DL850E/DL850EV
ScopeCorder
USER'S MANUAL

Features Guide

YOKOGAWA
Yokogawa Test & Measurement Corporation

IM DL850E-01EN
7th Edition

Thank you for purchasing the DL850E ScopeCorder or DL850EV ScopeCorder Vehicle Edition (hereinafter, “DL850E/DL850EV” will refer to both of these products). This manual contains useful information about the features of the DL850E/DL850EV. To ensure correct use, please read this manual thoroughly before beginning operation. Keep this manual in a safe place for quick reference in the event a question arises.

List of Manuals

This manual is one of six DL850E/DL850EV manuals. Please read all manuals.

Manual Title	Manual No.	Description
DL850E/DL850EV ScopeCorder Features Guide	IM DL850E-01EN	This manual. The supplied CD contains the PDF file of this manual. This manual explains all the DL850E/DL850EV features other than the communication interface features.
DL850E/DL850EV ScopeCorder User’s Manual	IM DL850E-02EN	The supplied CD contains the PDF file of this manual. The manual explains how to operate the DL850E/DL850EV.
DL850E/DL850EV ScopeCorder Getting Started Guide	IM DL850E-03EN	The manual explains the handling precautions and basic operations of the DL850E/DL850EV and provides an overview of its features.
DL850E/DL850EV ScopeCorder Communication Interface User’s Manual	IM DL850E-17EN	The supplied CD contains the PDF file of this manual.The manual explains the DL850E/DL850EV communication interface features and instructions on how to use them.
DL850E/DL850EV ScopeCorder Real Time Math/Power Math User’s Manual	IM DL850E-51EN	The supplied CD contains the PDF file of this manual.This manual explains the features of the DL850E/DL850EV Real Time Math/Power Math option and how to use them.
DL850E/DL850EV ScopeCorder Acquisition Software User’s Manual	IM DL850E-61EN	The supplied CD contains the PDF file of this manual. This manual explains all the features of the acquisition software, which records and displays data measured with the DL850E/DL850EV on a PC.
Precautions Concerning the Modules	IM 701250-04E	The manual explains the precautions concerning the modules. This manual is included if you ordered modules.
Model DL850E ScopeCorder, Model DL850EV ScopeCorder Vehicle Edition, User’s Manual	IM DL850E-92Z1	Document for China

The “EN”, “E” and “Z1” in the manual numbers are the language codes.

Contact information of Yokogawa offices worldwide is provided on the following sheet.

Document No.	Description
PIM 113-01Z2	List of worldwide contacts

Regarding the Conventional DL850 and DL850V

The DL850E/DL850EV manuals also cover how to use the conventional DL850/DL850V (firmware version 3.0 and later).

In the explanations, the model is indicated as DL850E/DL850EV, but if you are using the DL850 or DL850V, read “DL850E” as “DL850” and “DL850EV” as “DL850V.” The following options are available only for the DL850E and DL850EV. They cannot be used with the DL850 or DL850V.

- Power math (/G5 option)
- GPS interface (/C30 option)

7th Edition: April 2018 (YMI)

Notes

- The contents of this manual are subject to change without prior notice as a result of continuing improvements to the instrument's performance and functions. The figures given in this manual may differ from the actual screen.
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1 Main Features

Vertical Axis

This section explains how to configure the signal input settings and the amplitude-direction display settings. The items that can be set vary depending on the installed modules. The channel menu that corresponds to the key you pressed (CH1 to CH16) appears. You can set the various vertical axis settings for each channel. Press ALL CH to display a screen in which you can configure the settings of all channels while viewing the settings in a list.

DL850E/DL850EV Measurement Items

When the DL850E/DL850EV is equipped with the modules listed below, it can measure voltage, temperature, strain, acceleration, frequency, logic, CAN bus signals, CAN FD bus signals, LIN bus signals, SENT signals, and so on.

Voltage
701250 (HS10M12), 720250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 701267 (HV (with RMS)), 720268 (HV (AAF, RMS)), 720210 (HS100M12), 720211 (HS100M12), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT), 720254 (4CH 1M16)

Voltage (For the 16-CH Voltage Input Module)
720220 (16CH VOLT)

Temperature
701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV)

Temperature (For the 16-CH Temperature/Voltage Input Module)
720221 (16CH TEMP/VOLT)

Strain
701270 (STRAIN_NDIS), 701271 (STRAIN_DSUB)

Acceleration
701275 (ACCL/VOLT)

Frequency
701281 (FREQ), 720281 (FREQ)

Logic
720230 (LOGIC)

CAN Bus Signal Monitoring
720240(CAN MONITOR), 720242(CAN/CAN FD), 720241 (CAN & LIN)
These modules can be used only with the DL850EV.

CAN FD Bus Signal Monitoring
720242(CAN/CAN FD)
These modules can be used only with the DL850EV.

LIN Bus Signal Monitoring
720241 (CAN & LIN)
This module can be used only with the DL850EV.

SENT Signal Monitoring
720243 (SENT)
This module can be used only with the DL850EV.

Digital Filter and Real Time Math (Optional)

Vertical Scale

The vertical scale is used to adjust the displayed waveform amplitude so that you can easily view signals. You can set the vertical scale to determine the value per grid square (1 div) displayed on the screen and to set the measurement range.
Use the SCALE knob to set the vertical scale for each channel.

Vertical Position

Because the DL850E/DL850EV can display many waveforms, the waveforms may overlap and be difficult to view. If this happens, you can adjust the vertical display position to make waveforms easier to view (vertical position). Use the POSITION knob to set the vertical position for each channel.

Input Coupling

You can change the input coupling setting to match the signal that you are measuring. By changing the setting, you can choose how the vertical-axis (voltage-axis) control circuit is coupled to the input signal. The following types of input coupling are available: DC, AC, GND, TC, DC-RMS, AC-RMS, ACCEL, and OFF.* Set the appropriate input coupling for each input module.

* If you do not want to measure the selected sub channels on a 16-CH voltage input module or a 16-CH temperature/voltage input module, set them to OFF.

Vertical Zoom

You can zoom the waveform vertically. You can zoom the waveform by setting the vertical magnification or by setting upper and lower display limits.

Linear Scaling

Linear scaling is a function that converts measured values into physical values and reads them directly. There two types of linear scaling:

AX+B

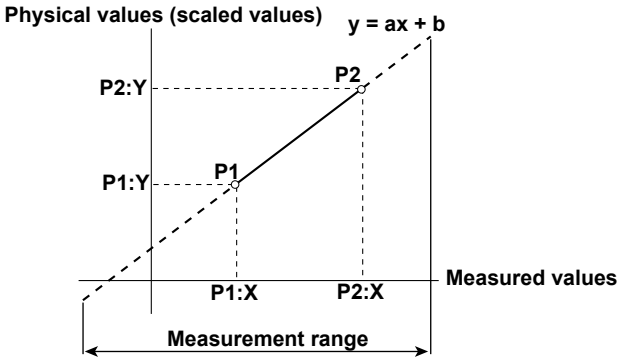
Using scaling coefficient A and offset B, the DL850E/DL850EV scales values according to the equation below.

Y= AX + B (where X is the measured value and Y is the physical value)

P1-P2

The DL850E/DL850EV determines the scale conversion equation (y = ax + b) using four values that you specify: two measured values (P1:X, P2:X) and the value that each one should be converted to (P1:Y, P2:Y).

The DL850E/DL850EV scales values using the scale conversion equation that it determines.



