講演番号	076

Verification on the effectiveness of Electro-mechanical coupled 1D models for vehicle system analysis and ECU circuit analysis

- Operation of the electromagnetic actuator and control circuit in vehicle power supply voltage drop -

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Recently, development competition in various vehicle systems like BEV(Battery Electric Vehicle), FCV(Fuel Cell Vehicle) solutions for achieving carbon neutrality are accelerating. MBD(Model Based Development) has been attracting attention to realize shorter development cycles and lower costs in development to gain a competitive edge. Since 2022, we, the "Model-Based Development Technology Division Committee with International Standard Description", have studied consistency between multi-domain simulations - mechanical, electrical, thermal- and experimental results using the electro-mechanical coupled 1D model of the onboard electromagnetic actuator and electronic device models and thermal models. In 2026, we are studying the effectiveness of vehicle system analysis based on such multi-domain simulations.

In this study, we analyze operating limit of the electromagnetic actuator by multi-domain simulations of mechanical and electrical using the electro-mechanical coupled 1D model and electronic device models to verify effectiveness of such multi-domain simulations for vehicle system analysis. We selected the onboard electromagnetic actuator, which is installed in an actual gasoline engine vehicle as verification sample. We assumed that the applied voltage to the electromagnetic actuator decreases due to the deterioration of the vehicle battery and the temporary increase of electrical load such as cranking. To identify the operation limit of the electromagnetic actuator in such a case, we verify feasibility of the vehicle system. Figure1 shows the verification circuit and measurement environment, Table 1 lists of mechanical, electrical specification of the sample onboard electromagnetic actuator.

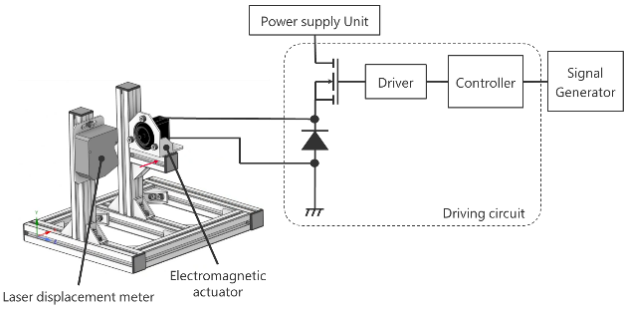

Fig.1 Driving circuit and measurement environment for verification of electromagnetic actuator

Application	Characteristics	
Air intake control	Body size[mm]	53
	Weight of plunger[g]	22
	Stroke of plunger[mm]	6
	Inductance[mH]	100
	saturation current [A] @12V	1.72

Table.1 Data list of the electromagnetic actuator in the study

Since the rated voltage of this onboard electromagnetic actuator is 12 V, the operating limit voltage is estimated to be sufficiently lower than this. Therefore, the output voltage of the DC power supply (Fig.1 Power supply unit) simulating the vehicle battery is set to $7.8V$, $7.7V$, $7.6V$. Fig.2 shows the waveform overlay of actual measurment and multi-domain simulations at the aforementioned power supply voltage. The detail of the this study will be explained.

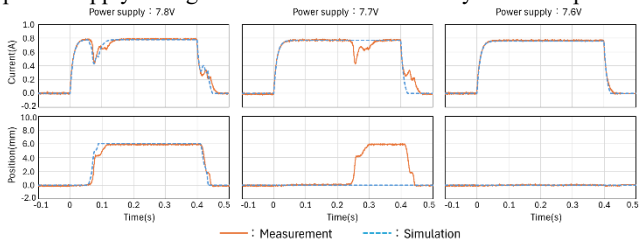

Fig.2 Overlay of measurement and multi-domain simulations waveforms