6 (Continued)

Items	Characteristics measuring conditions	Remarks
(c) Chime operation characteristics	Accelerate the vehicle speed from the chime starting speed -5 km/h to 0.2 km/h. Read the indications when chime starts and stops. Also measure the reversing amount of pointer when chiming. (Mean value of 10 times, unit: 1/10 km/h)	
(d) Indication response	① Vary vehicle speed from 0 to the maximum speed for one cycle with an acceleration rate of 10 km/h (10 mph/s). Here, measure indication change with a high-speed camera having a feeding speed of 100 frame per second or more. Determine delay time in indication from the result. (unit: 1/100 s) ② (Simplified method) Use the stopwatch and measure the time required for the meter to indicate from 0 to 90% of the maximum speed, accelerating the vehicle speed from 0 to the maximum speed at a rate of 10 km/h/s. (unit: 1/100 s, mean value of 10 times.)	
(e) Speed sensor output characteristics	Set the vehicle speed at that specified in the indication accuracy measurement. Here, with the oscilloscope, observe the waveform of voltage output from the vehicle speed sensor. Determine chattering time and ratio of on:off (unit: 1/1000 s, mean value of 10 times.)	
(f) Driving torque	① At constant speeds of 60 and 120 km/h, measure the mean and peak values of the driving torque (unit: 1/10 g·cm). ② (Static torque method) Measure the mean and peak values of the driving torque when revolving the speed meter cable 5 rounds (unit: 1/10 g·cm).	For mph indication, measure at 60 and 120 mph.
(g) Actuation	Measure the vehicle speed with which the pointer start to move from the zero point, when accelerating the speed from 0 at a rate of 0.5 km/h/s (1/10 of the minimum division, mean value of 10 times).	For mph indication, accelerate the speed at a rate of 0.5 mph/s.

Established/ 7 Revised: Jul.2001

Table 6 (Continued)

Items	Characteristics measuring conditions	Remarks
(h) Resetting	Measure the vehicle speed with which the pointer return to the zero point, when reducing the speed from 20 km/h at a rate of 0.5 km/h/s (1/10 the minimum division, mean value of 10 times).	For mph indication, decelerate the speed from 20 mph.
(i) Hysteresis characteristics	Under the measuring condition of the indication accuracy, vary the vehicle speed in the accelerating and reducing directions. Here, measure errors in indications.	Measure without tapping.

(2) Odometer and trip meter indicating characteristics
These include six characteristics, viz. indication accuracy, trip meter resetting characteristics, T belt warning accuracy, driving torque, indicating characteristics, and odometer indication storage.
Characteristics shall be determined via the method shown in Table 7.

Established/ 7 Revised:
Jul.2001

Table 7 Odometer and Trip Meter Indicating Characteristics (Mechanical and electric odometers)

Items	Characteristics measuring conditions	Remarks
(a) Indication accuracy	Measure the input pulse number of vehicle speed sensor or the revolution of speed meter cable during the integration of 1 km or 1 mile. For twin trip meter, both A and B channels shall be measured.	
(b) Trip meter resetting	Measure operating force required to reset the trip meter to zero and indication accuracy when reset to zero (unit: 1/10 g·cm). Also, check abnormal noise in operation (except the normal operation sound). For the twin trip meter, measure shaft rotating torque and operating forces required to reset to zero for both A and B.	
(c) T belt warning accuracy	① Operate the odometer for a cumulative distance. Check that the lamp lights at a distance value with the tolerance shown in the drawing. After operating the reset switch, check that the lamp goes off. Measure the reset switch operating force. ② When performing the durability test, check the warning function in the same manner as that in ①, after driving 100,000 km.	
(d) Driving torque	① Measure driving torque when indications of the odometer, the trip meter, and the T belt warning counter simultaneously change from 999,999 km (or mile) to 000,000 km (or mile), from 9,999 km (or mile) to 0,000 km (or mile), and from 99,999 to 00,000, respectively (when driving at 60 km/h). ② (Static torque method) Measure the mean and peak values when indications of the odometer, the trip meter, and the T belt warning counter simultaneously change in the same manner as that in ①.	Carry this out for mechanical odometers only. Measure at the speed meter revolving shaft.
(e) Indicating characteristics	Measure horizontal dislocation of the indicating digits of the odometer and the trip meter (unit: 1/10 mm).	

Established/ 7 Revised:
Jul.2001

Table 7 (Continued) (Electronic display odometers)

Items	Characteristics measuring conditions	Remarks
(a) Indication accuracy	Measure the cumulative input pulse number of vehicle speed sensor during drive for 1 km or 1 mile. With the twin trip meter, measure for both A and B channels.	
(b) Trip meter resetting characteristics	Measure operating force required to reset the trip meter to zero and indication accuracy when reset to zero. With the twin trip meter, measure operating force to reset separately for A and B. With the type reset by turning the knob, measure torque to turn the knob.	
(c) T belt warning accuracy	① Operate the odometer for a cumulative driving distance. Check that the lamp lights at a distance value with the tolerance shown in the drawing. After operating the reset switch, check that the lamp goes off. Measure the reset switch operating force. ② In durability tests, after driving 100,000 km or more, check for warning function as in ①.	
(d) Optical characteristics	Measure the display brightness and chromaticity of the odometer and trip meter. The measurement method shall be as described in "Meter Optical Characteristics Measurement Method" (provided later in this standard).	
(e) Odometer indication storage	Check the current odometer indication against the stored current value. For this purpose, read data in the non-volatile memory and CPU RAM(2). Check the stored value both before and after removing +B.	

Remark:
Check the odometer indication and stored value each time CPU software (or the dedicated IC) is changed.

Note (2):
When reading a value from CPU RAM (or the count on the dedicated IC) or the non-volatile memory, either of the following methods will do.
(a) Check that the CPU has a program to read RAM values or data in the non-volatile memory.
(Ex.) Display the memory value on the meter using a particular command.
(b) Read values in the memory using a memory reading device.

(3) Tachometer indicating characteristics
The tachometer indicating characteristics include 7 items, which are input signal detecting characteristics, indication accuracy, pointer deflection, actuation, indication response, pointer deflection when electrically charged, and hysteresis characteristics. Measure these items following procedures specified in Table 8.

Established/ 7 Revised:
Jul.2001

Table 8 Tachometer Indicating Characteristics Measuring Method

<table>
<tr><th>Items</th><th>Characteristics measuring conditions</th><th>Remarks</th></tr>
<tr><td>(a) Input signal detecting characteristics</td><td>Input to the tachometer a signal similar to an actual input. Observe the voltage waveform of the input terminals and that of shaped waveform using the oscilloscope. Measure the threshold voltage and allowance of time of the input signal and the tachometer.
Indication: from 0 to the maximum number of revolutions</td><td></td></tr>
<tr><td>(b) Indication accuracy</td><td>Sweep the input signal varying from 0 to the maximum number of revolutions for one cycle at a rate of 10 r/min. Here, measure the readings at the number of revolutions below in increasing and decreasing directions.
<table>
<tr><th>Measuring number of revolutions</th><th>Measuring unit</th></tr>
<tr><td>700, 3000 r/min</td><td rowspan="2">10 r/min or 1/10 of the minimum division.</td></tr>
<tr><td>(reference values)
1000, 2000, 4000, 6000, 7000, 8000 r/min</td></tr>
</table></td><td>Measure while tapping.</td></tr>
<tr><td>(c) Pointer deflection</td><td>Measure deflection amount of the pointer at revolution numbers shown below. (Measuring unit: 1/10 deg.)
Revolution number: 700, 3000, maximum number of revolution</td><td></td></tr>
<tr><td>(d) Actuation</td><td>Increase the input signal from 0 at a rate of 10 r/min, and measure the revolution number when the pointer levels the 0-point (mean value of 10 times).</td><td></td></tr>
</table>

Established/ 7 Revised: Jul.2001

Table 8 (Continued)

Items	Characteristics measuring conditions	Remarks
(e) Indication response	① Vary the input from 0 to the maximum number of revolutions (red zone beginning point) for one cycle with a rate of 8000 r/min. Here, measure indication change with a high-speed camera having a feeding rate of 100 frame/s min. Determine delay time in indication from the result. ② Input signals by step from 0 to the maximum number of revolutions (red zone), and measure the time required for the pointer to pass 90% the maximum number of revolutions using the high-speed camera. Here, observe whether it has an overshoot, if so, measure the indication. ③ Input a signal of the maximum number of revolutions (red zone beginning), and cut the signal. Here, use the stopwatch and measure the time required for the pointer to return to zero from the time the signal was cut (the mean value of 10 times, unit: 1/100 s).	
(f) Pointer deflection when electrically charged	① Charge the cover glass with static electricity by rubbing it with a chamois leather, then check whether the pointer deflects or not at idling. ② Apply an input signal to position the pointer at the nearest to the cover glass, and carry out a measurement similar to that in ①.	(1) Carry out the measurement under conditions of humidity 30% max. and temperature 25°C max. (2) Also measure the quantity of electricity charged.
(g) Hysteresis characteristics	Under the same measuring conditions as that in the indication accuracy, vary the input signal in the increasing and decreasing directions to measure reading errors.	Measure without tapping.

Established/ 7 Revised: Jul.2001

(4) Fuel gage indicating characteristics

The fuel gage characteristics measuring items include 7 items, which are indication accuracy, indication response, pointer stay-in characteristics, voltage characteristics of voltage stabilizing circuit, bimetal temperature characteristics, bimetal contact point characteristics, and hysteresis characteristics. Measure these items following procedures specified in Table 9.

Table 9 Fuel Gage Indicating Characteristics Measuring Method

Items	Characteristics measuring conditions	Remarks
(a) Indication accuracy	Vary the load resistance from F through 1/2 to E by step. Here, measure the readings at the fuel levels below in the decreasing direction (unit of pointing angle: 1/10°). Fuel levels: E, (1/4), 1/2, (3/4), F Remark: Values in parentheses are given for reference.	(1) Use the dummy resistor of the fuel sender for the load. (2) Carry out the measurement at the center value of the resistor of the fuel sender. (3) Do not give the meter any vibrations (unless measuring the indication accuracy). (4) Under the condition of mounting the gage on vehicle, leave the bimetal type for 3 min, and the cross coil type for 12 min.
(b) Indication response	① Measure the time required for the pointer to reach the 1/2 point after passing the E point, when varying the load resistance from 110 Ω to 2 Ω (unit: 1/10 s). ② Measure the time required for the pointer to reach the F point after passing the E point, when varying the load resistance from 110 Ω to 4 Ω (unit: 1/10 s). The measurement should be made after leaving the gage for 1 h or more at normal temperature. Measuring voltage: 13.0±0.1 V	
(c) Pointer stay-in characteristics	As the initial state, set the gage to E, 1/2, and F, then disconnect the power. Measure variation of the readings 30 min after the disconnection. (Carry out the measurement up to 24 h for reference.)	

