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\*DSP mini ADJC-19-S11-235045GP

# MCS

Measurement Control Simulation

2023 - 2024

Contribute to handling changes in the external environment with a tool that utilizes measurement, control, and simulation technologies.

## Message

Ever since we were first established, A&D has contributed to industrial and social development by providing a wide variety of electronic measurement and weighing devices based on high-accuracy, ultra-high-speed A/D (analog/digital) conversion technology.

We would like to take this moment to thank all of our customers for their ongoing support.

We will apply the following business philosophies as we strive to advance our company to the next stage.

### Mission

We provide tools using measurement and control technology based on analog/digital conversion technology to ascertain information from the natural world. These tools help our customers to create new value that contributes to industrial development and healthy lifestyles.

### Principle

We will remain committed to Honmono (genuine articles), find and tackle issues, and always finish what we start.

## What is MCS?

### An abbreviation for Measurement, Control, and Simulation.

#### Correct measurement:

Providing high accuracy measurement with the technologies that we have cultivated since A&D was established

#### Correct control:

Using tools with Digital Signal Processing (DSP) technology to process models at high speed in real time

#### Correct simulation:

Utilizing correct measurement and correct control to achieve correct simulation

## Pursuit of Solutions

MCS technology is a core competence of A&D and enables us to contribute to various fields, including the automobile, mobility, IT, robotics, and equipment control industries by combining high-accuracy measurement technology with control technology that analyzes measurement results and applies them to the target.

As part of our efforts to further contribute to the automobile industry, we strive to provide technologies that cover the entire field of vehicle development as we head toward model-based development.

We will continue to contribute to the progress of each industry by working with our customers to pursue ideal solutions.

## Our 5 Business Domains and Our Products



## Contributing to Carbon Neutrality

In our MCS business, we utilize our expertise cultivated in the field of automobile development assistance to help various customers in fields such as power generation, power storage, and novel fuels to help them achieve carbon neutrality and make their work more efficient.



## Serving Customers from a Global Perspective

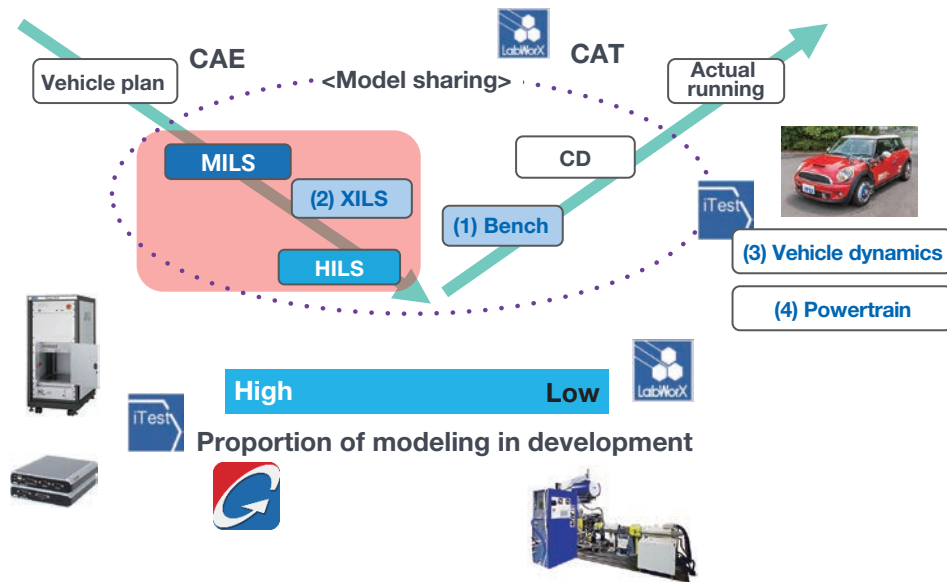
A&D has made it a policy to expand our business with a global mindset since we were first established. We currently have sales-based overseas subsidiaries in six countries and manufacturing sites in four countries.

Our general stance is to develop advanced or future technology in Japan and use our overseas sites for the development and production of products that require low costs or mass production. This allows us to meet a wide range of needs quickly.



We have development, manufacturing, and sales offices in 12 countries and regions.

## A&D Developed Devices in Overall Vehicle Development



## Features of A&D Core Fields for Vehicle Development

### (1) Features of Bench System

- Provides comprehensive support of automobile development by combining the core technologies of A&D (simulation, powertrain testing, vehicle dynamics testing, and engineering)
- Enables remote monitoring/operation to contribute to achieving more efficient development
- Prevents obsolescence of equipment after adoption via software updates, etc.
- Provides various tests for vehicles, motors (E-axes), HV, and internal combustion engines



### (2) Features of XILS

- We provide tools utilizing measurement control technologies to help make the entire process for model-based development more efficient.
- Easily-buildable high-accuracy HILS simulator including self-diagnostic functions
  - Common software platform to enable resources to be easily utilized in Bench, HILS, and SILS
  - Expandable rapid prototyping controller featuring a compact design



### (3) Features of Vehicle Dynamics Testers

#### Features of VD Sensor

- Achieves high-accuracy measurement with unique A&D component force sensor
- Visualizes a wide variety of situations at high resolution
- Real-time correction of disturbance via high-speed signal processing (with no post-processing required)



#### Features of VD Tester

- Reproduces actual driving on a test bed via high-speed signal processing
- Includes high-speed and high-density data collection function
- Achieves high-rigidity and high-accuracy testers with FEM analysis design
- Belt testers achieve high-accuracy levitation via patented air bearing technology

#### Features of VD Analysis

- Enables animation of vehicle behavior using vehicle test bed measurement data, parameter identification of tire testing model, and other arbitrary analysis

### (4) Features of Powertrain Measurement Analysis

- Enables high-accuracy execution of simplified modeling for important issues (such as fuel sticking inside the cylinder of an internal combustion engine) and detection of transient signals for physical core phenomena (gas flow and heat transfer)



## A&D Technologies/Testers to Support Vehicle Development

Since A&D was first established, we have provided methods for executing accurate measurement and contributed to high-quality development at our customers.

Our vehicle development fields include:

- **Powertrain:** Providing powertrain benches, HILS, and other methods to customers to contribute to high-quality MBD (model-based development).  
We have also started providing intake/exhaust/fuel transient measurement and analysis technologies to support the fuel modeling of internal combustion engines
- **Vehicle dynamics:** Providing high-accuracy sensors, tire behavior testers, and dynamic analysis technologies to support tire modeling
- **Improving the accuracy of core plant models,** which are the key to MBD, to solve important issues

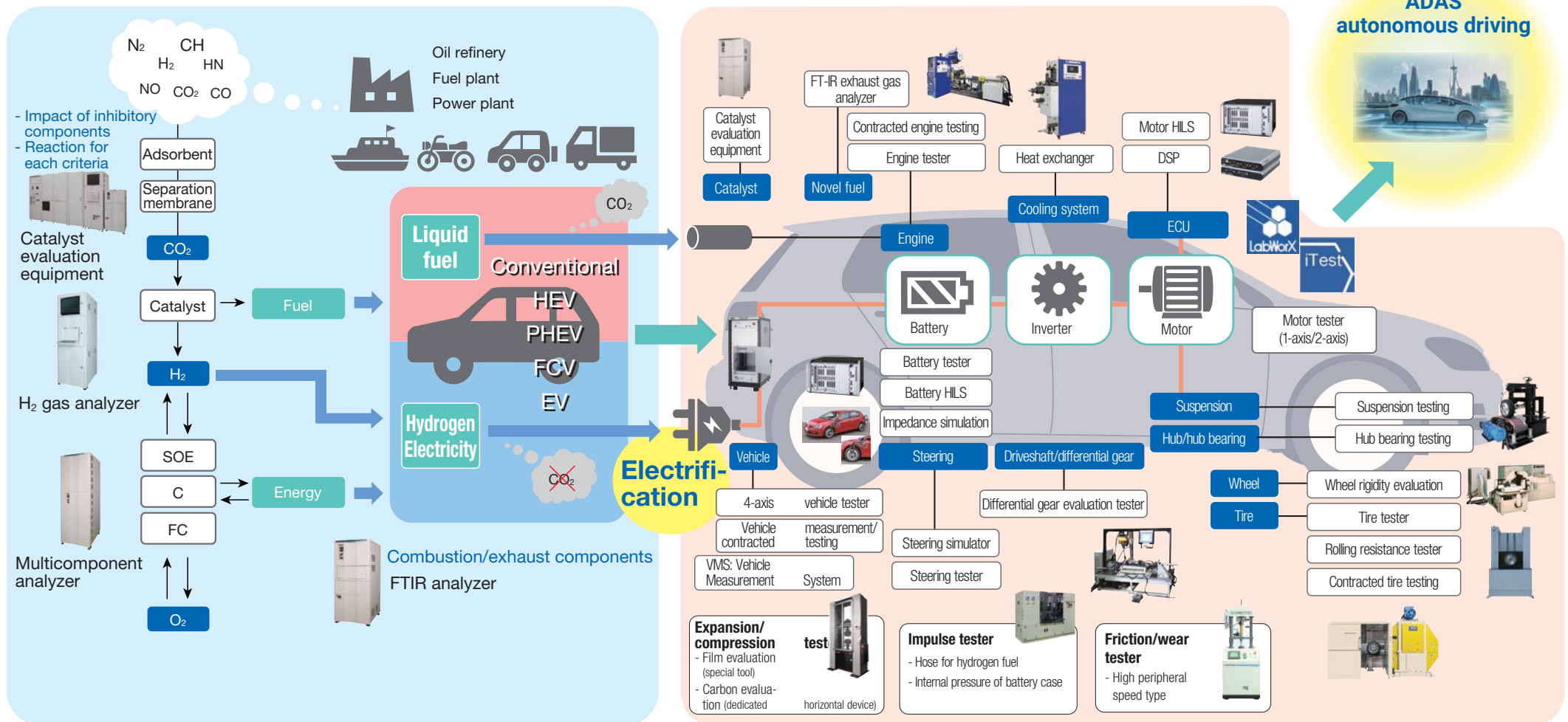
A&D will continue to develop and provide technologies and testers at an ever-faster rate to cover a wide range of core fields and overall vehicle development as we head toward MBD.

# MCS Solutions for the Next Generation of Testing Tools

MCS solution for advanced testing tool

A&D provides a wide range of measurement control solutions for various industries including the automobile industry.

A&D provides a wide range of cutting-edge testing tools to assist development in various industries including the automobile industry. Our products meet the needs of testing for individual constituent elements and components, and composite testing combining multiple elements. The MCS solutions of A&D effectively utilize software and simulations to increase customer convenience and avoid hardware entrenchment, while providing the flexibility to respond to changing needs for testing and research/development and reducing costs.



## Our New Vision and Mission

### Regarding the "Discover Precision" Tagline

"Discover" means that we will continue to constantly move forward to create new technologies and businesses, and "Precision" means that we strive to master Honmono (genuine articles) by pursuing correct and more accurate measurement.

"Precision" refers to the world that the A&D Group continues to aim for and the role it must fulfill, and "Discover" refers to new discoveries and the efforts we make to achieve them.

The needs of society and our customers change with the times, environment, and technologies.

We open up the future in advance of changes, while never being satisfied with the current situation.

We constantly strive to achieve new business with highly accurate technologies and products.

"Discover Precision" is the mission of the A&D Group.



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# Helping to Make Development More Efficient

# and Contribute to Carbon Neutrality

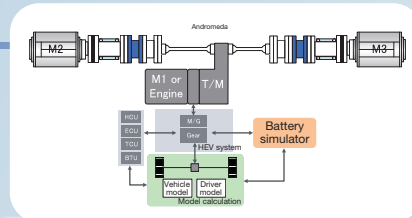
## PTT: Powertrain Testing

### Products that contribute to carbon neutrality

These products contribute to the development of high-efficiency internal combustion engines, electric mobility, and CN fuels.

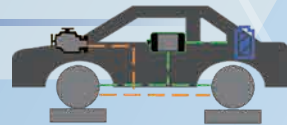
#### EV/HV Bench

Simulates the behavior of the entire vehicle on a test bed using a combination of engine and battery/motor. This enables highly reproducible quantitative evaluation.



#### 4-axis Hub System

Enables highly reproducible data measurement at higher accuracy than real road driving.



#### Battery Tester

Provides a standard UI independent of equipment manufacturer to enable the sharing of operation expertise and testing assets.

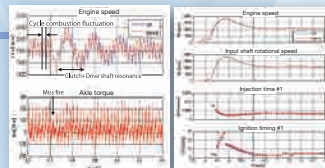


#### Gas Analyzer

Provides high-accuracy and high-speed measurement of multi-component gases via the FT-IR method.

#### High-speed Response Engine Bench

Enables evaluation of cold start emissions by covering operation at rotational speeds below idling speed.



### Products that help make development more efficient

These products help make development work more efficient via the automation of testing and remote support. They are also updatable to follow changes in the times and prevent obsolescence.

#### LabWorX

Reduce work inefficiencies with batch monitoring of testing equipment, data management, and report output.



#### ORION

Contributes to the automation and autonomous operation of bench testing by increasing the equipment operation rate and reducing the testing period.



#### iViewBox

Connects testing equipment without a DAQ (LA) system to LabWorX.



# Bench Integrated Development Environment

A tool suite that supports all powertrain development by integrating the management server functions and an automatic calibration measurement system with the iTest bench control/measurement system at its core.

