

COMBUSTION ANALYSIS SYSTEM

DS-3000 Series

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



ONOSOKKI

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

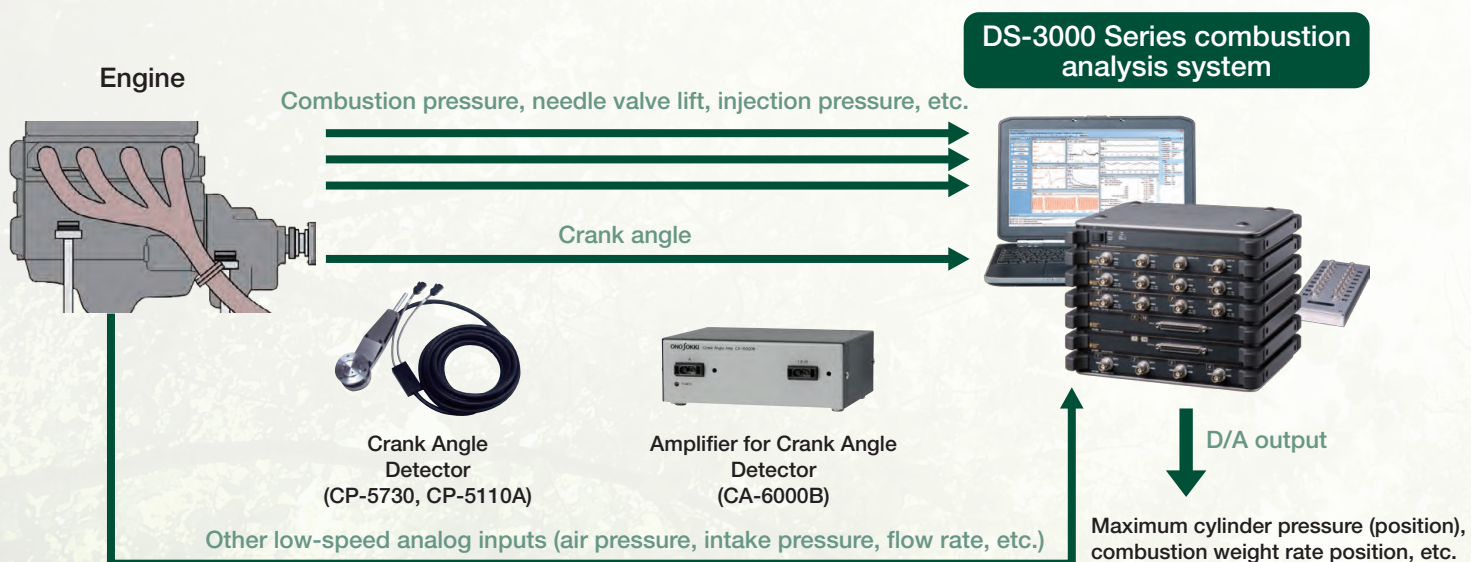
With the ongoing research and development for improving combustion technologies (HCCI, EGR, etc.), new power sources (HEV and PHEV) and new fuels (biodiesel and natural gas) and the quest to increase fuel efficiency with a smaller engine, combustion analyzers are in greater demand than ever.

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



Basic software of combustion analysis including monitor, measurement, calculation, and data storage functions.



- The number of input pulses: 180 / 360 / 720 / 1800 / 3600 P/R
- Angular sampling resolution: 0.05 / 0.1 / 0.25 / 0.5 / 1.0°
- Input rotation range: 0.05°:10 to 8,000 r/min
0.1°:10 to 16,000 r/min
0.25 / 0.5 / 1.0°:10 to 25,000 r/min
- Test mode: Manual, auto storage, starting test
- Setup specification (Environmental, engine, and fuel specifications)
 - Specific heat ratio calculations are possible, based on the entered fuel composition corresponding to thermodynamic calculation of liquid and gaseous fuel.
 - Liquid fuel: Setting of composition weight ratio for C, H, H₂O, O, S
 - Gaseous fuel: Setting of element ratio for C, H, O
 - EGR ratio, i.e. re-circulated gas weight, is calculated.
- Voltage monitor function
- 1 P/R and ANGLE pulse monitor function
- All cylinder TDC auto correction function
 - Corrections based by motoring and gap sensor
- Drift correction / physical quantity setting function
- Analysis function
 - List view, Crank angle diagram, Cycle trend diagram, Filter process (Moving average, FFT filter), Calculation method (Precise, Simple, K constant), Coolant heat loss ON / OFF, Selecting the correction formula of heat transfer coefficient / changing coefficient function, Measurement of low-speed A/D, high-speed A/D environmental specification value
- Calculating functions
 - Crank angle diagram:
 - Piston displacement, Cylinder pressure, Cylinder pressure rising rate, Heat release rate, Heat production, Combustion mass rate, Combustion gas temperature, Injection pressure, Injection quantity, Rate of fuel injection, Needle valve lifting amount, Arbitrary physical quantity, etc.