Established/ 7 Revised: Jul.2001

Table 9 (Continued)

Items	Characteristics measuring conditions	Remarks
(d) Hysteresis characteristics	Sweep the load resistance from E to F for one cycle, and measure the readings at the fuel levels below in the increasing and decreasing directions (unit: 1/10°). Seeping speed: For the bimetal type, 3 min/step For the cross coil type, 12 min/step Fuel levels: E, 1/4, 1/2, 3/4, F	Measure without tapping.
(e) Voltage characteristics of voltage stabilizing circuit	For the bimetal type fuel gage, measure the voltage output from the voltage stabilizing circuit (7 V) and indication variation, when setting the applied voltage to the meter to the following values. Applied voltage: 10 to 16 V (for 24 V type, 20 to 32 V) Load: E, 1/2, F	
(f) Bimetal temperature characteristics	For the bimetal type fuel gage, measure variation of the pointer indication (unit: 1/10°) when turning on/off heating elements (e.g., lamps)	Measure with the back light or on the fuel warning bulb turned on.
(g) Bimetal contact point characteristics	For the bimetal type fuel gage, measure wear loss of the contact point of the bimetal (unit: 1/10 mm), and check whether the contact has welded, using a magnifying glass with a magnifying power of 20 min.	
Oil supply check funtion (if provided)	(1) Check the indication function by repeatedly turning the power on and off, while supplying 7 L of oil using the gage. (2) Check the indication function by changing gage resistance over a period of 25 ± 2 seconds, so as to establish a condition equivalent to the supply of 7 L of oil. (3) Check the indication function through the following procedure: more than 1 minute after turning OFF power, change gage resistance over a period of 25 ± 2 seconds so as to establish a condition equivalent to the supply of 7 L of oil. Then, turn ON power.	

(5) Temperature Gage Indicating Characteristics

The temperature gage characteristics measuring items include 6 items, which are indication accuracy, indication response, intermediate stability, bimetal temperature/contact point characteristics, pointer deflection when electrically charged, and hysteresis characteristics. Measure these items following procedures specified in Table 10.

Established/ 7 Revised:
Jul.2001

Table 10 Temperature Gage Indicating Characteristics Measuring Method

<table>
<tr><th>Items</th><th>Characteristics measuring conditions</th><th>Remarks</th></tr>
<tr><td>(a) Indication accuracy</td><td>Sweep the load resistance from C to H for one cycle. Here, measure the readings at the water temperatures(3) in the increasing direction.
Sweeping rate: pointing angle (unit: 1/10°).
<table><tr><td rowspan="3">Water temperature (°C)</td><td rowspan="2">Cross coil</td><td rowspan="2">Intermediate stability</td><td>Japan, etc.</td><td>50, 83, 105, 120</td></tr><tr><td>The Middle East</td><td>70, 95, 105, 120</td></tr><tr><td>Bimetal</td><td>Other countries</td><td>50, (95 or 99), 120</td></tr><tr><td></td><td></td><td>The Middle East</td><td>70, (99), 115</td></tr></table>
Remark: Values in ( ) are given for reference.</td><td rowspan="3">(1) Use the dummy resistor of the temperature sender for the load.
(2) Carry out the measurement at the center value and the upper and lower limit of the resistor of the sender.
(3) Do not give the meter any vibrations (unless measuring the indication accuracy).
(4) Under the condition of mounting the gage on vehicle, leave the cross coil type for 20 s, and the bimetal type for 3 min.
(5) When measuring the indication accuracy, sweep resistance at a rate of 20 s/step for the cross coil type; 3 min/step for the bimetal type.

Note:(3)
Refer to the indicated values on drawings, for measuring points for the indication accuracy.</td></tr>
<tr><td>(b) Indication response</td><td>Vary the load resistance from 200 Ω to 15 Ω, and measure the time until the pointer passes the red zone beginning point.</td></tr>
<tr><td>(c) Intermediate stability</td><td>Sweep the load resistance in the temperature range below for one cycle, and measure reading variations in the increasing and decreasing directions (varying rate: 5 min/cycle).
<table><tr><th>Destination</th><th>Water temperature (°C)</th></tr><tr><td>Japan</td><td>83 to 105</td></tr><tr><td>The Middle East</td><td>95 to 105</td></tr></table></td></tr>
<tr><td>(d) Bimetal temperature/ contact point characteristics</td><td>Carry out the measurement by the same measuring method as that for the bimetal type fuel gage.</td><td></td></tr>
</table>

Established/ 7 Revised: Jul.2001

Table 10 (Continued)

Items	Characteristics measuring conditions	Remarks
(e) Pointer deflection when electrically charged	① Charge the cover glass with static electricity by rubbing it with a chamois leather, then check whether the pointer deflects or not. ② Apply an input signal to position the pointer at the nearest to the cover glass, and carry out a measurement similar to that in ①.	(1) Carry out the measurement under conditions of humidity 30% max. and temperature 25°C max. (2) Also measure the quantity of electricity charged.
(f) Hysteresis characteristics	Under the same measuring conditions as that in the indication accuracy, vary the load resistance in the increasing and decreasing directions to measure reading errors.	Measured without tapping.

(6) Oil pressure gage indicating characteristics

The temperature gage characteristics measuring items indicating include 7 items, which are indication accuracy, indicating response, actuation, resetting, pointer deflection, bimetal temperature characteristics, and hysteresis characteristics. Measure these items following procedures specified in Table 11.

Established/ 7 Revised:
Jul.2001

Table 11 Oil Pressure Gage Indicating Characteristics Measuring Method

Items	Characteristics measuring conditions	Remarks
(a) Indication accuracy	Sweep the load current from 0, L to H for one cycle. Here, measure the readings at the pressure (corresponding current) below in the increasing direction. Sweeping rate: 3 min/step Oil pressure (kPa): 0, (9.8), (19.6), (29.4), (39.2), (49.0), (196), 392, (588), (784) Remark: Values in ( ) are given for reference.	(1) Connect the oil pressure sender to the oil pressure receiver, and apply pressure (oil or air pressure) to the sender. Here, measure the load current to use it as substitute characteristics. (2) Carry out the measurement at the center value and the upper and lower limit of the sender characteristics. (3) Do not give the meter any vibrations (unless measuring the indication accuracy). (4) Under the condition of mounting the gage on vehicle, leave the gage for 30 min min.
(b) Indication response	Vary the load current H to 0 by step, and measure readings until the pointer stabilizes. Determine the time required for the pointer to indicate L. Initial value: The pointer should have been indicating H.	
(c) Actuation	Increase the load current from 0 at a rate of 9.8 kPa/min. Here, measure the pressure (converted from the current value) that moves the pointer from L.	
(d) Resetting	Decrease the load current at the rate below from the value corresponding to the idling oil pressure, and measure the pressure that the pointer returns to L (from idling to 0: 5 min).	
(e) Pointer deflection	Measure deflection amount of the pointer (deflection angle) in the same condition as that in the indication accuracy.	
(f) Bimetal temperature characteristics	Carry out the measurement by the same measuring method as that for the bimetal type fuel gage.	
(g) Hysteresis characteristics	Under the same measuring conditions as that in the indication accuracy, vary the load current in the increasing and decreasing directions to measure reading errors.	Measure without tapping.

Established/ 7 Revised:
Jul.2001

(7) Turbo gage indicating characteristics

The turbo gage characteristics measuring items include 2 items, which are indication accuracy and indication response. Measure these items following procedures specified in Table 12.

Table 12 Turbo Gage Indicating Characteristics Measuring Method

Items	Characteristics measuring conditions	Remarks
(a) Indication accuracy	Apply sender voltage to the meter, sweeping the turbo boosting pressure from 0 to maximum for one cycle. Here, measure the readings at the pressure below in the increasing and decreasing directions (5 min/cycle). Pressure: 0 (Atmospheric pressure), +26.7 kPa, max.	
(b) Indication response	Vary the input pressure from the atmospheric value to the maximum value by step, and measure the response time required for the gage to read 26.7 kPa. (Unit: 1/100 s, the mean value of 10 times)	

(8) Voltmeter

The voltmeter characteristics measuring items include 2 items, which are indication accuracy and indicating response. Measure these items following procedures specified in Table 13.

Table 13 Voltmeter Indicating Characteristics Measuring Method

Items	Characteristics measuring conditions	Remarks
(a) Indication accuracy	Sweep the meter applied voltage from 10 to 16 V (for the 24 V type, 20 to 32 V) for one cycle (sweeping rate: 10 min/cycle). Here, measure the readings at the voltage values below in the increasing and decreasing directions. Voltage(4): 0, 10, 13.5, 16 V: 12 V type 0, 20, 27, 32 V: 24 V type	Note (4): When these are different from the voltage shown on drawing, measure at the voltage on drawing.
(b) Indication response	① When varying the voltage from 0 to 16 V (for the 24 V type, 32 V), record the response time required for the meter to read 13.5 V (for the 24 V type, 27 V) using the high-speed video (unit: 1/100 s). ② Measure ① with the stopwatch (unit: 1/100 s, the mean value of 10 times).	

Established/ 7 Revised: Jul.2001

(9) Indicators/warning lamps display characteristics
Indicators and warning lamps are as classified in Table 14. The characteristics measuring items for these include checking display function and indication response. Measure these items following procedures specified in Table 15.

