YOKOGAWA

Engine Combustion Pressure Analysis Package

FOR DL700, DL750 & WE7000

New feature: Analyze and display multiple data simultaneously

Yokogawa is pleased to introduce version4.00 which accomplished the further evolution

- Various types of engine analysis included as standard
- Analyze and display multiple data simultaneously *NEW*
- Analysis of waveform data from the DL750, DL708E/DL716, and WE7000
- Support for transient operations as well as normal operations
- USB 1.1 added for real-time monitor interface of DL750 *NEW*
- Gasoline, natural gas, and diesel versions available
- Saving and recalling of analysis conditions *NEW*
- Saving of analysis results in CSV format
- Support for 2-cycle and 4-cycle engines
- Support for 0.1° crank angle resolution (select 0.1, 0.25, 0.5, or 1.0)
- Support for both all-cycle-average and cycle-by-cycle absolute pressure correction methods
- Greater scope of analysis (LNV, misfire rate, and cylinder-to-cylinder average value) *NEW*

Turn Your General-Purpose Measuring Instrument into an Engine Combustion Pressure Analysis System

This software package lets you turn general-purpose measuring instruments used primarily in field experiments into an engine combustion pressure analysis system.

The Engine Combustion Pressure Analysis Package enables engine combustion pressure to be analyzed using measurement data from the WE7000 as well as the DL750 and other Yokogawa DL700 series instruments, which are widely used throughout the auto industry. The package also allows you to monitor analysis data during measurement by connecting your DL750 or WE7000 to a PC through an Ethernet connection or through USB 1.1 *NEW* (only for DL750).
Now that these general-purpose measuring instruments can be used for engine combustion pressure analysis, setting up engine data analysis equipment is much easier.

●**Recommended module for each measuring instrument**

	Maximum number of cylinders	Recommended module (card)	Real-time monitoring capability
DL708E	6	701853 (100 kS/s, 16-bit, 1 channel)	No
DL716	8	701853 (100 kS/s, 16-bit, 1 channel)	No
DL750	8	701251 (1 MS/s, 16-bit, 2 channels)	Yes
WE7000	8	707272 (100 kS/s, 16-bit, 4 channels) 707275 (1 MS/s, 14-bit, 4 channels)	Yes

*1 Reference measurement ranges for each sampling rate
100 kS/s: 0.5 CA-approximately 8000 rpms
1 MS/s: 0.1 CA-approximately 16,000 rpms

Analyze and display multiple data simultaneously *NEW*

Multiple analysis data can be checked simultaneously while performing on-line monitoring and analysis.

