Digital Oscilloscopes

DL9000 Series

- **Fast acquisition rate**
  - Up to 25,000 frames/sec/channel in continuous mode (when the Accumulate function is used)
  - Up to 2.5 million frames/sec/channel in N Single mode

- **History Memory function**
  - With a partitioned large-capacity memory, the DL9000 can automatically accumulate and display up to 2,000 waveform frames.

- **Bandwidth and Sampling Rate**

<table>
<thead>
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<th>Model/Line</th>
<th>Analog frequency bandwidth</th>
<th>Maximum sampling rate</th>
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<tr>
<td>DL9040/DL9040L</td>
<td>500 MHz</td>
<td>5 GS/s</td>
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<tr>
<td>DL9140 / DL9140L</td>
<td>1.0 GHz</td>
<td>5 GS/s</td>
</tr>
<tr>
<td>DL9240 / DL9240L</td>
<td>1.5 GHz</td>
<td>10 GS/s</td>
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... and subscribe to "Newswave," our free e-mail newsletter
The DL9000 series allows you to measure waveforms for long periods of time using its large-capacity memory. In addition, the memory can be partitioned to capture only the necessary waveforms (History Memory function). The History Memory function retains up to 2,000 waveforms in its internal memory while constantly updating them. Now suppose an abnormal signal occurs. You can view it even if some time has elapsed since the occurrence, as long as the signal is included in the previous 2,000 waveforms. This feature is effective in capturing anomalies that may occasionally occur. Furthermore, you can compare all 2000 waveforms by overlaying them or view them with different brightness levels depending on their frequency of occurrence. This feature displays waveforms similar to how they would appear on analog oscilloscopes.

Yokogawa's proprietary signal-processing IC (Advanced Data Stream Engine [ADSE]) has made the History Memory function and display functions far more advanced than those of conventional scopes. High-speed data processing is achieved using this hardware-based computation.

**Maximum update rate in math mode:**
- **60 frames/sec** (1 MW, when adding channels)
- **12 frames/sec** (5 MW, when adding channels)

**Maximum update rate in parameter measurement mode:**
- **60 frames/sec** (1 MW, when measuring a channel's maximum value)
- **16 frames/sec** (5 MW, when measuring a channel's maximum value)

Note: The above rates can vary depending on the oscilloscope settings.

You can freely change from overlaid waveforms to any single waveform and vice versa as the DL9000 retains up to 2,000 frames of waveform data. You can go back to previously-captured waveforms in History Memory and view them one by one, just like browsing address book entries. Furthermore, you can use the new History Replay function to continuously play back, stop, fast-forward, and rewind captured waveforms like a video recording.
Enhanced functions for all signal handling tasks — capture, display, search and analysis

**Waveform Capture — Filter functions**

To be able to observe signals after filtering out unnecessary components is extremely useful during circuit design. The DL9000 series is equipped with two types of filters, the input stage filters and filters based on high-speed computation. You can filter out unnecessary signal components during signal capture or apply high-speed filtering afterwards.

**Filters in the input stage**
- Analog filters: 20 MHz/20 MHz
- Real-time digital filters: 8 MHz/4 MHz/2 MHz/1 MHz/500 kHz/200 kHz/125 kHz/62.5 kHz/32 kHz/16 kHz/8 kHz

**Filters based on computation**
- Select low pass or high pass filters with variable cutoff frequencies
- Display filtered waveforms in real time at up to 60 frames/sec
- Simultaneously display both pre-filtered and post-filtered waveforms

**Desired filter setting**
- The input stage filters and the computation filters can be combined.
- Effective filtering helps to shorten the time needed to evaluate and troubleshoot a design.

**Waveform Capture — Advanced trigger functions**

The DL9000 series can be triggered using two or more channels in addition to an edge trigger or TV trigger. You can capture only the desired signals by combining various trigger types and thereby predetermining trigger conditions. Effective filtering helps to shorten the time needed to evaluate and troubleshoot a design.