Table 14 Indicators and Warning Lamps

	Name	Description	Remarks
Indicators	A/T shift indicator	Gear shift position indication	A/T cars
	0/D OFF indicator	Indication of releasing overdrive function	A/T car with 0/D
	ECT indicator	ECT mode indication	ECT cars
	ED monitor	Gas mileage indication	For Europe
	Red hazard indicator	Hazard indication	
	Turbo indicator	Turbo action, turbo error indication	Turbo cars
	TEMS indicator	TEMS mode indication	TEMS cars
	High beam indicator	Beam high/low indication	
	Security indicator	Security action indication	
	Rear fog indicator	Rear fog lamp lighting indication	
	4WD indicator	4WD/2WD changeover indication	
	Locking differential indicator	Locking differential indication	
	ABS (ESC) indicator	ABS non-operation state indication	
	TRC indicator		
	Turn signal indicator		
	VSC indicator		
Warning lamps	Fuel remaining amount warning lamp	Fuel remaining amount	
	Oil pressure warning lamp	Oil pressure warning	
	Brake warning lamp	Brake fluid level	
	Rear disconnection warning lamp	Rear lamps disconnection indication	
	Open door warning lamp	Not completely closed door	
	Engine oil level warning lamp	Engine oil level	
	Radiator fluid level warning lamp	Radiator fluid level	
	Tire air pressure warning lamp		

Established/ 7 Revised:
Jul.2001

Table 15 Indicators and Warning Lamps Display Characteristics Measuring Method

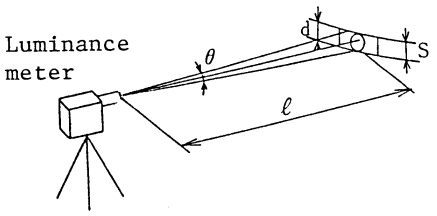
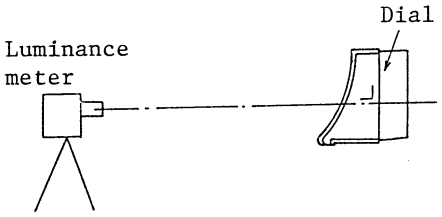
Items	Characteristics measuring conditions	Remarks
(a) Checking display function	Connect a switch box to input terminals and check display by on/off of the switch.	
(b) Display response	① For indication changeover types such as the turbo indicator and the ED monitor, record the response time required for the indicator to change display after switching the input switch, using the high-speed video (unit: 1/100 s). ② (Simplified method) Use the stopwatch for measurement (unit: 1/100 s, the mean value of 10 times).	Applicable only for the meters that have a delay circuit in them.

(10)Optical characteristics

Optical characteristics measuring items include 5 items, which are luminance/chromaticity of indicators/warning lamps, luminance/chromaticity of dial and pointer, chromaticity of dial, light control characteristics, and external illumination characteristics. Measure these items following procedures specified in Table 16.

Established/ 7 Revised:
Jul.2001

Table 16 Optical Characteristics Measuring Method

Items	Characteristics measuring conditions	Remarks
(a) Luminance/ Chromaticity of dial and pointer	① Adjust aperture θ and distance ℓ between the luminance meter and the indicators/warning lamps so that the aperture diameter d may have a dimension of 0.8 to 0.9 the width S of the measuring area.  ② Carry out the measurement in the eye point direction.  ③ Carry out the measurement at the highest and lowest luminance places of the luminous face of lamp by the following procedures. (a) Highest luminance place Holding the most luminous place selected visually within the measuring view of luminance meter, carry out the measurement in the area of diameter = 1±0.2 mm on the lamp face. For the lamp with a width less than 1 mm, carry out the measurement by holding at least 80% of the width within the measuring view. (b) Lowest luminance place Holding the darkest place selected visually within the measuring view of luminance meter, carry out the measurement in the same manner as (a).	Carry out measurement after supplying power to the meter for 10 min min.

Established/ 7 Revised: Jul.2001

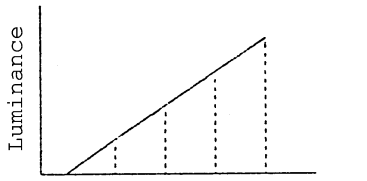
Table 16 (Continued)

Items	Characteristics measuring conditions	Remarks
(b) Luminance/ Chromaticity of dial and pointer	① For the light permeation type, measure the illuminating area such as letters, digits, and divisions, in the same manner as that for the indicators and warning lamps. ② For the indirect illumination type, take into consideration uneven luminance, so, measure 5 points min. Then determine the maximum, minimum, and mean values as the characteristics. Such areas that are different in color, for example, letters, digits, and divisions, should be measured separately.	With self-illuminating meters, measure brightness and chromalticity by day and night.
(c) Chromaticity of dial	① Irradiate the meter by the standard light source D65. Here, measure the chromaticity of the meter dial color. ② For the broad area such as the background area, measure 5 points min., then determine the mean value as the characteristics. Standard Light Source D65 Relative Spectral Energy Distribution	For reference

Wavelength nm	D_{65}	Wavelength nm	D_{65}	Wavelength nm	D_{65}	Wavelength nm	D_{65}
300	0.03	440	104.86	580	95.79	720	61.60
305	1.66	445	110.94	585	92.24	725	65.74
310	3.29	450	117.01	590	88.69	730	69.89
315	11.77	455	117.41	595	89.35	735	72.49
320	20.24	460	117.81	600	90.01	740	75.09
325	28.64	465	116.34	605	89.80	745	69.34
330	37.05	470	114.86	610	89.60	750	63.59
335	38.50	475	115.39	615	88.65	755	55.01
340	39.95	480	115.92	620	87.70	760	46.42
345	42.43	485	112.37	625	85.49	765	56.61
350	44.91	490	108.81	630	83.29	770	66.81
355	45.78	495	109.08	635	83.49	775	65.09
360	46.64	500	109.35	640	83.70	780	63.38
365	49.36	505	108.58	645	81.86	785	63.84
370	52.09	510	107.80	650	80.03	790	64.30
375	51.03	515	106.30	655	80.12	795	61.88
380	49.98	520	104.79	660	80.21	800	59.45
385	52.31	525	106.24	665	81.25	805	55.71
390	54.65	530	107.69	670	82.28	810	51.96
395	68.70	535	106.05	675	80.28	815	54.70
400	82.75	540	104.41	680	78.28	820	57.44
405	87.12	545	104.23	685	74.00	825	58.88
410	91.49	550	104.05	690	69.72	830	60.31
415	92.46	555	102.02	695	70.67		
420	93.43	560	100.00	700	71.61		
425	90.06	565	98.17	705	72.98		
430	86.68	570	96.33	710	74.35		
435	95.77	575	96.06	715	67.98		

Established/ 7 Revised: Jul.2001

Table 16 (Continued)

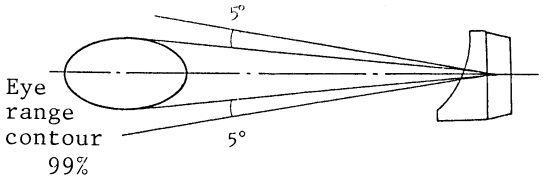
Items	Characteristics measuring conditions	Remarks
(d) Light control characteristics	This item is applicable when the illumination of the meter can be controlled by a rheostat, or for such indicators as the automatic transmission shift indicator that lessen luminance due to tail lamps.  Light control characteristics	• Measure at light control characteristics 0, 25 and 100%. • For illumination reduction due to the tail lamps, check whether reduction occurs or not. • Set the line voltage at 13.5 V. • With meters of the fixed illumination reduction type, measure at the fixed illumination reduction value.
(e) External illumination characteristics	Adjust the meter illuminance by a xenon lamp at 500, 1000, 5000, 10000, 50000, or 100,000 lx, then measure luminance ratio of lighting on and off the indicators and warning lamps.	For reference

Established/ 7 Revised: Jul.2001

(11)Visibility

The visibility measuring items include 2 items, which are visibility of the odometer/trip meter and visibility of illuminated meter. Measure these items following procedures specified in Table 17.

Table 17 Visibility Measuring Method

Items	Characteristics measuring conditions	Remarks
(a) Visibility of odometer/trip meter	View the meter from the directions within the eye range contour to check whether the dial frame conceal the odometer or the trip meter. Remark: Check from four directions; up, down, left, and right, within 99% of the eye range contour plus 5°.  	
(b) Visibility of illuminated meter	Illuminate the meter and check the items that follow: ① View the meter from the directions within the eye range contour, and carry out sensory inspection for uneven illumination. ② Check whether light beams leak viewing the meter from the directions within 99% of the eye range contour plus 5°, in up and down directions; and directions of ±45° in the left and right directions.	

Established/ 7 Revised:
Jul.2001

(12)Multiplex communications

Multiplex communication characteristics include transmitting and receiving characteristics, indication accuracy and indication response. This test shall apply to meters handling multiplex communication signals.

Table 18 Multiplex Communication Measurement Method

Items	Characteristics measuring conditions	Remarks
(a) Transmitting and receiving characteristics	Check if multiplex communication signals are correctly transmitted and received.	Use a multiplex communication evaluation system.
(b) Indication accuracy	Measure the indication accuracy of meters and gages handling multiplex communication signals.	
(c) Indication response	Measure time from the moment a multiplex signal is received until the indictor and warning lamp light.	

Remark:
The multiplex communication evaluation system is a tool having the following capabilities (e.g., LAN tester).
(1) Gathering, indicating and recording communication bus data
(2) Gathering, indicating and recording conditions under which an error occurred
(3) Transmitting given data at given timing
(4) Indicating and outputting given bits in real time
(5) Arbitrarily varying the bit length of transmission data
Measurements may be taken on a practical ECU. Other conditions shall conform to TSC7308G.

Established/ 7 Revised:
Jul.2001

6.2 Temperature/Voltage Characteristics Test

Set the atmospheric temperature for the meter to -40, -30, 25, 65, or 85℃, and the source voltage to 10, 13.5, or 16 V (for 24 V types, 20, 27, 32 V), then measure characteristics of the meter. The items given in Table 4 are the measuring items. Note that for the characteristics measurement, allowable ranges for the atmospheric temperature and the source voltage are within ± 3℃ and ±0.1 V, respectively.

6.3 Low Temperature Operation Test

Carry out the test according to the conditions given in Table 19.

Table 19 Low Temperature Operation Test Conditions

Items		Conditions
Temperature		-30 ± 3℃
Voltage		10 ± 0.1 V (for 24 V type, 20 ± 0.1 V)
Indication	Speedometer	Sweep the reading '0 ↔ maximum speed' at a rate of 30 s/cycle.
	Tachometer	Sweep the reading 'idling ↔ maximum number of revolutions' at a rate of 2.5 s/cycle.
	Fuel gage	Sweep the reading 'F ↔ E' at a rate of 6 min/cycle. For the cross coil type, 20 min/cycle.
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Sweep the reading 'L ↔ H' at a rate of 3 min/cycle.
	Turbo gage	Sweep the reading 'L ↔ H' at a rate of 2.5 s/cycle.
	Illumination, warning	Illumination: daylight-equivalent, warning lamps: off, indicators: off
Load		Dummy load (senders and vehicle speed signal output)
Time		192 h
Characteristics measurement		Measure characteristics 24 h after the test leaving the meter in normal temperature.

Established/ 7 Revised:
Jul.2001

6.4 High Temperature Operation Test

Carry out the test according to the conditions given in Table 20.