## Bench Test

Achieves Improved Development Efficiency, Continuous Function Expansion,

and Flexible Testing Support in Engine Bench/Motor Bench Testing

### Applications

- Manual and automatic measurement testing for stationary calibration tests, transient calibration tests, and performance endurance tests, etc.
- Integrate all bench testing operation (setting management, testing, analysis, and operation management)
- Build bench system configurations that utilize the customer environment and equipment

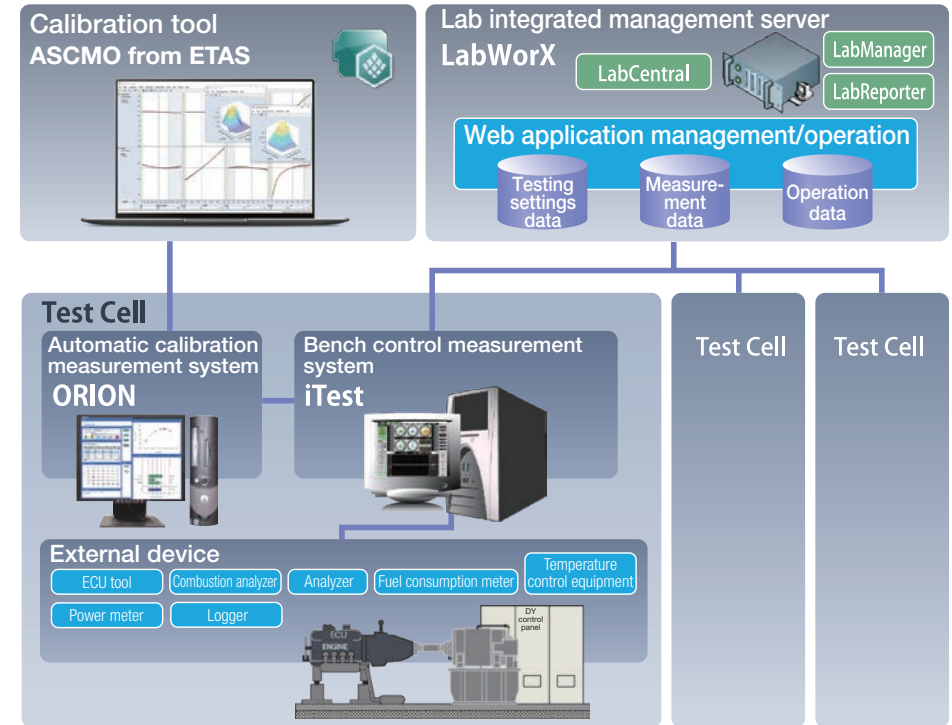
### Features

- A unified environment containing the iTest bench platform and the LabWorX server application that performs testing operation and management to meet all customer needs for all testing operation and management
- ORION and iTest are linked to provide flexible testing operation and efficiency in response to continuing evolution in measurement methods for calibration testing
- The modular concept enables flexible system expansion, device expansion, and testing function expansion, and provides continuous evolution to prevent system obsolescence
- System applications support the ASAM standard

### Products Forming the Bench Integrated Development Environment

- LabWorX: Lab integrated server management application**
  - Web-based operation without user application
  - Integrated system for data retrieval, file management, operation rate management, and testing operation management
  - A wide range of optional functions such as a notification function, remote operation function, background automatic report output, and linking with servers at other sites
- ORION: Stationary/transient calibration automatic measurement**
  - Creation of user-friendly automatic measurement sequences
  - Provides standard actions that incorporate operational know-how for calibration testing
  - Support for various ECU tool interfaces
- iTest: Bench testing measurement, configuration, and execution application**
  - Centralized configuration/management of the setting information required for bench testing
  - Testing execution functions such as manual, pattern, ORION linking, and trace testing
  - Standard inclusion of various interface modules, including those for other companies

### iTest - LA Configuration



### Example of Adopting iTest + LabWorX

Adopting iTest + LabWorX enables remote operation and promotes efficiency.

This system can be used in various fields including automobile development.

#### Example of Adopting Battery Testing

Before adoption, testing personnel were required to work at each machine. After adoption, work is possible at a remote location, which means that the entire floor can be managed by a small number of staff, and this contributes to labor saving and efficiency.



# HV/EV Bench

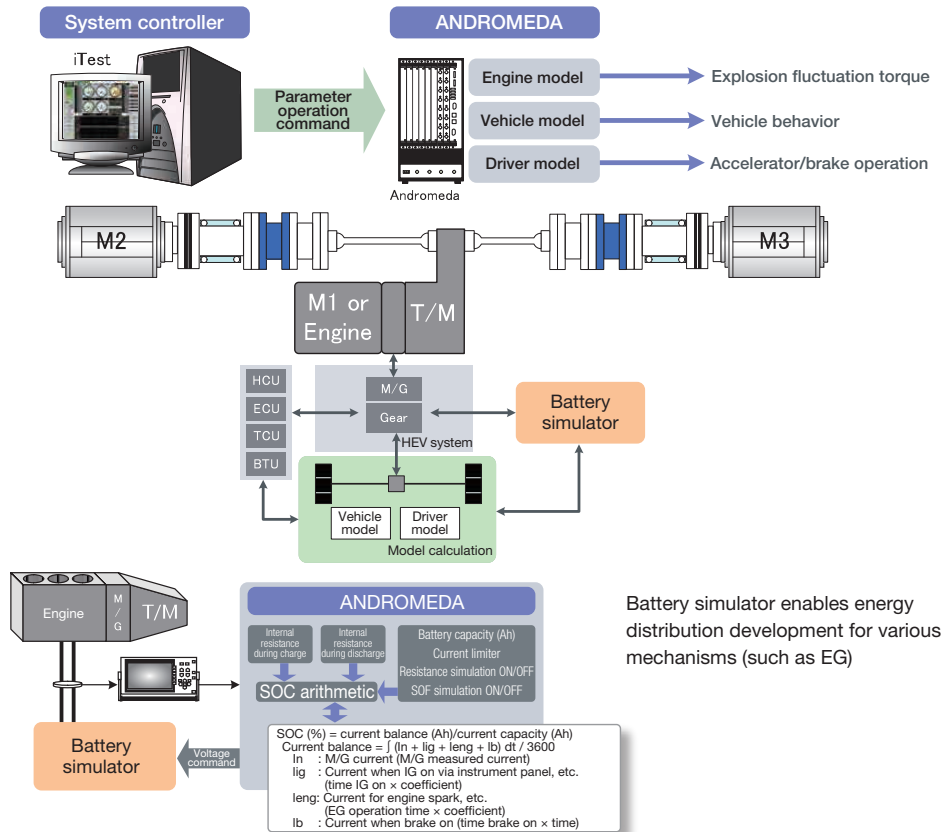
## Bench Test

Engine-free Development and Testing of HV/EV Systems and Drive Systems

### Applications

- Enables testing of HV/EV systems in environments without real vehicles or engines  
Supports split, parallel, and series types
- Also enables drive system and vehicle system testing without real vehicles or engines

### Configuration

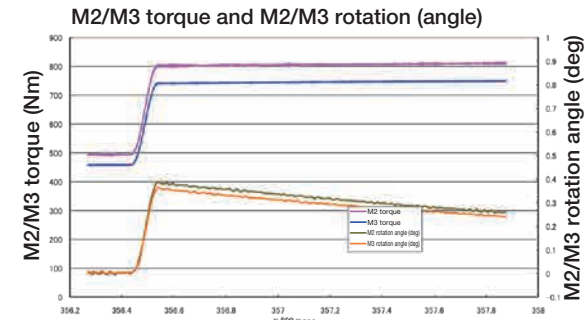


Battery simulator enables energy distribution development for various mechanisms (such as EG)

### Features

- Excellent repeated reproduction to enable testing with quantitative evaluation
- Since explosion fluctuation torque can be applied to the drive system from the engine model, tests that were previously difficult can be performed engine-free
- Since a battery simulator that includes SOC (State Of Charge) arithmetic can also be provided, coordinated control can be performed for controller development with higher accuracy

### All stall

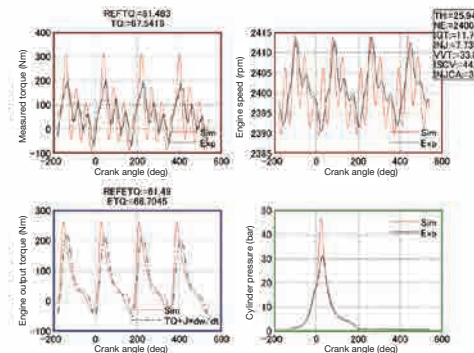


The rotational speed is within 0.5 degrees, even when 800 Nm of torque is instantaneously applied to M2 and M3.

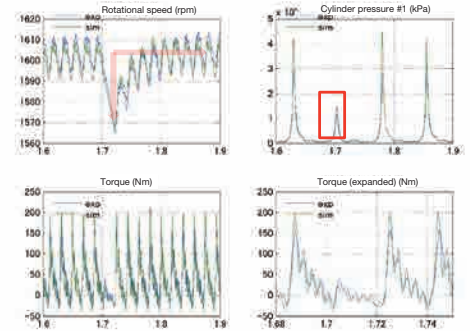
Engine model: Real-time simulation of explosion fluctuation from cylinder pressure.

### Misfire reproduction

- Result where the torque amplitude including resonance is large, from the combustion pressure deviation



- Misfire #1 cylinder for 1 cycle only with the same conditions as evaluation 1
- Reproduce the rotational speed reduction due to reduced torque and return





# Simulation Bench

## Bench Test

Connect Real Engine and Vehicle Models to Simulate Real Vehicle Running on Test Bed

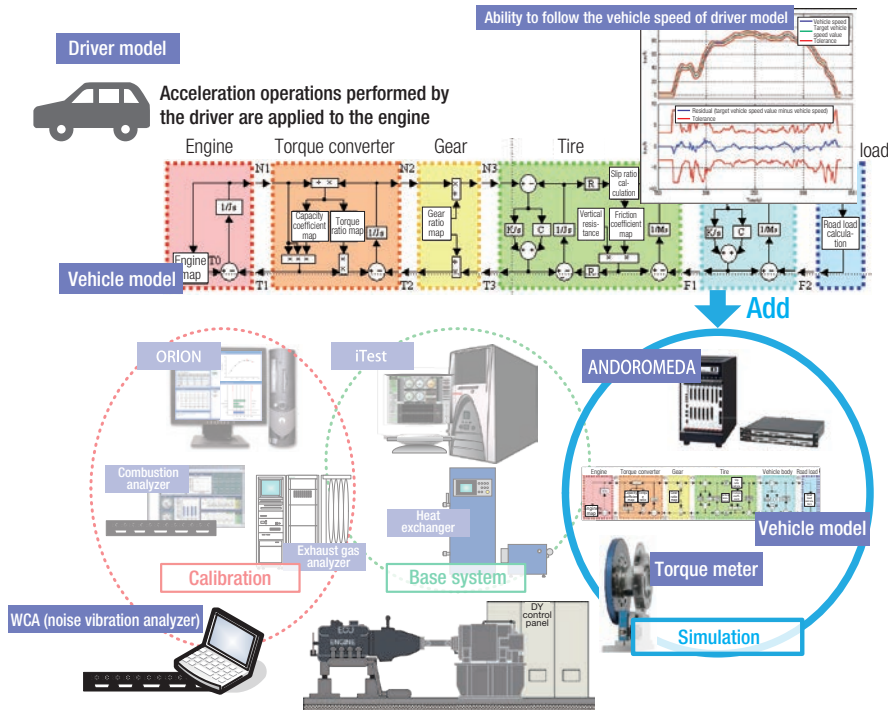
### Applications

- Enables ECU setting before vehicle completion

### Features

- Achieve benches by adding vehicle models/driver models to ANDROMEDA
- Evaluate accuracy of a real vehicle running on a test bed based on real vehicle running data with the MBD concept
- More practical with fewer vehicle model setting parameters
- Excellent repeated reproduction to enable testing with quantitative evaluation

### Configuration



# High-speed Response Engine Bench

## Bench Test

Inertia Correction Control Enables Real Vehicle Running Reproduction Including Rotational Speed Variation

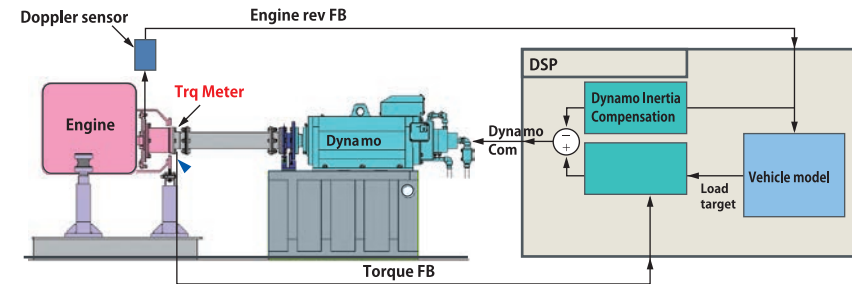
### Applications

- Misfire judgment evaluation
- Low speed combustion evaluation
- Cranking/idling stop evaluation
- Reproduction and evaluation of powertrain type machinery resonance

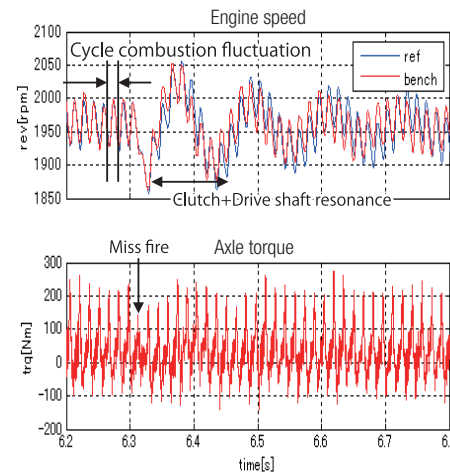
### Features

- Rotational speed variation reproduction via dynamometer inertia correction control enables misfire evaluation and reproduction of powertrain type machinery resonance
- Setting the natural frequency of the shaft to 200 Hz or higher enables evaluation of low speed combustion of 600 rpm or lower

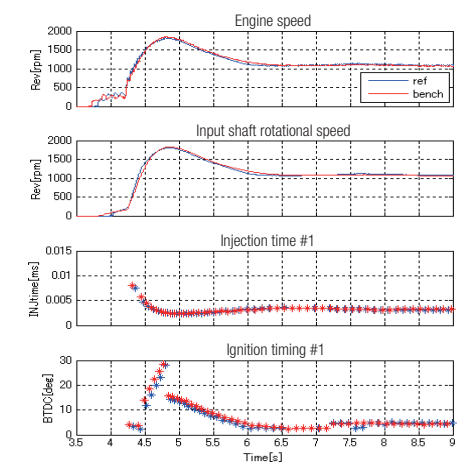
### Configuration



### Misfire Behavior Reproduction when Real Vehicle Is Locked Up



### Vehicle Starting Behavior Reproduction



\*ref: Real vehicle data  
bench: Engine bench measurement data using vehicle model

# 4-axis Hub Dynamometer

## 4-axis Hub Dynamometer

We Provide a Range of Applications Required for Vehicle Testing

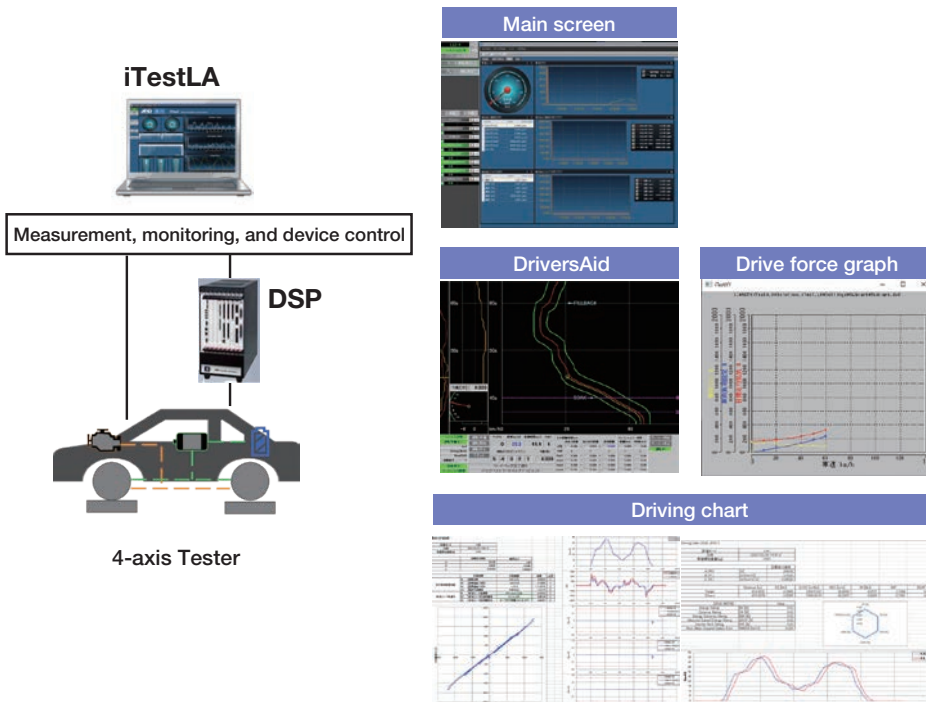
### Applications

- Uses stationary equipment to enable highly reproducible data measurement at higher accuracy than real road driving

### Features

- More compact configuration than a chassis dynamometer
- Enables safe testing with higher reproducibility than a real road driving
- Provides data in same format as Bench to enable common analysis
- Function extension enables connection devices such as data loggers
- Enables linking with various [vehicle simulation tools \(CarSim/CarMaker\)](#)

### Configuration



# ORION

## Test Automation Tool

Software for Automated Testing

**Increases the equipment operation rate and reduces the testing period**

ORION is test automation software.