**DL9000 Series’ Trigger Functions**

- **Edge/state triggers**
  - Edge
  - Edge (Qualified) conditions
  - Edge OR
  - State

- **Pulse width triggers**
  - Pulse width
  - Pulse width (Qualified)
  - Pulse states
  - (Triggered using the length of period during which the conditions are true)

- **Examples of Trigger Application**
  - Trigger-based gating: Edge (Qualified): conditional trigger
  - Ch. 1 edge trigger:
  - Ch. 2 edge trigger (Example: ‘valid at Trig’)

- **Setup and hold time triggers**
  - To derive setup and hold time conditions, event delay/event sequence triggers are set as shown in the following figures.

**Enhanced triggers**

- TV (NTSC/PAL SECAM/HDTV)
- IC
- SPI
- CAN
- Serial pattern (all patterns are up to 128 bits long)

**Event interval triggers**

- Event cycle
- Event delay
- Event sequence

**Slew rate trigger** — Window comparator and pulse state

- The time taken to pass through the voltage level range specified for the window comparator is used to detect the pulse width/time. With pulse data triggers, it is possible to derive trigger conditions, such as “More Than”, “Less Than” and “Between”, by specifying the length or the relationship between the voltage levels.

**Runt pulse trigger**

- Runt pulse (pulses with width shorter than those of normal pulses) can also be captured in the same way as explained above. A runt pulse typically has a higher frequency than the window comparator, as shown in the following figure. It is therefore possible to capture the runt pulse by selecting the trigger conditions to a time shorter than those of normal pulses.

**Waveform Search and Display — Searching for and displaying selected waveforms from the large-capacity memory**

- **Dual-window Zoom function simultaneously zooms in on two areas**
  - The DL9000 series allows the zooming magnification and position to be set separately for two different areas of a waveform. Thus you can change the timescale and view the two windows simultaneously.
  - The waveform on the right shows a measurement example of the time taken from the point of power-on to the point of gate array oscillation. The DL9000 measures the time length from the rising edge (occurring immediately after power-on (cursor 1 of Zoom 1)) to the start of oscillation (cursor 2 of Zoom 2).

- **Auto Scroll function for observing the entire waveform**
  - The Auto Scroll function automatically moves the zoom windows through a long acquisition. Selecting the area to be zoomed in can be done easily by scrolling forward, backward, fast forwarding or pausing.

- **A variety of search functions**
  - The DL9000 series has a variety of waveform search functions, enabling you to detect abnormal signals or find specific serial or parallel data patterns.
  - Data search types include:
    - State search (based on high/low states of one or more channels)
    - Serial pattern search (I2C/SP/CAN (general-purpose pattern))
    - Zone search
    - Waveform window search
    - Waveform parameter search (measured parameters, FFT, etc.)

- **Waveform parameter search**
  - Select a waveform parameter and define a selection area using the zoom windows.
  - The waveform on the right shows a measurement example of the time taken from the point of power-on to the point of gate array oscillation. The DL9000 measures the time length from the rising edge (occurring immediately after power-on (cursor 1 of Zoom 1)) to the start of oscillation (cursor 2 of Zoom 2).

**Waveform Analysis — Serial bus analysis I2C/SP/CAN**

- The DL9000 can perform I2C, SPI and CAN bus analysis with the different available options (FS, I7 and I8). Triggers for these bus types are standard features. These functions make it easy to discriminate between partial software failures and physical-layer waveform problems when troubleshooting systems by observing the physical-layer characteristics of signals.

- **Real-time bus analysis-up to 15 updates/sec**
  - The DL9000 displays protocol analysis results while concurrently capturing bus signals.

- **Simultaneous analysis of different buses**
  - With the Dual-window Zoom function, the DL9000 can simultaneously analyze and display the waveform of buses running at different speeds.