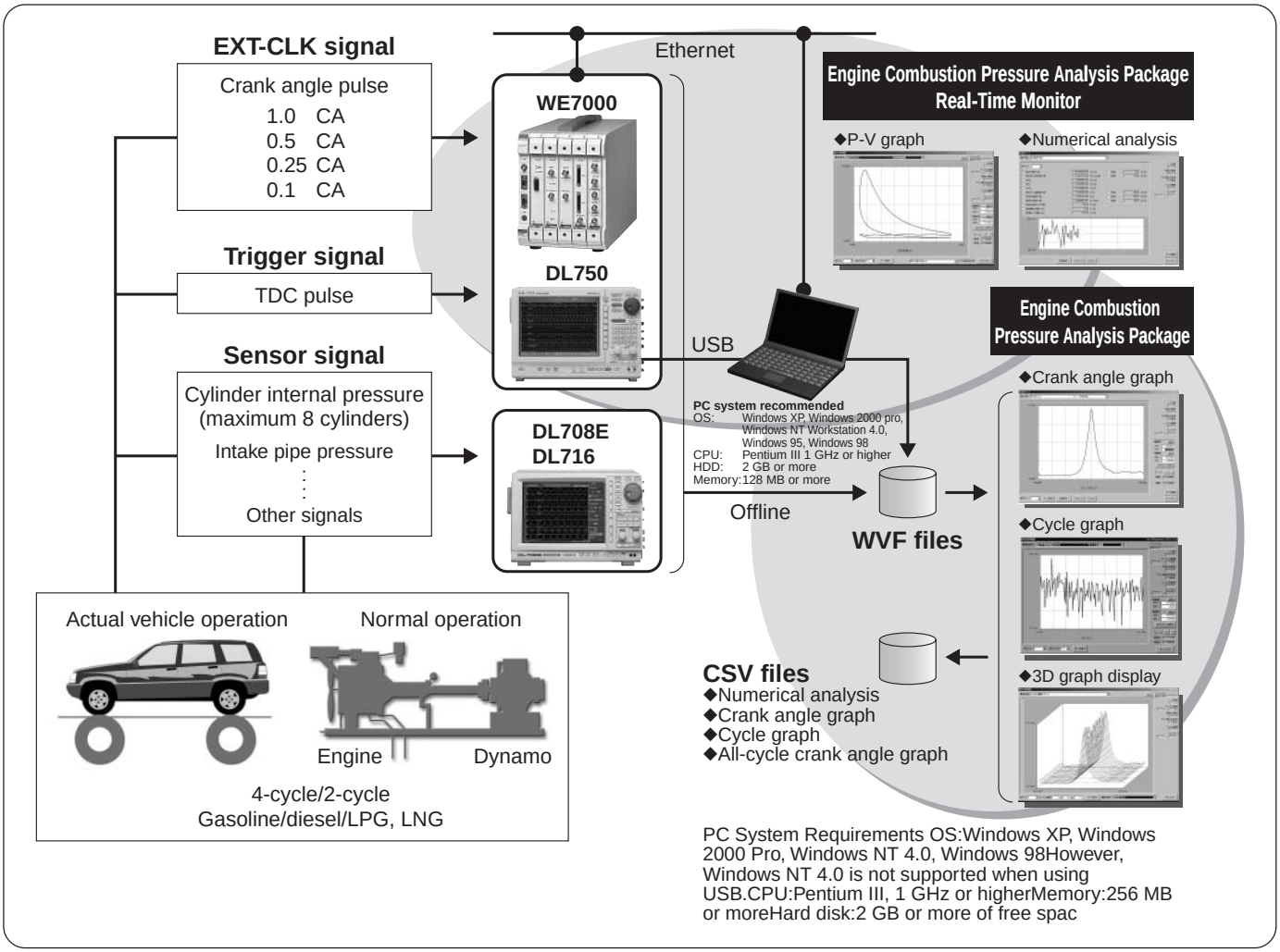
Greater scope of analysis *NEW*

The number of arbitrary setting points for combustion mass rate has been increased from one to three. In addition, LNV, misfire rate and cylinder-to-cylinder average value can now also be analyzed.

Transient combustion pressure analysis

Analysis of transient combustion pressure is possible thanks to the addition of intake pipe pressure, intake pipe temperature, engine rpm, and fuel consumption as measurement items. This type of analysis is invaluable for developing clean, high-efficiency engines for which there is strong demand.

Configuration of Engine Combustion Pressure Analysis System

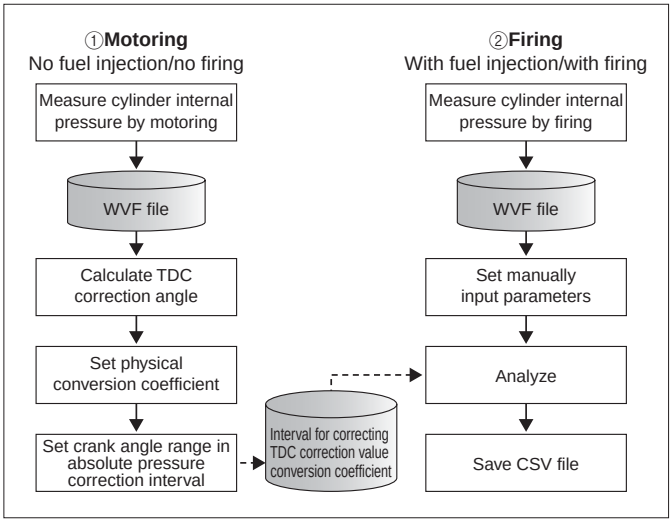


PC System Requirements OS:Windows XP, Windows 2000 Pro, Windows NT 4.0, Windows 98However, Windows NT 4.0 is not supported when using USB.CPU:Pentium III, 1 GHz or higherMemory:256 MB or moreHard disk:2 GB or more of free spac

Specifications

Engine Combustion Pressure Analysis Package

(1) Analysis procedure



(2) Supported engine types
Gasoline/diesel/natural gas, and 2-cycle/4-cycle

(3) Measurement channels Maximum 16 channels (analog signals)
- Cylinder internal pressure: Maximum 8 channels
- Other signals: Maximum 15 channels

When the following measurements are taken, they can be used in analysis calculations.
> Gasoline engine
Intake pipe pressure, intake pipe temperature, fuel consumption, engine rpms
> Natural gas engine
Intake pipe pressure, intake pipe temperature, fuel consumption, engine rpms, residual oxygen concentration in exhaust gas
> Diesel engine
Intake pipe pressure, intake pipe temperature, fuel consumption, engine rpms, exhaust gas pressure, exhaust gas temperature, supercharger entrance pressure, supercharger entrance temperature

