High-speed processing for the next level of combustion analysis!

COMBUSTION ANALYSIS SYSTEM

DS-3000 Series
The ultimate combustion analyzer for research and development on increasing fuel efficiency with smaller engines.

With the ongoing research and development for improving combustion technologies (HCCI, EGR, etc.), new power sources (HEV and PHEV) and new fuels (biodiesel and natural gas) and the quest to increase fuel efficiency with a smaller engine, combustion analyzers are in greater demand than ever. Succeeding the DS-2000 Series combustion analysis system, which have the largest market share in Japan, the DS-3000 Series combustion analysis system meets growing expectations with its new, more powerful hardware.

Features

- Supports multiple types of fuels (Liquid fuel, gaseous fuel)
- Measurement and calculation in real time
- Trend display in real time
- Supports start / stop combustion testing
- Enables measurement without an encoder

With the ongoing research and development for improving combustion technologies (HCCI, EGR, etc.), new power sources (HEV and PHEV) and new fuels (biodiesel and natural gas) and the quest to increase fuel efficiency with a smaller engine, combustion analyzers are in greater demand than ever. Succeeding the DS-2000 Series combustion analysis system, which have the largest market share in Japan, the DS-3000 Series combustion analysis system meets growing expectations with its new, more powerful hardware.
Low-speed A/D input function

By adding the DS-0381 16-ch Low-speed A/D Unit for Combustion, environment specifications and other data can be measured. Measurements, made every 45°, are averaged out to obtain the representative cycle value.

<table>
<thead>
<tr>
<th>Angular Resolution [°]</th>
<th>The number of maximum cycles</th>
<th>Recording time (1,800 r/min average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>2,000</td>
<td>Approx. 2 min</td>
</tr>
<tr>
<td>0.1</td>
<td>4,000</td>
<td>Approx. 5 min</td>
</tr>
<tr>
<td>0.25</td>
<td>10,000</td>
<td>Approx. 10 min</td>
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<tr>
<td>0.5</td>
<td>20,000</td>
<td>Approx. 20 min</td>
</tr>
<tr>
<td>1.0</td>
<td>20,000</td>
<td>Approx. 20 min</td>
</tr>
</tbody>
</table>

* The above values apply to 4-ch operation. Values can change widely depending on the type of calculation, the number of channels used and other conditions.

Analog output function

By adding the DS-0382 16-ch D/A Unit for Combustion, calculated combustion values can be sent out as voltage signals during calculation monitoring. The combustion parameters whose functions can be shown during monitoring are programmable.
Software

Optional functions

**DS-0328T** Transient Combustion Analysis

This application software is designed for multiple cycle (extended) measurement such as transient mode tests (JC08 and JE05). Efficient analysis can be achieved by processing only the areas specified by cycle trends in transient measurement.

<table>
<thead>
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<th>The number of maximum cycles</th>
<th>Recording time (1,800 r/min average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>30,000</td>
<td>Approx. 30 min</td>
</tr>
<tr>
<td>0.1</td>
<td>60,000</td>
<td>Approx. 60 min</td>
</tr>
<tr>
<td>0.25</td>
<td>100,000</td>
<td>Approx. 110 min</td>
</tr>
<tr>
<td>0.5</td>
<td>100,000</td>
<td>Approx. 110 min</td>
</tr>
<tr>
<td>1.0</td>
<td>100,000</td>
<td>Approx. 110 min</td>
</tr>
</tbody>
</table>

* The above values apply to 4-ch operation. Values can change widely depending on the type of calculation, the number of channels used and other conditions.

**DS-0336** Combustion Link

Data communication through TCP/IP sockets enables the following processing. For example, synchronized recording of performance and combustion analysis data can be achieved by linking up to an engine bench.

- Specification setup (environmental specification, engine specification, fuel specification)
- Measurement condition / calculation setup
- Measurement start / calculation result output
- Calculation monitor start / reading of calculation monitor value

**DS-0337** Combustion Noise Analysis

CPL (Cylinder Pressure Level) is calculated based on cylinder pressure while CNL (Combustion Noise Level) is calculated based on the magnitude of engine structural attenuation. Calculation monitoring and trend and numerical displays are available. Angle sampling data enables combustion noise analysis.

Moreover, you can perform real-time octave analysis by adding the DS-0364 sound & vibration input unit.