- **Serial data bus triggers**
  - A variety of trigger conditions can be set, including triggers based on ID-Data combinations and combinations of a serial bus trigger and a regular edge trigger.
Advanced Analysis and Math Functions

Versatile Connectivity

- USB Compliance Test Solution
- Flexible System Configuration
- User-friendly Operability based on PC Software
- Collaboration with Xviewer

Math Functions (Addition, Subtraction, Integration, Edge Count, and Rotary Count)

Eye Pattern Analysis and Mask Testing

Eye Pattern Analysis
- The function automatically measures the waveform parameters of an eye pattern, including the waveform period, eye opening, and area.
- Parameters can be measured from a single frame, or from binary data such as frame data/setup data.
- The signature editor software can be used to display waveform patterns based on the eye pattern parameters.

Mask Testing
- The function is used to evaluate the signal quality of high-speed data communication systems.
- Mask Editor software is used to generate and load mask patterns.
- The mask editor software can be downloaded from Yokogawa Electric's website.

Histogram Displays
- Histograms show waveform behaviors over an extended period of time, relative to time (X), amplitude (Y), and other parameters.
- According to an on-screen histogram, you can analyze data including max., min., average, and standard deviation.
- Histograms, such as voltage FFT frequency etc., can be acquired from the waveform analysis software to analyze the waveform parameters very over time.

Real-time Math Traces (Rotary Count)
- The function counts and displays the time difference of edge between 2 input signals (Phase A and Phase B).
- The function marks the time (time between 2 input signals) on the waveform, and the rotation angle of a motor can be used to check the rotational angle of a motor.

Rotary Count Math Trace
- Rotary Count Math Trace
- Measurement of Phase A and Phase B (Ch. 1 and Ch. 2)
- Rotary Count Math Trace

USB-PC connection port
- Can be used to control the DL9000 externally or to upload data from the DL9000 to a PC.

Software Tools

Additional details about Yokogawa's software tools and information for downloading free software and trial versions of non-free software can be found at:
http://www.yokogawa.com/tm/tm-softdownload.htm

MATLAB Control Tool Kit (optional software)
- With the MATLAB tool kit, you can easily deal with waveform data captured using the DL series and display it in a MATLAB environment. The software can be used to control the DL series or other settings.

DL Series Library (heaven)
- This API lets you control the DL9000 series from an external program or to transfer the DL9000 series data to an external program. The API is available as a DLL and can be accessed from your program.

For more information, see Bulletin 7159 W81, “10BASE-T implemented Test Solutions.”

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### Optional Accessories

**PBA2500**  2.5 GHz active probe  
- **Bandwidth**: DC to 2.5 GHz (±2 dB)  
- **Input impedance**: 50 Ω  
- **Amplifier gain**: 20 dB  
- **Input capacitance**: Approx. 5 pF (typ.)  
- **Output impedance**: 50 Ω  
- **Weight**: Approx. 240 g

**PBD2000**  2.0 GHz differential probe  
- **Bandwidth**: DC to 2.0 GHz (±2 dB)  
- **Input impedance**: 50 Ω  
- **Amplifier gain**: 20 dB  
- **Input capacitance**: Approx. 5 pF (typ.)  
- **Max. differential input voltage**: ±5 V  
- **Output impedance**: 50 Ω  
- **Weight**: Approx. 200 g

**PB500**  500 MHz passive probe  
- **Bandwidth**: DC to 500 MHz (±2 dB)  
- **Input impedance**: 10 MΩ (when used with the DL9000)  
- **Input capacitance**: Approx. 14 pF (typ.)  
- **Max. input voltage**: ±300 V DC to AC peak  
- **Weight**: Approx. 220 g

**PBL5000**  5 GHz low capacitance probe  
- **Bandwidth**: DC to 5 GHz (±2 dB)  
- **Input impedance**: 50 Ω  
- **Amplifier gain**: 20 dB  
- **Input capacitance**: Approx. 14 pF (typ.)  
- **Max. input voltage**: ±25 V DC to AC peak  
- **Weight**: Approx. 200 g