It enables testing during times when equipment was previously not operated, to contribute to reducing the total test time.

It supports the testing of motors in addition to engines.

### Automation of Testing

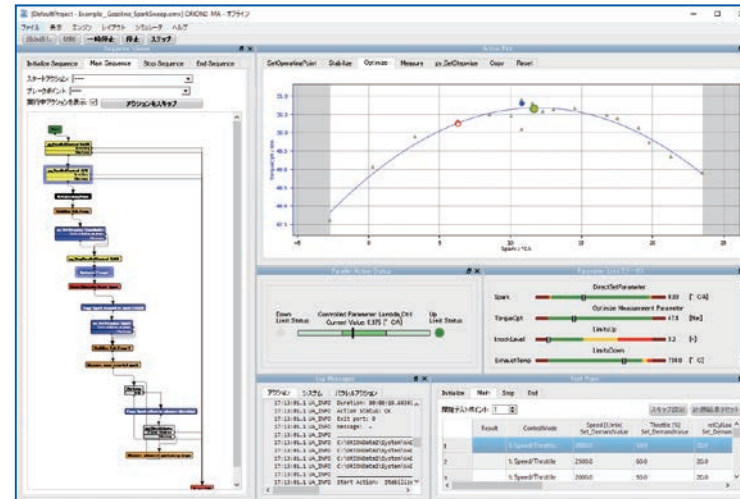
Bench operations previously performed by an operator can be replaced by a test flow. A test flow is a flowchart for a combination of actions (function components). Various actions are provided, such as commands for the dynamometer, changing ECU parameters, and sending commands to peripheral devices. Since each action includes the series of operations for achieving a function, it is easy to build test flows.

### Provides Support for Test Automation

- Our support center answers questions regarding these products and how to use them
- We perform training. Contact your A&D sales representative.

### Features

- Graphically create test flows
- Rich range of standard actions
- Create user-defined actions
- iLink-RT support
- Automatic update function
- Easy embedding in existing benches
- License format
  - Standalone license: License for a fixed PC
  - Network license: License for sharing among PCs on the same network



# Multifunction Heat Exchanger System

## Multi Function Heat Exchanger System

### Reproduce mode driving transient engine temperatures thanks to excellent control response

Multifunction heat exchanger systems reproduce the real running state of the coolant temperature, engine oil temperature, and fuel temperature via model based control using engine heat generation models.

### Combined feed forward control and PID control via engine heat generation models

Conventional heat exchangers with a large heat capacity have excellent temperature stability but are not suitable for tests where the target temperature changes transiently, such as in mode driving. The multifunction heat exchanger systems of A&D provide excellent trackability of the target temperature and enable transient temperature reproduction thanks to combined feed forward control and PID control via a small heat capacity and engine heat generation models. This establishes both the contrary properties of temperature stability and target trackability, in order to provide the performance required for stabilizing the temperature within a short period of time, in all conditions from low load to high load and low speed to high speed.

#### Functions

- **Mode driving transient temperature reproduction**  
Reproduction with engine normal/open thermostat  
Engine rapid cooling soak
- **Cold start**  
Cold start from -7°C
- **Low pressure loss circuit**  
Radiator pressure loss reproduction
- **Coolant bypass function**  
High transient control response
- **Security function**  
Failsafe function (software/hardware sequence)  
Engine coolant and oil filler/ejector (optional)
- **Auxiliary function (optional)**  
Fuel temperature control  
Intercooler temperature control  
AUX control output
- **Shortened test time**  
Shortens the time for 1 step cycle (condition change ⇒ state stable ⇒ data retrieval) and reduces test time



# iViewBox

## Measurement device with LabWorX interface

### Enables device measurement data to be managed on a server

By adopting iViewBox, devices not connected to a network can connect to LabWorX (a server-based integrated management environment).

This enables linking with the various functions of LabWorX, in addition to server-based management of measurement data.

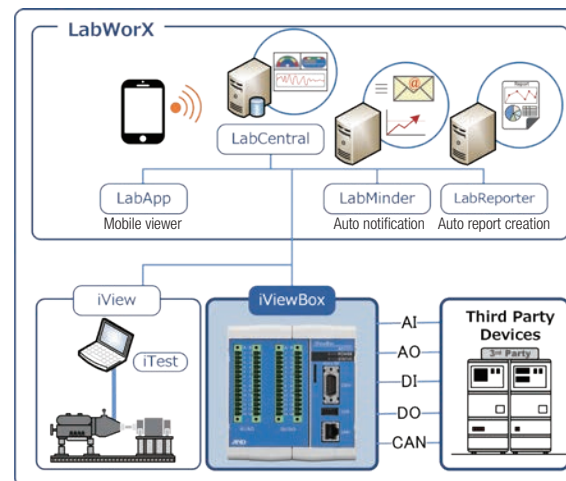
#### Operation Enabled by Connecting to LabWorX

- Use a Web browser to monitor the device status from an office
- Automatically save measurement data to a server
- Device uptime monitoring
- Remote connection of devices
- Simultaneous monitoring of measurement data for other systems/devices
- Link with LabWorX family of tools
  - LabApp: Monitoring from smartphone/tablet
  - LabMinder: Remote error notification to administrators
  - LabReporter: Automatically creates reports

#### Features

- No computer required
  - Compact and lightweight
  - Includes basic IO as standard
    - Analog input: 8 channels
    - Analog output: 4 channels
    - Digital input: 8 channels
    - Digital output: 4 channels
    - CAN: 1 channel
  - Extends the A&D fieldbus IO module
    - AD7313-11HV: 8 channel analog input
    - AD7313-21: 8 channel analog output
    - AD7313-31: 8 channel digital input/output
    - AD7313-12HV: 8 channel thermocouple input
    - AD7313-41HV: 8 channel PWM input/output
- \*Up to two can be added per module

#### Functional Diagram



#### Exterior



# Hydraulic Variable Valve

## Hydraulic Variable Valve System

Improves Efficiency of Variable Cam Profile Optimization Work

### Supports Hydrogen Fuel

#### Features

The cam profile and valve timing of intake and exhaust valves greatly impact engine combustion efficiency. Therefore, the cam profile shape and timing setting are important elements in engine development. A&D provides a variable valve system via a hydraulic system to contribute to improved efficiency for such optimization work.

- Reproduction function for 4 valve independent arbitrary valve profiles (lift, operating angle and central angle change)
- Supports single cylinder engines
- Engine control and hydraulic valve control with the same GUI

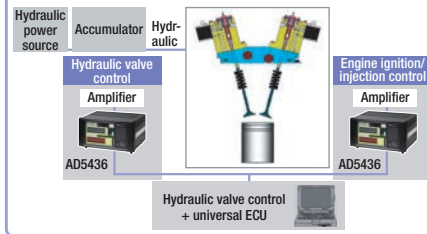


Example incorporated in real vehicle cylinder head

#### Specifications (Hydraulic Variable Valve System)

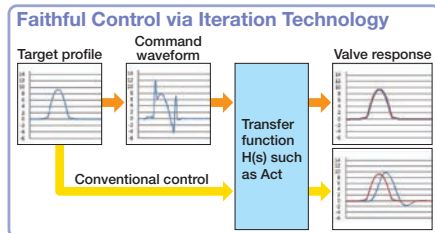
Supported valves	2 intake valves, 2 exhaust valves
Maximum lift	15 mm
Reproduction accuracy	Error deviation ±0.05 mm or less (*When equivalent to 2000 rpm)
Hydraulic operation oil	Engine oil
Actuator seal structure	Seal-free
Maintenance	Maintenance-free
Oil pipe	2 ports (1 supply port, 1 return port)
Engine speed	Maximum 6000 rpm
Supported engines	Single cylinder engine
Supported stroke	4 stroke
Engine oil/coolant temperature	Up to 110°C

#### Hydraulic Variable Valve System

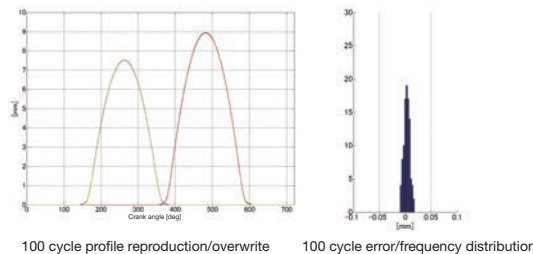


#### Iteration Technology

Technology that derives the transfer function of an actuator system and adjusts the target signal with its inverse transfer function to achieve highly accurate control.



#### Combustion Test Results



# Fully Variable Engine

## Fully Variable Engine

Improves Efficiency of Piston Motion and Valve Profile Optimization Work  
Achieves High Speed and High Exhaust Via Super High-speed Response Servo Valve

### Supports Hydrogen Fuel

#### Features

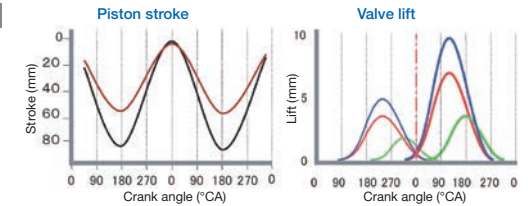
Variable compression ratio single cylinder engines such as VCR engines are often adopted for basic engine development and evaluation. Since these are purely mechanical, a large effort is required to change the conditions such as the piston stroke and crank offset. A&D enables arbitrary piston motion via advanced hydraulic operation technology and combines this with a hydraulic variable valve system to provide Fully Variable Engines.

- Reproduction function for arbitrary piston motion (crank radius, connecting rod length, crank offset, and compression ratio)
- Reproduction function for 4 valve independent arbitrary valve profiles (lift, operating angle and central angle change)
- Achieves simultaneous engine control, hydraulic piston control, and hydraulic valve control
- Controls the optimal engine cooling temperature via a heat exchanger
- Provides simultaneous control of fuel pressure, exhaust air pressure, and intake air pressure
- Also enables automatic control of fuel injection time with IMEP average value
- Perform simultaneous fuel consumption measurement, exhaust gas analysis, and combustion analysis evaluation

#### Specifications (Hydraulic Variable Valve System)

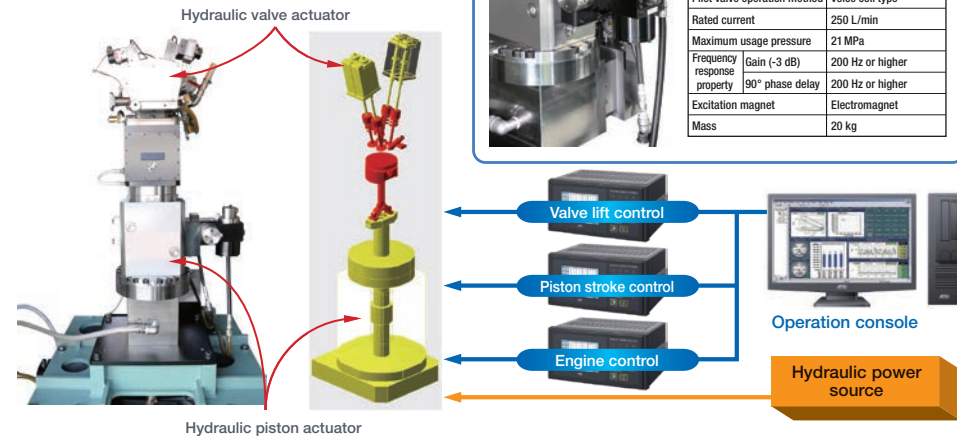
Maximum piston stroke	150 mm
Maximum combustion pressure	10 MPa
Supported valves	2 intake valves, 2 exhaust valves
Maximum valve lift	15 mm
Rotational speed	0 rpm to 3000 rpm*
Hydraulic operation oil	Engine oil
Actuator seal structure	Seal-free
Maintenance	Maintenance-free
Engine coolant temperature	Up to 120°C

\*With conditions



#### Super High-speed Response Servo Valve

Operation method	Linear motion 2 stage valve
Pilot valve operation method	Voice coil type
Rated current	250 L/min
Maximum usage pressure	21 MPa
Frequency response property	Gain (-3 dB) 200 Hz or higher 90° phase delay 200 Hz or higher
Excitation magnet	Electromagnet
Mass	20 kg



# High-speed Response Technology

## Transient Intake Flow Measurement

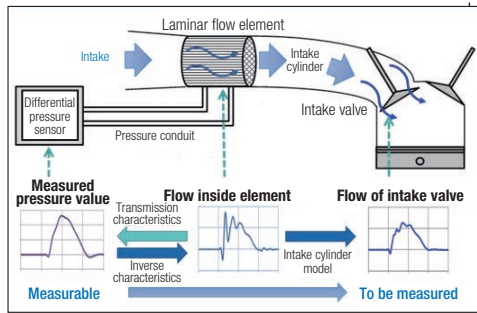
## Transient Temperature Measurement

### Features

- Greatly improved performance as a laminar intake flow meter (50 Hz to 200 Hz, the highest in the world)
- Achieve passing flow measurement of intake valve via intake cylinder model
- Waveform retrieval based on crank angle contributes to more accurate models and more accurate control

- Thermocouples can be made to give a higher-speed response from 10 Hz to 150 Hz
- Accurate real-time temperature measurement

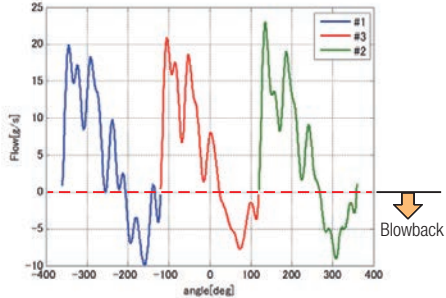
### Principle



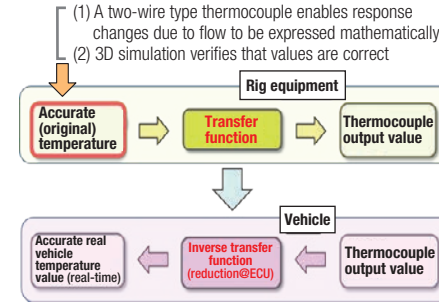
By calculating the transfer function between the differential pressure sensor and laminar flow element and utilizing the inverse properties, the transient flow inside the element is obtained. By calculating and utilizing the intake cylinder model between the laminar flow element and intake valve, the transient flow of the intake valve is obtained.

