규 격 서

COMMODITY DESCRIPTION

세부품명번호	품목 및 규격	단 위	수 량
Item No.	Description	Unit	Quantity
피로시험기 (Fatigue tester) 41114608	파워트레인용 기어내구시험기 Gear durability test rig for Powertrain	대	1

 $\hfill\square$ Principles and characteristics

- o Equipment to test a gear set (a part of gear box) of vehicle powertrain
- Torque generated by an electric motor is transmitted to the gear set to simulate real vehicle powertrain conditions.
- Oil supply control system to simulate a real vehicle oil temperature and flow rate.
- Function for automatic stop by the detection of acceleration
- o Function for automatic data recording including acceleration etc.

Essential requirements

- o Power Circulation Type Gear Tester Main Body
- Rotating Speed : 0 or ±60 to ±12,000 rpm
- Measuring Accuracy : ±1 rpm
- Control Accuracy : ±5 rpm
- Torque (Input, Out put) 0 to ±600Nm
- Measuring Accuracy : ±0.5Nm
- Control Accuracy : ±3Nm
- Drive Motor (Input site)
 Vector Invertor Motor 75kW
- Torque Loader
- Servo Motor (11kW) with Gear Box
- Lubricating Oil Unit for Sample Gear
- Oil : ATF Oil
- Oil Temp. Range : RT~180°C ±2.5°C
- Oil Flow rate : 0~8L/min ±0.1L/min
- Oil Pressure : 0~0.2MPa ±0.005MPa

Detail requirements

1. Constitution

- 1.1 Main system
- 1.1.1 Dimensions for a test sample
- Test sample : gears for vehicle powertrain
- Dimensions : Max :q190 mm, Max Length : 110 mm
- $\ensuremath{\mathbb{X}}$ The size of test samples is variable. Therefore the fixture for input and output and
 - the test gear sets should be available to switch.

1.1.2 rotational speed

0 (stop) or ±60 ~±7,000 rpm(loading)

~ ±12,000 rpm(unloading)

- Measurement accuracy : ±1rpm Control accuracy : ±5rpm
- 1.1.3 Loading torque

0(stop) or~ \pm 600Nm

- Measurement accuracy : ±0.5Nm Control accuracy : ±3Nm
- * Both automatic and manual control and operation must be available.
- 1.1.4 Lubrication for a test

Lubrication Type: ATF

- Controlled flow rate : $0 \sim 8 \pm 0.1$ {/min(for a sample,1 Port) × 2 Port Controlled temperature: RT~180 ± 2.5 °C (inside of oil supply reservoir)
- Controlled pressure: $0 \sim 0.2 \pm 0.005$ MPa (measure at oil supply exit)
- * Both automatic and manual control and operation must be available.
- 1.2 Requirements for control and measurement
- 1.2.1 Configuration for test conditions
- ① rotational speed setting
- rotational speed rpm ·시간 sec
- Loading torque setting
- Torque Nm ·시간 sec
- ③ lubrication condition setting
 - flow rate /min · temperature ℃ · pressure MPa

% Digital level setting on control panel

1.2.2 Test operation setting

- ① Continuous operation(constant rotation speed, Torque, lubrication condition)
- ② Step Cycle operation(feasible for multi-step, multi-cycle operation of rotation speed, torque)

Number of Step : Max 99, Number of Cycle : Max 99,999

1.2.3 Monitoring of operation

- 1 Rotational speed setting ±00rpm
- ② Loading torque setting ±00Nm
- 3 Lubrication flow rate setting ± 00 /min
- \circledast Lubrication temperature setting $\pm 00^{\circ}\!C$
- $\$ Lubrication pressure setting $\pm 00 MPa$
- 6 Vibration(Sample Gear BOX) setting ±00 mm/sec2
- ※ Recording of data and emergency stopping, visible warning lamp etc. Output recording by touch panel and feasible export to CSV data format.
- 2. Configuration
- 2.1 Configuration of hardwar
- 2.1.1 Driving motor