**701921**  ±12 V/500 MHz differential probe  
- **Bandwidth**: DC to 500 MHz (±2 dB)  
- **Input impedance**: 50 Ω  
- **Amplifier gain**: 20 dB  
- **Input capacitance**: Approx. 14 pF (typ.)  
- **Max. input voltage**: ±150 V DC to AC peak  
- **Weight**: Approx. 240 g

**701922**  ±20 V/200 MHz differential probe  
- **Bandwidth**: DC to 200 MHz (±2 dB)  
- **Input impedance**: 50 Ω  
- **Amplifier gain**: 20 dB  
- **Input capacitance**: Approx. 14 pF (typ.)  
- **Max. input voltage**: ±50 V DC to AC peak  
- **Weight**: Approx. 200 g

%### Main Specifications

**Models**
- **Model name**: PBA2500  
- **Max. sampling rate**: 4 GS/s  
- **Freq. BW**: 2.5 GHz  
- **Input impedance**: 50 Ω  
- **Max. input voltage**: ±20 Vpk-pk  
- **Input capacitance**: Approx. 5 pF (typ.)  
- **Weight**: Approx. 240 g

**Basic Specifications**
- **Input coupling**: AC-Coupled  
- **Input impedance**: 1 MΩ or 10Ω, 25 Vp-p (when using PBA60 probe, 10 MΩ or 10Ω, 25 Vp-p)  
- **Voltage range**: ±20 V/200 MHz differential probe  
- **Max. common mode input voltage**: ±100 V  
- **Max. allowable differential voltage**: ±700 V (DC + ACpeak)

**Trigger Logic**
- **Trigger modes**: Auto, Auto-Level, Normal, Single, and Single Edge  
- **Trigger source**: CH1 to CH4  
- **Internal trigger level**: 0.8 V  
- **Window comparator**: Center  
- **Input source**: Center

**Display**
- **Display size**: 4.4 inches (10.2 cm) TFT liquid crystal display  
- **Total number of pixels**: 230,400 (1280 x 640)

**Trigger level accuracy**
- **CH1 to CH4**: ±0.2% or ±10% of trigger level  
- **EXT**: ±0.5% or ±10% of trigger level

**Trigger sensitivity**
- **CH1 to CH4**: 0.3 V/div to 20 V/div (10% of trigger level)  
- **EXT**: 0.3 V/div to 20 V/div (10% of trigger level)
Main Specifications

Functions

Waveform Acquisition/Display Functions

Acquisition modes: Selection from three acquisition modes - Normal, Average and Envelope.

High resolution mode: Allows switching between realtime and repetitive sampling in certain time axis settings.

Interpolating function: Interpolates actual sampled data up to 1000 times (or up to 2000 times in high-mode, DSO/DSO) and increases the time resolution (up to 2.5 TS/s).

Roll mode: Roll-mode display is enabled during the following time axis range when the trigger mode is Auto, Level Set or Level Cal. 0 to 1000 samples.

Record length:
- DL6400/9450/9450L: 2.5 kS, 25 S, 250 S, 2.5 kS, 25 kS, 125 kS, 250 kS, 1.25 MS, 2.5 MS, 12.5 MS, 25 MS, 125 MS
- DL6404/9450/9450L: 2.5 kS, 25 S, 250 S, 2.5 kS, 25 kS, 125 kS, 250 kS, 1.25 MS, 2.5 MS, 12.5 MS, 25 MS, 125 MS, 250 MS, 1.25 GS, 2.5 GS, 12.5 GS

Accumulate waveforms on the display. Choose courtesy 'Time and acquisition settings'.

Snapshot: Retains the current displayed waveform on the screen.

Analysis Functions

Search and Zoom function: ZOOMs displayed waveform along the time (horizontal) and voltage (vertical) axes. Independent vertical and horizontal zooms can be applied to zoom in on the screen.