**DS-0329** Knocking Analysis

Engine knocking is detected by monitoring for disturbance in cylinder pressure signals. Real-time processing for knocking values and occurrence rates are available. Calculation of knocking and thresholds are monitored and displayed in trend and numerical forms.

Knocking time waveform

Knocking frequency analysis

Overall monitor of combustion noise

Combustion noise
Overall trend graph

Approx. 30 min
Approx. 60 min
Approx. 110 min
Approx. 110 min
Approx. 110 min

0.05
0.1
0.25
0.5
1.0

30,000
60,000
100,000
100,000
100,000

DS-0324 4ch Input Unit

Time sampling

Angle sampling

Cylinder pressure
We developed a new algorithm which converts time sample data into high-resolution angle sample data. It converts small number input pulses such as 8 to 360 pulses per rotation into sample sequences of high angular resolution (e.g. 0.5 °) in real time. Therefore, both encoder-less measurements and stable measurements can be performed even during acceleration and deceleration.

This function measures crank angle pulse cycle and performs calculations. (The above graph is an example to show the start testing data using absolute angle text file (abs format).)

Measurement items related to fuel injection and combustion can be calculated. (Up to 10 stages)

- **Calculation items to each injection**
  - Maximum injection pressure, position of maximum value, valve-opening pressure, fuel injection start / stop position, center of gravity position for fuel injection rate, center of gravity position, ignition delay angle

- **Calculation items to each combustion**
  - Center of gravity position for heat release rate, center of gravity position, combustion start / stop position, cylinder pressure and gas temperature in a combustion chamber at combustion start position

Note: Please check carefully the specifications (magnitude and shape) of input angle pulse signal before purchase.
Engine torque data complete with cylinder pressure, friction and inertia for each cylinder is available. The analog output feature shows any fluctuation in a single cycle. (The above graphs have been created using absolute angle text files (in abs format).)

Calculation formulas can easily be created as required as part of basic combustion analysis functions.

Cycle-by-cycle analysis can be made by synchronizing combustion analysis data with CAN data, which is becoming increasingly important as the basis for automotive control.

### Table of optional functions and versions of hardware

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>DS-0328T Transient Combustion Analysis</td>
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<tr>
<td>DS-0329 Knocking Analysis</td>
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<td>○</td>
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<tr>
<td>DS-0383 CAN Measurement</td>
<td>○</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>

*1: When the DS-2000 Series is used as a measuring device, the degree of accuracy is less than that of the DS-3000 Series.

*2: Hardware option (VN1610 CAN interface) is required to use this function.
Hardware

**DS-3284 4 ch Combustion Analysis Unit**

- **AC adapter:** 60 W type (100 to 240 VAC / 1.4 A) / 150 W type (100 to 240 VAC / 2.5 A)
- **DC power supply:** 10.5 to 16.5 V
- **Power consumption:** 27 to 67 W
- **Operating temperature range:** 0 to +40 °C (With no condensation)
- **CE marking:** conformed
- **The number of maximum units:** 9 units (DS-0380: up to 28 ch, DS-0381 / 0382: up to 32 ch)
- **Weight:** approx. 3.1 to 8.5 kg
- **Interface:** USB 3.0 interface (USB 2.0 also can be used, however data transmission speed is slower than using USB 3.0)

**Assemble example:**
8 ch high-speed A/D input + 16 ch low-speed A/D input + 16 ch D/A output + 4 ch sound & vibration input

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**1 DS-3280 Main Unit for Combustion**

- **1 P/R input, angle pulse input**
  - Input method: single-ended
  - Input impedance: 100 kΩ
  - Coupling: AC or DC coupling
  - Voltage range: ±10 V
  - Absolute maximum input voltage: ±45 V
  - Minimum input voltage: 1.0 Vp-p
  - 1 P/R input: 0.5 / 1 P/R
  - Angle pulse input: 180 / 360 / 720 / 1800 / 7200 P/R

- **Isolation**
  - Isolated between "1 P/R input, angle pulse input", "External start input" and "Status output" (Common of 1 P/R input and angle pulse input is shared.)