### Example Implementation

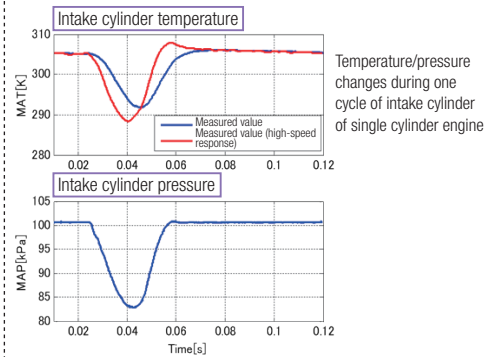
(Example of measurement with three cylinder engine)



- The intake valve flow corresponding to the crank angle can be measured for each cylinder
- Blowback from the intake valve to the intake cylinder can also be measured



Response changes can be expressed mathematically to retrieve the transfer function (sensor model). Including an inverse transfer function in a real vehicle enables accurate real-time temperature measurement.



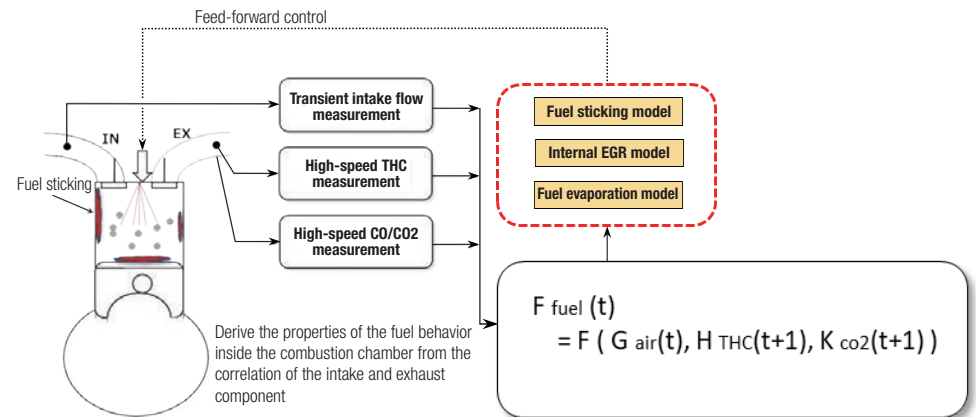
- High-speed response processing enables the measurement of temperature properties according to rapidly changing pressure inside the intake cylinder

# Cold Emission Reduction Modeling Technology

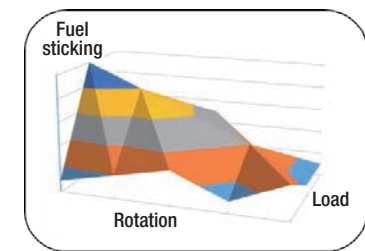
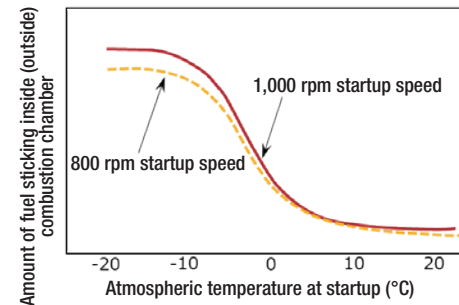
### Features

- Without visualizing the engine combustion chamber, the combustion property signals outside the combustion chamber (transient intake flow measurement, high-speed THC measurement, high-speed CO/CO2 measurement) can be used to obtain a fuel sticking model, internal EGR model, and fuel evaporation model for cold starting
- By performing cold start fuel injection feedback control (and ignition control) using the above models, contribute to  $\lambda = 1$  control from the initial stage of cold starting

### Principle



### Example Implementation



- Accurately identify the amount of fuel sticking inside (or outside) the combustion chamber according to the cold start conditions

# AD7832/AD7833 RTS Torque Meter

## Rotation Torque Sensor

### Features

- True torque measurement with distributed force sensor type
- Direct installation to engine axle/CVJ axle
- Simultaneous crank angle measurement
- 1/5 dual range for arithmetic processing with guaranteed high-accuracy
- High-accuracy real-time measurement with high-speed telemeter



AD7832

AD7833

### Rated Capacity of RTS Series

The RTS Series can be used with the rated F.S. or 1/5 of the rated F.S.

Series/capacity	200 Nm	500 Nm	1 kNm	2 kNm	5 kNm	Dual range support
AD7832	○	○	○	○	○	○
AD7833	○	○	○	○	○	○

### AD7832 Series

#### Compact (small diameter type) torque meter

- Dedicated model for torque measurement with distributed force sensor type
- Rated torque: 200 Nm to 5 kNm
- 2.4 GHz/4 Mbps compact telemeter
- Total error: 0.03%
- Maximum rotational speed:  
12,000 rpm (200 Nm to 1 kNm)/  
10,000 rpm (2 kNm/5 kNm)
- Lightweight/low inertia/simple structure



AD7832

AD7893-S

### AD7833 Series

#### High-speed torque meter

- Distributed force sensor type
- 6 component force monitor available
- Rated torque: 200 Nm to 5 kNm
- 300 MHz/20 Mbps high-speed telemeter
- Total error: 0.03%
- Maximum rotational speed:  
10,000 rpm (200 Nm to 1 kNm)/  
7,000 rpm (2 kNm)/5,000 rpm (5 kNm)
- Can support 25 kHz DA output (requires consultation)



AD7833

AD7882-02

AD7893-E3

Best SOKKI

# Gas Analyzer

## Gas Analyzer

Gas Analysis to Contribute to Carbon Neutrality

### H<sub>2</sub> Gas Analyzer

#### Bex-1000H Series



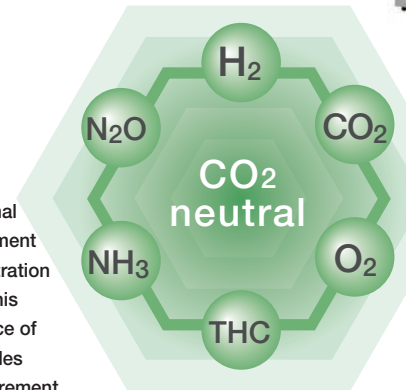
You can select the optimal model for your measurement needs, from low concentration to high concentration. This minimizes the interference of coexisting gas and enables high-accuracy H<sub>2</sub> measurement.

### Cross Leak Gas Analyzer

#### Bex-1600XL Series



This product has been used for the cross leak gas analysis of fuel cells for a long time. It provides accurate analysis of cross leak phenomena with both small quantity sampling and high-speed response.



### FT-IR Exhaust Gas Analyzer

#### Bex/BOB Series



BOB-1000FT  
(vehicle mounted)

This product adopts unique technology to achieve high-accuracy measurement of various components. It enables the addition of a H<sub>2</sub>, O<sub>2</sub>, and THC meter, which cannot be measured with FT-IR. It is also used for analysis of NH<sub>3</sub>, which is gaining attention in the fields of new energy and exhaust gas regulations, as well as the analysis of N<sub>2</sub>O, which is subject to greenhouse gas regulations.



Bex-2200FT  
(H<sub>2</sub>, O<sub>2</sub>, THC meter added)

# Simulation Platform That Supports

# Efficient Model-based Development

X In the Loop Simulation

## SILS

Tool for the development/verification of control software that enables assets to be shared with HILS



A common software platform enables the entire development process to be seamlessly connected to efficient control development.

## Controller

Controller providing measurement/control for various applications



## HILS

HILS platform with excellent environment constructability and expandability



Multi node



High-speed communication

# HELIOS

We provide large-scale HILS systems and integrated HILS systems that are highly expandable by linking to multiple CPUs and multiple units.

## HELIOS System Platform for HILS

### Platform Supporting CASE/MBD

#### Features

- Select from two types of CPU boards
- Distributed processing with core division and multi-node operation
- Commercial PCs can be used as nodes
- High-speed communication between nodes and low-latency model synchronization
- Highly expandable
- A rich range of options that enable testing environments to be constructed in a short time
- All-in-one design that integrates I/O and an interface to make the system more compact and lower cost
- Adopts integrated software platform (iTest) with A&D Test Bench
- Enables flexible configurations for various goals, from small scale to large scale configurations

Board name	Function
AD7005	Intel Xeon 3.5 GHz (4 core)
VS2000-A7006	Intel Core i3-7100E 2.9 GHz (2 core)



HELIOS-PRO

HELIOS-LITE

#### I/O Board Lineup

Board name	Function
ENG-IO	Simulation of crank/cam signal Measurement/output of rotation synchronization signal (injection, ignition, knock, etc.)
ACT-IO	Voltage and current measurement of a solenoid or DC motor, etc.
SENSOR-IO	Analog input/output Analog voltage simulation/measurement of sensors, etc.
PLS-IO	Pulse input/output Simulation/measurement of switches and pulse output sensors, etc. (duty, on/off, or solenoid measurement)
COM-IO	CAN/CAN FD/LIN/K-LINE/RS-232C
VB-SW	VB supply relay (with voltage and current monitor)
SENSOR-OUT	Analog output Analog voltage simulation of sensors, etc.
PATTERN-OUT	Output arbitrary waveforms Rotation sensor simulation via voltage/current output Resolver simulation (with excitation signal input circuit)
FPGA Board	Includes large-scale FPGA that can be freely programmed by the user Includes high-speed I/O required for motor simulation
SENT-IO	SENT input/output Serial communication standard for automobiles: Sensor simulation supporting SENT Analysis of SENT protocol



Includes self-diagnostic function and failure function as standard (the VB-SW has the self-diagnostic function only)

#### Options

##### Load box

- Enables load to be easily fixed and wired, and expansion via boards
- Includes internal temperature monitoring function and various fixed parts

##### Manual operation box

- Enables the HILS to be operated with a dial, slider, or mechanical switch

##### Connector conversion box

- Conversion and rewiring are also possible for using a connector provided by the customer

##### Low pressure box

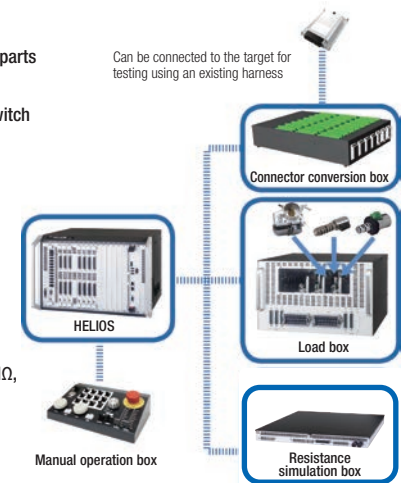
- Enables testing by placing an ECU inside a box with a built-in atmospheric pressure sensor
- Enables atmospheric pressure conditions to be changed

##### Resistance simulation box

- Enables simulation of temperature sensors, etc. (range of 1 Ω to 1 MΩ, 16 channels included)
- Up to eight can be connected

##### Breakout box

- Enables easy signal confirmation by connecting this between the board and the ECU
- Enables open circuits and short circuits for each signal line

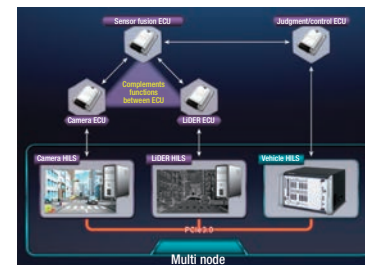


#### Multi-node

The use of PCIe 3.0 enables high bandwidth (8 Gbps) data communication and synchronization and the connection of multiple HILS and multiple CPUs.

This enables the construction of large-scale accurate models required for the testing of next-generation automobile development (CASE).

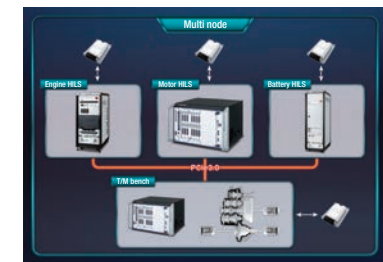
#### A&D's Integrated HILS



Achieves HILS testing of actual ECU for autonomous driving/Advanced Driving Assistant System, which has been difficult up until now.

- Connect multiple HILS
- Enables testing of complementary functions between ECU due to sensor failure

#### Link HILS to Test Bench



Test actual ECU while reproducing real driving phenomena on a test bed.

- Connect HILS and test bench
- A test environment close to the real world with little wasted communication time



# XILS Platform Software

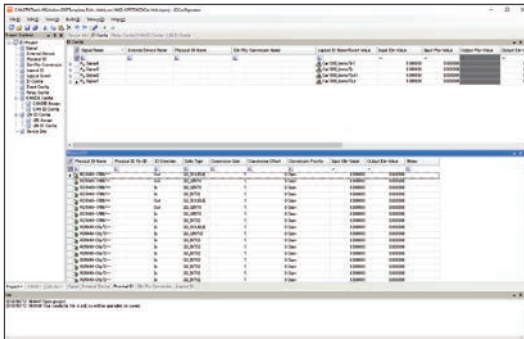
## XILS Platform Software

Simple Construction and Operation Enable Efficient HILS Testing

This product provides robust support for model-based development, such as model creation to test result management and interprocess linking with server software.

### IOConfigurator: Improves Model Reusability

IOConfigurator is software for connecting I/O and models. Model reusability has increased because the I/O information retained by the previous model is now managed in IOConfigurator. Model changes are not required when changing the I/O and ECU because the model does not retain the detailed I/O information.



- The I/O parameters for HILS can be set outside the model
- Contributes to model creating that is not dependent on I/O
- Contributes to model sharing between Software in the Loop Simulation (SILS) and Model in the Loop Simulation (MILS) and MILS

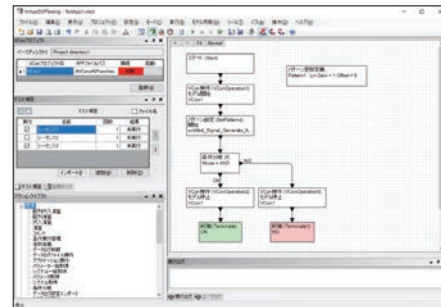
### GSIL: SILS Tool

A SILS tool that adopts the iTest platform. Enables easy environment construction and easy utilization of HILS and Bench assets. GSIL is software jointly developed with Ubiquitous AI Corporation.



### iTest-VSA: The New GUI Runtime Environment for HILS

A GUI runtime environment for HILS operations with excellent visibility. In addition to the functions required for HILS, iTest-VSA enables remote monitoring and linking with a remote management server.