Voltage axis zoom factor: 1 to 10 times

Time axis zoom factor: 1 time to 10 times

Auto zoom function: Automatically zooms the waveform window along the time axis.

Search function: Searches the currently displayed waveform for a specified occurrence beyond a specified time, and displays the searched result on the screen.

Search type: 
- Edge: Vertical, Horizontal, Top, Bottom, Center, Peak
- Frequency: 1 kHz to 2.5 GHz
- Amplitude: 0.1 mV to 250 V

History memory:
- DL6400/9450/9450L: 2020 (2.5 kS), when using history
- DL6404/9450/9450L: 2030 (2.5 kS), when using history
- DL6404/9450/9450L: 8100 (2.5 kS)

History search: Searches and displays waveforms from the history memory that meet specific conditions.

Search type:
- Rect. WITH Polygon - Parameter (FFT/KY) (optional)
- Display: Automatically replay history waveforms.

Cursor measurement functions: The following cursor functions can be selected: Vertical, Horizontal, X, Y, Peak, cursor.

Automatic measurement of waveform shape:
- Performs automatic measurement of the following waveform shape parameters:
  - Vrms, Vmean, Vpeak, Vpeak-to-peak, Vrms, Vmean, Vpeak, Vpeak-to-peak

Values unrelated to cycle which will be derived out of all data in the range.

Items related to cycle which will be derived out of all data in the range:
- C-corr, C-em, C-xem, C-em, (1/FREQ), (FREQ)

Limit which will be derived from the limit formula when exceeding the specified range of parameter:
- MAX, MIN, HIGH, LOW, P H, HIGH, LOW, \( \overline{HD}, \overline{RD}, \overline{MIN}, \overline{MAX}, \overline{WEIGHT}\)

SIP: Trigger Functions

Trigger function:
- Type:
  - Edge: 2, 3, 4, 16 GHz (including trigger)
  - Level: 2, 3, 4, 16 GHz (including trigger)
  - Time: 2, 3, 4, 16 GHz (including trigger)
  - Voltage: 2, 3, 4, 16 GHz (including trigger)

- Source: CH1 to CH4
- Pattern match: CH1 to CH4

Analysis result display:
- Simple display mode: Data-tree representation, WVT, start condition, presence/absence of V, W, address, or data start
- Simple display mode: Detailed display data (optional).

PC Bus Analysis Functions (optional)

- Applicable bus: DL9040/9140/9240: 2000 (2.5 kW), when in N single mode
- Applicable bus: DL9040/9140/9240: 1600 (2.5 kW), when in N single mode

- Analysis function:
  - Pattern search: Searches data that agrees with the preset address pattern, and pattern trigger parameter.
  - Sample analysis list data: The data can be saved to CSV/formatted files.

USB-PC Connection Ports

- USB Type-B connectors (optional)

Ethernet Communication (C10 and C8 Options)

- Connectors (10BASE-T/100BASE-TX)

- Transmission methods:
  - Ethernet (100BASE-TX/10BASE-T)

- Maximum device connection: 100 (10BASE-TX), 1000 (100BASE-TX)

USB-Peripheral Connection Ports

- USB Type-B connectors (optional)

- Transmission methods:
  - USB (full-speed 12 Mbps)

- Maximum device connection: 128 (USB)

General Specifications

Rated supply voltage: 100 V to 120 V (AC) at 50/60 Hz (optional)

Maximum input power: 200 W (max)

External dimensions: 150 (W) x 90 (D) x 207 (H) mm (When front panel is closed)

Weight: Approx. 6.5 kg (including printer)

Battery life: Approximately 5 years at an ambient temperature of 25°C

Operating temperature range: 5°C to 40°C

USB Memory Card (Max. 40 GB (FAT32))

- USB Type-B connector: USB Type-B connector

- Write protection: Write-protect (optional)

- Storage of analysis list data: The data can be saved to CSV-formatted files.