List display, trend display:

Engine rotation speed, Maximum value of cylinder pressure, Maximum value position, Heat production, Combustion mass rate position (every 10%), Combustion efficiency, Combustion start / stop position, Center of gravity value / center of gravity position for heat release rate, Maximum value / maximum value position of gas temperature in a combustion chamber, Constant volume degree, IMEP, NMEP, COV, Weibe function value, Fuel injection start / stop position, Center of gravity value / center of gravity position for fuel injection, Ignition delay angle
Others: P-V, Log (P-V)

- Overlaying / Multiple cycle window
With this application software, it is possible to overlay a selected set of data, one over the other. It is also possible to overlay the results of the current calculation over the calculation results of another CBD/CBDR file, and to overlay multiple cycle data one upon the other on the calculation results screen.
- Calculation results, both real-time and intermittent, shown on the same trend window
Real-time and intermittent calculation results can be paired as desired and shown in up to ten windows. Up to 20 functions can be shown in one window.
- Calculated waveform window data export
Θ diagrams and trend windows data shown on the screen can be exported as CSV files or in Metafile format.
- Others
Auto storage measurement, Simple operation measurement, External start input, Calculation cursor, Averaging process of calculation monitor, Setting for text file output format, Output of absolute angle text file, Continuous calculation / environmental specification file reading function, Graph scale zooming function, 1 P/R and 1 P/2R measurement function

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.

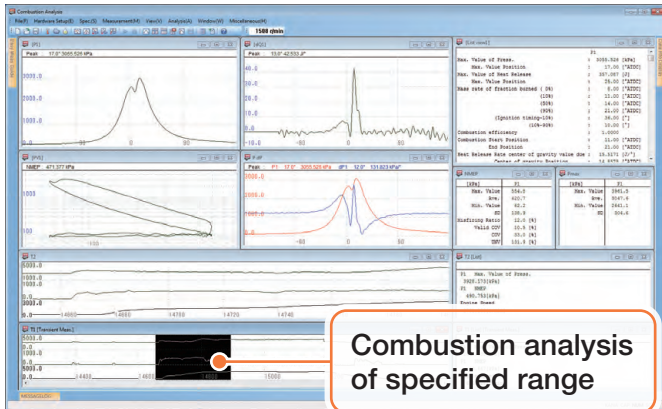
Analog output function

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.

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

* 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-0328T Transient Combustion Analysis

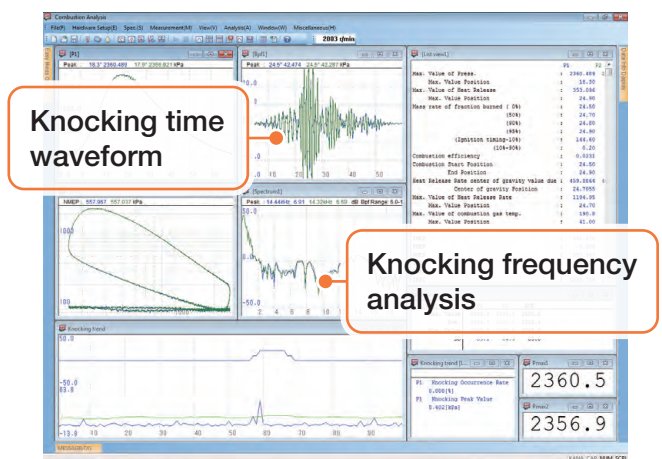


This application software is designed for multiple cycle (extended) measurement such as transient mode tests (JC08 and JE05). Efficient analysis can be achieved by processing only the areas specified by cycle trends in transient measurement.

Angular Resolution [°]	The number of maximum cycles	Recording time (1,800 r/min average)
0.05	30,000	Approx. 30 min
0.1	60,000	Approx. 60 min
0.25	100,000	Approx. 110 min
0.5	100,000	Approx. 110 min
1.0	100,000	Approx. 110 min

* 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-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.