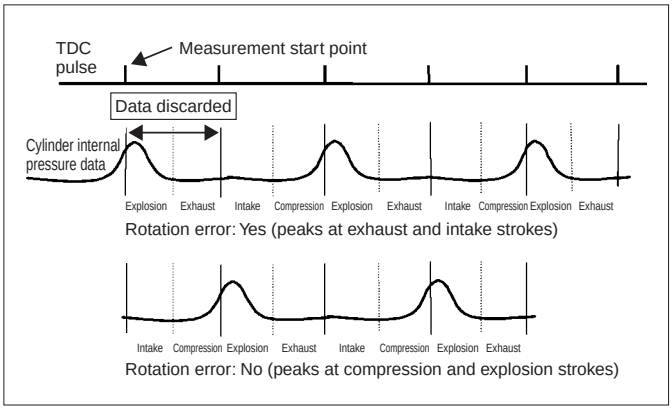
(4) Maximum number of analyzed cycles
User-defined intervals (up to 800 cycles) in the following valid cycle data are extracted and analyzed.
- At 1.0 CA: 25,000 cycles
- At 0.5 CA: 12,500 cycles
- At 0.25 CA: 6250 cycles
- At 0.1 CA: 2500 cycles

(5) Angle resolution: 1.0/0.5/0.25/0.1 CA

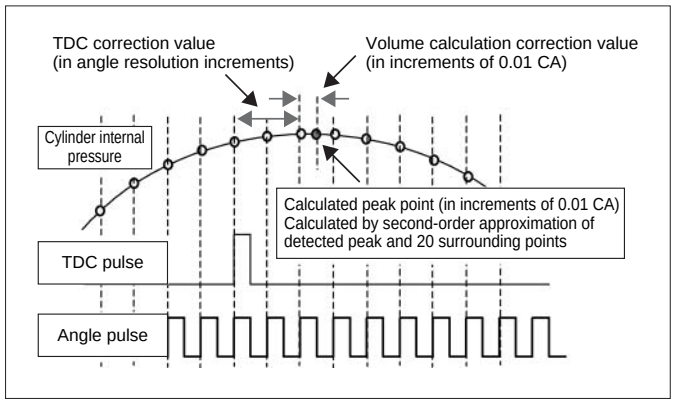
(6) Conversion to physical values
Physical value = A × Voltage value + B

(7) Filter processes
- Filter types: None, low-pass, band-pass, high-pass
- Characteristics: 4th Order (24 dB/oct) Butterworth
- Cutoff frequencies
  At 1.0 CA: Rpms 7.2-order (times) (2%) to 72nd order (times) (20%)
  At 0.5 CA: Rpms 14.4-order (times) (2%) to 144th order (times) (20%)
  At 0.25 CA: Rpms 28.8-order (times) (2%) to 288th order (times) (20%)
  At 0.1 CA: Rpms 72nd order (times) (2%) to 720th order (times) (20%)

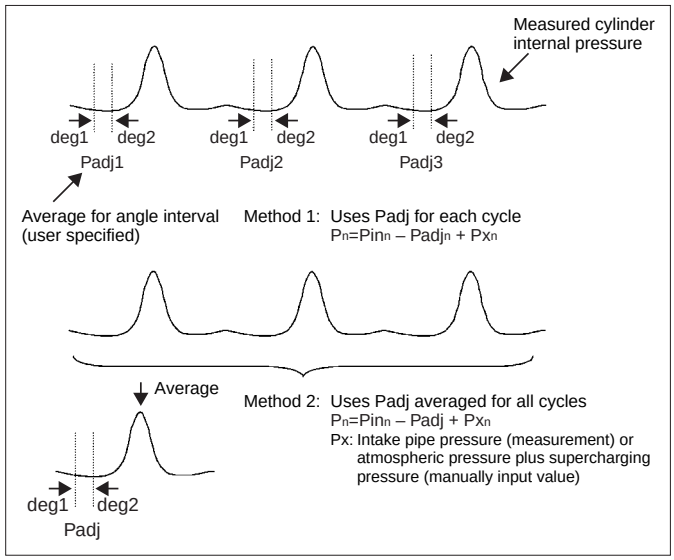
(8) Rotation error correction
If the cylinder internal pressure peak is less than –180 C or greater than +180 CA, then a rotation error is recognized and a shift of 360 CA is made.