Horizontal Axis (Time Axis)

Time Axis Setting

Normally, under the initial settings, the time axis scale is set as a length of time per grid division (1 div). The selectable range is 100 ns/div to 20 days/div.* As you adjust the value, the unit changes between seconds, minutes, hours, and days automatically. Because the horizontal display range is 10 div, the amount of time on the waveform that is displayed is equal to the time axis setting × 10.

* If a 720210 (HS100M12) or 720211 (HS100M12) module is installed, the lowest setting is 100 ns/div. Otherwise, it is 1 µs/div.

Internal and External Clocks (Time base selection)

Under the initial settings, the DL850E/DL850EV samples the measured signal using the internal clock signal produced by its internal time-base circuit.

You can also use an external clock signal to control sampling. Apply the external clock signal to the external-clock input terminal. This external clock input is useful for synchronizing to the clock signal of the waveform that is being measured.

Relationship between the Time Axis Setting, Record Length, and Sample Rate

If you change the time axis setting, the sample rate and the acquisition-memory record length also change. For details, see appendix 1 in the *Getting Started Guide*, IM DL850E-03EN.

Sample Rate

If you change the time axis setting, the sample rate also changes. The sample rate is the number of samples-per-second (S/s). When the sample rate is low compared to the frequency of the input signal, the high-frequency components of the waveform are misread as low-frequency components. To prevent the high-frequency components from being misread, sample the signal at the highest sample rate possible, or set the waveform acquisition mode to Envelope.

Roll Mode Display

When the trigger mode is set to Auto, Auto Level, Single, or On Start and the time axis setting is greater than or equal to 100 ms/div, instead of updating waveforms through triggering (update mode), the DL850E/DL850EV displays the waveforms in roll mode. In roll mode, waveforms scroll from right to left as new data is captured and the oldest values are deleted from the screen.

Trigger

A trigger is a cue used to display the waveform on the screen. A trigger occurs when the specified trigger condition is met, and a waveform is displayed on the screen.

Trigger Modes

The trigger mode determines the conditions for updating the displayed waveforms. There are six trigger modes: Auto, Auto Level, Normal, Single, N Single, and On Start. The trigger mode setting applies to all trigger types.

Trigger Types

Triggers can be broadly divided into “simple triggers” and “enhanced triggers.”

Simple Triggers

Input Signal Trigger

The DL850E/DL850EV triggers when the trigger source passes through the specified trigger level in the specified way (rising edge, falling edge, or rising or falling edge).

Time Trigger

The DL850E/DL850EV triggers at the specified date and time and at specified intervals afterwards.

External Signal Trigger

The DL850E/DL850EV triggers when the signal applied to the TRIG IN terminal passes through the specified trigger level in the specified way (rising or falling edge).

Power Line Signal Trigger

The DL850E/DL850EV triggers on the rising edge of the power supply signal that it is receiving. This trigger enables you to observe waveforms in synchronization with the power supply frequency.

Enhanced Triggers

A -> B(N) Trigger

After state condition A is met, the DL850E/DL850EV triggers when state condition B is met N times.

A Delay B Trigger

After state condition A is met and the specified amount of time elapses, the DL850E/DL850EV triggers when state condition B is first met.

Edge On A Trigger (Enhanced)

While state condition A is met, the DL850E/DL850EV triggers on the OR of multiple trigger source edges.

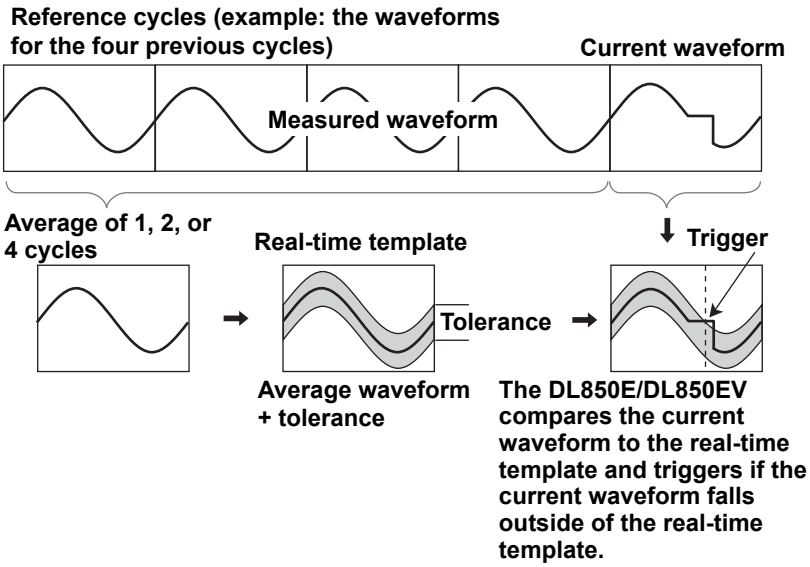
OR Trigger
The DL850E/DL850EV triggers on the OR of multiple trigger source edges.

AND Trigger
The DL850E/DL850EV triggers on the AND of multiple trigger source conditions. The DL850E/DL850EV triggers when all the specified conditions are met at a single point.

Period Trigger
The DL850E/DL850EV triggers on a specified period of occurrence of state condition B. The DL850E/DL850EV triggers when state condition B occurs again.

Pulse Width Trigger
The DL850E/DL850EV triggers according to the relationship between the state condition B achievement time and the specified reference times (Time or T1 and T2).

Wave Window Trigger
The DL850E/DL850EV creates real-time templates (Wave Window) using a number of cycles directly preceding the current waveforms. The DL850E/DL850EV compares the current waveforms to the real-time templates and triggers if one of the current waveforms falls outside of its real-time template.



Trigger Source
Trigger source refers to the signal that is used to check the specified trigger conditions. You can set the trigger source to an analog signal, logic signal, time, external signal, or power line signal. Select the appropriate trigger source for the trigger type.

Trigger Level
Trigger level refers to the signal level used as a reference for detecting a signal's rising and falling edges or high and low states. With simple triggers such as the edge trigger, the DL850E/DL850EV triggers when the trigger source level passes through the specified trigger level. The range and resolutions that you can use to set the trigger level vary depending on the type of signal being measured.

Waveform Acquisition
Based on the data that has been stored in the acquisition memory, the DL850E/DL850EV performs various operations, such as displaying waveforms on the screen, computing, measuring cursors, and automatically measuring waveform parameters.
You can set the number of data points to store in the acquisition memory (the record length), enable or disable the sample data averaging feature, and so on.

Record Length

Record length refers to the number of data points that are stored to the acquisition memory for each channel. *Display record length* refers to the data points from the data stored in the acquisition memory that are displayed on the screen. Normally, the acquisition-memory record length and display record length are the same, but the time axis setting may cause them to differ. When you change the time axis setting, the sample rate and record length also change.

On the standard model of the DL850E/DL850EV, you can set the record length to a value between 1 kpoint and 250 Mpoint. Depending on the model, you can set the record length to a value of up to 2 Gpoint.

Acquisition Mode

Specify how the DL850E/DL850EV processes the sampled data, stores it in the acquisition memory, and uses it to display waveforms. There are four acquisition modes: Normal, Envelope, Averaging, and BoxAverage.

Hard Disk Recording

When measurement starts, you can record data to an external hard disk that supports eSATA (external Serial ATA; /HD0 option) or to an internal hard disk (/HD1 option).* The recorded data is saved to files automatically.