- **External start input**
  - Input format: TTL or non-voltage contact signal
  - Internal pull-up resistor: 100 kΩ connected to internal +5 V
  - Minimum pulse width: 10 ms

- **Status output**
  - Output format: TTL

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**2 DS-0378 Pulse Input Unit for Combustion**

- **The number of input channels:** 4 ch / unit (Max. 28 ch)
- **Input method:** single-ended
- **Isolation:** isolated between units (COM signal of 4 inputs in an unit is shared.)
- **Input impedance:** 1 MΩ
- **Coupling:** DC coupling
- **Voltage range:** ±0.1 / 0.2 / 0.5 / 1.0 / 2.0 / 5.0 / 10.0 V
- **Absolute maximum input voltage:** ±50 V
- **Offset voltage:** ±100 % / voltage range F.S.
  (Error: ±1.0 % or less)
- **A/D resolution:** 16-bit sequential transformation type
- **Sampling frequency:** max. 1 MHz

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**3 DS-0380 4 ch High-speed A/D Unit for Combustion**

- **The number of input channels:** 4 ch / unit (Max. 28 ch)
- **Input method:** single-ended
- **Isolation:** isolated between units
  (COM signal of 4 inputs in an unit is shared.)
- **Input impedance:** 1 MΩ
- **Coupling:** DC coupling
- **Voltage range:** ±0.1 / 0.2 / 0.5 / 1.0 / 2.0 / 5.0 / 10.0 V
- **Absolute maximum input voltage:** ±50 V
- **Offset voltage:** ±100 % / voltage range F.S.
  (Error: ±1.0 % or less)
- **A/D resolution:** 16-bit sequential transformation type
- **Sampling frequency:** max. 1 MHz

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**4 DS-0381 16 ch Low-speed A/D Unit for Combustion**

- **The number of input channels:** 16 ch / unit (Max. 32 ch)
- **Input method:** single-ended
- **Isolation:** non-isolated
- **Input impedance:** 1 MΩ
- **Coupling:** DC coupling
- **Voltage range:** ±1.0 / 2.0 / 5.0 / 10.0 V
- **Offset errors:** ±0.1 % F.S. or less
- **A/D resolution:** 16-bit multiplex method
- **Sampling angle:** 45°

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**5 DS-0382 16 ch D/A Unit for Combustion**

- **The number of output channels:** 16 ch / unit (Max. 32 ch)
- **Output method:** single-ended (Common of each channel is shared.)
- **Isolation:** non-isolated
- **Output impedance:** 1 Ω or less
- **Load impedance:** 10 kΩ or more
- **Voltage range:** ±10 V
- **Maximum output current:** ±1 mA
- **D/A resolution:** 14-bit
- **Settling time:** 100 μs or less (From -10 V to +10 V)
- **Coupling:** DC coupling

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**6 DS-0364 4 ch Input Unit**

- **The number of input channels:** 4 ch / unit (Max. 4 ch)
- **Input method:** single-ended
- **Isolation:** non-isolated
- **Input impedance:** 1 MΩ
- **Coupling:** AC or DC coupling
- **Voltage range:** -40 dB to 20 dBVrms (10 dB-step, 7-range)
- **Residual offset:** -60 dB F.S. (-20 dB to 20 dBVrms range)
- **A/D resolution:** 24-bit Δσ type
- **Sampling frequency:** max. 102.4 kHz
- **Power supply current for sensor:** +24 V / 4mA

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**Note:** 150W type AC adapter is required in 5 or more units.
(Cooling fan is attached.)
CPU: Intel® Core™ i5 or more
Memory: 4 GB or more
Interface: USB 3.0 interface
   (USB 2.0 can also be used, however data transmission speed is slower than using USB 3.0)
OS: Microsoft® Windows® 7
   Ultimate / Professional
   (64/32-bit version)
Microsoft® Windows® XP
   Professional
   (SP2 or later / 32-bit version only)

CP-5110A  Crank Angle Detector
(Slit disk is required.)
- Optical fiber offering high resistance to noise
- Improved optical system offering reliable detection
- Compact and lightweight, so can be used even on engines with heavy vibration
- Designed to match your settings
- No bearings, therefore light rotational load

CP-5730  Crank Angle Detector
(Slit disk is included.)
- Optical fiber offering high resistance to noise
- Improved optical system offering reliable detection
- Weight reduction of the rotating parts and structural improvement of the rotation stops have increased the vibration resistance
- High-speed bearings offering smooth operation

CA-6000B  Crank Angle Amplifier
- Receives signals
   (Phase A: angle signals, 1 P/R: reference signals) from a crank angle detector;
- Sends out TTL level or analog signals
- Crank angle detector sensitivity matching through an external volume
- High noise resistance corresponding to the CE marking requirements
- Adaptable to different crank angle detectors with the flick of a switch

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