

Test Equipment for Production Line of Transmission for Plug-in Hybrid Electric Vehicle (PHEV)

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Abstract

We have been manufacturing automatic transmission test equipment for the Automatic Transmission (AT) with a torque converter and for the Continuously Variable Transmission (CVT). We recently delivered transmission test equipment to an overseas automotive manufacturer. This is a transmission to be loaded on the Plug-in Hybrid Electric Vehicle (PHEV).

This type of test equipment is intended to create conditions close to those of actual vehicles.

The prominent features of this equipment are as follows:

- (1) Adoption of a three-axis motor system
- (2) Layout is designed to fit the setup position for the PHEV control unit.

1 Preface

In the auto industry field, hybrid cars are becoming more popular because of its fuel efficiency and low CO₂ emission addressing issues of global warming and depletion of fossil fuel resources.

The transmission unit, a major assembly of automobiles, is an important component that transfers the engine power to the wheels. We are a supplier of transmission test equipment for production lines. Currently, the Automatic Transmission (AT) and the Continuously Variable Transmission (CVT) are mainstream. The AT features high power transmission capability and outstanding environmental performance (high fuel efficiency and reduced CO₂ emission). It is urgent to address climate change and energy shift from gasoline. As part of such challenges, wider penetration of transmissions for the Plug-in Hybrid Electric Vehicle (PHEV) becomes necessary

This paper introduces a case study of our supply of a transmission test equipment for PHEV for an overseas automaker.

2 System Overview

Fig. 1 shows an overall layout (top view diagram) of this system. A transmission set on the dedicated pallet in the previous process is filled with an Automatic Transmission Fluid (ATF) oil at the oil

injection Station (ST) and then is carried to the test ST. This transmission unit undergoes various measurement tests at the test ST and the result of testing is identified by OK or NG judgment. The test result is recorded in the ID unit that is attached to the dedicated pallet. The transmission unit is then carried to the oil drainage ST. After the ATF oil has been extracted at the oil drainage ST, the transmission unit is moved to the post-process.

At the ATF tank unit, supply and recovery of oil and temperature control are carried out. At the various control panels, transmission control, I/O axis motor control, and transport control are carried out. At the CPU unit, measurement control, noise measurement, and data collection are performed.

Table 1 shows a list of major equipment specifications of this system and **Table 2** shows a list of measuring items.

3 System Configuration

Fig. 2 shows the system diagram of the control equipment. A PHEV control unit, which is used on a real car, is mounted as the control equipment so that a control system equivalent to that of a real car can be constructed. This PHEV control unit is installed in the vicinity of the main body of the transmission.

By this layout arrangement diffusion of electrical noise generated by high voltage and high fre-