* Models with the /HD0 option are equipped with eSATA connectors. You need to purchase a hard disk that supports eSATA separately. Note that hard disks that can be used are those whose disk partition is in MBR format and whose format is FAT32.

History

When waveforms are being measured, the waveform data stored in the acquisition memory as a result of a trigger occurrence is displayed as a waveform on the DL850E/DL850EV screen and can be viewed. When waveform acquisition is being triggered in succession and an abnormal waveform appears, it is impossible to stop acquisition before a new waveform appears on the screen. Normally, it would be impossible to view the abnormal waveform. However, with the history feature, you can view the past waveform data (history waveforms) stored in the acquisition memory when waveform acquisition is stopped. You can select specific history waveforms and display them.

You can also search through the history waveforms for waveforms that meet specified conditions.

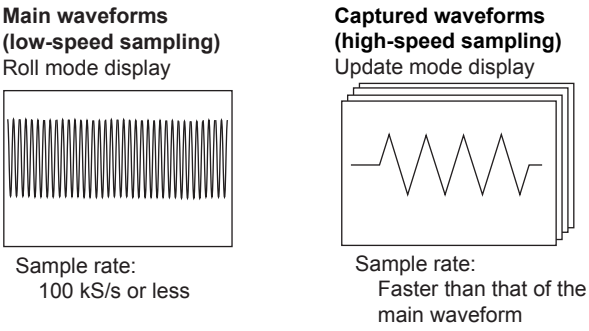
- **Zone Search**

  The DL850E/DL850EV searches for history waveforms that passed (or did not pass) through a specified search zone.
- **Waveform Parameter Search**

  The DL850E/DL850EV searches for waveforms whose measured waveform parameter values meet (or do not meet) specified conditions.

Dual Capturing

You can use dual capturing to simultaneously record a trend at a low sampling speed in roll mode and at a high sample rate. This is useful for capturing fast phenomenon while observing a trend over a long period of time.



Waveform Display

The DL850E/DL850EV has a main window for displaying normal time-domain waveforms, zoom windows for displaying zoomed time-axis waveforms, and X-Y windows for displaying X-Y waveforms. In addition, you can split screens and change the sizes of waveform display areas so that waveforms and measured values are easier to see and display an FFT window that shows the results of FFT analysis.

Zooming along the Time Axis (GIGAZoom)

You can magnify displayed waveforms along the time axis. The zoomed waveforms of two locations can be displayed simultaneously (the dual zoom feature). This feature is useful when you set a long acquisition time and want to observe a portion of the waveform closely.

Displaying X-Y Waveforms

You can observe the correlation between two waveform signal levels by displaying one signal level on the X-axis (horizontal axis) and a second signal level on the Y-axis (vertical axis). You can display X-Y waveforms at the same time as normal T-Y (time and signal level) waveforms. You can display up to four overlapping X-Y waveforms in both Window1 and Window2. Because multiple X-Y waveforms can be displayed, it is easy to compare the relationships between phases. You can use this feature to evaluate DC motors using Lissajous waveforms.

Snapshot

You can continue displaying a waveform on the screen as a snapshot waveform after the screen has been updated and the waveform has been cleared in update mode or after the waveform has left the screen in roll mode. Snapshot waveforms appear in white. You can compare them with new waveforms. You can also save and print snapshot waveforms as screen captures.

Waveform Computation and Analysis

Waveform Computation

You can perform basic arithmetic, binarization, FFT (power spectrum), and phase shifting (display the waveform with its phase shifted). On models with the /G2 option, you can use a rich variety of functions (square root, trigonometric functions, differentiation, integration, digital filtering, six types of FFT functions, and so on) to define up to eight equations.

Cursor Measurement

There are cursors for T-Y (time-axis), X-Y, and FFT waveforms. You can position a cursor over a waveform to view the various measured values at the intersection of the cursor and the waveform.

Automated Measurement of Waveform Parameters

You can use this feature to automatically measure waveform levels, maximum values, frequencies, and other values. You can measure 29 waveform parameters (including the delay between channels) that relate to the voltage axis, time axis, and waveform area.

- You can display a total of 32 measured values for all the waveforms.
- You can save a total of 64000 items of data for all the waveforms.
- You can also perform computations on measured waveform parameter values.
- You can display the following statistics for the specified waveform parameter.
  The maximum value (Maximum), minimum value (Minimum), average value (Average), standard deviation (SDev), and number of measured values used to calculate statistics (Count)

There are three statistical processing methods:

- **Normal statistical processing**

  While acquiring waveforms, the DL850E/DL850EV measures the measurement items and calculates the statistics of the waveforms that it has acquired so far.
- **Cyclic statistical processing (measurement and statistical processing are performed for each period)**

  The DL850E/DL850EV divides the waveform into periods starting at the left side of the screen (the oldest waveform) and moving to the right side of the screen, measures the selected measurement items within each period, and performs statistical processing on the measurement items.
- **Statistical processing of history waveforms**

  The DL850E/DL850EV measures the measurement items and calculates the statistics of history waveforms. Measurement and statistical processing begin with the oldest waveform.

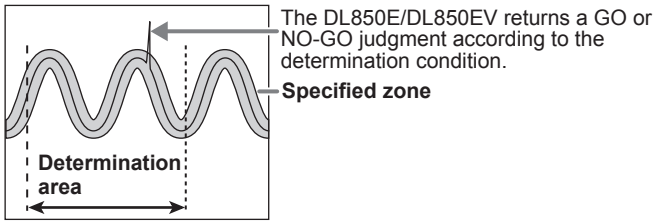
GO/NO-GO Determination

This feature is useful for signal testing on production lines and for tracking down abnormal phenomena. The DL850E/DL850EV determines whether the waveform enters the specified range. When the DL850E/DL850EV returns a GO (or NO-GO) result, specified actions are performed.

Determination Methods

- **Waveform Zone**

  The DL850E/DL850EV returns GO/NO-GO results based on whether waveforms leave or enter the zone that you create using a base waveform.



- **Waveform Parameter**

  Set the upper and lower limits for automated measurement values of waveform parameters. The DL850E/DL850EV performs GO/NO-GO determination based on whether the values are within or outside of the limits.

Actions Performed according to Determination Results

The DL850E/DL850EV can print and save screen captures, save waveform data, beep, and send emails according to the results of GO/NO-GO determination.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

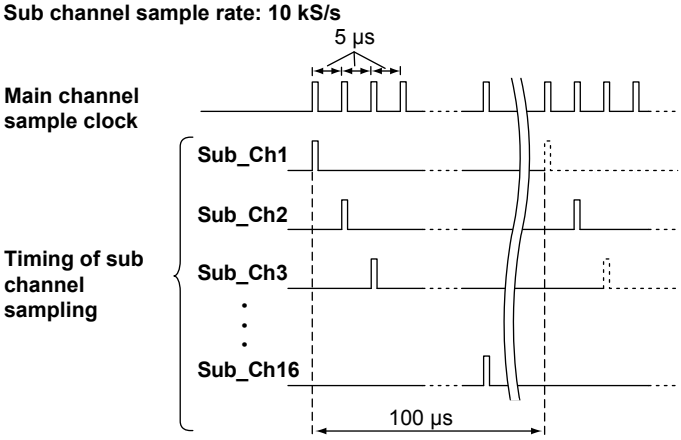
Notes about Using the 16-CH Voltage Input Module (720220)

While normal voltage input modules have two main channels for analog input, the 16-CH voltage input module has 16 sub channels for analog input. The 16-CH voltage input module samples the measured sub channels in order.