- Capacity:
  - 40 GB FAT32

- Format: USB Type-B connector

- Connector type: USB Type-B connector

- Transmission methods:
  - USB (full-speed 12 Mbps)

USB Memory Card (Max. 40 GB (FAT32))

- USB Type-B connector: USB Type-B connector

- Write protection: Write-protect (optional)

- Storage of analysis list data: The data can be saved to CSV-formatted files.

- Capacity:
  - 40 GB FAT32

- Format: USB Type-B connector

- Connector type: USB Type-B connector

- Transmission methods:
  - USB (full-speed 12 Mbps)

CPU Card Interfaces

- PC Card Interfaces
  - CardBus (optional)
  - cardBus (optional)

- USB Peripheral Connection Ports
  - USB Type-B connector (optional)

- Transmission methods:
  - USB (full-speed 12 Mbps)

- Maximum device connection: 128 (USB)

Built-in Printer (B/S Option)

- Printing method: Thermal dot-dot
- Effective print width: 110 mm (632 dots)

Built-in Hard Drive (C8 Option)

- Capacity/option:
  - 40 GB FAT32

- Usage:
  - Printing and waveform display

- Storage:
  - Internal storage media
    - 512 MB (Flash ROM)
  - USB mass storage device
    - Capacity/file system: 40 GB FAT32

USB-Peripheral Connection Ports

- USB Type-B connectors (optional)

- Transmission methods:
  - USB (full-speed 12 Mbps)

- Maximum device connection: 128 (USB)

External Dimensions (Common to All Models)

- Unit: mm

For detailed specifications, visit our homepage at http://www.yokogawa.com/tm/DL9000
Model and Suffix Codes of DL9040/9140/9240

<table>
<thead>
<tr>
<th>Model</th>
<th>Suffix Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>701307</td>
<td></td>
<td>DL9040 digital oscilloscope</td>
</tr>
<tr>
<td>701308</td>
<td></td>
<td>DL9040L digital oscilloscope</td>
</tr>
<tr>
<td>701310</td>
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<td>DL9140 digital oscilloscope</td>
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<tr>
<td>701311</td>
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<td>701312</td>
<td></td>
<td>DL9240 digital oscilloscope</td>
</tr>
<tr>
<td>701313</td>
<td></td>
<td>DL9240L digital oscilloscope</td>
</tr>
</tbody>
</table>

Power cable
- D: UL/CSA standard
- F: VDE standard
- Q: BS standard
- R: AS standard
- H: GB standard

Options
- /B5: Built-in printer
- /P2: Probe power connections on rear panel (2 outputs for 900 MHz FET probe and current probe)
- /CB: Built-in HDD + Ethernet Interface
- /CS: Built-in HDD + LXI Compliant Ethernet Interface
- /CT: Ethernet Interface
- /CU: LXI Compliant Ethernet Interface
- /G2: User-defined math function
- /G4: Power Supply Analysis Function
- /FS: UART + PC + SPI bus analyzer
- /F7: UART + PC + SPI bus analyzer
- /F8: UART + CAN + SPI bus analyzer

Accessories (Optional)
- Power cable
- 3 prong-to-2 prong adapter
- PB500 passive probe
- Printer roll paper (when option /BS is specified)
- User’s manual (1 set)
- Front panel cover
- Rubber leg gap
- Soft case

Standard Accessories
- Power cable
- 3 prong-to-2 prong adapter
- PB500 passive probe
- Printer roll paper (when option /BS is specified)
- User’s manual (1 set)
- Front panel cover
- Rubber leg gap
- Soft case

Related Products
DL7400 series digital oscilloscopes
DL1700E series digital oscilloscopes

Yokogawa’s Approach to Preserving the Environment
- Yokogawa’s electrical products are developed and produced in facilities that have received ISO14001 approval.
- In order to protect the global environment, Yokogawa’s electrical products are designed in accordance with Yokogawa’s Environmentally Friendly Product Design Guideline and Product Design Assessment Criteria.

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