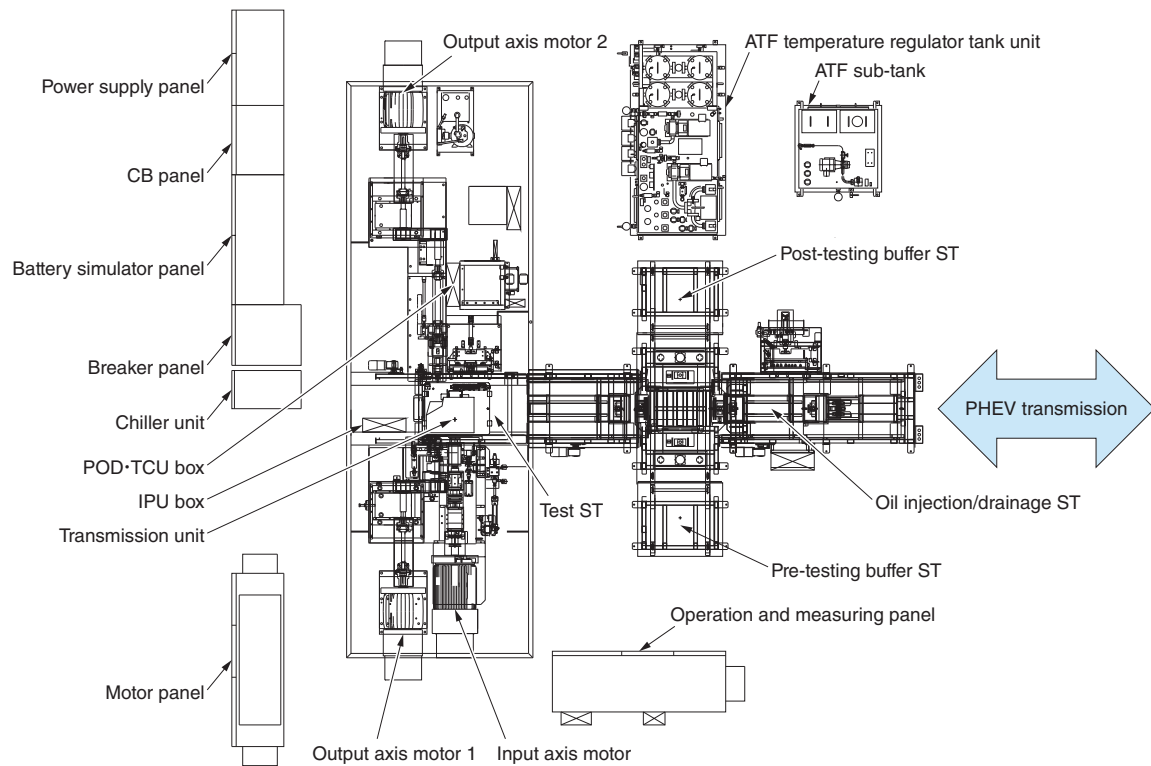


Fig. 1 Overall Layout Diagram (Top View)

The overall arrangement of each main component is shown. The PHEV transmission unit is carried from the carry-out exit on the right of the test ST on the left. After testing, it is carried to the right.

Table 1 List of Major Equipment Specifications

A list of major equipment for this test equipment is shown.

Facility name	Specifications, configuration, function
Test ST	Input-axis motor capacity: 36kW rpm: 3283/6200min ⁻¹ Output-axis motor capacity: 22kW rpm: 1450/4500min ⁻¹
ATF temperature regulator tank unit	Oil temperature regulator: 80±5°C Tank capacity Dirty side: 125L Clean side: 250L Heating capacity: 20°C → 80°C/40min Sub-tank capacity: 500L
Work carrier	Carry system: Conveyer transport Carry-in/out port used in common Pre-testing buffer ST: 1ST Post-testing buffer ST: 1ST A maximum of 3 works can be loaded continuously.
Oil injection/drainage ST	A work and a pre-dressed pallet can be automatically joined and separated through a coupler.
Controller panel (Installed with CPU unit)	Breaker panel, power supply panel, CB panel, motor panel, operation and measuring panel (CPU unit functions: waveform display, data storage)
Battery simulator panel	Source for HEV motor Max. DC output voltage: 400V Max. DC output current: 190A Max. capacity: 76kW Panel size: W1500 × H2100 × D600mm
Chiller unit (IPU chiller unit)	Cooling water circulation (Cooling water temperature: 65°C or below, 8L/min or more)

quencies can be reduced in the EV motor. By this method, measures have been taken against control disorders and highly reliable measuring data have been collected. At the PHEV control unit, command dispatch and data logging are carried out by using Controller Area Network (CAN) communication in the same manner as for the real car.

4 New Measurement Test

This system controls the EV motor mounted on the main body of PHEV transmission and motor-powered oil pump. This is in addition to conventional measuring items of automatic transmission. The EV motor control unit (IPU: Integrated Power drive Unit), the motor-powered oil pump control unit (POD: Pump On Demand), and the Transmission Control Unit (TCU) and the measuring personal computer are controlled through the Control Area Network (CAN) based on the CAN communication protocol. The major measurement items are as follows:

(1) EV motor control

The torque output of the EV motor is controlled to a constant level and revolutions of the input-axis motor are changed as a substitute of an engine. In

Table 2 List of Measuring Items

A list of measurements and operating items of this test equipment is shown.

Measuring and operating items	Measuring range	Transducer	Measuring and operating items	Measuring range	Transducer
I/O axis revolving speed	0~6500min ⁻¹	Encoder	Turbine shaft speed	0~6500min ⁻¹	Operation
I/O axis torque	-1000~1000N·m	Torque meter	Various CVT pressures	0~6500kPa	Operation
Detent torque	-10~10N·m	Torque meter	CVT oil temperature	0~100DegC	Operation
Oil pressure at various check ports	0~10MPa	Pressure sensor	Detection at various inhibitor switches		
ATF oil supply temperature	0~100DegC	Thermocouple	Brake		
Cooler inflow rate	0~50L/min	Flow meter	Parking front/rear		
I/O axis motor speed	0~6000min ⁻¹	Encoder	Motor output	0~75kW	Operation
Various duties	0~100%	Operation	Motor-powered pump speed	0~2000min ⁻¹	Encoder
Various CVT shaft speeds	0~6500min ⁻¹	Operation	Motor-powered pump current		Current sensor

