Test code for hydrodynamic torque converters

1. Scope

This standard specifies the test methods for the performance of the hydrodynamic torque converter (hereinafter referred to as the “torque converter”) used for automobiles.

The standard can be also applied to fluid couplings for automobiles.

Note: The units and numerals used in this standard are based on the SI units. The units and numerals in brackets { } are based on the conventional units and included as reference.

2. Objective of establishment

The standard aims at facilitating the convenience of users by standardizing the test methods for the performance of torque converters.

3. Types of test

This standard includes the basic performance tests aiming at examining the torque converter performance itself, and the practical performance tests aiming at examining the torque converter performance in practical use.

4. Test items

4.1 Basic performance tests

The following basic performance tests shall be performed. Some of the tests, however, may be omitted through discussions between the parties concerned.

a) General performance test

b) Stall performance test

c) Reverse drive performance test

4.2 Practical performance tests

The following practical performance tests shall be performed. The tests to be performed, however, shall be determined through discussions between the parties concerned in accordance with the purpose.

a) Engine full throttle torque performance test

b) Road load performance test

c) Coasting performance test

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5. Test conditions

The test conditions common to all test items are shown below. When the test is performed under detailed conditions not specified in this standard and conditions different from the specifications, the conditions shall be determined through discussions between the parties concerned.

a) As a general rule, the test shall be performed on a torque converter itself. When the test has to be performed on a torque converter attached to a transmission, required corrections shall be made.

b) Hydraulic fluid in practical use (hereinafter referred to as “hydraulic oil”) shall be used in the test.

c) Before the test, an installation jig and measuring equipment shall be calibrated.

d) The measurement shall be performed after confirming that an operating state is stable enough. However, if the temperature of hydraulic oil (hereinafter referred to as the “oil temperature”) is significantly increasing in the range of stalling or low speed ratio, the measurement shall be performed immediately after confirming that the oil temperature is within the range of predetermined temperatures.

e) The oil temperature shall be (100±10) °C at an outlet of the torque converter except for the stall test in which the maximum temperature shall be 130 °C.

f) The pressure of the hydraulic oil (hereinafter referred to as the “oil pressure”) shall be maintained in order to prevent cavitations and the like from generating in the torque converter.

6. Test equipment

The test equipment shall be able to measure the torque converter performance in the practical operation range and satisfy the accuracies specified in **7.2**, and shall be as follows.

a) Drive and absorption equipment

Equipment shall be a dynamometer, or a combination of devices capable of driving and absorbing as well as capable of measuring and controlling torque and rotation speed.

b) Installation jig

An installation jig shall be able to install a test torque converter in the same state as the practical use and to circulate hydraulic oil between a hydraulic oil supply unit and the inside of the torque converter.

c) Hydraulic oil supply unit

A supply unit shall be capable of controlling hydraulic oil to meet the test conditions and preferably be equipped with a flow meter.

d) Tachometer

A tachometer shall measure the rotation speed of input and output shafts and preferably be of a digital type.

e) Remark

An input shaft shall be always connected to a pump and an output shaft to turbine of the torque converter.

f) Thermometer and oil pressure gauge

A thermometer and oil pressure gauge shall be capable of measuring oil temperature and oil pressure at an inlet and outlet of the torque converter.

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7. Test items and accuracies

7.1 Measurement items

The following items shall be measured at each test point.

a) Input shaft torque

b) Output shaft torque

c) Input shaft rotation speed

d) Output shaft rotation speed

e) Oil temperature at a torque converter inlet

f) Oil temperature at a torque converter outlet

g) Oil pressure at a torque converter inlet

h) Oil pressure at a torque converter outlet

Note: It is preferable to measure torque and rotation speed simultaneously.

7.2 Test accuracy

The test accuracy shall be as follows unless otherwise specified.

a) Input shaft torque shall be within 1 % of the maximum input shaft torque.

b) Output shaft torque shall be within 1.5 % of the maximum input shaft torque.

c) A rotation speed shall be within 0.5 % of the maximum input shaft rotation speed.