Type : vector inverter motor

Rated output power : 75kW $\,$ rotational speed : 0~3,000rpm $\,$

- 2.1.2 gearbox ×2
- Suitable for Space Creation, Speed increasement: four times
- 2.1.3 Torque Loader
- Type : Servo Motor (rated output 11 kW) + Planetary Gear reducer
- $\ensuremath{\mathbb{X}}$ Automatic gain control for Torque
- 2.1.4 Lubrication temperature control supply (AC200V(3 ϕ) 12 kVA)
- 2.1.5 Torque Meter
- Type : Strain Gage Type Torque Meter

Model : HBM T10FS or similar

Capacity : app. 1,000 Nm : ±0.05%FS rated speed : 12,000rpm

% Torque calibration device included



<Fig 1. Concept for Lubrication Unit for Gear Box>

2.1.6 Lubrication Unit for Gear Box

Lubrication type : Oil mist(air) lubrication

Model : Oil Mist Unit(TACO MCD-01 L-3 H36) or similar

2.1.7 Safety Cover

Safety cover to protect from scattering of rotating test sample and other material

2.1.8 Box for electric signal conditions Type: : BNC for sensor measurement ·for pressure measurement : 2ch for temperature measurement : 4ch for vibration(pressure pickup) : 2ch for external voltage input(auxiliary) : 4ch % Protection covers are need when not used.

2.1.9 Control unit

Type : independent control unit(anchor for bench) Configuration : PLC- Inverter ·Servo Amp. ·Sensor Amp. · Temp control etc. 2.1.10 Operation unit Type : 19 inch Rack (independent movable caster+anchor for locking) Interior unit : ·CPU ·Monitor ·Operation Control Panel(Rotational Speed, Torque Controller, Temp. Controller · Current(Amp) Source, Switch for manual/automatic Emergency Stop Button Display Panel : Operation status monitoring, A preparatory stag, On-going status, alarm, auxiliary equipment monitoring etc. Program for operation control function : Program set-up for operation condition operation control button etc. Auxiliary equipment control function : Temp. control(manual control for flow rate, pressure) External output panerl : BNC output Data recording panel : BNC input Emergency stop panel : Emergency Stop button & Status Display, Buzzar, Reset Button. etc. 2.2 Software for control unit 2.2.1 Outline of Operation Software ① Type Level input type : keyboard ② set-up

% Target speed : 0rpm~Max 12,000rpm(Unloading condition),

0rpm~7,000rpm(loading condition) resolution: 1 rpm

% Target Torque : Every 1 Nm, Upto Max600 Nm target level set-up available

- $\ensuremath{\mathbb{X}}$ RPM Slope : $\pm\,\varDelta1{\sim}\,\pm\,\varDelta100$ rpm/sec
- % Torque Slope : $\pm\,\varDelta1{\sim}\,\pm\,\varDelta10$ Nm/sec

 $\,$ % Upper/Lower Limit set(Every Step Set-up linked with PC)

- Upper/Lower Limit ON/OFF, Operation Pattern Image
- Number of Pattern : 20 (save feasible)
- Number of Step : 30(max)
- $\cdot\,$ When the program is malfunctioned, manual operation should be available
- · While program operation, HOLD, Temporary STOP should be available.
- \cdot Recovering from HOLD or Temparary STOP should be available.
- · Feasible to keep holding current STEP when HOLD required
- · Feasible to keep stopping current STEP when STOP required



<Fig 2. Example of Program Operation>

③ Emergency Stop

- \cdot When it is over the given driving torque upper/lower limit
- \cdot When it is over the given rotational speed upper/lower limit
- \cdot When it is over the given pressure upper/lower limit
- · When it is over the given temperature upper/lower limit

- \cdot When it is over the given vibration upper/lower limit of Sample Gear BOX
- \cdot When Emergency Stop button is released
- * Combination of above condition can be available
- * Separable Emergency Stop command (ie. only for motor stop, only for alarm etc)
- * Emergency Stop should not affect to torque loadcell.
- When Emergency Stopped, it is necessary to input manual operation command to be recovered.