Table 20 High Temperature Operation Test Conditions

Items		Conditions
Temperature		65 ± 3℃
Voltage		16 ± 0.1 V (for 24 V type, 32 ± 0.1 V)
Indication	Speedometer	Sweep the reading '0 ↔ maximum speed' at a rate of 30 s/cycle.
	Tachometer	Sweep the reading 'idling ↔ maximum number of revolutions' at a rate of 2.5 s/cycle.
	Fuel gage	Sweep the reading 'F ↔ E' at a rate of 6 min/cycle.
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Sweep the reading 'L ↔ H' at a rate of 3 min/cycle.
	Turbo gage	Sweep the reading 'L ↔ H' at a rate of 2.5 s/cycle.
	Illumination, warning	Illumination: day mode, warning lamps: off, indicators: those that are turned on by IG ON.
Load		Dummy load (senders and vehicle speed signal output)
Time		24 h
Characteristics measurement		Inspect filters, cases, etc. 5 h after the operation to check whether there is any deformation in appearance. Then, continue the test up to 24 h, and carry out the characteristics measurement.

Remark:
Carry out the test up to 500 h for reference.

Established/ 7 Revised:
Jul.2001

6.5 Humidity Operation Test

Carry out the test according to the conditions given in Table 21.

Table 21 Humidity Operation Test Conditions

Items		Conditions
Temperature, humidity		65 ± 3℃, 90 to 95% RH
Voltage		13.5 ± 0.1 V (for 24 V type, 27.0 ± 0.1 V)
Indication	Speedometer	Sweep the reading '0 ↔ maximum speed' at a rate of 30 s/cycle.
	Tachometer	Sweep the reading 'idling ↔ maximum number of revolutions' at a rate of 2.5 s/cycle.
	Fuel gage	Sweep the reading 'F ↔ E' at a rate of 6 min/cycle.
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Sweep the reading 'L ↔ H' at a rate of 3 min/cycle.
	Turbo gage	Sweep the reading 'L ↔ H' at a rate of 2.5 s/cycle.
	Illumination, warning	Illumination: day-light equivalent, warning lamps: off, indicators: off
Load		Dummy load (senders and vehicle speed signal output)
Time		192 h
Characteristics measurement		Measure characteristics 24 h after the test leaving the meter in normal temperature.

Remark:
Carry out the test up to 1000 h for reference.

Established/ 7 Revised:
Jul.2001

6.6 Temperature/Voltage Composite Cycle Test

Carry out the test according to the conditions given in Table 22.

Table 22 Temperature/Voltage Composite Cycle Test Conditions

Items		Conditions
Temperature		-30 ± 3℃ (6 h) ↔ 65 ± 3℃ (6 h)
Voltage		13.5 ± 0.1 V (30 s) ↔ 0 V (30 s) (for 24 V type, 27.0 ± 0.1 V)
Indication	Speedometer	Sweep the reading '0 ↔ maximum speed' at a rate of 30 s/cycle.
	Tachometer	Sweep the reading 'idling ↔ maximum number of revolutions' at a rate of 2.5 s/cycle.
	Fuel gage	Sweep the reading 'F ↔ E' at a rate of 6 min/cycle.
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Sweep the reading 'L ↔ H' at a rate of 3 min/cycle.
	Turbo gage	Sweep the reading 'L ↔ H' at a rate of 2.5 s/cycle.
	Illumination, warning	Illumination: fully on, warning lamps: off, indicators: on
Load		Dummy load (senders and vehicle speed signal output)
Time		192 h
Characteristics measurement		Measure characteristics 24 h after the test leaving the meter in normal temperature.

Remark:
Shift to each setting temperature within 2 h.

Established/ 7 Revised:
Jul.2001

6.7 Operation Durability Test

Carry out the test according to the conditions given in Table 23.

Table 23 Operation durability Test Conditions

Items		Conditions
Temperature		Normal temperature
Voltage		13.5 ± 0.1 V (for 24 V type, 27.0 ± 0.1 V)
Indication	Speedometer	Sweep the reading '0 ↔ maximum speed' at a rate of 30 s/cycle.
	Tachometer	Sweep the reading 'idling ↔ maximum number of revolutions' at a rate of 2.5 s/cycle.
	Fuel gage	Sweep the reading 'F ↔ E' at a rate of 6 min/cycle.
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Sweep the reading 'L ↔ H' at a rate of 3 min/cycle.
	Turbo gage	Sweep the reading 'L ↔ H' at a rate of 2.5 s/cycle.
	Illumination, warning	Illumination: fully on, warning lamps: off, indicators: on
Load		Dummy load (senders and vehicle speed signal output)
Time		3000 h (turn power (of all +B, ACC and IG) off for 1 h or longer every 1000 h)
Characteristics measurement		Measure characteristics every 1000, 2000 and 3000 h.

Remark:
With electronic display odometers, check the indication against the data in the non-volatile memory before and after turning power off every 1000 h and when turning it on again.

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6.8 Lamp Illumination Test

Carry out the test according to the conditions given in Tables 24, 25 and 26.

Table 24 Lamp Illumination Test Conditions (1)

Items		Conditions
Temperature		65 ± 3℃: windless
Voltage		12.5 ± 0.1 V
Indication	Speedometer	0 km/h
	Tachometer	Indicating engine stop (0 r/min)
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating L
	Turbo gage	
	Illumination, warning	Illumination: day mode, Indicators/warning lamps: P-range, Indicating engine stop
Load		Dummy load
Time		5 h
Characteristics measurement		Measure temperatures at optional points during the test. When the test has been completed, the meter at normal temperature for 24 h. Then, check whether the case, filter, etc. are deformed.

Table 25 Lamp Illumination Test Conditions (2)

Items		Conditions
Temperature		65 ± 3℃: windless
Voltage		15.0 ± 0.1 V, 16.0 ± 0.1 V
Indication	Speedometer	0 km/h
	Tachometer	Indicating idling (1000 r/min)
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating L
	Turbo gage	
	Illumination, warning	Illumination: day mode, Indicators/warning lamps: P-range, Indicating idling
Load		Dummy load
Time		2 h (If no abnormalities have been found after illumination for 2 h, continue illumination for an additional 1 h or longer, to check performance.)
Characteristics measurement		Measure temperatures at optional points during the test. When the test has been completed, the meter at normal temperature for 24 h. Then, check whether the case, filter, etc. are deformed.

Established/ 7 Revised:
Jul.2001

Table 26 Lamp Illumination Test Conditions (3)

Items		Conditions
Temperature		Meter front face: normal temperature Meter case (back face): 70℃, windless
Voltage		15.0 ± 0.1 V, 16.0 ± 0.1 V
Indication	Speedometer	80 km/h
	Tachometer	3000 r/min
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating H
	Illumination, warning	Illumination: day mode, Indicators/warning lamps: indicating D range running
Load		Dummy load
Time		72 h
Characteristics measurement		Measure temperatures at optional points during the test. When the test has been completed, the meter at normal temperature for 24 h. Then, check whether the case, filter, etc. are deformed.

Established/ 7 Revised:
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6.9 Odometer Drive Test

Carry this out under the conditions shown in Table 27. This test shall apply to electronic display odometers only.

Table 27 Odometer Drive Test

Items	Characteristics measurement conditions
Temperature	Normal
Voltage	13.5 ± 0.1 V
Load	Dummy load (vehicle speed signal)
Cumulative distance	999,999 km or 999,999 miles (up to the maximum indication distance when the test odometer's maximum indication distance is 299,999 km or 299,999 miles)
Characteristics measurement	Operate the odometer from 0 to 300,000 km (or 300,000 miles). Check that the meter indication is stored every 100,000 km (100,000 miles). When performing this check every 100,000 km (100,000 miles), do so both before and after removing +B. Then, operate the meter from 300,000 to 999,999 km (or miles). After test, check that the meter indication is stored. During test, turn +B off every 100,000 km (or miles). When checking stored values, read data from the non-volatile memory and CPU RAM. It is permissible to input the maximum vehicle speed signal possible to input to operate the odometer.

Remark 1:
The odometer drive test shall be performed each time CPU software (or the dedicated IC) is changed.
Remark 2:
When reading a value from CPU RAM (or the count on the dedicated IC) or the non-volatile memory, either of the following methods will do.
(1) Check on CPU having a program to read RAM values or data in the non-volatile memory.
(Ex.) Display the memory value on the meter using a particular command.
(2) Read values in the memory using a memory reading device.

Established/ 7 Revised:
Jul.2001

6.10 Low Temperature Intermittent Electric Charging Test
Carry out the test according to the conditions given in Table 28.

Table 28 Low Temperature Intermittent Electric Charging Test Conditions

Items		Conditions
Temperature		-40 ± 3℃
Voltage		13.5 ± 0.1 V
Indication	Speedometer	Sweep the reading '0 ↔ maximum speed' at a rate of 30 s/cycle.
	Tachometer	Sweep the reading '0 ↔ maximum number of revolutions' at a rate of 2.5 s/cycle.
	Fuel gage	Sweep the reading 'F ↔ E' at a rate of 6 min/cycle.
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Sweep the reading 'L ↔ H' at a rate of 3 min/cycle.
	Turbo gage	Sweep the reading 'L ↔ H' at a rate of 2.5 s/cycle.
	Illumination, warning	Illumination: fully on, warning lamps: off, indicators: on
Load		Dummy load (senders and vehicle speed signal output)
Time		Switch on (6 min) ↔ Switch off (54 min) 450 cycles
Characteristics measurement		Measure characteristics when the test has been completed.

6.11 High Temperature Intermittent Electric Charging Test
Carry out the test according to conditions given in Table 29.

Table 29 High Temperature Intermittent Electric Charging Test Conditions

Items	Conditions
Temperature	85 ± 3℃
Others	According to Table 28

Established/ 7 Revised:
Jul.2001

6.12 Thermal Shock Test

Carry out the test according to the conditions given in Table 30.

Table 30 Thermal Shock Test Conditions

Items	Conditions
Temperature	-30 ± 3℃ (0.5 h) ↔ 80 ± 3℃ (0.5 h)
Voltage	Power supply: off
Time	Repeat 1000 times the above temperature cycle.
Characteristics measurement	Leave the test piece in normal temperature for 24 h after 1000 cycles and carry out the measurement.

Remark:
Use a test vessel of gaseous phase. Shift to each set temperature within 5 min. Start test from low temperatures.

6.13 Solder Life Test

Carry out the test according to the conditions given in Table 31.

Table 31 Solder Life Test Conditions

Items	Conditions
Temperature	-30 ± 3℃ (0.5 h) ↔ 80 ± 3℃ (0.5 h)
Voltage	Power supply: off
Time	Repeat 3000 times the above temperature cycle. (Repeat 2000 times after thermal shock.)
Characteristics measurement	(1) Using a magnifying glass, inspect whether cracks have generated in soldering position every 1000 cycles. (2) When the conductivity of a crack is doubtful, carry out the conductivity check. (3) If the conductivity is not good, take the following procedures. ① Take photographs. ② Cut the solder and inspect the inside state of cracks by metaloscope or SEM.

Remark:
Use a test vessel of gaseous phase. Shift to each set temperature within 5 min.