Main channel sample rate: 200 kS/s

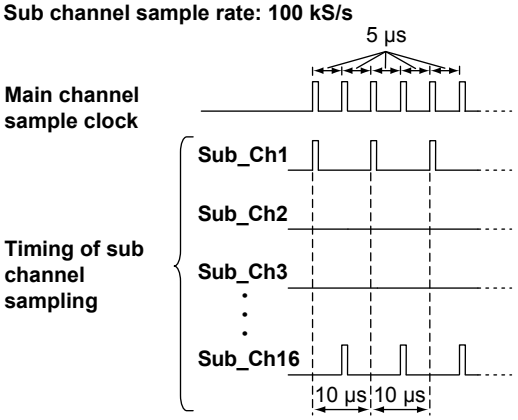
When the number of measured sub channels is 16 (all the sub channels are measured)

Sub channel sample rate: 10 kS/s



When the number of measured sub channels is 2 (sub channels 1 and 16 are measured)

Sub channel sample rate: 100 kS/s



- The 16-CH voltage input module uses only the odd main channels of the slot that it is inserted into. It cannot use the slot's even main channels.
- If you do not want to measure an individual sub channel, turn its input coupling off. Sub channels whose input coupling has been turned off are not scanned.
- The maximum sample rate of the 16-CH voltage input module is 200 kS/s (when only one sub channel is measured). The rate at which data is written to the sub channel acquisition memory varies depending on the main channel sample rate and the number of measuring sub channels. For details on the rate at which data is written to the sub channel acquisition memory, see appendix 2 in the *Getting Started Guide*, IM DL850E-03EN.
- The sample rate that is displayed on the screen is the sample rate of the main channel.
- The record length of each sub channel varies depending on the set record length and the number of measured sub channels.

  Record length of each sub channel ≤ set record length/number of measured sub channels
- The timing of waveform acquisition is different for each sub channel, but all the sub channels are stored in the acquisition memory as if they had been sampled at the same timing. This means that the sampling times of the acquired waveform data are different from the sampling times of the actual applied waveforms.

- Because the waveform data stored in the acquisition memory is used to display waveforms on the screen, the data of all sub channels is displayed as if though it were sampled at the same timing.
- The following operations are performed on the waveform data stored in the acquisition memory: waveform zooming, cursor measurement, the automated measurement of waveform parameters, computation, FFT, waveform searches, and the loading and saving of waveform data.
- GO/NO-GO determination and the display and searching of history waveforms are not performed on sub channels.
- When you execute auto setup on the 16-CH voltage input module, sub channel on/off settings and settings that relate to the horizontal axis (TIME/DIV) are not changed.
- Wire all the L input terminals for all the sub channels on the same module to the same potential. The L input terminals of the sub channels are common. Because the L input terminals are electrically connected inside the DL850E/DL850EV, connecting different potentials to them could result in short circuiting and damage to the 16-CH voltage input module.
  For information about the terminal arrangement, see section 3.13 in the *Getting Started Guide*, IM DL850E-03EN.
- For information about attaching and removing the terminal block and connecting and removing wires from the terminal block, see section 3.13 in the *Getting Started Guide*, IM DL850E-03EN.

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

In comparison with normal temperature modules, which can receive input from two thermocouples, the 16-CH temperature/voltage input module has sub channels that enable it to receive input from 16 thermocouples through a scanner box. You can also measure the voltage of 16 channels. The 16-CH temperature/voltage input module samples the measured sub channels in order.

- The 16-CH temperature/voltage input module uses only the odd main channels of the slot that it is inserted into. It cannot use the slot's even main channels.
- If you do not want to measure a given sub channel, turn its input coupling off. Sampled data is not acquired for channels whose input coupling is turned off.
- Regardless of the number of measured sub channels, the actual maximum sample rate is 100 kS/s. The rate at which data is written to the acquisition memory varies depending on the main channel sample rate. For details on the rate at which data is written to the acquisition memory, see appendix 2 in the *Getting Started Guide*, IM DL850E-03EN.
- The sample rate that is displayed on the screen is the sample rate of the main channel.
- Record length of each sub channell ≤ set record length/16
- The timing of waveform acquisition is different for each sub channel, but all the sub channels are stored in the acquisition memory as if they had been sampled with the same timing. This means that the sampling times of the acquired waveform data are different from the sampling times of the actual applied waveforms.
- Because waveforms on the screen are displayed using the waveform data stored in the acquisition memory, the data of all sub channels is displayed as though it were sampled with the same timing.
- The waveforms displayed on the screen are updated at the set data update period regardless of the number of measured sub channels. The previous value is stored repeatedly in acquisition memory until the value changes. Saved waveform data is treated in the same manner.
- The waveform data stored in the acquisition memory is used when you perform the following operations: waveform zooming, cursor measurement, the automated measurement of waveform parameters, computation, FFT, waveform searches, and the loading and saving of waveform data.
- GO/NO-GO determination and the display and searching of history waveforms are not performed on sub channels.
- When you execute auto setup on the 16-CH temperature/voltage input module, sub channel on/off settings and horizontal axis (TIME/DIV) settings are not changed.
- Connect the 16-CH temperature/voltage input module to the scanner box with a cable and then connect a thermocouple to the scanner box to perform temperature measurements. For information about how to connect thermocouples to the scanner box's terminal block, see section 3.14 in the *Getting Started Guide*, IM DL850E-03EN.

2 Vertical Axis

This section explains how to configure the signal input settings and the amplitude-direction display settings. The items that can be set vary depending on the installed modules.

Input Settings

CH1 to CH16

The channel menu that corresponds to the key you pressed appears. You can set the various vertical axis settings for each channel.

ALL CH

You can configure the settings of all channels while viewing the settings in a list. You can also copy the various vertical axis settings of one channel to another channel. There are some items that cannot be configured from the ALL CH menu.

▶ See here.

DL850E/DL850EV Measurement Items

When the DL850E/DL850EV is equipped with the modules listed below, it can measure voltage, temperature, strain, acceleration, frequency, logic, CAN/CAN FD bus signals, LIN bus signals, SENT signals, and so on.

- **Voltage measurement**
  701250 (HS10M12), 720250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 701267 (HV (with RMS)), 720268 (HV (AAF, RMS)), 720210 (HS100M12), 720211 (HS100M12), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT), 720254 (4CH 1M16)
  You can install up to four 720210 modules, and these modules must be installed in the top slots.
- **Voltage measurement (for the 16-CH Voltage Input Module)**
  720220 (16CH VOLT)
- **Temperature measurement**
  701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV)
- **Temperature measurement (for the 16-CH Temperature/Voltage Input Module)**
  720221 (16CH TEMP/VOLT)
- **Strain measurement**
  701270 (STRAIN_NDIS), 701271 (STRAIN_DSUB)
- **Acceleration measurement**
  701275 (ACCL/VOLT)
- **Frequency measurement**
  701281 (FREQ), 720281 (FREQ)
- **Logic measurement**
  720230 (LOGIC)
- **CAN Bus Signal Monitoring**
  720240 (CAN MONITOR), 720242 (CAN /CAN FD), 720241 (CAN & LIN)
  These modules can be used only with the DL850EV. You can install up to a total of two 720240, 720241, or 720242 modules in slots 7 and 8.
- **CAN FD Bus Signal Monitoring**
  720242 (CAN /CAN FD)
  These modules can be used only with the DL850EV. You can install up to a total of two 720242 modules in slots 7 and 8.
- **LIN Bus Signal Monitoring**
  720241 (CAN & LIN)
  This module can be used only with the DL850EV. You can install up to two 720241 modules in slots 7 and 8.
- **SENT Signal Monitoring**
  720243 (SENT)
  This module can be used only with the DL850EV. You can install up to four 720243 modules in slots 5 to 8.