(9) TDC correction
The cylinder internal pressure data on the first channel (first firing) during motoring are averaged over all cycles. The maximum value in the data is detected, and this value, together with the ten points on both sides (21 points in total), are approximated in a second-order equation to determine the maximum value. The corresponding angle position (in increments of 0.01) is used as the Top Dead Center (TDC). Or, the TDC position may be set by manual input.



(10) Absolute pressure correction
The measured cylinder internal pressure is converted to absolute pressure.



(11) Crank angle graph display for measurement data
- Motoring and firing displays
- Displays before and after TDC correction
- Display for each channel and all-channel overlapping display
- Display for each cycle, display for cycle average, and all-cycle overlapping display
- Direct reading of values using cursor

(12) Analysis

(12-1) Manually input parameters
- Parameters for all engine types (gasoline, natural gas, and diesel)
  Con rod length, bore diameter, piston offset, stroke length, gap volume or compression ratio, absolute pressure correction method, number of data points for determining start/end of explosion, fuel consumption, atmospheric temperature, atmospheric pressure, engine rpms, supercharging pressure, Starting angle of correction interval, Ending angle of correction interval, Search range of maximum rate of heat release, Ratio for judging angle of combustion mass rate (3 locations), Value for judging misfire
- Parameters for gasoline engines
  Gas constant, intake volume efficiency, fuel specific gravity, specific heat ratio
- Parameters for natural gas engines
  Engine output, number of engine cylinders, methane composition ratio, ethane composition ratio, propane composition ratio, isobutane composition ratio, normal butane composition ratio, residual oxygen concentration in exhaust gas, lower calorific value of gas fuel
- Parameters for diesel engines
  Gas constant, intake volume efficiency, fuel specific gravity, exhaust pressure, exhaust gas temperature, supercharger entrance temperature, boost temperature, supercharger entrance pressure, piston head ratio, cylinder wall temperature, cylinder head wall temperature, piston head wall temperature, lower calorific value

(12-2) Numerical results
- Results for all engine types (gasoline, natural gas, and diesel)
  Average start point of combustion (point a), Average end point of combustion (point b), Averaged maximum cylinder pressure of all cycles and cylinders, Averaged maximum rate of cylinder pressure rise of all cycles and cylinders, Averaged NMEP of all cycles and cylinders, Averaged IMEP of all cycles and cylinders, Averaged PMEP of all cycles and cylinders, Minimum IMEP of all cycles and cylinders, LNV of IMEP of all cycles and cylinders, Averaged PMEP of all cycles and cylinders, Minimum IMEP of all cycles and cylinders, LNV of IMEP of all cycles and cylinders
  Average values, standard deviations, and fluctuation rates for the following: cylinder internal pressure maximum value, pressure rise rate maximum value, output mean effective pressure, indicated mean effective pressure, pump mean effective pressure, cylinder internal gas temperature maximum value, heat release rate maximum value, heat release amount maximum value, fuel consumption ratio N% angle, average combustion start position (point a), average combustion end position (point b)
- Results for natural gas engines
  Required oxygen amount, exhaust gas amount, theoretical air amount, theoretical exhaust gas amount, produced water amount, theoretical dry exhaust gas amount, air excess rate, intake air amount, intake amount (fuel + air), volume efficiency, fuel gas specific gravity, intake air weight, intake fuel weight, intake mixed gas weight, mixed gas constant, gas fuel lower calorific value, cooling loss, cooling loss rate, net heat efficiency, friction loss, combustion efficiency, isochoric degree, indicated efficiency
- Results for diesel engines
  Intake fuel weight, intake air weight, air excess rate, corrected gas constant, residual gas weight

(12-3) Crank angle graph
Cylinder internal pressure, pressure rise rate, heat release amount, heat release rate, heat release rate (heat obtained from gasoline combustion) (diesel only), heat release rate (heat loss) (diesel only), combustion mass ratio, cylinder internal gas temperature, polytropic index, specific heat ratio (excluding gasoline), other signals, graph of cylinder internal pressure versus stroke volume, graph of logarithmic cylinder internal pressure versus logarithmic stroke volume

(12-4) Cycle Graph
Crank angle at maximum cylinder pressure, Crank angle at maximum rate of cylinder pressure rise, Crank angle at maximum amount of heat release, Crank angle at maximum rate of heat release, Crank angle at combustion mass rate N % (3 points), NMEP, IMEP, PMEP, Averaged maximum cylinder pressure of all cylinders, Averaged crank angle at maximum cylinder pressure of all cylinders, Averaged maximum rate of cylinder pressure rise of all cylinders, Averaged angle at maximum rate of cylinder pressure rise of all cylinders, Averaged NMEP of all cylinders, Averaged IMEP of all cylinders, Averaged PMEP of all cylinders, Crank angle at maximum rate of heat release, Other signals