- Easily create rich GUIs
- Also edit GUIs during HILS execution
- Share HILS functions between multiple HILS systems
- Python can be executed from the GUI by linking with Python



### Recording/Playback/Automation of DSP Operations

The block design visually provides an automatic testing environment. It also enables manual recording of parameter settings, playback, and real-time processing. Support for the ASAM XIL API enables the utilization of automatic testing tools from other companies.

### LabWorX: Centralized Management of Equipment/Data

Link with LabWorX to centrally manage multiple HILS systems and perform test data management and operation status monitoring from office PCs.



- Central management of the operation status of multiple HILS systems
- Automatic collection/management of test data
- Operation status monitoring from an office
- LabScheduler enables tests to be scheduled and performed automatically

# Motor HILS

A high-speed application for achieving motor HILS via an FPGA.  
Includes a highly expandable HELIOS platform and a VS2000-010 high-speed arithmetic FPGA board.

## Motor HILS

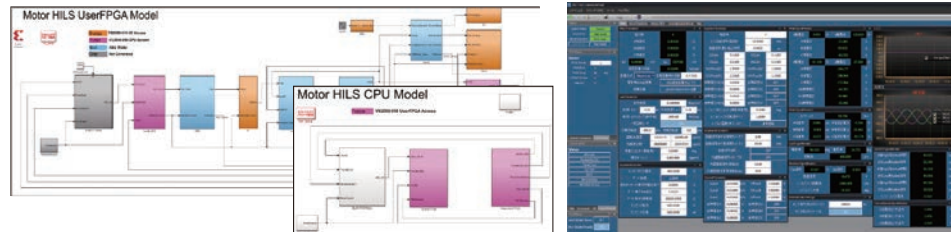
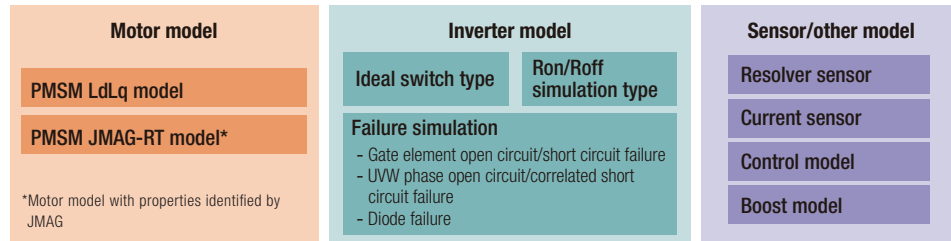
### High-speed Applications Via User FPGA Models

This product contributes to reducing man-hours for the development and verification of motor control logic via high-speed I/O and motor behavior reproduction via high-speed calculation enabled by an FPGA board.

- Includes the largest scale FPGA in the industry to operate large-scale/high-density models at a maximum speed of 200 MHz
- Includes high-speed I/O to support up to two motors
- Communication between FPGAs enables linking between multiple FPGA models
- Two types available with different FPGA capacities

### FPGA Model Lineup

A PMSM LdLq model is included as standard and can be used immediately after delivery.

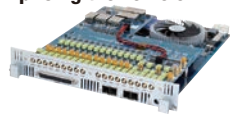


This product addresses concerns about insufficient FPGA resources and can be implemented with the accuracy of the JMAG-RT model maintained. In addition to the PM version compatible with LdLq/JMAG-RT, IM and boost converters are also available. The above models can be partially customized by the user.

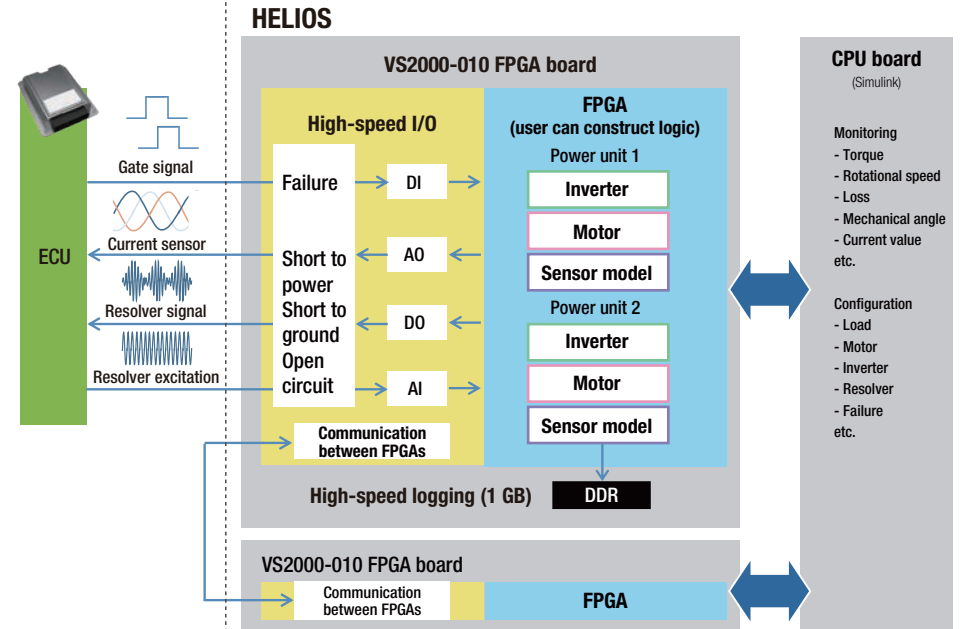


**AND** Discover Precision High capacity FPGA board **TTDC** High-accuracy model

Parallel calculation of models comprising the vehicle



### Configuration Example (Two Motor)



### Specifications

Specs		VS2000-010-060	VS2000-010-115
FPGA	Included FPGA	Kintex UltraScale (KU060)	Kintex UltraScale (KU115)
	FPGA logic capacity	725 k	1451 k
	DSP	2,760	5,520
	RAM	38 Mb	75.9 Mb
I/O	AI	4 channels/100 MHz/16 bit	
	AO	14 channels/50 MHz/14 bit	
	DI	12 channels/200 MHz	
	DO	4 channels/200 MHz	
Operation cycle		200 MHz	
Communication between FPGAs		8 lane x 2 port 4 Gbps high-speed serial communication	
Failure relay		Yes	
FPGA development environment		VS2000-010 Blockset (XSG/HDL coder)	MATLAB R2019b Vivado 2020.2

PTT  
XILS  
DSP Platform  
VDT/Force Sensor  
A&D Businesses

# Battery HILS

It enables arbitrary reproduction of cell charge/discharge states that are difficult to achieve with a real battery. This contributes to the efficiency

of cell charge/discharge states that are difficult to achieve with a real battery. of control logic development and verification for the BMS (battery management system).

## Battery HILS

### Efficiency of BMS Development/Verification

This is a HILS system for control logic development/verification for a BMS (Battery Management System). It enables arbitrary reproduction of cell charge/discharge states that are difficult to achieve with a real battery.

It supports third party battery models. System construction engineering from model embedding to the HILS connection of the BMS enables the provision of a turnkey system that can be operated immediately after delivery.

#### Functions

- Cell voltage output value setting
- Cell voltage/current monitor
- Open circuit between HILS and BMS (failure simulation)
- Noise superimposing
- Expandable to include sensor/switch simulation, communication, and power supply functionality

#### Features

- A compact HILS that combines functionality into one exclusively developed multifunctional I/O board
- Safe design
  - BMS stored in rack to prevent accidents caused by contact with the high voltage area (interlock function included)
  - Includes chassis internal temperature monitoring and overcurrent/short-circuit protection
- Automatic testing function
  - Enables the building of real-time testing synchronized with a model
  - Build automatic testing using flowcharts, scripts, and time-series data
  - Real-time playback of actual machine measurement data
  - Provides engineering service for building automatic testing environment
- Battery model
  - Battery models from NEXTY Electronics can be used
  - Calculates the battery state, such as the voltage of each cell, state of charge (SOC), state of health (SOH), and cell temperature
- Configuration/monitoring
  - Application included



#### Example Battery HILS Configuration

The entire unit can be stored in a rack.

Rack size: 570 mm (W) x 1440 mm (H) x 850 mm (D) (up to 192 cells)



#### Specifications of High Voltage Area

Type		Budget	Standard
Maximum cell count		264 cells (expandable from minimum 12 cells, in increments of 12 cells)	
Voltage output function	Range	Range: 0 to 5 V (16-bit resolution)	
	Accuracy	±0.02% of F.S.	
	Output current	±280 mA	
Voltage measurement function	Range	-	0 to 5 V
	Accuracy	-	±0.1% of F.S.
Current measurement function	Range	-	±200 mA/±20 mA
	Accuracy	-	±0.1% of F.S.
Disconnection function		Open circuit possible for each cell*2	
Noise superimposing function (optional*1)	Overview	-	Superimposes sine waveform on cell voltage
	Frequency	-	10 kHz
	Amplitude	-	1 Vp-p

\*1 The superimposing noise option is not available if there are more than 192 cells.

\*2 The maximum number of open circuits for continuous cells is 43 channels. There is no restriction on the total number of open circuits for the entire system.

# Battery Internal Impedance Emulator

## Battery Internal Impedance Emulator

### Cell Emulator Supporting Superimposed AC Method

This battery internal impedance emulator is a HILS device for on board BMS software development. It contributes to reduced development work by enabling battery-free BMS verification, which normally involves the preparation and management of real batteries.

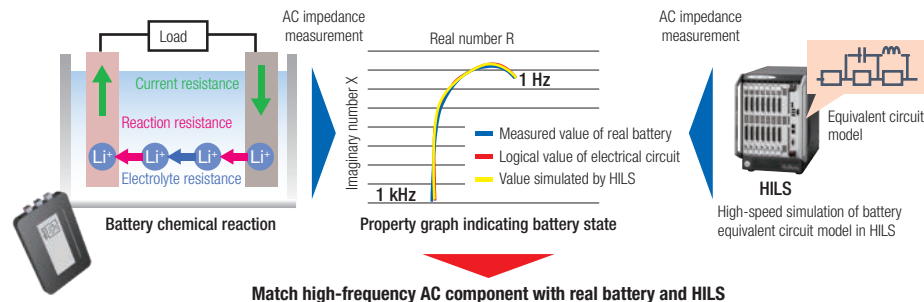
#### Features

- Enables battery properties and deterioration state to be arbitrarily configured for each cell
- Enables reproducible tests not dependent on environment or battery state
- Supports the more detailed superimposed AC method for estimating battery deterioration

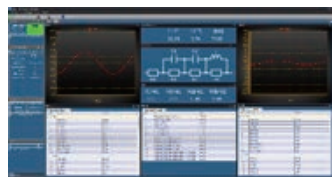
#### Principle

The superimposed AC method of battery evaluation provides higher accuracy deterioration estimation than using the DC component only, and is gaining attention in the field of on board BMS in recent years.

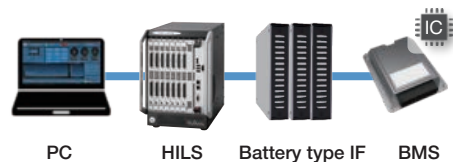
This product enables the reproduction of minute cell voltage variation caused by AC variation that flows as load.



#### Configuration Example



iTest-VSA (GUI)



# Engine HILS

## Engine HILS

### Providing an Engine HILS with Superior Constructability

This product provides hardware/software to reduce the user burden of environment construction and dramatically reduce startup time.

#### Features

- Able to directly measure injector/solenoid current (noise proof)
- Supports both direct injection and port injection, and enables switching in software
- Enables configuration of each load/solenoid in software
- Provides 10 systems per board without the need for an external relay in the ECU power supply line
- Supports a wide variety of communication interfaces
- Includes failure function (short to power or ground/open circuit)
- Graphical pattern creation software (crank/cam/knock)



# SELENE

## Rapid Prototyping Controller

### Compact DSP Controller with Low-temperature Resistance

SELENE is a compact, lightweight controller for various usage scenarios, and also supports model-based development.

#### Features

- Operating temperature range: -20°C to +60°C (power of 40 VDC or lower)
- Compact and lightweight
- Enables I/O expansion with expansion modules (up to two)
- Supports 48 VDC power supplies and operation at battery voltages
- Standalone operation possible



#### Module Lineup

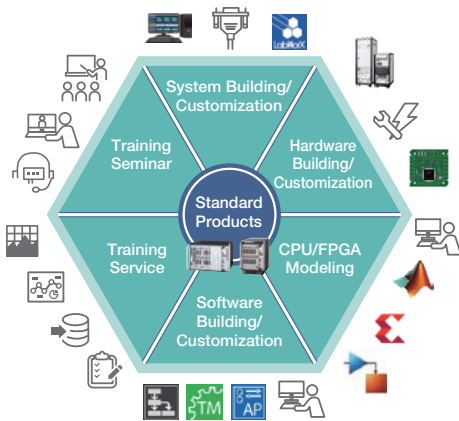
Module name	Included functions
CPU module (VS3100-001)	Included CPU: NXP i.MX61 1 GHz (Quad) CAN FD, LIN, SERIAL, USB 2.0, micro SD
Expansion IO module (VS3100-002)	AD, DA, PWM IN, PWM OUT

# HILS Engineering

## HILS Engineering

Providing Flexible Engineering via HILS Development Technicians at A&D

### HILS Engineering



Model-based development (MBD) has widely spread and development front-loading is now performed with MILS/SILS/HILS in various fields. However, companies have trouble finding the time to conduct ECU testing because of the various preparations required before adoption, as well as the training required after operation has started.

A&D has defined six fields of engineering to help our customers in this way.

We also provide flexible customization both during and after system adoption.

### Engineering Services

Menu	Description
System Building/Customization	We assist with the work required to prepare the customer to perform ECU testing.
Hardware Building/Customization	We perform hardware work for our customers and propose solutions to improve customer systems.
CPU/GPU Modeling	We create and modify control/plant models for the customer.
Software Building/Customization	We help achieve further efficiency with software functionality from the stage of software setup, including the GUI creation for operating and monitoring models in HELIOS, the creation of automation sequences for ECU testing, and implementation of functionality for automatically generating reports.
Testing Service	We provide a service for ECU testing using a HILS provided by the customer.
Training Seminar	We support human resource development at your company with training on HIL systems, including how to use the various software and hardware, and training on how to create FPGA models.

### Examples of Engineering Services

#### ■ System building/customization

- Support for ECU failure
- HELIOS environment setup
- IO communication settings
- External device/equipment connection
- Linking with HILS from other companies



#### ■ Hardware building/customization

- Harness design/production
- Load connection
- Switching circuit design
- Dedicated rack design



#### ■ Modeling CPU/customization

- Plant model creation
- FPGA model creation
- Third party tool linking



#### ■ Software building/customization

- GUI creation for testing operation
- IO configuration
- Automatic test pattern creation
- Automatic report creation



#### ■ Training seminar

- HELIOS basic training
- FPGA training (System Generator version)
- FPGA training (HDL Coder version)
- Other training



#### ■ Testing service

- Contracted ECU testing



# DSP Platform

Our DSP platform that combines model-based simulation with measurement/control based on AD/DA technologies can be utilized in various fields and applications.