You can use auto setup to automatically configure the appropriate settings (such as vertical axis, horizontal axis, and trigger settings) for the input signal. This feature is useful when you are not sure what type of signal will be applied to the DL850E/DL850EV. The auto setup feature will not work properly on some input signals. Also, there are some modules with which the auto setup feature cannot be used.
▶ See here.

Digital Filter and Real Time Math (Optional) ▶ See here.

Voltage Measurement

For voltage measurement, the items that have to be set for each input signal (CH1 to CH16) include vertical scales, the vertical positions, input coupling, probe attenuation, the bandwidth limit, the zoom method, the offset, waveform inversion, trace settings, and linear scaling.

You can measure voltage by connecting probes, measurement leads, etc. to one of the following voltage measurement modules: 701250 (HS10M12), 720250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 701267 (HV (with RMS)), 720268 (HV (AAF, RMS)), 720210 (HS100M12), 720211 (HS100M12), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT), 720254 (4CH 1M16).

For the probe connection method, see section 3.5 in the *Getting Started Guide*, IM DL850E-03EN. For the measurement lead connection method, see section 3.7.

Waveform Display (Display)

Select whether to display each channel's input signal waveform. On the 720254 4-CH module , set each sub channel.

* 4-CH modules have sub channels 1 and 2. Sub channel 1 is displayed as "Channel number_1," and sub channel 2 as "Channel number_2." For example, sub channels are displayed as CH3_1 and CH3_2

- ON: Displays the waveform
- OFF: Does not display the waveform

Labels (Label)

You can specify a name of up to sixteen characters in length for each channel.

You can set whether to display labels using the DISPLAY menu.

▶ See here.

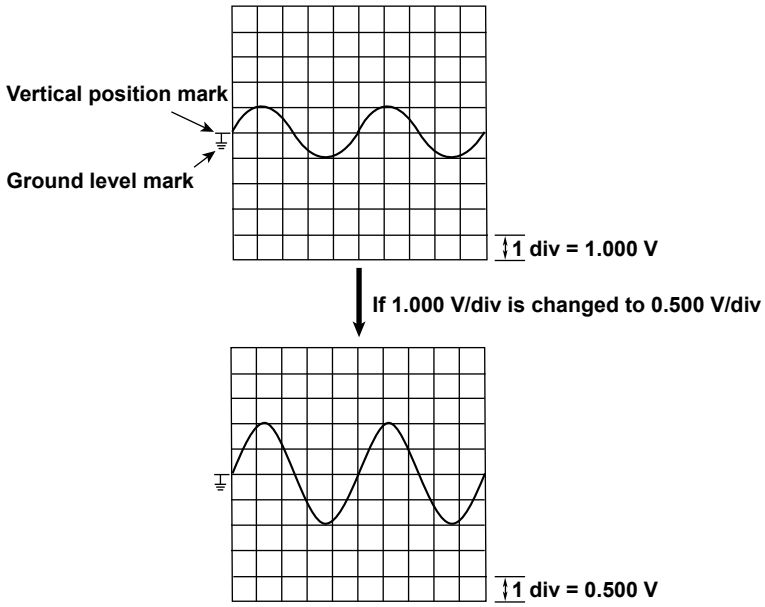
- The waveform display on/off setting changes to the waveform acquisition on/off setting in cases such as during hard disk recording and when an increase in the record length places a limitation on the number of channels that can be used.
- The specified display label is used in labels, scale values, the numeric display, and cursor-measurement values.
- Depending on the display and zoom formats, label names may not appear when the waveform display is narrow.

Vertical Scale (SCALE knob)

Voltage Scale Setting

The vertical scale is used to adjust the displayed waveform amplitude so that you can easily view signals. Set the vertical scale by voltage per grid square (V/div) or current per grid square (A/div) on the screen.
Use the SCALE knob to set the vertical scale for each channel and sub channel.
The same SCALE knob is used to adjust the scale of each channel and sub channel.
To change the vertical scale of a channel, press the key from CH1 to CH16 that corresponds to the channel. On a 720254 4-CH module, select the sub channel.
To change the vertical scale of a sub channel on a 720220 or 720221 16-CH module, press an odd channel key from CH1 to CH15, and then press the soft key that corresponds to the sub channel.
The vertical scale changes when you switch to an input attenuator with a different attenuation. You can change the scale in steps like this: 1 V/div -> 2 V/div -> 5 V/div.

Example



- While waveform acquisition is stopped, turning the SCALE knob will not change the displayed waveform. The changed V/div value will be applied the next time that waveform acquisition is started.
- While waveform acquisition is stopped, turning the SCALE knob will not change the cursor-measurement values or the automated measurement values of waveform parameters, they will continue to be based on the V/div value at the time of measurement.

Selectable range of V/div

The selectable range varies as shown below depending on the input module.

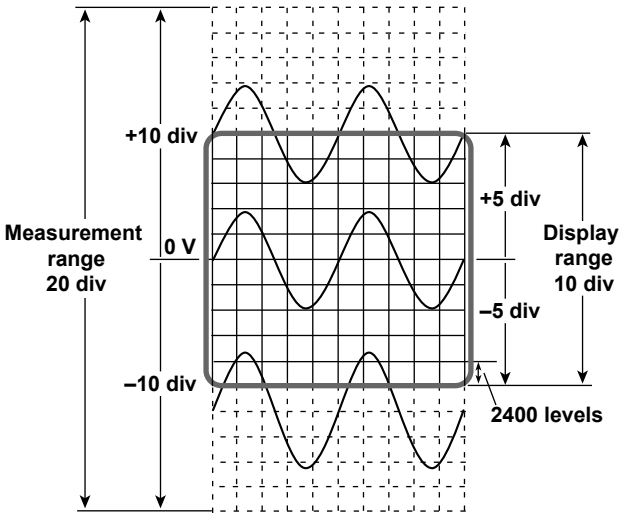
Input Module	Selectable Range
701250 (HS10M12), 720250 (HS10M12)	5 mV/div to 20 V/div
701251 (HS1M16)	1 mV/div to 20 V/div
701255 (NONISO_10M12)	5 mV/div to 20 V/div
701267 (HV (with RMS)), 720268 (HV (AAF, RMS))	20 mV/div to 200 V/div
701261 (UNIVERSAL)	5 mV/div to 20 V/div
701262 (UNIVERSAL (AAF))	5 mV/div to 20 V/div
701265 (TEMP/HPV)	0.1 mV/div to 10 V/div
720266 (TEMP/HPV)	0.1 mV/div to 20 V/div
701275 (ACCL/VOLT)	5 mV/div to 10 V/div
720210 (HS100M12), 720211 (HS100M12)	10 mV/div to 20 V/div
720220 (16CH VOLT)	200 mV/div to 2 V/div
720221 (16CH TEMP/VOLT)	1 mV/div to 2 V/div
720254 (4CH 1M16)	10mV/div to 50V/div

These values are for when the probe attenuation is 1:1. Multiply the values by 10 when the attenuation is 10:1, by 100 when the attenuation is 100:1, and by 1000 when the attenuation is 1000:1.