Established/ 7 Revised:
Jul.2001

6.14 Dew Condensation Test

Carry out the test according to the conditions given in Table 32.

Table 32 Dew Condensation Test Conditions

Items		Conditions
Temperature		-30 ± 3℃ (1 h) ↔ 25 ± 3℃ (1 h)
Humidity		At 25℃ 90 to 95% RH
Voltage		13.5 ± 0.1 V (only at 25℃) (for 24 V type, 27.0 ± 0.1 V) During the measurement only
Indication	Speedometer	60 km/h
	Tachometer	3000 r/min
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating median
	Turbo gage	
	Illumination, warning	Fully off
Load		Dummy load (senders and vehicle speed signal output)
Time		Repeat the temperature cycle above three times.
Characteristics measurement		Measure the following items every 15 min, after setting at 25℃. (1)Measure the indicated value. (2)Check the movement of needle by making the speed signal sweep 0 → max. → 0 (3)Check whether malfunction occurs or not during test.

Remark 1:
Prepare thermostatic chambers set to -30℃ and 25℃, and take the meter out and put it in within 5 min.
Remark 2:
Test piece shall not be exposed to the wind in the thermostatic chamber at 25℃.

Established/ 7 Revised:
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6.15 Temperature Limit Test

Carry out the test according to the conditions given in Table 33.

Table 33 Temperature Limit Test Conditions

Items		Conditions
Temperature	Low	Lower every 10℃ in a range from -50 ± 3℃.
	High	Raise every 10℃ in a range from 90 ± 3℃.
Voltage		13.5 ± 0.1 V (for 24 V type, 27.0 ± 0.1 V)
Indication (High temperature only)	Speedometer	Maximum speed
	Tachometer	Maximum number of revolutions
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating H
	Turbo gage	
	Illumination, warning	Illumination: fully on, Warning lamps: fully on
Load		Dummy load
Characteristics measurement	Low	After setting the temperatures at non-operation, apply voltage, then immediately measure characteristics.
	High	Operate for 3 h under the indicating conditions above, then measure characteristics.

Remark:
Carry out the characteristics measurement leaving the meter for at least 30 min at each setting temperature.

Established/ 7 Revised:
Jul.2001

6.16 Dust Resistance Test

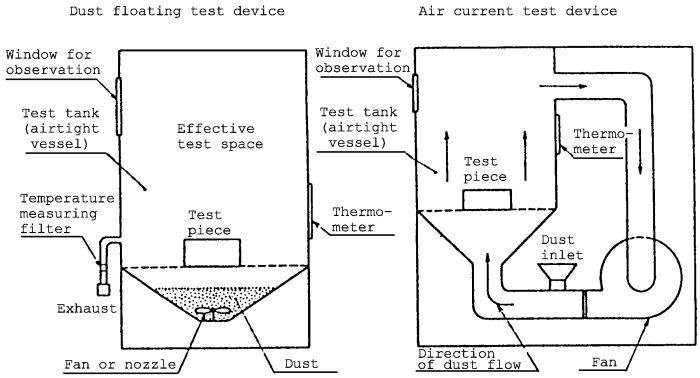
Carry out the test according to the conditions given in Table 34.

Table 34 Dust Resistance Test Conditions

<table>
<tr><th>Items</th><th>Conditions</th></tr>
<tr><td>Voltage</td><td>13.5 ± 0.1 V (For 24 V type, 27 ± 0.1 V)</td></tr>
<tr><td>Sand dust</td><td>Portland cement with a particle size of 24 to 28 μm; or a powder with a particle density of 2.9 to 3.1 g/cm^3, whose chemical composition is as shown below.
Chemical composition
<table><tr><th>Constituent</th><th>Mass percentage %</th></tr><tr><td>SiO_2</td><td>34 to 40</td></tr><tr><td>Fe_2O_3</td><td>17 to 23</td></tr><tr><td>Al_2O_3</td><td>26 to 32</td></tr><tr><td>CaO</td><td>0 to 3</td></tr><tr><td>MgO</td><td>3 to 7</td></tr><tr><td>TiO_2</td><td>0 to 4</td></tr><tr><td>Ignition loss</td><td>0 to 4</td></tr></table>
Particle size distribution
<table><tr><th rowspan="2">Particle size μm</th><th>Oversize (mass standard) %</th></tr><tr><th>Type 8</th></tr><tr><td>1</td><td>—</td></tr><tr><td>2</td><td>—</td></tr><tr><td>4</td><td>—</td></tr><tr><td>5</td><td>61 ± 5</td></tr><tr><td>6</td><td>—</td></tr><tr><td>8</td><td>—</td></tr><tr><td>10</td><td>43 ± 3</td></tr><tr><td>20</td><td>27 ± 3</td></tr><tr><td>30</td><td>15 ± 3</td></tr><tr><td>40</td><td>9 ± 3</td></tr><tr><td>75</td><td>3 max.</td></tr></table></td></tr>
<tr><td>Jetting compressed air</td><td>Jet compressed air of 294 to 490 kPa every 15 min for 5 s.</td></tr>
</table>

Established/ 7 Revised:
Jul.2001

Table 34 (Continued)

Items	Conditions
Test device	Dust concentration: 100 mg/m3 min. Test temperature : 20 × 15°C Relative humidity : 45 to 85% 
Time	8 h
Characteristics measurement	When the test has been completed, immediately remove the dust on the meter surface. Check condition of dust entered the meter.

Remark:
Connect a meter connector (meter cable) to the meter to set it at a state equivalent to mounting it in the instrument panel.

6.17 Light Resistance Test

Carry out the test according to the conditions given in Table 35.

Table 35 Light Resistance Test Conditions

Items	Conditions
Temperature	63 ± 3℃
Voltage	Power: off
Test device	Sunshine carbon arc lamp light resistance tester
Time	150 h
Characteristics measurement	Carry out a visual inspection 24 h after the test leaving the meter in normal temperature.

Established/ 7 Revised:
Jul.2001

6.18 Inductive Noise Test

Carry out the test according to the conditions given in Table 36.

Table 36 Inductive Noise Test Conditions

Items		Conditions
Voltage		Supply voltage 11 V or more from a battery (rated value: 12 V) (for 24 V type, 22 V min.).
Indication	Speedometer	60 km/h
	Tachometer	3000 r/min
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating median
	Turbo gage	
	Warning	Warning lamps: completely off, indicators: on
	Illumination	Fully on (minimum illumination mode(5)).
Electric loads operation times		Under the indicating conditions above, operate activating switches SW_1, SW_2, and SW_3, 10 times or more, connected to electric horns, headlamps, and a wiper, then check whether malfunction occurs.
Characteristics measurement		Measure the deflection amount of pointer when electric loads operate.

Note (5):
When including a rheostat.

Remark:
See the following for details of the test conditions.

(1) The test device and test method shall comply with TSC7001G, Section 5.4.
(2) Notes on the test
  (a) Check whether an error occurs with BEAN communications. (Periodic transmission data should be transmitted as intended. Received data should be processed properly.)

Established/ 7 Revised:
Jul.2001

6.19 Electromagnetic Interference Resistance Test

Carry out the test in accordance with TSC7006G and under the conditions specified in Table 37.

Table 37 Electromagnetic Interference Resistance Test Conditions

Item		Condition
Voltage		Supply voltage 11 V or more from a battery (rated value: 12 V) (for 24 V type, 22 V min.)
Indication	Speedometer	60 km/h
	Tachometer	3000 r/min
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating median
	Turbo gage	
	Warning	Warning lamps: fully on or off; indicators: on
	Illumination	Fully on and minimum illumination mode
Characteristics measurement		Check whether a malfunction occurs during test. If a malfunction is detected at a specific frequency, determine the electric field strength that causes the malfunction at that frequency. Inspect also the state of the malfunction. Check whether an error occurs with BEAN communications. (Periodic transmission data should be transmitted as intended. Received data should be processed properly.)

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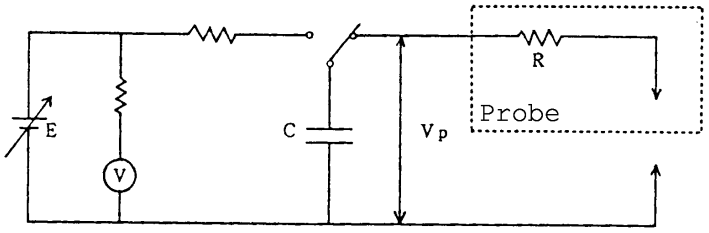
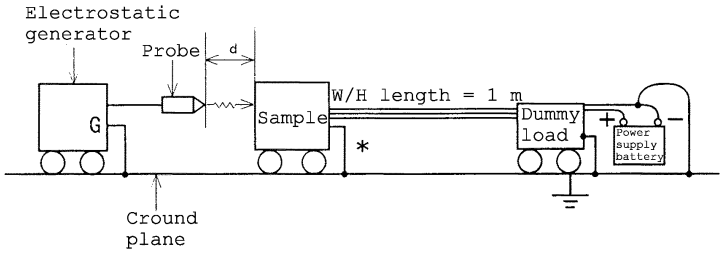
Jul.2001

6.20 Static Electricity Test

Carry out the test according to the conditions given in Tables 38 and 39.

(1) Static electricity test (operation)

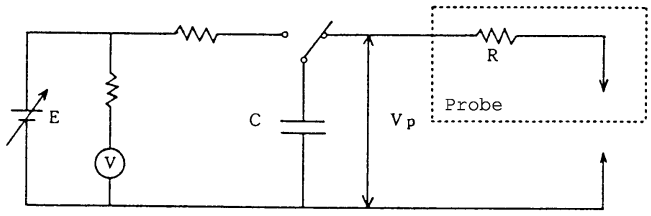
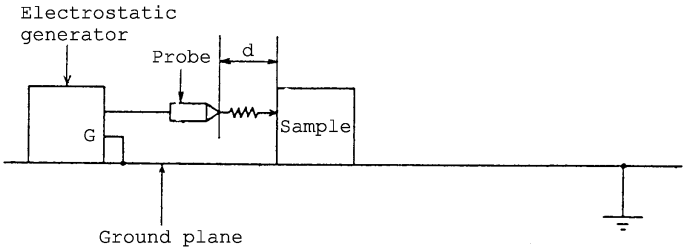
Table 38 Static Electricity Test Conditions (Operation)

Items		Conditions
Voltage		Supply voltage 11 V or more from a battery (rated value: 12 V) (for 24 V type, 22 V min.).
Indication	Speedometer	60 km/h
	Tachometer	3000 r/min
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating median
	Turbo gage	
	Warning	Warning lamps: completely off, indicators: on
	Illumination	Fully on or maximally light-reduced
Equivalent circuit of the electrostatic generator		 Discharged resistance: R = 150 Ω ± 5% Discharging capacitor: C = 150 pF ± 10%
Test device layout		 Remark: Make connection * during assembly on the vehicle if the casing is grounded.
Discharge voltage		±5, ±10, ±15, ±20 and ±25 kV
Discharge gap and interval		Set the gap for 50% flash-over (discharge trigger causes a 1/2 spark) at the rate of 1 discharge/s.
Target location		Casing, selector switches, assembling bolts, W/H (at 100 and 900 mm from sample), and chime
Frequency		20 times at a location (20 spark discharges)
Characteristics measurement		Check for malfunction during application of static electricity. Measure characteristics after test.