8. Test methods

8.1 Basic performance tests

8.1.1 General performance test

Perform the test as specified below.

a) While stopping the output shaft or maintaining the state in which the shaft is almost stopped, adjust the input shaft torque to a predetermined torque. Continuously, while maintaining the input shaft torque constant, gradually increase the rotation speed of the output shaft and perform the measurements at each test point.

b) The intervals of test points shall be equal based on the output shaft rotation speed unless otherwise specified. The test point intervals may be appropriately changed, for example, by shortening the interval in the range of the low speed ratio, near the maximum efficiency point and the clutch point or by extending the interval in the coupling range. It is preferable, however, to determine the interval so that it does not exceed 0.1 of the speed ratio and the minimum speed ratio is 0.2 or less.

c) It is preferable to perform the test using several values of the input shaft torque (for example, 100 %, 50 %, 25 % and the like of the engine maximum torque) taking the output torque range of an engine used in combination with the torque converter in practical use (hereinafter referred to as the “engine”) into consideration.

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d) To compare the performance with other types of torque converters, the input shaft torque shown in **Table 1** shall be used according to values of the design maximum input shaft torque of the torque converter or the engine maximum torque.

Note: When there are combinations with several types of engines, the engine having the largest output torque shall be the reference.

Table 1 Input shaft torque

Unit: N•m {kgf•m}

Design maximum input shaft torque or engine maximum torque	Input shaft torque
Less than 50 {5}	25 {2.5}
50 {5} min. and less than 100 {10}	50 {5.0}
100 {10} min. and less than 200 {20}	100 {10.0}
200 {20} min. and less than 400 {40}	200 {20.0}
400 {40} min. and less than 800 {80}	400 {40.0}
800 {80} min.	800 {80.0}

8.1.2 Stall performance test

Perform the test as specified below.

a) With the output shaft fixed, gradually increase the rotation speed of the input shaft and perform the measurements at each test point.

b) Normally, the intervals of test points shall be equal based on the input shaft rotation speed.

8.1.3 Reverse drive performance test

Perform the test as specified below.

a) While stopping the input shaft or maintaining the state in which the shaft is almost stopped, drive the output shaft to adjust the output shaft torque to a predetermined torque. Continuously, while maintaining the output shaft torque constant, gradually increase the rotation speed of the input shaft and perform the measurements at each test point.

b) Although the intervals of test points shall be normally equal based on the input shaft rotation speed, the intervals may be appropriately changed, for example, by extending the interval in the high speed range. It is preferable, however, to determine the interval so that it does not exceed 0.1 of the speed ratio (see **9.2**) and the minimum speed ratio is 0.2 or less.

c) It is preferable to perform the test using several values of the output shaft torque taking the motoring torque range obtained when the engine throttle is fully closed into consideration.

8.2 Practical performance tests

8.2.1 Engine full throttle torque performance test

Perform the test as specified below.

a) Adjust the relationship between the rotation speed and torque of the input shaft to the relationship between the rotation speed and torque obtained when the engine throttle is fully open. While stopping the output shaft or maintaining the state in which the shaft is almost stopped, gradually increase the rotation and perform the measurements at each test points.

b) Normally, the intervals of test points shall be equal based on the output shaft rotation speed.

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8.2.2 Road load performance test

Perform the test as specified below.

a) Adjust the relationship between the rotation speed and torque of the output shaft to the relationship between the vehicle speed and running resistance when a vehicle runs at a constant speed. While stopping the output shaft or maintaining the state in which the shaft is almost stopped, gradually increase the rotation speed and perform the measurements at each test points.

b) Perform the test assuming that a vehicle runs on a flat surface road with the transmission gear set in the highest speed.

Additionally, perform the test assuming travelling uphill and downhill and that the gear is in different positions as needed.

8.2.3 Coasting performance test

Perform the test as specified below.

a) Adjust the relationship between the rotation speed and torque of the input shaft to the relationship between the rotation speed and motoring torque obtained when the engine throttle is fully closed and drive the output shaft. While gradually increasing the rotation speed of the output shaft from a low speed, perform the measurements at each test points.

b) Normally, the intervals of test points shall be equal based on the output shaft rotation speed.

9. Calculation of test results

9.1 Symbols and units for measured values

The measured value symbols and units used for calculating the measurement results shall be as follows.

a) Input shaft torque = T_i (N•m) {kgf•m}

b) Output shaft torque = T_o (N•m) {kgf•m}

c) Input shaft rotation speed = n_i (rpm)

d) Output shaft rotation speed = n_o (rpm)

9.2 Equations, symbols and units

The equations, symbols and units used for calculating measured values shall be in accordance with **Table 2**.