Measurement and Display Ranges

The measurement range of the DL850E/DL850EV is ±10 div, with 0 V in the center (the absolute width, or span, is 20 div). The default display-range setting is ±5 div (the span is 10 div). Using the features listed below, you can move and scale the displayed waveform so that parts of it that were outside of the display range are displayed.

- Vertical position adjustment
- Offset voltage setting
- Vertical zoom



- **How to Measure the Voltage with High Accuracy**
  To measure the voltage with high accuracy, increase the vertical scale so that the input signal is measured with the largest possible amplitude. To display multiple waveforms so that they do not overlap without dividing the screen, you have to set the vertical scale to a low value. This prevents you from taking advantage of the A/D converter's resolution. However, if you divide the screen ▶ See here. and arrange the waveforms ▶ See here. in the divided screens, they will not overlap, and you can raise their vertical scales.
- **Measurement Resolution**
  The measurement resolution varies depending on the module. For example, the 701250 (HS10M12), 720250 (HS10M12), 701255 (NONISO_10M12), 720210 (HS100M12), and 720211 (HS100M12) use 12-bit A/D converters and sample the input signal at a resolution of 150 levels per div. The 701251 (HS1M16), 701267 (HV (with RMS)), 720268 (HV (AAF, RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT), 720220 (16CH VOLT), 720221 (16CH TEMP/VOLT), and 720254 (4CH 1M16) use 16-bit A/D converters and sample the input signal at a resolution of 2400 levels per div.

Waveform Vertical Position (Vertical POSITION knob)

The DL850E/DL850EV can display the waveforms of the main analog-input channels, the waveforms of the sub analog-input channels, and computed waveforms. Because the DL850E/DL850EV can display so many waveforms, the waveforms may overlap and be difficult to view. If this happens, you can adjust the vertical display position to make waveforms easier to view (vertical position).

The vertical position can be moved within the range of ±5 div.

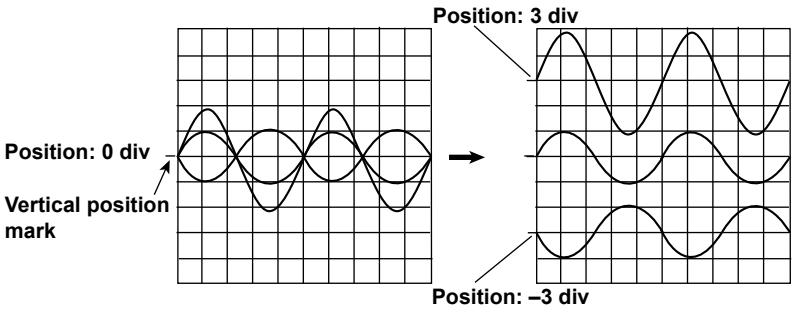
When you change the vertical scale (V/div), the location of the vertical position mark does not change.

Use the POSITION knob to set the vertical position for each channel and sub channel.

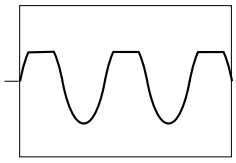
The same POSITION knob is used to adjust the position of each channel and sub channel.

To change the position of a channel, press the key from CH1 to CH16 that corresponds to the channel. On a 720254 4-CH module, select the sub channel.

To change the vertical position of a sub channel on a 720220 or 720221 16-CH module, press an odd channel key from CH1 to CH15, and then press the soft key that corresponds to the sub channel.



- You cannot use the vertical POSITION knob to move the vertical position of a temperature, strain, or computed waveform.
- When the menu for configuring all channels (ALL CH) or all sub channels (ALL Sub Channels Setup) is displayed, you can use the job shuttle to change the vertical positions.
- When you change the vertical position, offset voltage (when V Scale is set to DIV), or upper or lower limit ((when V Scale is set to SPAN)), data that is outside of the measurement range is handled as overflow data. As shown in the figure below, waveforms appear cut off when there is overflow data.



Input Coupling (Coupling)

It is easier to measure the amplitude of an AC signal if you remove its DC component. On the other hand, there are times when you want to measure the ground level or observe the entire signal, including both the DC and AC components. In these kinds of situations, you can change the input coupling setting. By changing the setting, you can choose how the vertical-axis (voltage-axis) control circuit is coupled to the input signal. You can set the input coupling to one of the options listed below.

DC

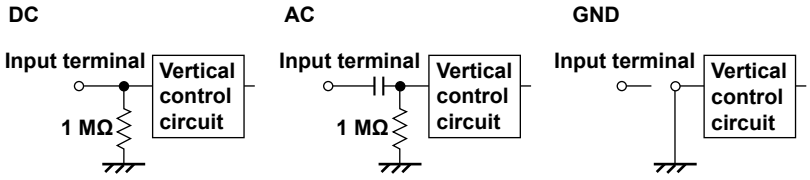
The input signal is coupled directly to the attenuator of the vertical control circuit. Set the input coupling to DC when you want to measure the entire signal, including both the DC and AC components.

AC (Only when measuring AC voltage)

The input signal is coupled to the attenuator of the vertical control circuit through a capacitor. Set the input coupling to AC when you want to measure only the amplitude of the AC signal without the DC component.

GND

The input signal is coupled to the ground rather than to the attenuator of the vertical control circuit. Set the input coupling to GND to check the ground level on the screen.



TC (Only when measuring temperature)

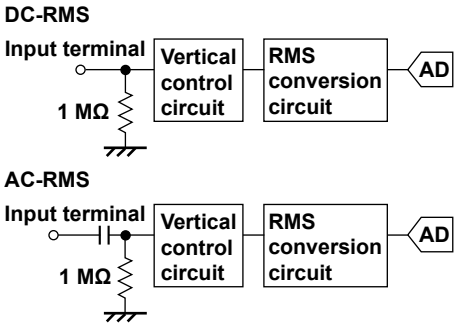
Set the coupling to TC when you are measuring temperature using the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), or 720221 (16-CH TEMP/VOLT).

DC-RMS

With the 701267 (HV (with RMS)) or 720268 (HV (AAF, RMS)), the DC and AC components of the input signal are converted to RMS values and displayed. An RMS conversion circuit is connected to the same vertical-control-circuit coupling arrangement that is used when the coupling is set to DC.

AC-RMS

With the 701267 (HV (with RMS)) or 720268 (HV (AAF, RMS)), only the AC components of the input signal are converted to RMS values and displayed without the DC component. An RMS conversion circuit is connected to the same vertical-control-circuit coupling arrangement that is used when the coupling is set to AC.



ACCEL (Only when measuring acceleration)

To measure acceleration with the 701275 (ACCL/VOLT), set the input coupling to ACCEL.

OFF (For the 16-CH Voltage Input Module and 16-CH Temperature/Voltage Input Module)

Set the coupling to OFF to not include in the measurement the sub channels selected on the 720220 (16CH VOLT) or 720221 (16CH TEMP/VOLT).

Probe Attenuation and Current-to-Voltage Conversion Ratio (Probe)

In voltage (current) measurement, a probe is used to connect the circuit under measurement to a signal input terminal. Using a probe has the following advantages.

- Prevents the disturbance of the voltage and current of the circuit being measured.
- Allows signals to be applied with no distortion.
- Expands the voltage (current) range that the DL850E/DL850EV can measure.