Established/ 7 Revised:
Jul.2001

(2)Static electricity test (without power supply)

Table 39 Static Electricity Test (Without Power Supply)

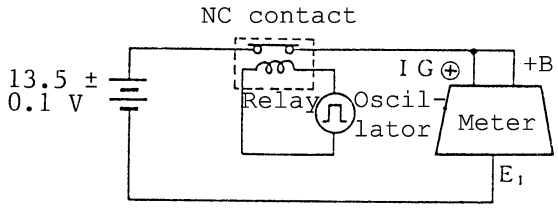
Items		Conditions
Voltage		11 V min. on the battery (rating 12 V) (22 V min. for rating 24 V)
Indication	Speedometer	No power supply (do not connect W/H)
	Tachometer	
	Fuel gage	
	Temperature gage	
	Oil pressure gage	
	Warning	
	Illumination	
Equivalent circuit of the electrostatic generator		 Discharge resistance: R = 150 Ω ± 5% Discharging capacitor: C = 150 pF ± 10%
Test device layout		
Discharge voltage		±5, ±10 and ±15 kV
Discharge gap and interval		Set the gap for 50% flash-over (discharge trigger causes a 1/2 spark) at the rate of 1 discharge/s.
Target location		Casing, selector switches, all connector terminals, and chime
Frequency		20 times at a location (20 spark discharges)
Characteristics measurement		Measure characteristics after test.

Established/ 7 Revised:
Jul.2001

6.21 Momentary Power Interruption

Carry out the test according to the conditions given in Table 40.

Table 40 Test Conditions for Momentary Power Interruption

Items		Conditions
Voltage		13.5 ± 0.1 V
Indication	Speedometer	Sweep the reading '0 ↔ maximum.'
	Tachometer	Sweep the reading '0 ↔ maximum number of revolutions.'
	Fuel gage	Sweep the reading 'E ↔ F.'
	Temperature gage	Sweep the reading 'C ↔ H.'
	Oil pressure gage	Sweep the reading 'L ↔ H.'
	Turbo gage	
	Warning	Warning lamps: completely on and off, indicators: on
	Illumination	Fully on and minimum illumination mode.
Test circuit		
Time of momentary interruption of power		Interrupt momentarily the power supply to IG+ and +B at a rate of 2 s/cycle or more. Interruption shall be for 1, 10 and 100 ms.
Number of times of power interruption		200 times for each
Characteristics measurement		Measure the deflection of pointer during and after the power interruption.

Remark 1:
Chattering of the power interruption relay should be 10 ms max.
Remark 2:
Monitor the number of times of interruption with the operation counter of the relay.

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6.22 Line Voltage Fluctuation Test

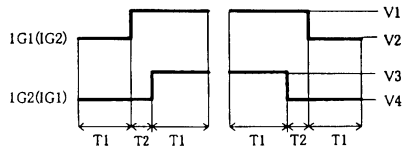
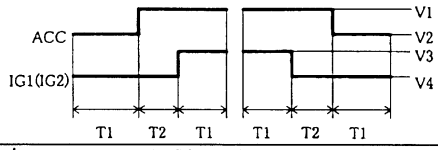
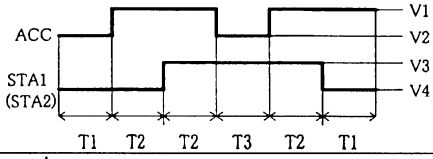
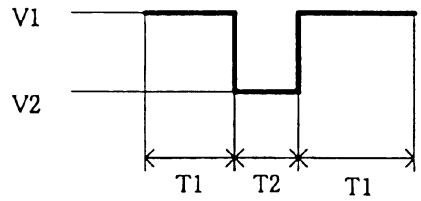
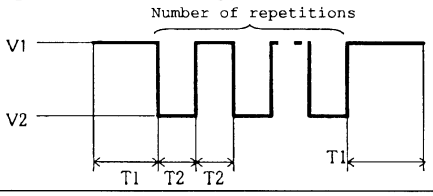
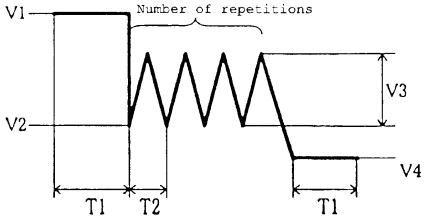
Carry this out under the conditions shown in Tables 41 and 42.

Table 41 Line Voltage Fluctuation Test

Items		Conditions
Indication	Speedometer	0 and 60 km/h
	Tachometer	0 and 3000 r/min
	Fuel gage	At F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	At center
	Turbo gage	
	Warning	Warning lamp: off; indicator: fully on
	Illumination	Fully on or maximally light-reduced
Line voltage fluctuation conditions		As per Table 43
Voltage fluctuation terminal		+B, ACC and IG and +B only (with ACC and IG off)
Characteristics measurement		Check for needle movement during line voltage fluctuation. Check that the warning lamp lights and goes off as specified. After test, measure characteristics. Check whether an error occurs with BEAN communications. (Periodic transmission data should be transmitted as intended. Received data should be processed properly.)

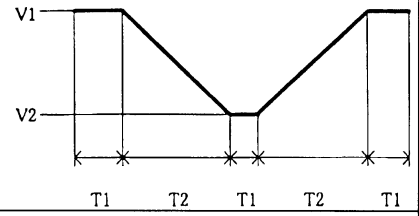
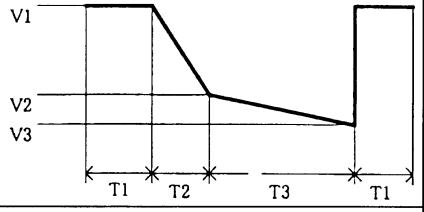
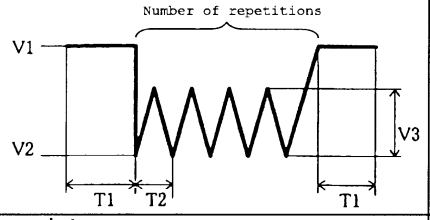
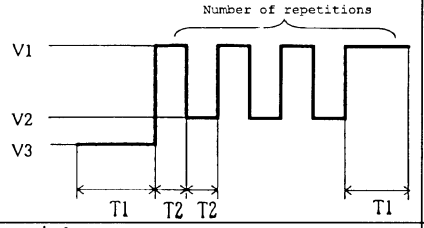
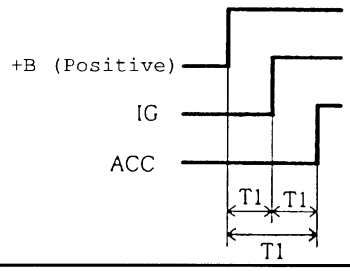
Established/ 7 Revised:
Jul.2001

Table 42 Line Voltage Fluctuation Conditions

No.	Line voltage fluctuation pattern	Condition
①	Line voltage timing errors (IG1, IG2) 	① V1, V3 = 13.5 V ② V2, V4 = 0 V ③ T1 = 5 s ④ T2 = 1, 10, 100 ms, 1, 10 s ⑤ Number of tests: 10
②	Line voltage timing errors (ACC, IG, STA) <IG SW operation Ⅰ> 	① V1, V3 = 13.5 V ② V2, V4 = 0 V ③ T1 =1, 5 s ④ T2 = 1, 10,100 msec ⑤ Number of tests: 10
③	Line voltage timing errors (ACC, IG, STA) <IG SW operation Ⅱ> 	① V1, V3 = 13.5 V ② V2, V4 = 0 V ③ T1 = 5 s ④ T2 = 1, 10, 100, 1000 ms ⑤ T3 = 1, 5 s ⑥ Number of tests: 10
④	Momentary interruption <One-time interruption> 	① V1 = 13.5 V ② V2 = 0, 2, Reset voltage ± 1 V ③ T1 = 5 s ④ T2 = 1, 5, 10, 100 ms ⑤ Number of tests: 10
⑤	Momentary interruption <Repeated interruption (chattering)> 	① V1 = 13.5 V ② V2 = 0, 2, Reset voltage ± 1 V ③ T1 = 5 s ④ T2 = 1, 5, 10, 100 ms ⑤ Number of repetitions: 10 ⑥ Number of tests: 10
⑥	Voltage drop 	① V1 = 13.5 V ② V2 = 2, Reset voltage ± 1 V ③ V3 = 3 V ④ V4 = 0 V ⑤ T1 = 5 s ⑥ T2 = 1, 2 s ⑦ Number of repetitions: 10 ⑧ Number of tests: 10

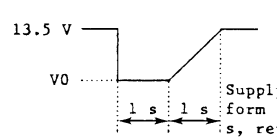
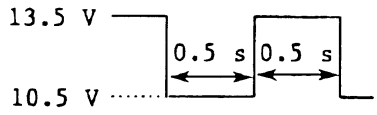
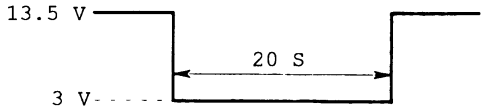
Established/ 7 Revised:
Jul.2001

Table 42 (Continued)

No.	Line voltage fluctuation pattern	Condition
⑦	Discharged battery <Pattern I> 	① V1 = 13.5 V ② V2 = 0, 2 V ③ T1 = 5 s ④ T2 = 60 s ⑤ Number of tests: 10
⑧	Discharged battery <Pattern II> 	① V1 = 13.5 V ② V2 = 4, 6 V ③ V3 = 0, 2 V ④ T1 = 5 s ⑤ T2 = 0,30 s ⑥ T3 = 60 s
⑨	Cranking 	① V1 = 13.5 V ② V2 = 2,Reset voltage ± 1 V ③ V3 = 3 V ④ T1 = 5 s min. ⑤ T2 = 0.1, 0.5, 1.0 s ⑥ Number of repetitions: 10 ⑦ Number of tests: 10
⑩	Removal of battery with IG on and ACC on <chattering> 	① V1 = 13.5 V ② V2 = 0,Reset voltage ± 1 V ③ V3 = 0 V ④ T1 = 5 s ⑤ T2 = 1, 10, 100 ms ⑥ Number of repetitions: 10 ⑦ Number of tests: 10
⑪	Removal of battery with IG on and ACC on <Line voltage start-up sequence> 	① T1 = 0, ±1, ±10, ±100ms ② Number of tests: 10

Established/ 7 Revised:
Jul.2001

Table 42 (Continued)

No.	Line voltage fluctuation pattern	Condition
⑫	Test conditions K, L  Supply line voltage in the waveform shown at left once every 10 s, repeating this 10 times.	
⑬	Test condition P  Fluctuate line voltage in the waveform shown above, for 10 min.	
⑭	Test condition T Fluctuate supply voltage to accord with the waveform shown below, for 10 cycles of testing.  	