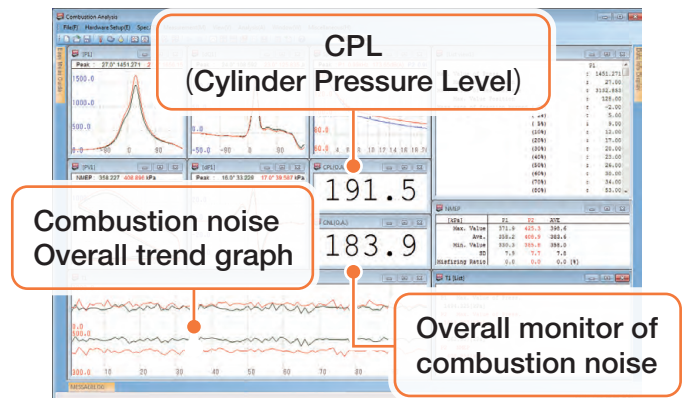
DS-0336 Combustion Link



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.

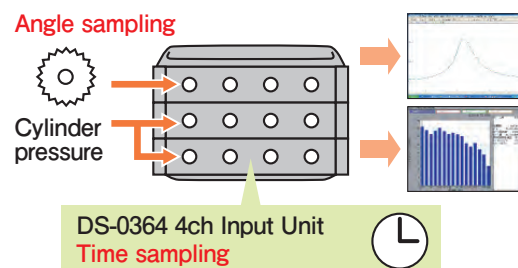
- Specification setup (environmental specification, engine specification, fuel specification)
- Measurement condition / calculation setup
- Measurement start / calculation result output
- Calculation monitor start / reading of calculation monitor value

DS-0337 Combustion Noise Analysis

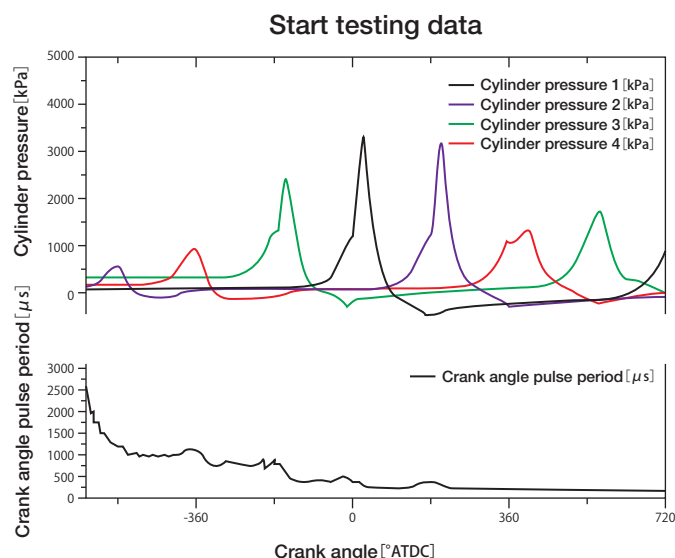


CPL (Cylinder Pressure Level) is calculated based on cylinder pressure while CNL (Combustion Noise Level) is calculated based on the magnitude of engine structural attenuation. Calculation monitoring and trend and numerical displays are available. Angle sampling data enables combustion noise analysis.

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



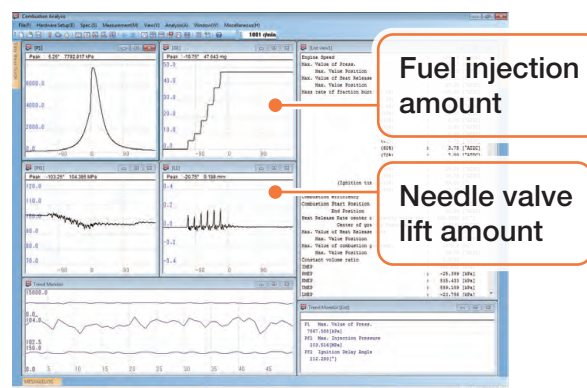
DS-0349 Crank Angle Pulse Period Measurement



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).)

DS-0358 Multiple Injection Analysis



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

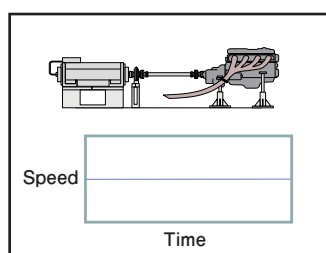
Center of gravity position for heat release rate, center of gravity position, combustion start / stop position, cylinder pressure and gas temperature in a combustion chamber at combustion start position

DS-0360 Encoderless Measurement

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.