Contributing to Solutions in Various Fields with a Platform Utilizing DSP Technologies



# Measurement/Control Hardware Platform

## Measurement Controller

### AD-PROCYON High Performance Measurement/Control Platform



AD5448-S    AD5448-M    AD5447-L

- Real-time simulator enabling parallel processing with multiple cores/CPU's
- Model-based design and coding-free environment using MATLAB/Simulink and Stateflow
- Synchronized sampling between boards and units
- Ultra-low-latency system
- Range of chassis selectable according to the required system scope/performance (5 slot/9 slot/20 slot chassis)
- Range of CPU boards selectable according to the required system performance
- Rich I/O expandability and versatility

Model	Name
AD5440-01	A/D 32 channel
AD5440-02	D/A 32 channel
AD5440-03	Digital I/O
AD5440-06	Multi-function I/O
AD5440-10A	Synchronization between units
AD5440-13A	PWM input/output
AD5440-17	On board network
AD5440-30A	RAM monitor

Model	Name
AD5440-31	Engine HILS
AD5440-34	CAN-FD communication board
AD5440-76	Sine wave output
AD5440-77	SENT communication board
AD5440-78	Pattern output
AD5440-PX27	FPGA board
AD5440-PX27-M1	FPGA board (1 mezzanine board)
AD5440-PX27-M2	FPGA board (2 mezzanine board)

\*The I/O board lineup is subject to change.

### AD5436B Generic Measurement/Control Platform



AD5436B

- Real-time simulator including Intel® Core i3-7100E 2.90 GHz dual core processor
- Model-based design and coding-free environment using MATLAB/Simulink and Stateflow
- Synchronized sampling between boards and units
- 8-inch color LCD (touch panel) and function keys
- Standalone operation
- Rich I/O expandability and versatility
- Mount a maximum of seven I/O boards

Model	Name
AD5430-01A	Generic 16 channel AD
AD5430-02C	Generic 8 channel DA
AD5430-03	Digital I/O
AD5430-11B	6 axis encoder input
AD5430-12A	Timing detection
AD5430-13	PWM input/output

Model	Name
AD5430-17B	On board network
AD5430-18	3 phase PWM motor control
AD5430-20	100 kHz 8 channel high-speed AD
AD5430-71	AUD interface
AD5430-34	CAN-FD communication board

\*The I/O board lineup is subject to change.

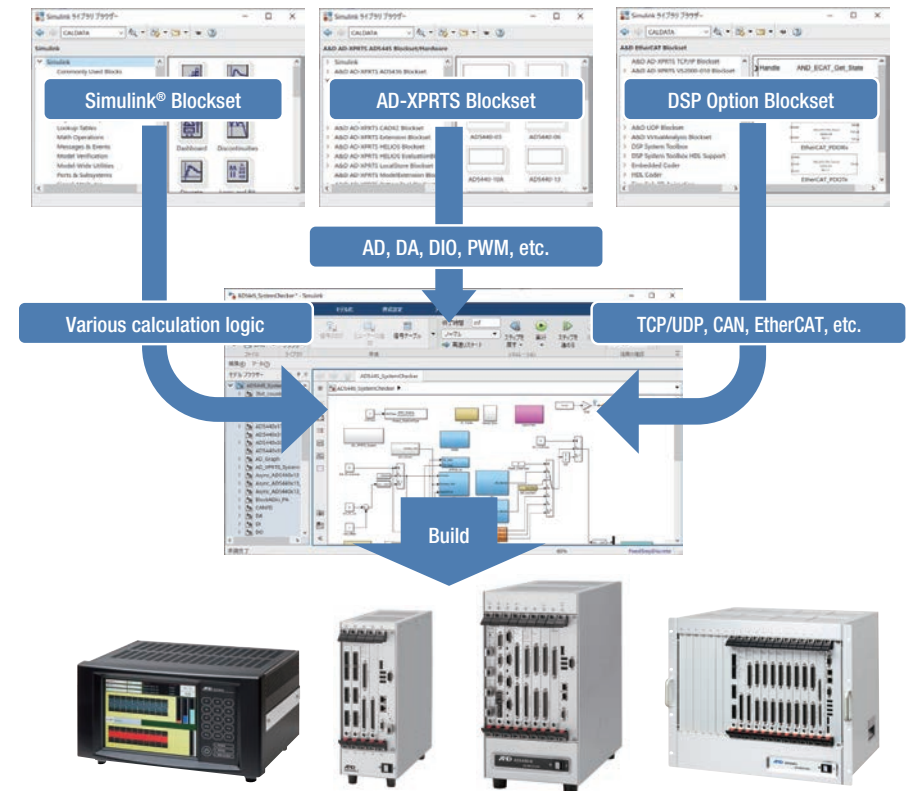
# Model Development/Execution Environment

## AD-XPRTS SW Development Environment

### Development Environment Platform

The model development/execution environment platform provides a development environment for the creation and real-time execution of MATLAB/Simulink models so users can achieve high-accuracy measurement/control equipment at will.

- **AD-XPRTS Blockset**  
Provides the functionality of A&D hardware I/O as an S-Function part.
- **DSP Option Blockset**  
Provides the functionality not provided in the standard blockset as an S-Function part.
- **Simulink model build environment**  
Provides an environment for building the created Simulink model.  
The built and generated module can be executed in real-time on the measurement/control platform.



The measurement/control platform enables the execution of high-speed measurement/control/real-time simulation based on a real-time OS.

# iTest-DC (DSP Control)

GUI Software for DSP Platform

## DSP GUI Software Platform

In addition to the basic functionality for changing control parameters and monitoring measurement signals, this product includes a variety of functions for creating applications. We provide more advanced testing environments



### SolutionBuilder

- Enables Windows applications to be easily created  
Create screens, scripts, and settings on a single screen.

GUI

Use multiple DSP systems at the same time

Create screens

● GUI creation tool

### LabAgent

- Enables various equipment to be connected to the A&D server app (LabWorX).  
Enables centralized management of equipment/testing data and automatic report generation

Consolidate models, screens, and sequences

Management tool

### AutomationPanel

- Enables the screen construction and execution of Windows applications.  
Enables screen construction while the application is executing.

Operate as application

● DSP execution environment

Use in various types of measurement control and simulation

### (Optional)

- Provides an automatic testing environment for the DSP system  
Test blocks enable code-free testing synchronized and asynchronous with an RT environment.

Perform automatic testing

Execute sequences in real-time

● Automatic DSP testing



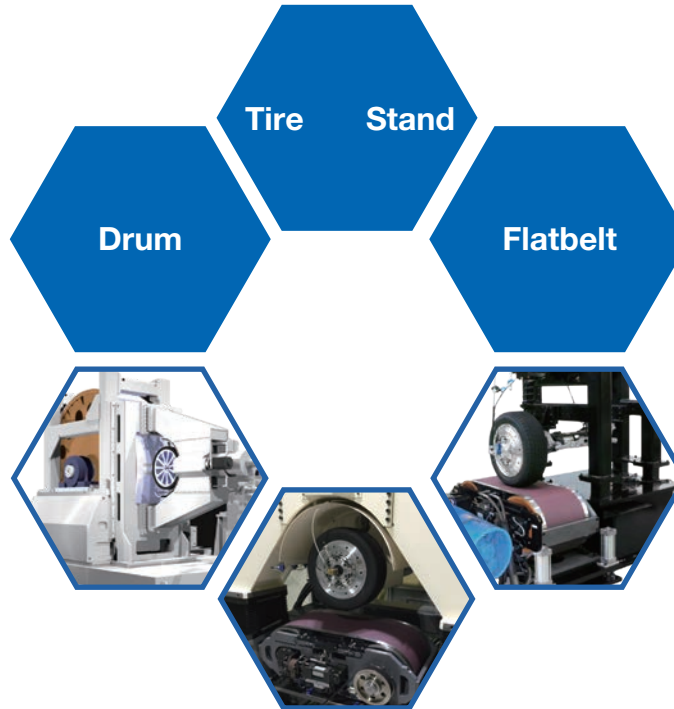
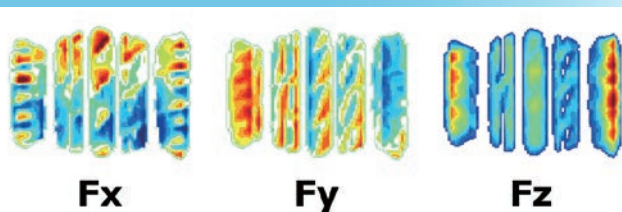
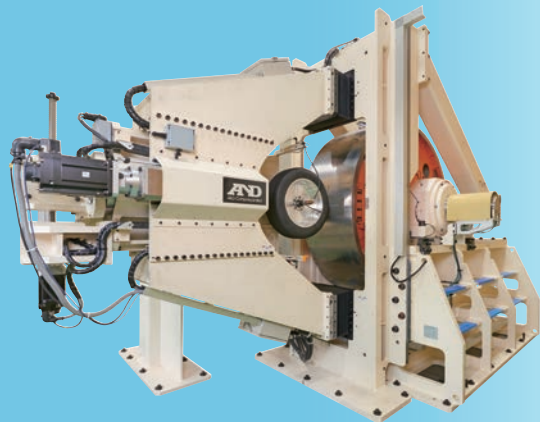
# Contributing to MBD Development in the Field of Tire/Vehicle Testing

## Vehicle Dynamics Testing

### Large Drum Type Tire Tester

Measures the force generated on tires and road surfaces in an environment similar to a flat road

- A drum internal ground component force sensor (small three component force sensor) measures the dynamic tire ground force distribution
- Large curvature radius (Ø3.2 m) steel drum + high-accuracy tire stand



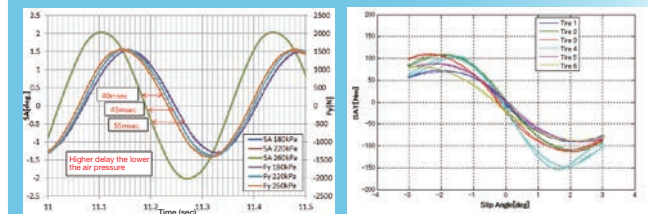
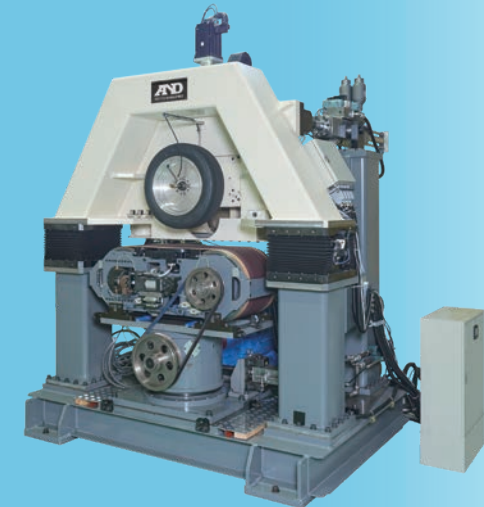
### Tire Stand

A function that reproduces the state of an actual vehicle driving operation to data to assist tire transfer function analysis

### Flatbelt Tire Testing Machine

Correct device control and correct measurement

- Correct device control:
  - High-speed response of FEM analyzed high-rigidity device
  - Good tire posture accuracy
  - High-accuracy belt meandering prevention control with horizontal belt displacement of  $\pm 0.5$  mm or less
- Correct measurement:
  - A&D sensing technology 6 component force sensor
  - High-accuracy measurement of micro steering force



# On-Board Measurement System

## Vehicle Measurement System

Visualize Vehicle Behavior Based on Wheel Input



### 6 Component Wheel Force Sensor



Visualize input to wheel at high resolution

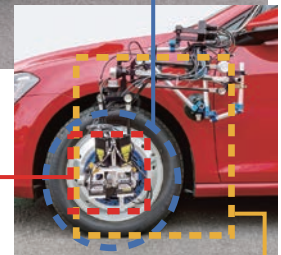
Force resolution: 6 N/1 Nm  
Angle resolution: 360/6,400 deg  
Sampling: 10 ksps

### Laser Ground Sensor



Quantify vehicle ground speed

Speed detection range: 0 to 120 km/h  
Speed resolution: 0.2 km/h



### Wheel Posture Sensor



Visualize wheel behavior at high resolution.

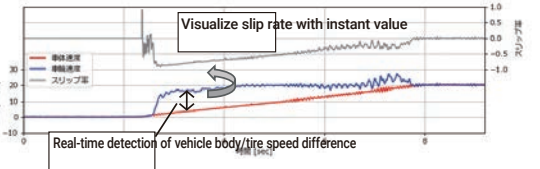
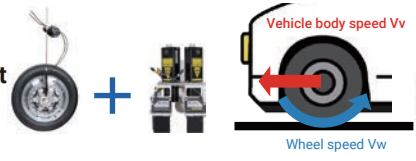
Detection resolution: 0.02 mm/0.003 deg  
Sampling: 10 ksps

### VMS Logger

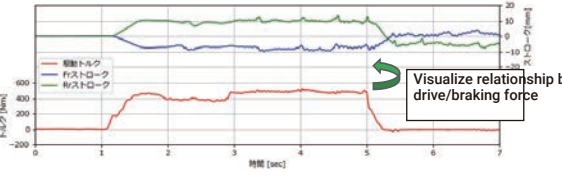
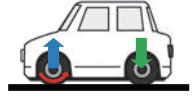


A VMS logger can be used to collect synchronized measurement

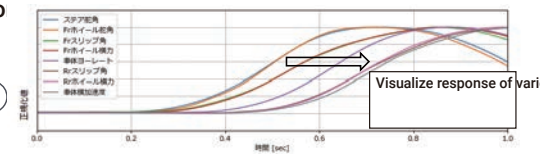
Example on-board vehicle



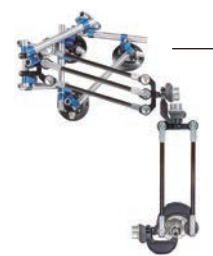
### <Measurement of suspension stroke behavior>



### <Measurement of handling delay behavior>



Each sensor controller enables data saving and external output

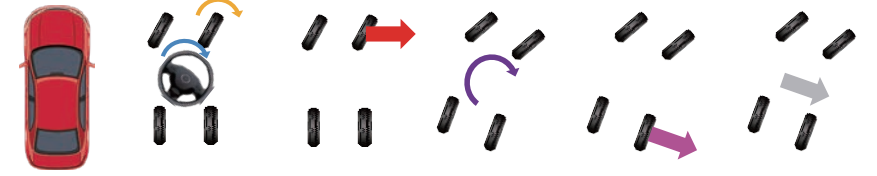


➔ Analog voltage output  
➔ CAN output



Save files to external media

Move fr Steering op Fr CF Yaw rate Rr CF Vehicle bo



P.T.T  
XIL-S  
DSP Platform  
VDT/Force Sensor  
A&D Businesses

# 3 Component Force Sensor/6 Component Force Sensor

## Plate Force Sensor

Enables Real-time Measurement of 3 Component Force/6 Component Force in Various Situations

Measure at accuracy of total error 0.1%

Real-time output of measurement data at high-speed rate of 10 kHz

Usable with various applications

(Example application: Road surface reaction force measurement of tire attached to real vehicle, engine/suspension mount reaction force measurement, and wind tunnel balance, etc.)