2.2.2 Detail of display for measurement output

- ※ Measurement Parameter
- \cdot Sampling Period : 1 ms ~ over 5 sec
- \cdot Data recording duration : 30 min(@ 1 ms sampling $\label{eq:lambda}$)~500 Hrs
- · Data output format: : CSV
- 2.2.3 Manual operation
- ③ Target speed : every 1 rpm, Max12,000 rpm(Unloadint), 7,000 rpm(Loading) by user's input set-up
- ② Target Torque : every 1 Nm, Max600 Nm by user's set-up
- 3 Lubrication flow rate : 0~8 /min
- ④ Lubrication temp. : RT~180 ℃
- (5) Lubrication pressure : 0~0.2 MPa
- 6 Emergency Stop : Emergency Stop Button released.

속정 정목		표시		외부 단자		
	측정 레인지	Screen	조작반	출력 (0-10V)	측정 정도	비고
구동 회전수 1	0 ~ 12,000 rpm	٠	•	0	±1 rpm	
구동 회전수 2	0 ~ 12,000 rpm	٠	•	ō	±1 rpm	
구동축토르크 1	0 ~ 1,0000 Nm	•	•	o	0.05 %FS	
구동축토르크 2	0 ~ 1,0000 Nm	•	•	0	0.05 %FS	
응할유 공급유량 1	0 ~ 20 /min	٠	•	0	±0.1 /min	반복 정도
윤활유 공급유량 2	0 ~ 20 /min	•		o.	±0.1 /min	반복 정도
응활유 공급 유운	0 ~ 200 °C	•	•	0	±0.1 ℃	반복 정도
요할유 공급 유압	0 ~ 1 MPa	÷	•	0	0.1 %FS	
실내 온토(건구)	0 ~ 50 °C			o		
실내 온도(승구)	0 ~ 50 °C	•	•	0		
대기안	560 ~ 1170 hPa	٠	•	0		
토르크 이터 주변 온도	0 ~ 200 °c			o	±0.1 ℃	반복 정도
공시체 기어 BOX 진동 1	0 ~ 10 G	•		0		
공시체 기어 BOX 전동 2	0 ~ 10 G	•	0	o		
에비 안객 1	0 ~ 1 MPa	•	:03	0	0.1 %FS	
에비 안객 2	0 ~ 1 MPa	•	0	0	0.1 %FS	
에비 운도 1	0 ~ 200 °C	•	0	o	±0.1 ℃	반복 정도
에비 온도 2	0 ~ 200 °C	•	•	0	±0.1 ℃	반복 정도
외부 입력 1	±10V	•	0	o		
외부 입력 2	±10V	•	: e::	o		
외부 입력 3	±10V	•	0	0		
외부 입력 4	±10V	•	0	0		

- 2.3 AE(Acoustic Emission) Sensor(Optional)
- ① AE Sensor : freq. range 250 kHz~1 MHz, operation Temp Range-20~200°C
- ② AE Pre-Amp : freq. range 2 kHz~1.2 MHz, gain switchable
- ③ Discriminator: freq. range 1 kHz~2 MHz, Analog output RF/ENV/AVE
- 3 Analysis : internal S/W, graph, FFT analysis
- 2. Possible to upgrade, compatability with other equipment(including S/W)
 - Equipment configuration is shown in Fig 3.
- It should be easy to upgrade.
- Equipment consists of independent modules

- It should be available to test general gears other than vehicle powertrain gear set.

- Test Gear Box is designed to exchange test gear sets.

- Schematic diagram for powertrain gear test machine is shown below.



< Fig 3. Concept diagram and similar test machine for powertrain gear durability test>



<Fig 4. Concept for Test Gear Box to operate various test >

- DAQ and control board for the system is recommended to use NI DAQ. Otherwise must be compatible with NI DAQ.
- Labview is recommended for the programming. Otherwise must be compatible with NI LabVIEW.
- The example display of programming is shown in Fig 5.



- O Before delivery of the test machine, at least one durability test report of gear set sampling should be submitted.
- o When the equipment is delivered, installation check list should be submitted.o Maintenance plan should be submitted.