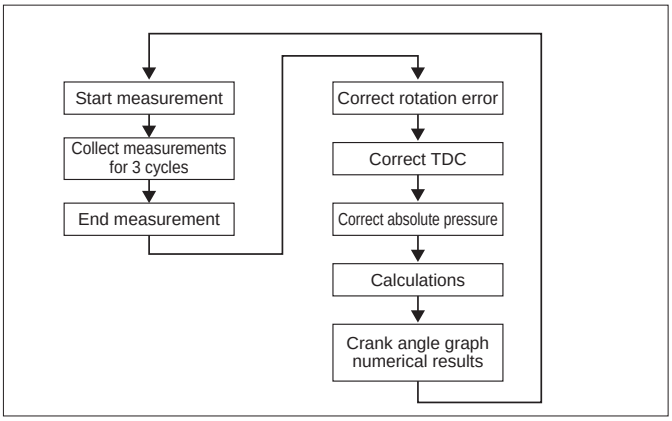
(12-5) Graph features
- Display for each channel and all-channel overlapping display
- Display for each cycle, display for cycle average, and all-cycle overlapping display (when crank angle graph is displayed)
- Direct reading of values using cursor
- Automatic/manual scale settings for X and Y axes

(12-6) Analysis results file saving (CSV format)
- Comments
  Measurement data saving date, data name, tester, department, test name, engine model, serial number, test location, test bench type, comments
- Manual input fields
  TDC correction value, physical value conversion coefficients (A, B), crank angle range for absolute pressure correction, channel names, and manual input fields during analysis
- Numerical results data
  Numerical results during analysis
- Crank angle graph data (cycle average values)
  Crank angle graph data during analysis and measurement data used in analysis
- Cycle graph data
  Cycle graph data during analysis and measurement data used in analysis
- Crank angle graph data for specified cycle range
  During analysis: Cylinder internal pressure, cylinder internal pressure rise rate, cylinder internal gas temperature, heat release rate, heat release amount, combustion mass ratio
  Measurement data used in analysis

(12-7) Saving Analysis Conditions
You can save conditions required for analysis in text format (as .ecp or .ecm files)..ecp: When running the Engine Combustion Pressure Analysis only.ecm: When running the Monitor Function of Engine Combustion Pressure Analysis
- TDC correction value
- Number of cylinders
- Interval of absolute pressure correction
- Coefficients for conversion to physical values (calibration factors)
- Filter setting conditions
- Calculation parameters
- Calculation execution items
- Analysis graph display conditions
- Screen layout

Engine Combustion Pressure Analysis Package Real-time Monitor

(1) Flow chart



(2) Numerical results for all engine types (gasoline, natural gas, and diesel)
Crank angle at combustion mass rate N % (3 points) Cylinder internal pressure maximum value and crank angle, pressure rise rate maximum value and crank angle, output mean effective pressure, indicated mean effective pressure, pump mean effective pressure, heat release amount maximum value and crank angle, heat release rate maximum value and crank angle, combustion mass ratio N% crank angle, other signals

(3) Crank angle graph for all engine types (gasoline, natural gas, and diesel)
Cylinder internal pressure, pressure rise rate, heat release amount, heat release rate, combustion mass ratio, cylinder internal gas temperature, other signals, graph of cylinder internal pressure versus stroke volume

(4) Graph features
- Display for each channel and all-channel overlapping display
- Direct reading of values using cursor
- Automatic/manual scale settings for X and Y axes

(5) File saving

(5-1) Collection conditions
An amount of data, calculated from the angle resolution (1.0/0.5/0.25/0.1 CA) and the number of saving cycles (up to 800 cycles), is collected continuously, with the TDC signal serving as a trigger.

(5-2) File format
WVF format (binary files conforming to Yokogawa's standard)

Product list

Product	Model
Engine Combustion Pressure Analysis Package	
• Gasoline engine version	707764
• Natural gas engine version	707765
• Diesel engine version	707766
Engine Combustion Pressure Analysis Package Real-time Monitor (*1)	
• Gasoline engine version	707767
• Natural gas engine version	707768
• Diesel engine version	707769

(*1) Real Time Monitor (models 707767, 707768, and 707769) is an add-on software program that adds the real time monitor function to the Engine Combustion Pressure Analysis Package. The models above can not run independently and must be used together with the package.

NOTICE
- Before operating the product, read the instruction manual thoroughly for proper and safe operation.
- If this product is for use with a system requiring safeguards that directly involve personnel safety, please contact the Yokogawa sales offices.

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