Conditions	K	L
V0 (V)	2	4

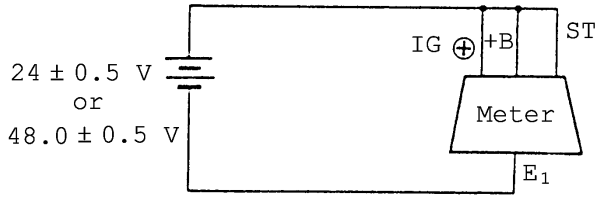
Remark :
The line voltage tolerance shall be ±0.1 V.

Established/ 7 Revised:
Jul.2001

6.23 Overvoltage Test

Carry out the test in accordance with TSC7001G, Section 5.6 and under the conditions specified in Table 43.

Table 43 Overvoltage Test Conditions

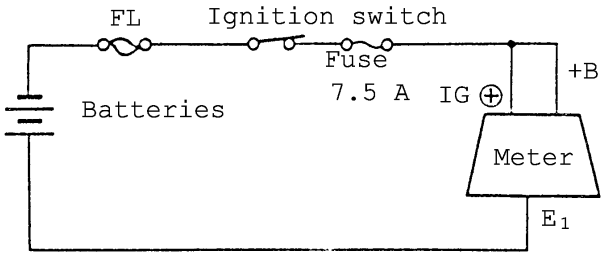
Items		Conditions
Indication	Speedometer	0 km/h
	Tachometer	600 r/min
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating L
	Turbo gage	
	Illumination, warning	Illumination: fully on and off, indicators: on
Test circuit		
Characteristics measurement		Carry out the characteristics measurement immediately after the test.

Established/ 7 Revised: Jul.2001

6.24 Reverse Power Connection Test

Carry out the test in accordance with TSC7001G, Section 5.8 and under the conditions specified in Table 44.

Table 44 Power Source Inverse Connection Test Conditions

Items		Conditions
Indication	Speedometer	0 km/h
	Tachometer	Indicating engine stop (0 r/min)
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating L
	Turbo gage	
	Illumination, warning	Illumination: day mode, warning lamps: off, indicators: on
Test circuit		 Use a fuse installed on the vehicle (this applies when power supply (e.g., ACC) other than +B and IG+ is available as well).
Characteristics measurement		Carry out the characteristics measurement immediately after the test.

Remark:
For products for the Middle East, carry out a confirmatory test in 24 V for reference.

Established/ 7 Revised:
Jul.2001

6.25 Field Decay Test

Carry out the test in accordance with TSC7001G, Section 5.2 and under the conditions specified in Table 45.

Table 45 Field Decay Test Conditions

Items		Conditions
Indication	Speedometer	0 km/h
	Tachometer	Number of idling revolutions
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating L
	Turbo gage	
	Illumination, warning	Illumination: day mode, warning lamps: off, indicators: on
Characteristics measurement		Carry out the characteristics measurement immediately after the test.

Remark:
Apply negative surge of field decay to all terminals that are supplied with power through the ignition switch.

6.26 Load Dump Test

Carry out the test in accordance with TSC7001G, Section 5.5 and under the conditions specified in Table 46.

Table 46 Load Dump Test Conditions

Items		Conditions
Indication	Speedometer	Maximum speed
	Tachometer	Maximum number of revolutions
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating F
	Turbo gage	Indicating H
	Illumination, warning	Illumination: off, warning lamps: off, indicators: on
Characteristics measurement		Carry out the characteristics measurement immediately after the test.

Remark:
Apply the positive surge and ignition noise of load dump to all power source terminals.

Established/ 7 Revised:
Jul.2001

6.27 Ignition Pulse Test

Carry out the test in accordance with TSC7001G, Section 5.7 and under the conditions specified in Table 47.

Table 47 Ignition Pulse Test Conditions

Items		Conditions
Indication	Speedometer	Maximum speed
	Tachometer	Maximum number of revolutions
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating F
	Turbo gage	Indicating H
	Illumination, warning	Illumination: fully on, warning lamps: off, indicators: on
Characteristics measurement		Carry out the characteristics measurement immediately after the test.

Remark:
Apply the ignition pulse to signal terminals such as ST and power supply (IG+) to which ignition pulses can be supplied through the wire harness in the engine compartment.

6.28 Floating Earth Test

Carry out the test in accordance with TSC7001G, Section 5.3 and under the conditions specified in Table 48.

Table 48 Floating Earth Test Conditions

Items		Conditions
Indication	Speedometer	60 km/h
	Tachometer	3000 r/min
	Fuel gage	Indicating F
	Temperature gage	(85 to 105℃)
	Oil pressure gage	Indicating median
	Turbo gage	
	Warning	Warning lamps: completely off, indicators: on
	Illumination	Fully on and minimum illumination mode.
Characteristics measurement		Measure the deflection amount of pointer while electric loads operate.

Remark:
Carry out the test under a condition that the supply voltage is at least 11.0 V (for 24 V type, 22.0 V or more).

Established/ 7 Revised:
Jul.2001

6.29 Radio Noise Test

Carry out the test in accordance with TSC7508G.

Footnote:

(1) FM and TV band conductive noise measuring method

Carry out the measurement at all terminals, however, apply the battery earth of meter (E1) as the standard for probe. When measuring the battery earth terminal, cover the chassis with aluminum foil and measure at the battery earth terminal, taking aluminum foil as standard. In addition, note the following conditions.

(a) Connect the power supply system of meter, ACC, IG, +B and the grounding system E1, E2 with the battery. Here, connecting wire shall be as straight as possible and the meter connector and the battery terminal shall be at the same height. Further, they shall be away from the measuring probe.

(b) Other terminals than those of power supply system and grounding system above shall be open.

(c) In measuring FM and TV band noise level, the length of the end portion of the measuring probe must be 50 mm in principle. Only for terminals to which the probe cannot reach because of the connector location, ⊕ side may be elongated.

(2) AM, SW and LW band conductive noise measuring method

Indications of each meter during the test shall meet Table 49. Wiring harness connecting the test sample to the load and battery shall be as straight as possible.

Table 49 Meter Indication Conditions

Items	Conditions
Speedometer	Maximum speed
Tachometer	Maximum number of revolutions
Fuel gage	FULL
Temperature gage	HIGH
Oil pressure gage	
Turbo gage	
Warning	All off, indicators: on
Illumination	No light reduction mode and fixed light reduction mode

(3) AM, SW and LW band radiant noise measuring method

Connect all the power supply system (IG, ACC and +B) and grounding system to the battery. Measure for both of ① no light reduction and ② fixed light reduction modes of illumination. For fixed light reduction mode, connect the load required.

(4) AM, SW and LW band conductive noise measuring method (active rod antenna test)

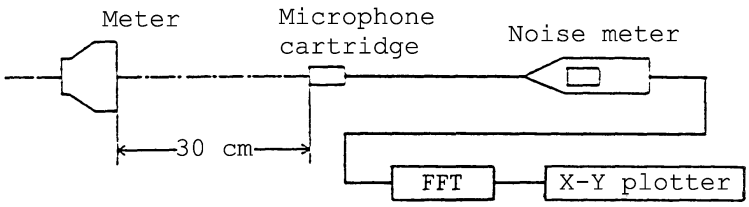
For AM and LW bands, also measure conductive noise using an active rod antenna. Measure for both of ① no light reduction and ② fixed light reduction modes of illumination. For fixed light reduction mode, connect the load required.

Established/ 7 Revised:
Jul.2001

6.30 Noise Test

Measure noise generated by the meter, according to the conditions given in Table 50.

Table 50 Noise Test Conditions

Items	Conditions
Instrument installation	
Voltage	13.5 ± 0.1 V (for 24 V type, 27.0 ± 0.1 V)
Warming-up time	5 min
Meter installation	Hold the sample in the posture as it is mounted on actual vehicle.
Speedometer	15 km/h, 30 km/h and 0 to the maximum speed
Tachometer	The maximum number of revolutions
Fuel gage	Indicating F
Temperature gage	85 to 105℃
Illumination	Day and night mode
Ground noise at measurement	NC 20 max.
Data analysis	1/3 octave analysis from 1 to 10 kHz
Measurement time	30 s

Remark:
Frequency correction characteristic of the noise meter shall be A-characteristic.

Established/ 7 Revised:
Jul.2001

6.31 Vibration Test

Check resonance frequencies of the meter case and electronic components. Also, carry out the vibration resistance test.

(1) Checking resonant frequencies

Install the meter as it is installed on vehicle, and excite it according to the conditions given in Table 51. Measure acceleration of each part of the meter and determine the resonance frequencies fc.

Table 51 Checking Resonance Frequencies

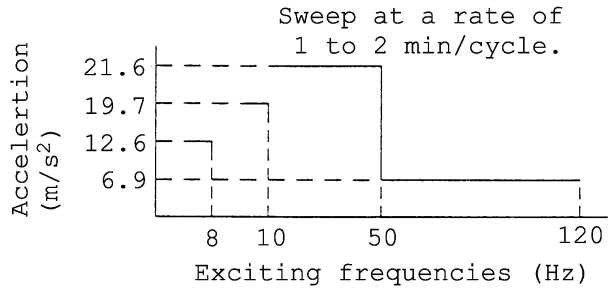
Exciting frequencies (Hz)	Acceleration (m/s^2)	Excitement
8 to 50	9.8	up/down, left/right, back/forth
50 to 120	4.9	

Remark:
Also check whether the internal components (e.g. coil, bimetal) have any resonance frequency.

(2) Vibration resistance test

Carry out tests according to the conditions given in Table 52, depending on whether the meter has resonance frequency or not. Carry out the characteristic measurement immediately after the test.