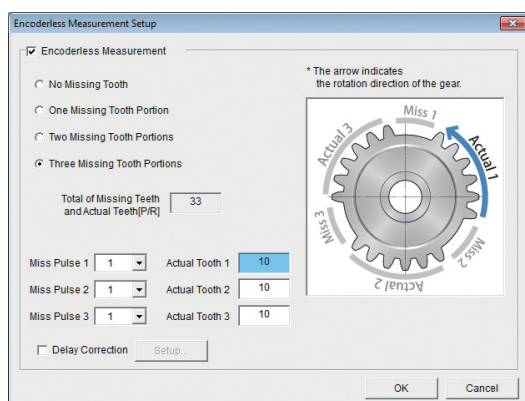
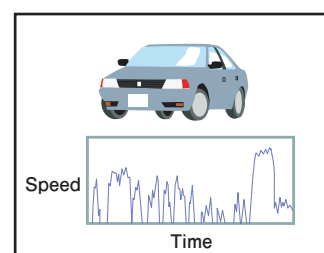
DS-2000

Supports steady driving on the bench



DS-3000

Designed for mode operation of an actual vehicle. Transient analysis can also be made.

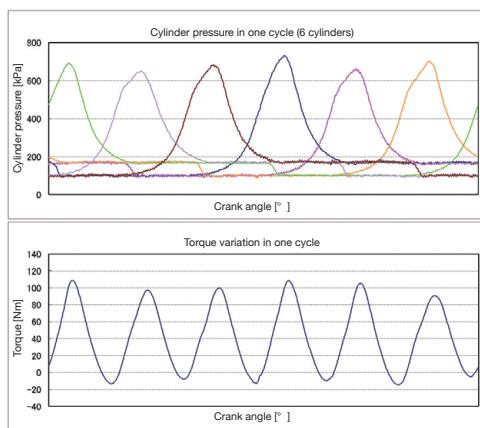
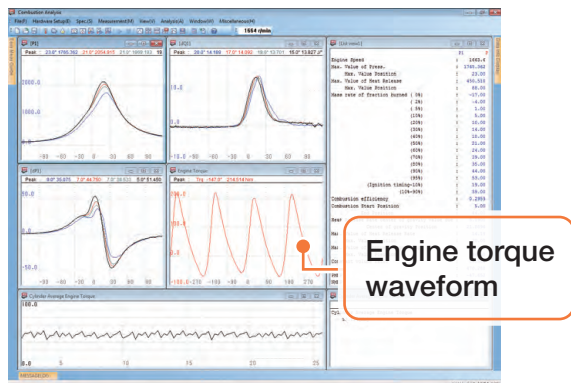


Measurements are based on small number pulses such as crank angle signals for ECU (missing teeth pulse signals) and ring gears, eliminating the need for a crank angle detection encoder. Delay correction is also available.

- Angle pulse: 8 to 360 P/R
- Missing teeth: 0 to 4 P / location (1 P/R needed for 0 P/location)

NOTE: Please check carefully the specifications (magnitude and shape) of input angle pulse signal before purchase.

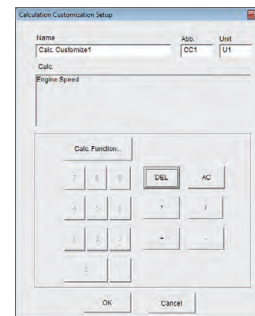
DS-0361 Torque Variation Analysis



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).)

DS-0363 Customizing Calculation



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

DS-0383 CAN Measurement

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.