AD7827-102-3K



AD7827-112-30K

6 component force sensor 3 component force sensor

### <Example usage of 3 component force sensor/6 component force sensor: Evaluation of vehicle response property>

Bury 3 component force sensor Attach gyro sensor to vehicle body in road surface



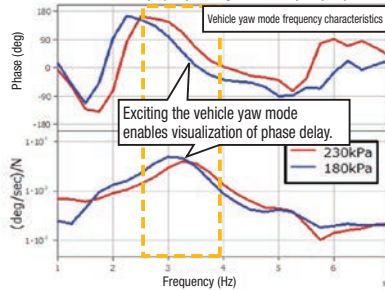
Measure the lateral force input to the vehicle body as the road surface reaction force

Measure the yaw rate indicated as the lateral force response



3 component force sensor with cleats buried in road surface

Evaluate vehicle yaw mode from road surface lateral force (input) and yaw rate (output)



The vehicle yaw mode is excited to identify the difference in yaw behavior caused by different tire air pressures

## We also accept requests for regular calibration of A&D sensors.

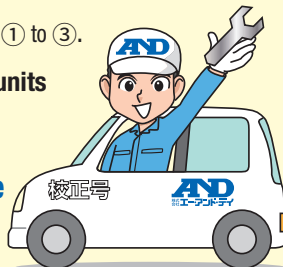
Please send us a query upon confirming the information below in ① to ③.

- ① Calibration schedule
- ② Model name
- ③ Number of units



Symbol indicating that contracted testing is available

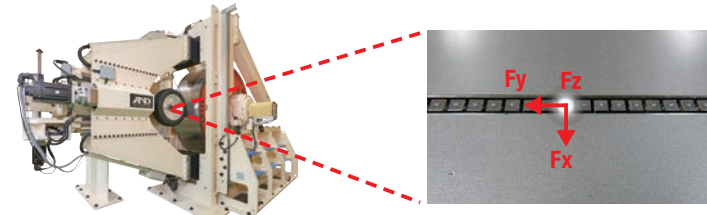
Please contact your nearest A&D office.



# Ground Component Force Sensor

## Force Matrix Sensor

Visualizes the Distribution of the Force the Tire Applies to the Road Surface



DCFR: Dynamic Contact Force Testing Rig

Installed inside drum of DCFR

### Ground Component Force Sensor

- Visualize force distribution and shape of the tire touching the ground.
- Enables simultaneous measurement of force in three directions (Fx, Fy, and Fz) instead of only Fz.

Sensor size: 7.5 mm

Sensor pitch: 8 mm

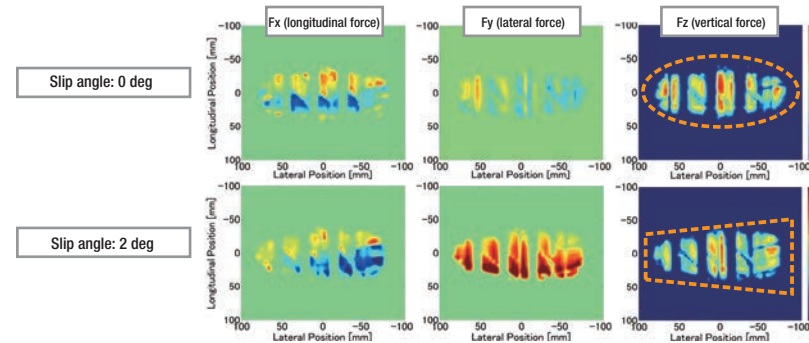
Capacity: Longitudinal force Fx of 50 N, lateral force Fy of 50 N, and vertical force of 100 N

Sensor size: 3.5 mm

Sensor pitch: 4 mm

Capacity: Longitudinal force Fx of 30 N, lateral force Fy of 30 N, and vertical force of 50 N

### <Measuring impact of slip angle>



The force distribution and shape of the tire touching the ground differ with slip angles of 0 degrees and 2 degrees.

Even the force distribution inside the block of the tread pattern can be determined.

JIS D 4234/ISO 28580 compliant

# Tire Rolling Resistance Test Equipment

Tire Rolling Resistance Test Equipment

Achieves Both High-Accuracy Data and Stability



## Features

This tester is an ISO 28580-compliant tire rolling resistance tester using the force method. The force method requires accurate measurements from the component force sensors attached to the tire rotation axis. A&D uses a high-accuracy proprietary 6 component force sensor to measure torque (Fx) with an accuracy greater than 1/1,000. Reproducibility is achieved with a standard deviation ( $\sigma$ ) of less than 0.05, meaning that it can be used as a rolling resistance tester in the operation of tire labeling systems from JATMA, and we have delivered more than 20 units in Japan and overseas.



PC-only type

## Main specifications

Item	Type	PC (passenger car)	TB (truck/bus)
Maximum load		15,000N	60,000 N
Measurement range (Fx)		±300 N	±600 N
Measurement accuracy (Fx)		±0.3 N	±0.5 N
Test speed		5 to 120 km/h	5 to 120 km/h
(options)		(up to 270 km/h)	(up to 270 km/h)
Applicable tire rim diameter		10" to 24"	17.5" to 24"
Exterior shape of tire		ø500 to ø900 mm	ø700 to ø1,500 mm
Tire-dynamic radius		220 to 520 mm	300 to 750 mm

- The road simulation drum is thermally sprayed with an aluminum cast with a steel surface, achieving both strength and a lighter weight and reducing the power consumption of the motor



6 component force sensor for PCs

Aluminum cast drum

Drum specifications of tester  
 Drum diameter: ø2,000 mm  
 Drum width: 600 mm  
 Material: Aluminum cast

## Example of Test Data

### Typical Data for Standard Tires

ID	Calculation			Measurement				Skim test measurement					
	RR	RR (corrected)	RRC	Spindle force	Tire load	Distance (Drum surface - tire axis)	Ambient temperature	Drum speed	Spindle force	Tire load	Distance (Drum surface - tire axis)	Drum speed	Parasitic loss
	[N]	[N]	[N/kN]	[N]	[kN]	[mm]	[°C]	[km/h]	[N]	[kN]	[mm]	[km/h]	[N]
1/FWD	27.38	27.41	6.02	25.05	4.550	298.3	25.1	80.0	3.89	0.100	322.6	80.0	5.15
1/REV	26.80	26.86	5.90	25.99	4.550	298.3	25.3	80.0	5.25	0.100	322.6	80.0	6.94
2/FWD	27.34	27.40	6.02	24.98	4.550	298.2	25.3	80.0	3.85	0.100	322.6	80.0	5.09
2/REV	26.95	27.01	5.94	25.94	4.550	298.2	25.3	80.0	5.08	0.100	322.6	80.0	6.72
3/FWD	27.39	27.43	6.03	24.74	4.550	298.3	25.2	80.0	3.57	0.100	322.6	80.0	4.73
3/REV	26.73	26.77	5.88	26.09	4.550	298.2	25.2	80.0	5.40	0.100	322.6	80.0	7.14

ID	Rolling resistance coefficient			Repetition accuracy	
	1	2	3	Avg	$\sigma$
Fwd	6.02	6.02	6.03	6.02	0.004
Rev	5.90	5.94	5.88	5.91	0.027
Avg	5.96	5.98	5.96	5.97	0.012

# Vibrating Moving Belt

Excitation Type Moving Belt System

Reproduction of Rough Road Conditions on a Test Bed

## Example of Features and Practical Use

This system reproduces a bumpy road by applying vibration in the vertical and steer directions on the moving belt unit being used as a mock-up road on the test bed. The belt unit is made with a steel belt with an extensive history of success. Its excellent meandering prevention control is used to 30 Hz of vertical vibration and 3 Hz in the steering direction to reproduce steady running above 200 km/h.



Example use with moving belt unit with vibration function for vertical and steering directions

Belt drive unit

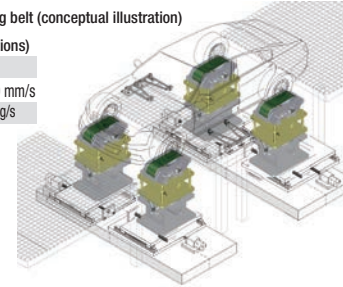
### 4-wheel drive rough road simulator using moving belt (conceptual illustration)

#### Abbreviated Specifications (Operating Specifications)

- Belt speed: Max. 200 km/h
- Vibration performance: Vertical: ±50 mm, 25 Hz, max.500 mm/s
- Steering: ±20 deg, 3 Hz, max. 50 deg/s
- Withstand lateral force per wheel: Max. 10 kN
- Withstand load per wheel: Max. 12 kN

#### Abbreviated Specifications (Vehicle Specifications)

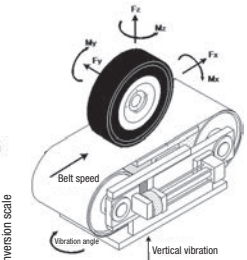
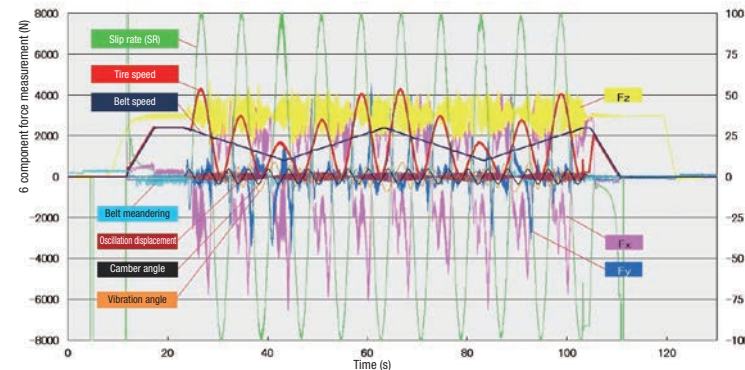
- Wheel base: 2,200 mm to 3,000 mm
- Tread: 1,350 mm to 2,400 mm
- Vehicle weight: Max. 4 ton



Air bearing (all carbon)  
 Contains various moving belt technology from A&D, including all-carbon air bearings, high meandering prevention control with laser sensing, and eddy current crack detection and warnings.

## Example of Test Data

Below is an example of test data recorded for the force occurring in each direction between the tires and road surface during simultaneous sweeping of cycles with differing steer angle, camber angle, speed, slip rate, vertical position on road and load.



- Belt speed: 10 to 30 km/h, acceleration/ deceleration: 20 sec
- Initial tire pressing load: 3 kN
- Camber angle: ±5 deg, 5 deg/sec
- Vertical oscillation: ±0.2 to 3.5 mm, 20 to 1 Hz
- Vibration oscillation: ±1 to 10 deg, 1 to 0.1 Hz
- Slip rate: ±0 to 100%

# Flatbelt Tire Tester

## Flat Belt Test Rig

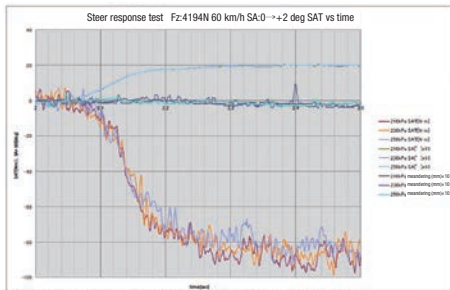
Cutting-Edge Driving System Using Mechatronics



There are two methods for performing running tests and tire tests of vehicles on test beds: the roller type and flatbelt type. The flatbelt type is preferable when taking into account factors such as the contact area between the tire and the driving surface.

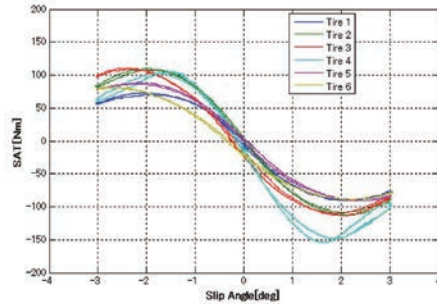
A&D's moving belt system is a cutting-edge system developed as a basic drive part for machines such as tire testers and chassis dynamometers for two-wheeled and four-wheeled vehicles.

### Example of Measurement Data



Graph: Example of A&D belt tester data (195/65R15 comfort tire, air pressure level 3, sampling at 1 kHz, no filter)

Enables plotting of 1 kHz sampling data without averaging or filtering



1-return SAT (0 deg -> 3 deg -> 0 deg -> 3 deg -> 0 deg) in 6 types of name-brand tires

### Example Use of Tire Testing System

Belt speed: ±180 km/h	Tire speed: ±203.5 km/h
Applicable tire diameter: ø500 to 900 mm (O.D.)	(for tires of 600 mm diameter)
Peak load: 10 kN	Tire driving force: Min. 2,500 Nm
Belt straightness: ±1 mm	(rated value for 30 seconds)
Slip angle: ±20 deg, within ±0.03 deg, 20 deg/sec	Belt material: Steel
Camber angle: -5 to +30 deg, within ±0.03 deg, 5 deg/sec	Belt size: Width 450 mm, 800 mm between pulleys
	External dimensions: 2,600 (W) × 2,500 (D) × 3,000 (H)
	Mass: Approx. 8,500 kg

### Delivery Examples



Moving floor belt system for large wind tunnels made for Nissan Motor Co., Ltd.



Belt testing machine for small tires made for Nagoya University



# Belt Type Suspension Test Rig

## Belt Type Suspension Test Rig

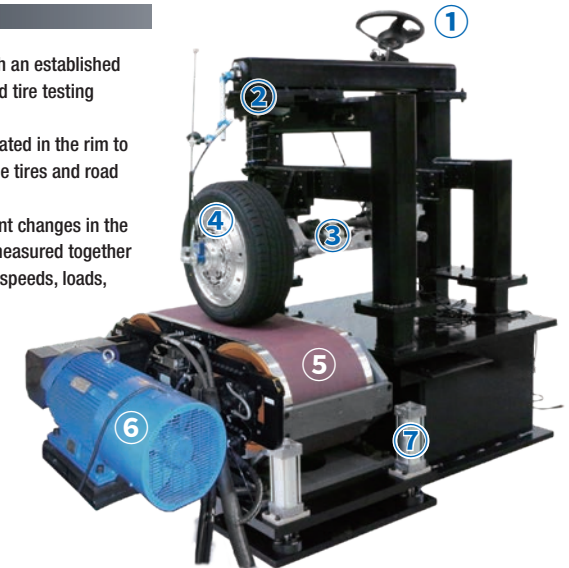
Achieves Test Bed Flat Road Testing Using Real Vehicle Suspension



When developing suspension, it is necessary to achieve subtle riding comfort and driving stability in various driving conditions. The belt type suspension unit contributes to this development by reproducing flat road steering tests on a test bed.