When you use a probe, to read the measurement voltage (current) correctly, you must set the attenuation on the DL850E/DL850EV to match the probe attenuation or current-to-voltage conversion ratio.

Set the attenuation ratio as indicated below for each probe. (The probes are optional accessories that are sold separately.)

Probe Type	Attenuation
Isolated probe (700929)	10:1
Isolated probe (701947)	100:1
Current probe (701933, 701932)	10 A:1 V
Current probe (701930, 701931)	100 A:1 V
Current probe (701917, 701918)	1 A:1 V
Clamp-on probe (720930)	100 A:1 V
Clamp-on probe (720931)	400 A:1 V
Differential probe (700924)	1000:1, 100:1
10:1 passive probe (701940)	10:1

The attenuation settings available on the DL850E/DL850EV are 1:1, 10:1, 100:1, 1000:1, 1 A:1 V[1], 10 A:1 V[2], 100 A:1 V[3], and 400 A:1 V[4]. If you use a probe other than one of the separately sold optional accessories provided by Yokogawa, set the attenuation ratio in accordance with that probe.

1 Output voltage rate: 1 V/A
2 Output voltage rate: 0.1 V/A
3 Output voltage rate: 0.01 V/A
4 Output voltage rate: 0.0025 V/A

Use a probe that is appropriate for the input capacitance of the module that you are using it with. The capacitance cannot be adjusted for an inappropriate probe.

Bandwidth (Bandwidth)

You can specify a bandwidth limit for each module. You can use bandwidth limits to observe input signal waveforms with their noise components removed.

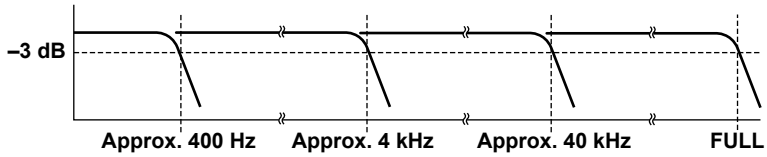
Normal Bandwidth Limits

You can remove high-frequency components from the input signal. The bandwidth limits vary as shown below depending on the input module.

Input Module	Bandwidth Limit
701250 (HS10M12), 720250 (HS10M12), 701255 (NONISO_10M12)	500 Hz, 5 kHz, 50 kHz, 500 kHz, Full
701251 (HS1M16)	400 Hz, 4 kHz, 40 kHz, Full
701267 (HV (with RMS))	100 Hz, 1 kHz, 10 kHz, Full
720268 (HV (AAF, RMS))	400 Hz, 4 kHz, 40 kHz, Auto, Off
720210 (HS100M12), 720211 (HS100M12)	10 kHz, 20 kHz, 40 kHz, 80 kHz, 160 kHz, 320 kHz, 640 kHz, 1.28 MHz, 2 MHz, Full
720220 (16CH VOLT)	500 Hz, Full
701261 (UNIVERSAL)[1], 701262 (UNIVERSAL (AAF))[1], 701265 (TEMP/HPV)	2 Hz, 8 Hz, 30 Hz, Full
720266 (TEMP/HPV)	Line Filter : 15 Hz Digital Filter : 0.1 Hz, 1Hz, 8Hz, Off
701270 (STRAIN_NDIS), 701271 (STRAIN_DSUB)	10 Hz, 100 Hz, 1 kHz, Full
701261 (UNIVERSAL)[2], 701262 (UNIVERSAL (AAF)), 701275 (ACCL/VOLT)	40 Hz, 400 Hz, 4 kHz, Auto, Full
701281 (FREQ)[3], 720281 (FREQ)[3]	100 Hz, 1 kHz, 10 kHz, 100 kHz, Full
720254 (4CH 1M16)	6.25 Hz, 12.5 Hz, 25 Hz, 50 Hz, 100 Hz, 200 Hz, 400 Hz, 800 Hz, 1.6 kHz, 3.2 kHz, 6.4 kHz, 12.8 kHz, 40 kHz, Full

1 When measuring temperature.
2 When measuring voltage. Auto cannot be selected on the 701261.
3 Full cannot be selected when Preset is set to AC100V or AC200V.

For example, on the 701251 (HS1M16), you can set the bandwidth limit to 400 Hz, 4 kHz, or 40 kHz. The frequency characteristics for the different bandwidth limits are shown below. If you select Full, the module's maximum bandwidth is used.



Bandwidth Limitation on the 701262 (UNIVERSAL (AAF)), the 701275 (ACCL/VOLT) and the 720268 (HV(AAF, RMS))

When measuring voltage on the 701262 (UNIVERSAL (AAF)) or 720268 (HV (AAF, RMS)) or when bandwidth limit on the 701275 (ACCL/VOLT) is set to Auto, the anti-aliasing filter and low-pass filter settings are set to values shown below according to the sample rate.

701262/701275		
Sample Rate	**Anti-Aliasing Filter**	**Low-Pass Filter**
100 kS/s	40 kHz	OFF
50 kS/s	20 kHz	OFF
20 kS/s	8 kHz	OFF
10 kS/s	4 kHz	4 kHz
5 kS/s	2 kHz	4 kHz
2 kS/s	800 Hz	4 kHz
1 kS/s	400 Hz	400 Hz
500 S/s	200 Hz	400 Hz
200 S/s	80 Hz	400 Hz
100 S/s	40 Hz	40 Hz
50 S/s	20 Hz	40 Hz
20 S/s to 5 S/s	20 Hz	40 Hz
2 S/s or less	20 Hz	40 Hz
Ext sample	40 kHz	OFF

720268		
Sample Rate	**Anti-Aliasing Filter**	**Low-Pass Filter**
1 MS/s	40 kHz	40 kHz
500 kS/s	40 kHz	40 kHz
200 kS/s	40 kHz	40 kHz
100 kS/s	40 kHz	40 kHz
50 kS/s	20 kHz	40 kHz
20 kS/s	8 kHz	40 kHz
10 kS/s	4 kHz	4 kHz
5 kS/s	2 kHz	4 kHz
2 kS/s	800 Hz	4 kHz
1 kS/s	400 Hz	400 Hz
500 S/s	200 Hz	400 Hz
200 S/s	80 Hz	400 Hz
100 S/s	40 Hz	400 Hz
50 S/s or less	40 Hz	400 Hz
Ext sample	OFF	OFF

For example, when the sample rate is between 100 kS/s and 50 kS/s, the cutoff frequency of the anti-aliasing filter is 40% of the sample rate.

Bandwidth Limit on the 720221 (16CH TEMP/VOLT)
The bandwidth limits vary depending on the set data update period.

Data Update Period	Bandwidth Limit	Data Update Period	Bandwidth Limit
100 ms	600 Hz	1 s	50 Hz
300 ms	200 Hz	3 s	10 Hz

Zoom Method (V Scale)

You can choose the method for zooming the waveform vertically.

- DIV: The waveform is zoomed by a set magnification.
- SPAN: The waveform is zoomed to fit within specified upper and lower display limits.

Zooming by Setting a Magnification (V Zoom)

When V Scale is set to DIV, you can set the vertical magnification and enlarge or reduce the waveform along the vertical axis. This method is useful when you want to change the vertical scale of the waveform after it has been displayed.

Zoom Factor (V Zoom)

The magnifications that you can choose from are listed below.
x0.1, x0.111, x0.125, x0.143, x0.167, x0.2, x0.25, x0.33, x0.4, x0.5, x0.556, x0.625, x0.667, x0.714, x0.8, x0.833, x1, x1.11, x1.25, x1.33, x1.43, x1.67, x2, x2.22, x2.5, x3.33, x4, x5, x6.67, x8, x10, x12.5, x16.7, x20, x25, x40, x50, x100

The range of zoom magnifications that you can choose varies under special circumstances as described below.