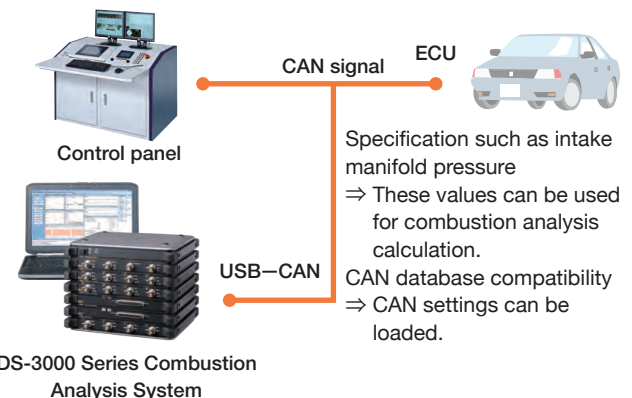


Table of optional functions and versions of hardware

Optional function	DS-3000 (DS-0380)	DS-2000 B version (DS-0280B)	DS-2000 A version (DS-0280A)	DS-2000 (DS-0280)
DS-0328T Transient Combustion Analysis	○	○	○	○
DS-0329 Knocking Analysis	○	○	○	○
DS-0337 Combustion Noise Analysis	○	○	○	○
DS-0349 Crank Angle Pulse Period Measurement	○	○	○	×
DS-0358 Multiple Injection Analysis	○	○	○	○
DS-0360 Encoderless Measurement	○	○*1	○*1	×
DS-0361 Torque Variation Analysis	○	○	○	×
DS-0363 Customizing Calculation	○	○	○	○
DS-0383 CAN Measurement*2	○	×	×	×

*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.

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)

Note: 150W type AC adapter is required in 5 or more units.
(Cooling fan is attached.)

1 DS-3280 Main Unit for Combustion

2 DS-0378 Pulse Input 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

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



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

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°

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

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)

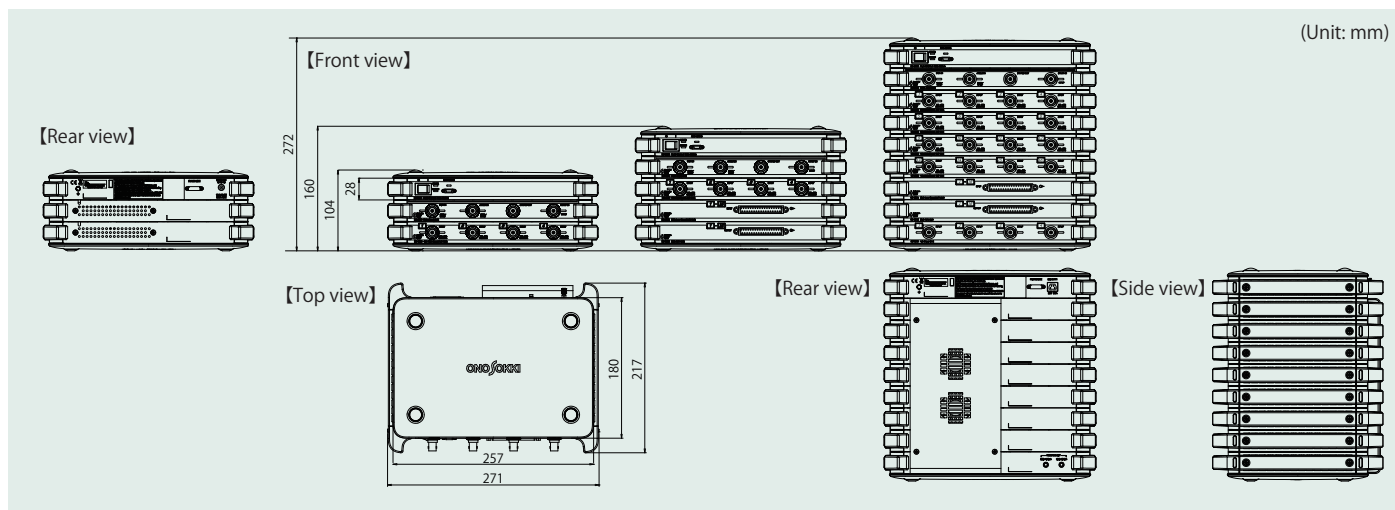
Residual offset: -60 dB F.S. (-20 dB to 20 dBVrms range)

A/D resolution: 24-bit Δσ type

Sampling frequency: max. 102.4 kHz

Power supply current for sensor: +24 V / 4mA

Outer dimensions



Operating environment

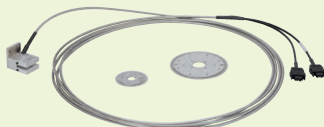
CPU: Intel® Core™ i5 or more
 Memory: 4 GB or more
 Interface: USB 3.0 interface
 (USB 2.0 can also be used, however data transmission speed is slower than using USB 3.0)
 OS: Microsoft® Windows® 7 Ultimate / Professional (64/32-bit version)
 Microsoft® Windows® XP Professional (SP2 or later / 32-bit version only)

Peripherals (sold separately)

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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