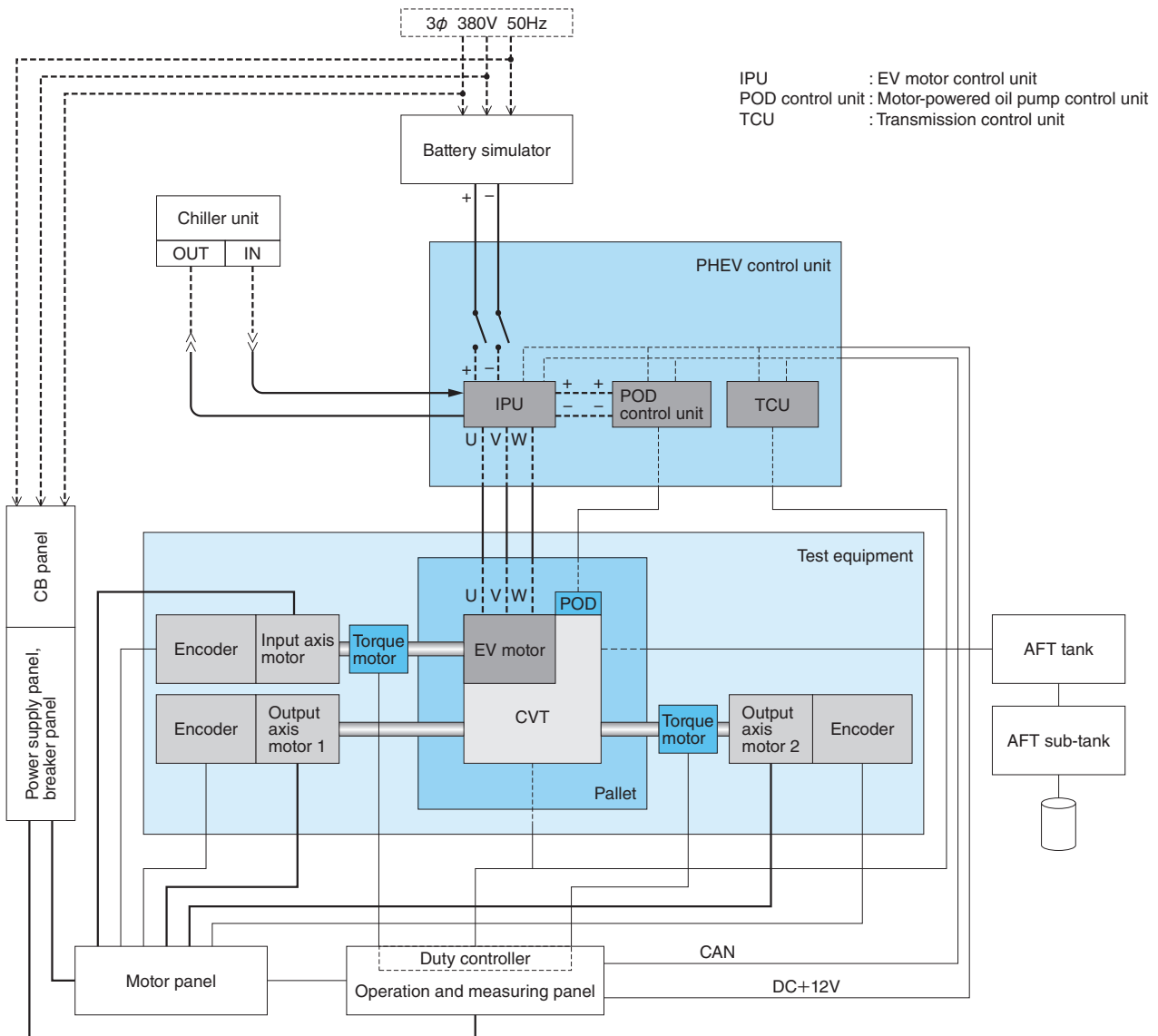


Fig. 2 System Diagram of Control Equipment

A system diagram of control equipment for this test equipment is shown.

this state, the drive performance and power generating performance of the EV motor, plus the torque value within the transmission, are measured and evaluated.

(2) Motor-powered oil pump control

The rpm value of the motor-powered oil pump is controlled at the specified level so that the motor-powered valve mounted on the transmission unit is regulated by current control. At that time, pressure of each valve is measured and evaluated.

5 Postscript

This paper introduced the features of the test equipment for production line of PHEV transmission units. Going forward, we will work on product development that can meet the changing needs of our customers and will deliver products that can provide the best product experiences to them.

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