Table 2 Equations, symbols and units

	Symbols and equations		Unit
	Forward drive	Reverse drive	
Speed ratio	$e = \frac{n_o}{n_i}$	$\bar{e} = \frac{n_i}{n_o}$	
Torque ratio	$t = \frac{T_o}{T_i}$	$\bar{t} = \frac{T_i}{T_o}$	
Efficiency	$\eta = e \cdot t$	$\eta = \bar{e} \cdot \bar{t}$	
Capacity coefficient	$C = \frac{T_i}{{n_i}^2}$	$\bar{C} = \frac{T_o}{{T_o}^2}$	N•m/rpm^2 {kgf•m/rpm^2}

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Annex A
(Normative)
Representation with performance curve graph

Introduction

This annex specifies the representations of test results with the performance curve graph.

A.1 Figure A.1 shows an example of the representation for the general performance test results (based on the output shaft rotation speed).

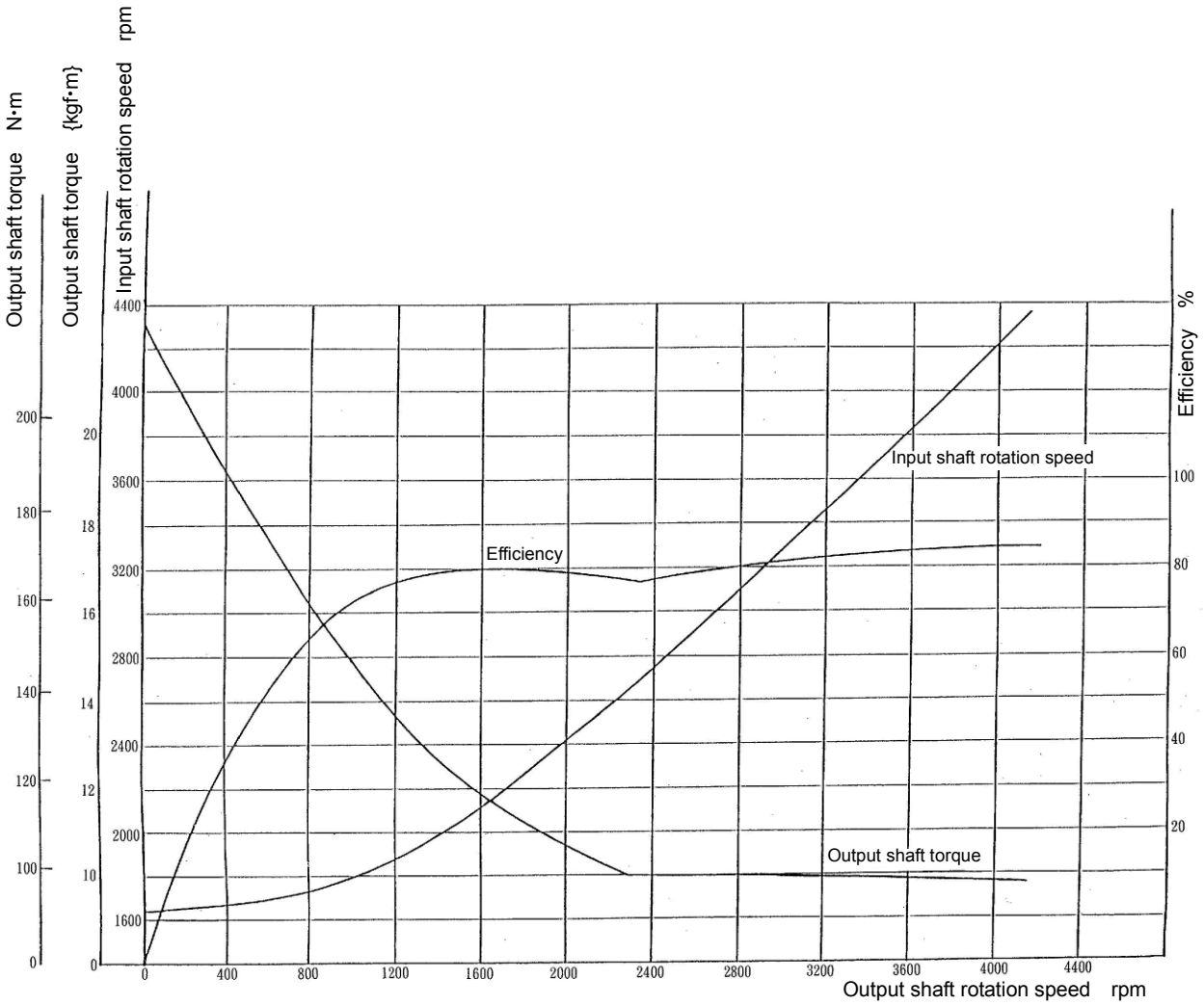

Figure A.1 Example of representation for general performance test results (based on output shaft rotation speed)

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