### Features

- The moving belt unit includes air bearings with an established reputation in wind tunnel testing machines and tire testing machines.
- A 6 component wheel force sensor is incorporated in the rim to measure the 6 component forces applied to the tires and road surface in a steering state.
- Various sensors enable deviation and alignment changes in the suspension parts during actual driving to be measured together with the received load in various drive states (speeds, loads, and steering situations).



### Example Specifications

	Speed	Max. ±180 km/h
Belt flat road surface	Bear support width	440 mm
	Maximum withstand lateral force	10 kN
	Peak load	10 kN
	Belt meandering	±1 mm
Belt unit	Belt size/pulley diameter	450 (W), ø500 mm
	Belt manufacturer	Sandvik
Belt drive	Drive output	215 kW (electric)
	Maximum road surface drive power	3,000 N
Other	Belt trace detection	Laser sensor
	Crack detection mechanism	Via eddy sensor
	Load support method	Air bearing

### Example Applications

- Automatic steering machine
- Strut base 6 component force sensor  
Accurately measures the directional forces transmitted to the strut base
- Suspension unit
- 6 component wheel force sensor  
Accurately measures the directional forces transmitted to the wheel rim
- Moving belt unit
- Belt drive motor  
Drives and controls the rotation of the mock-up road (belt)
- Belt vertical mechanism  
Enables vertical vibration operation

# Hydraulic Testing Machine

## Hydraulic Testing Machine

### Outstanding Waveform Reproduction and Stable Long-time Testing

We provide fatigue durability testers, physical property testers, and strength testers to customers in the automobile and automobile parts industries.

- We respond to customer requirements to the maximum extent possible.
- We accept requests for servo valve maintenance.
- We also accept requests for the electrification of testers, including hydraulic power sources.
- We also provide support for carbon neutral hydraulic oil derived from plants.

(We offer these services both for newly adopted equipment and existing equipment (including testers from other manufacturers))

#### ■ Expansion/Compression Tester



- Optimal for expansion/compression fatigue durability testing
- Enables installation of actuator (up type/down type) to match the test piece
- Down type optimal for small test pieces and up type for large test pieces
- Allows installation of thermostatic bath to enable changes to the environmental temperature conditions of test pieces (optional)
- We produce both hydraulic and electric actuator type testers
- Servo amplifier and testing software enable production of dedicated testers

#### ■ Twist Durability Tester



- Add arbitrary torsional moment to rod/cylinder shaped test piece to perform test piece measurement
- Enables measurement of the strength to torsion and yield point, shearing modulus, and torsional angle at rupture
- Secures one side of the sample with a chuck jaw, etc. and rotates the other side at a constant rotation/force (torque)
- Measures the twist count until rupture, twist torque value, and twist angle, etc.
- Also enables the transmission torque and twist rotation fatigue testing of the motor shaft or drive transmission shaft (propeller shaft) of vehicles or vessels

#### ■ Impulse Tester



- Outstanding waveform reproduction
- Stable long-time testing
- Reproduction of various environmental conditions (temperature, pressure, and vibration)

Samples

- Hoses for hydrogen stations
- Samples for vehicles (hoses, fuel cell cases, valves, gaskets)
- Samples for general industry (pipes, hoses)

#### ■ Steering Tester



- Features a full digital controller for control on the input drive side/load absorption side to enable testing specified by the customer. We propose hydraulic servo types and electrical servo types to meet various requirements.
- Also ask us about extended support for HILS linking systems and support for various third party models
- We investigate the various requirements for performance testing, durability testing, and property testing
- Evaluates durability by repeatedly applying rotation load to the sample (steering assembly)
- Enables rack and pinion forward/reverse testing
- Gear testing
- Power steering pump testing

#### ■ Seat Belt Tester



- Enables testing according to standards such as FMVSS210 and UN14 (also child anchorage and sliding door strength, etc.)
- Seamless execution of everything from testing to report creation with dedicated software
- Achieves excellent controllability and response via a digital controller
- Also supports control system updating and upgrading

#### ■ CC-04 Controller



- Includes function for constant control of load/displacement
- Enables fatigue/durability testing with a single unit
- Includes signal generator for sine waves, square waves, triangular waves, and SAE waves
- Has remote control and enables phase control of multiple actuators

#### ■ Hydraulic Vibrator

- Portable and portal types available
- Enables selection of hydraulic and electric actuator power sources
- Supports two axes
- Supports thermostatic bath (-150° to 250°C \*Cooling with N2 liquid)

#### ■ Servo Valve

- A two-level nozzle flapper type electrical/hydraulic servo valve
- Supports high powers and high speeds and provides advanced controllability and tracking
- Suitable for a high-speed response and high-accuracy hydraulic control system
- Sapphires almost as hard as diamonds used as the tip balls of the feedback pin
- This head passed a 251,425,121 time durability test

# Parts, Materials and Physical Property Testers

## Universal Testing Machine

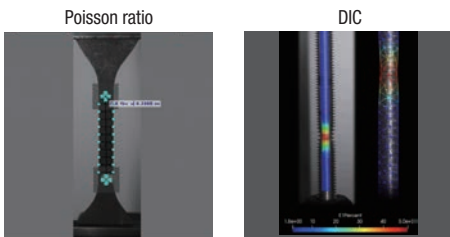
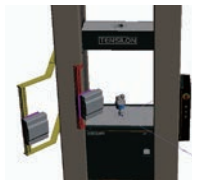
We supply various testers. Contact your nearest A&D office.

### Video Extensometer



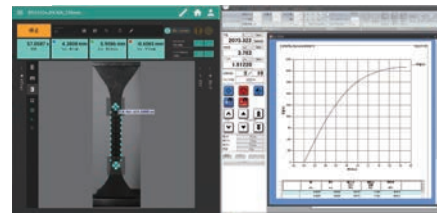
- Simply place the cursor over the sample mark in the software
- Select one of three types of cameras (2.3/5/9 MPx) according to your accuracy, measurement range, and budget needs
- Easily prepare the sample by marking it with a commercial pen or spray
- Optimal for highly extendable samples such as film or rubber
- Wide range of variations with mounting bracket and multiple cameras

Customizable mounting bracket to meet a range of **viewpoint needs**



### Wide Range of Applications

\*Additional applications required.



ALPHA  
(extensometer software)

TACT  
(TENSILON data processing)

### TENSILON Universal Material Testing Instrument



The TENSILON universal material testing instrument from A&D has been a favorite tester at many companies and laboratories, thanks to its excellent force sensor technology and its measurement and control technology that links together sensors and machines. We offer a wide range of models that support up to a maximum of 300 kN, such as the RTH series of high-accuracy measurement models that meet the requirements of Tester Level 0.5, and the RTI series (Level 1) with excellent cost performance.

- RTH series high-accuracy type: Load accuracy 0.3%: 1/1 to 1/100; 0.5%: 1/1 to 1/1000
- RTI series high-accuracy type: Load accuracy 0.5%: 1/1 to 1/500
- Wider speed range: 0.0001 to 1,650 mm/min
- Return speed: 1,650 mm/min
- 7-inch color touch panel
- Administrator function: Enables user management/usage restrictions by ID
- Wireless access: Enables operation log management
- Enables data transfers to smartphones
- Low noise
- In consideration of usage environment, 40% reduction compared to other A&D products (at speed of 1,000 mm/min)
- Achieves high-speed sampling of 0.2 msec
- Does not miss momentary load changes

### Automatic Tension Tester \*Supports automatic compression and bending

This product fully automates the process from sample loading to testing. Reduces measurer error (high reproducibility) Used with a wide variety of samples.

### Multi Tester \*Supports tension, compression, and bending

Optimal for testing of large amounts of samples, this product contributes to greater efficiency. Load cell mounted for each sample axis, space-saving design

### Desktop Tension Tester (Force Tester)

MCT2150W/2150/1150

### Small material testers

- Desktop installation means no moving to testing laboratory
- We provide jigs for various material testers
- Compact and portable (250 mm (W) × 405 mm (D) × 711 mm (H), from 17kg)
- Easy operations with touch panel
- Connect PC for operation and data analysis (when using MAST-Lite)
- Immediately use after turning power on



### Friction/Wear Tester (Thrust Type)

EFM series

Enables friction characteristics evaluation, dynamic friction coefficient measurement, and wear measurement

- Evaluate friction characteristics via combinations of various materials
- Evaluate relevance of surface treatment and friction characteristics
- Evaluate relevance of environmental conditions and friction characteristics



### High Pressure Atmospheric Tester

We provide friction testing environments with the high-pressure atmospheres required by our customers as refrigerants switch from CFC substitutes to green refrigerants. CO2, R32, R134a, HFO-1234yf, propane, and other gases are supported.

### Extensometer Lineup (Contact Type)

#### ■ Strain gauge type extensometer

<SG series>

- High resolution with strain gauge
- Ultra-lightweight extensometer for minimum impact on sample
- Distance between reference lines: 25 or 50 mm
- Maximum extension: 2 to 50 mm

#### ■ Extensometer supporting highly extendable samples

<U-4310 series>

- Optimal for highly extendable rubber/plastic samples
- Improved reproducibility with automatic clamp opening/closing
- Range of clamp edges selectable according to the sample
- Maximum extension: 1,000 mm
- Minimum reference line: 10 mm

# Industrial Measurement Device

## Recorder/Recording Equipment

### Omniace RA3100

The RA3100 is a data acquisition unit that can perform high-speed high-accuracy recording to a thermal printer and high-speed long-term recording to large capacity storage media.

- Multi-channel input Max 36 channels (for analog input)  
Max 144 channels (for logic input)
- High-speed sampling at maximum 20 MS/s
- Long-time recording
  - Memory capacity: 4 GB (when using 18 channels, 20 MS/s for 5.6 seconds)
  - SSD capacity: 256 GB (when using 36 channels, 1 MS/s for 50 minutes)
- Input unit: voltage, temperature, logic
- High-speed printing with a recording speed of 100 mm/s
- Playback of recorded data possible without ending measurement
- Enables Y-T waveform view, X-Y view, or FFT analysis during measurement



RA3100

### Omniace RA2300 MKII (-S)

The RA2300 MKII is a user-friendly data acquisition unit that achieves operation like a pen-written recorder via amplifier configuration screen visualization and a touch panel.

- Types
  - RA2300MKII (model with 320 GB HDD and maximum 16 channels of analog input)
  - RA2300MKII-S (model with 256 GB SSD and maximum 16 channels of analog input)
- Enables recording (paper feeding) and sampling via external synchronization signal
- Direct input from sensor
- Contains an amplifier unit supporting various signals (such as voltage, strain, temperature, vibration, pressure, and rotation pulse) to enable direct signal input from sensors
- Enables high-speed recording to an internal HDD or SSD over a long time
- Enables Y-T waveform view or X-Y view during measurement



RA2300 MKII (-S)

### Omnilight II RM1102

The RM1102 is a portable data acquisition unit with improved environmental durability.

- Enables input of up to 8 channels of voltage/temperature and 8 channels of logic signals
- Excellent portability
  - Provides fully-fledged measurement performance with a lightweight design of approx. 1.5 kg
- Continuous long-time operation with battery
- 3 types of measurement modes
  - High-speed sampling enables memory recording, long-term recording to SD card, and real-time recording to thermal printer
- Environmental durability
  - Durable body resistant to impacts and drops enables continuous measurement in vehicle running tests
  - Dust-proof and drip-proof design for use in all usage environments
  - Superior heat-resistance for use in extreme temperature environments (from -20°C to +60°C)



RM1102

## Signal Conditioners

### Strain amplifier



AS3503 AS3603 AS3703 AS3803 AS3903

AS3503: f property, DC up to 5 kHz, measurement range 500 to 50 kµε  
 AS3603: f property, DC up to 2 kHz, measurement range 200 to 20 kµε  
 AS3703: f property, DC up to 10 kHz, measurement range 500 to 50 kµε  
 AS3803: f property, DC up to 2 kHz, measurement range 200 to 20 kµε  
 AS3903: f property, DC up to 5 kHz, measurement range 500 to 50 kµε

### Charge amplifier



AG3103

- Enables input of charge type and voltage output type piezoelectric sensors  
 - Inclusion inside integrator enables measurement of speed and displacement in addition to acceleration

### Voltage amplifier



AL1101 AL1201A AL1301A

AL1101: 2 channel type, f property, DC up to 10 kHz  
 AL1201A: High-accuracy, high-speed response type, f property, DC up to 100 kHz  
 AL1301A: High withstand voltage type, input 10 mV to 2,000 V

### Compact remote control amplifier



AR1100

- 16 channel rack-mounted measurement amplifier controllable from a personal computer  
 - Enables input of voltage, strain, vibration, temperature, and rotation signals



AR1200

- 8 channel benchtop/on-board measurement amplifier controllable from a personal computer  
 - Enables input of voltage, strain, vibration, temperature, and rotation signals

## Sensors

### Strain gauge

Main types of strain gauge

Gauge pattern	Applications	Gauge pattern	Applications
	For wide range strain measurement		For measuring strain in a 2 shaft stress field
	For localized strain measurement		For rosette analysis
	For stress concentration measurement		Easy for errors to occur when the strain slope is large
	For twist strain torque measurement		

### AD1281 unguided strain gauge

This unguided gauge prevents noise from contaminating the measurement signal and reduces the induced voltage occurring in the strain gauge, even in environments where electromagnetic induction occurs.



### Strain gauge converter

Load converter 9E01 series

Type	Rated capacity (Pa)	Non-linearity (%R0)
High-accuracy type	20 N to 1 MN	0.015 to 0.05
Popular type	50 N to 1 MN	0.05 to 0.2
Compact type	500 N to 200 kN	0.15
Ultra compact type	5 N to 2 kN	1 to 2



9E07 series acceleration converter



Rated capacity: 20 to 10k (m/s<sup>2</sup>)

9E08 series displacement converter



Rated capacity: 5, 10, 20, 30 (mm)  
 Rated capacity: 30, 50, 100, 200, 300 (mm)

### Special load cell

Two axle simultaneous measurement type load cell  
 Simultaneous measurement of both the X axis and Y axis with a single unit

Model	Rated capacity (X axis)	Rated capacity (Y axis)
XY-500L/250L	5 kN	2.5 kN
XY-750L/250L	7.5 kN	2.5 kN
XY-100L/500L	10 kN	5 kN



### Washer type load cell

[RWL]  
 Rated capacity: 100 kN to 5 MN  
 Mass: 2 to 24 kg



### Piezoelectric acceleration sensor

Piezoelectric acceleration converter SV1000 series

Maximum usable acceleration : 100,000 m/s <sup>2</sup>	5,000 m/s <sup>2</sup>	5,000 m/s <sup>2</sup>	25,000 m/s <sup>2</sup>
Frequency range : Up to 20 kHz	Up to 1.3 kHz	Up to 7 kHz	Up to 20 kHz
Mass : 0.2 g	1.3 g	13.5 g	1.2 g

Acceleration converter with built-in amplifier SV2000 series

Maximum usable acceleration : 3,500 m/s <sup>2</sup>	[3 axis type] 5,000 m/s <sup>2</sup>
Frequency range : Up to 15 kHz	Up to 10 kHz
Mass : 19 g	4.4 g