Table 52 Vibration Resistance Test Conditions

Resonance frequencies fc	Exciting frequencies	Acceleration (m/s^2)	Excitation times
8 to 10 Hz	fc ± 3 Hz, 1 to 2 min/cycle	10 mm P-P(11)	2×10^6 for each up/down, left/right, back/forth
10 to 50 Hz		21.6	
50 to 120 Hz		6.9	
Not applicable			10′ for each up/down, left/right, back/forth

Note (11):
At 10 Hz, 19.7 m/s^2; 8 Hz, 12.6 m/s^2

Established/ 7 Revised:
Jul.2001

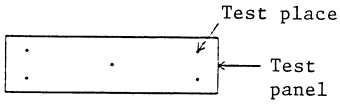
6.32 Drop Test

Drop a packed meter 3 times naturally from 1 m high to the concrete floor. Carry out the characteristics measurement immediately after the test.

6.33 Scratch/Peeling Test

Carry out the test according to the conditions given in Table 53.

Table 53 Scratch/Peeling Test

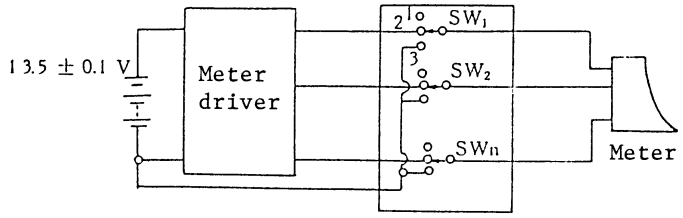
Items	Conditions	Test subject
Pencil scratch test	Fix the test panel on a horizontal stand. Hold a pencil so that it forms an angle of approx. 45 degrees with the panel. Then, scratch the panel surface with the pencil, by sliding the pencil approx. 1 cm in forward direction at a uniform speed (approx. 1 cm/s). In so doing, press the pencil against the surface as strongly as possible, while avoiding breakage of the pencil. After each scratch, sharpen the tip of the pencil, and repeat the test. For the test, use assorted pencils of different colors for depth symbols (1 pencil for each symbol). Scratch 5 different places with each pencil, and check for flaws. A testing device may be used for the test. 	(1) Meter surface glass (2) Print, plating and deposited film
Cross cut test	Cut 11 lines crosswise at 1 mm intervals at the center of the test panel. Use a new knife blade for cutting each line. Ensure that the blade forms a fixed angle (between 35 and 45 degrees) with the paint surface. Make cuts by sliding the knife at a uniform speed (approx. 0.5 s for each cut), with the blade penetrating the paint film and reaching the panel foundation. Attach an approx. 50 mm-long portion of cellophane tape to the area with cuts; make sure that the tape adheres firmly to the area by rubbing over the tape with an eraser. One to 2 minutes after attaching the tape, hold an end of the tape in such a way that the end makes a right angle with the paint surface, and pull off the tape instantaneously. After pulling off the tape, check for peeling of the paint film.	Print, plating and deposited film

Established/ 7 Revised:
Jul.2001

6.34 W/H Open-/Short-Circuit Test

Carry out the test according to the conditions given in Table 54.

Table 54 W/H Open-/Short-Circuit Test Conditions

Items		Conditions
Test device		 Open-/short-circuit switch box Remark: Normally, set the switch to position 2. (1: Open, 3: Short-circuit)
Indication	Speedometer	Sweep the reading '0 ↔ maximum speed.
	Tachometer	Sweep the reading '0 ↔ maximum number of revolutions.'
	Fuel gage	Sweep the reading 'F ↔ E.'
	Temperature gage	Sweep the reading 'C ↔ H.'
	Oil pressure gage	Sweep the reading 'L ↔ H.'
	Turbo gage	
	Warning, indicator	On
	Illumination	
Other conditions		Check whether a malfunction occurs when open-/short-circuiting each switch.
Characteristics measurement		Carry out the characteristics measurement immediately after the test.

Remark:
If a condition, for example short-circuiting meter, obviously breaks the meter fuse, such condition is allowed to be exempted. In that case, state it clearly.

Established/ 7 Revised:
Jul.2001

6.35 Solvent Resistance Test

Carry out the test according to the conditions shown in Table 55.

Table 55 Solvent Resistance Test Conditions

Items	Conditions
Test procedures	1. Apply a solvent to the cover glass (with a piece of gauze or a brush). 2. Leave it for 30 min at room temperature. 3. Rinse it with water for 3 min. 4. Leave it for 3 h at 60℃.
Solvent	Leather wax
	Car shampoo
	Glass cleaner
	Windshield washer liquid
	Chemical moist hand towel liquid
Characteristics measurement	During and after the test, also after cooling the meter naturally in normal temperature, check whether the cover glass has been deformed, discolored, or clouded.

Remark:
The test may be carried out with the cover glass alone. When applying the solvent, care should be taken not to damage the cover glass.

Established/ 7 Revised:
Jul.2001

6.36 Migration Test

(1) Characteristics test
Measure items specified in Section 6.1, "Initial Characteristics Test."

(2) Examining residual flux (excluding unwashed parts)
Observe under the microscope (× 30 to 100) residual flux on substrate and element surfaces and under elements. Where necessary, analyze (e.g., EPMA and FT-IR) residues for chemical composition. For examination under elements, mechanically detach the elements from substrates. Examine all elements involved.

(3) High temperature, high humidity conductivity test
Conform to Table 56.

Table 56 High Temperature, High Humidity Conductivity Test

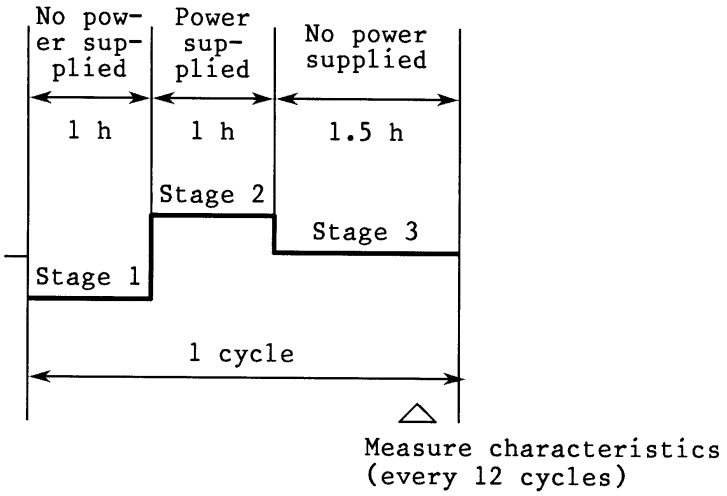
Items	Conditions
Temperature and humidity	85 ± 3℃, 85 ± 5% RH.
Line voltage	16 ± 0.1 V (12-V specifications) or 32 ± 0.2 V (24-V specifications)
Testing time	1000 h
Characteristics checks	During test, carry out the characteristics test provided in Section 4.1 every 250 h. Take measurements with samples placed in the oven (in the atmosphere of 85℃ and 85% RH). Then, removing samples therefrom, check substrate and element surfaces for discoloration and migration. (This may be omitted if it is impossible to examine the interior during test because of the structure of the samples.) After test, check the area under elements for migration. To do this, mechanically detach elements from substrates. Examine all elements involved.
Others	Set test conditions as follows. (1) Power supply: +B, ACC (when setting is specified), IG and GND (2) Sensors: connect dummy load in normal condition. (Set sensors so that applied voltage is maximum.) (3) Speedometer and tachometer: shall be inoperable. (4) Fuel and temperature gages: shall indicate a given value. (5) Illumination: daylight-equivalent (6) Tell tale: shall be off (including A/T indicator), (7) Exterior: detach front plate and front acrylic panel so that heat is not contained in the meter. (Connect connectors in normal condition.)

(4) Thermal shock test
Carry this out in the method specified in Section 6.12. Repeat 1000 cycles. However, start the test from high temperature.

(5) Dew condensation cycle test
Conform to Table 57.

Established/ 7 Revised:
Jul.2001

Table 57 Dew Condensation Cycle Test Conditions

Items	Conditions
Sample condition	Front plate and front acrylic panel detached (The test may be carried out with these in place.)
High humidity oven	Shall have a sufficient volume to accommodate samples. Install screens around samples so that air currents do not blow directly on them.
Test pattern	 Remark 1: Transfer from stage 1 to 2 within 5 min. There is no specification for time from stage 2 to 3. Remark 2: Stage 3 may be omitted depending on the dryness inside, or testing time be changed.
Temperature and humidity	Stage 1: -30 ± 3℃ Stage 2: 25 ± 3℃ and 90% RH Stage 3: 25 ± 3℃ and 50% RH or less (Stage 3 may be carried out at normal temperature and humidity.)
No. of cycles	48
Line voltage	16 ± 0.1 V (12-V specifications) or 32 ± 0.2 V (24-V specifications)
Test sequence	Carry out this test on the samples which were used for the thermal shock test.
Characteristics measurement	Carry out the characteristics test every 12 cycles during test (measure at 25℃ and 90% RH). Then, removing samples from the oven, check substrate and element surfaces for discoloration and migration. (This may be omitted if it is impossible to examine the interior during test because of the structure of the samples.) After test, check the area under elements for migration. To do this, mechanically detach elements from substrates. Examine all elements involved.

Established/ 7 Revised:
Jul.2001

Table 57 (Continued)

Items	Conditions
Others	Set that conditions as follows: (1) Power supply: +B, ACC (when setting is specified), IG and GND (2) Sensors: connect dummy load in normal condition. (Set sensors so that applied voltage is maximum.) (3)Speedometer and tachometer: shall be inoperable. (4) Fuel and temperature gages: shall indicate a given value. (5) Illumination: daylight-equivalent (6) Tell tale: shall be off (including A/T indicator). (7) Exterior: detach front plate and front acrylic panel so that heat is not contained in the meter. (Connect connectors in normal condition.) When the test has to be interrupted, do so after the completion of one cycle. During interruption, keep the samples at low or normal temperature under normal humidity without supplying power.

6.37 Body Electronics Area Network (BEAN) Test

Carry out the test in accordance with TSC7308G.

6.38 Narrow-Band Emission Noise Test

Carry out the test in accordance with TSC7026G.

6.39 Electromagnetic Radiation Test

Carry out the test in accordance with TSC7025G.

Established/ 7 Revised:
Jul.2001

Applicable Standards

TSC7001G	Bench Test Method for Electric Noise of Automotive Electronic Devices
TSC7006G	Bench Test Methods for Electromagnetic Interference Susceptibility of Automobile Electronic Equipment
TSC7025G	Electromagnetic Radiation Test Method for Components Subject to EC Regulation for Electromagnetic Compatibility
TSC7026G	Bench Measurement Method for Narrow-Band Emission Noise on EC Regulation (Commission Directive, 95/54/EC) for Automotive Electronic
TSC7308G	Test Methods for Each ECU Part of Body Multiplex Communication System
TSC7508G	Electric Parts Test Method for Radio Noise Interference

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Jul.2001