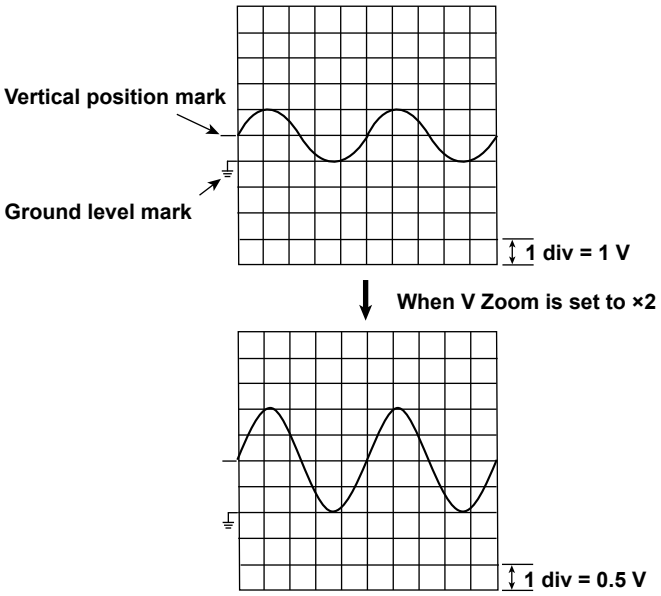
When measuring acceleration using the 701275 (ACCL/VOLT)
x0.5 to x50

When using the 701281 (FREQ) or 720281 (FREQ)
x0.33 to x100

When using the 720230 (LOGIC)
x0.1 to x3.33

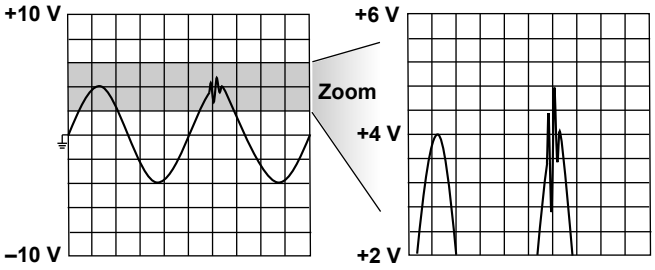
Zoom Position

Zooming is centered on the vertical position.



Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

When V Scale is set to SPAN, you can set the upper and lower vertical limits and enlarge or reduce the waveform along the vertical axis. By setting the appropriate upper and lower limits for the displayed waveform, you can zoom in vertically on the area of the waveform that you want to observe. You can also increase the display range to view parts of the waveform that were outside the range. Zooming the waveform does not change its A/D conversion resolution or accuracy.



Selectable Range of the Upper and Lower Limits

The upper and lower limits can be set within ±(100 × the specified V/div value) or ±2000 V, whichever is lower. Set the limits so that the upper limit is greater than the lower limit.

- The range of the upper and lower limits for the 701270 (STRAIN_NDIS) and 701271 (STRAIN_DSUB) varies as indicated below depending on the range unit.
  When the range unit is μSTR: ±30000 μSTR
  When the range unit is mV/V: ±15 mV/V
- For the 701275 (ACCL/VOLT), the range of the upper and lower limits is ±2000000 units.
- For the 701281 (FREQ) or 720281 (FREQ), the range of the upper and lower limits is (offset) ± (Value/div × 30). However, depending on the type of signal being measured, the maximum range is as follows:
  When measuring frequencies: −1500 kHz to 1500 kHz
  When measuring revolutions in rpm: −300 krpm to 300 krpm
  When measuring revolutions in rps: −6000 rps to 6000 rps
  When measuring periods: −150 s to 150 s
  When measuring duty ratios: −600% to 600%
  When measuring pulse widths: −150 s to 150 s
  When measuring pulse integration: −1.5E+21 to 1.5E+21
  When measuring velocity: −1.5E+21 to 1.5E+21

The displayed V/div will not change if you turn the SCALE knob after you set the upper and lower limits, but the measurable range will change. If you change the measurable range so that it is narrower than the range of the set upper and lower limits, when you start waveform acquisition, the parts of the waveform that do not fit within the measurable range may not appear. The measurable range is approximately ±10 div (with 0 in the center) when V Scale is set to DIV.

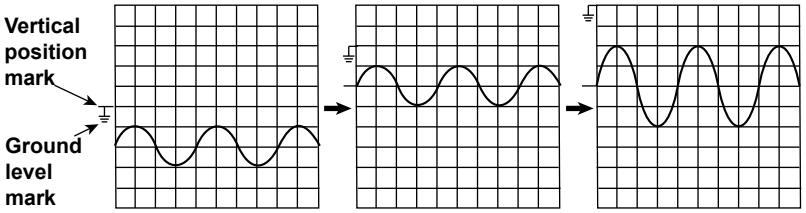
Offset (Offset)

By adding an offset, you can move the waveform to a vertical position that is easier to see. For example, when measuring a signal with a fixed voltage component, you can use the offset to cancel out the fixed voltage and measure the signal changes at a higher voltage sensitivity.

You can set the offset for each channel.

The offset is useful when you are measuring voltage or using the frequency module to measure frequency or some other value.

Voltage sensitivity:	1.000 V/div	1.000 V/div	0.500 V/div
Vertical position:	0.00 div	1.00 div	1.00 div
Offset voltage:	0.000 V	–2.000 V	–2.000 V



Selectable Range of the Offset

When measuring voltage: ±5 div

For the frequency module, the range varies depending on what is being measured.

- When measuring frequency: ±(Value/div) × 1000 or 500 kHz
- When measuring revolutions in rpm: ±(Value/div) × 1000 or 50 krpm
- When measuring revolutions in rps: ±(Value/div) × 1000 or 1000 rps
- When measuring periods: ±(Value/div) × 1000 or 50 s
- When measuring duty ratios: ±(Value/div) × 1000 or 100%
- When measuring pulse widths: ±(Value/div) × 1000 or 50 s
- When measuring pulse integration: ±(Value/div) × 1000 or 1.0000E+22
- When measuring velocity: ±(Value/div) × 1000 or 1.0000E+22

Notes about Setting the Offset

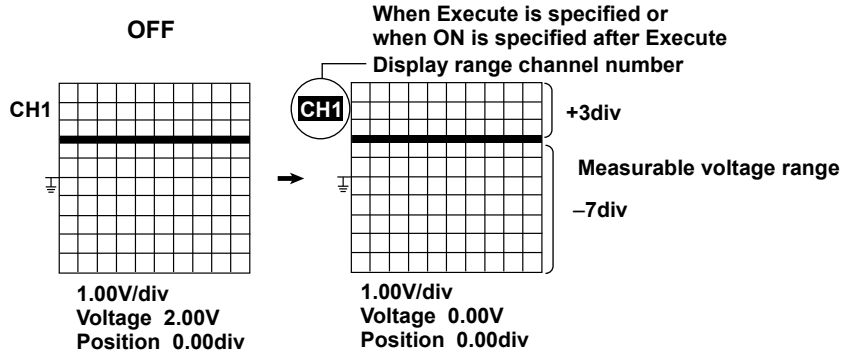
- When you are measuring voltage, changes to the offset are applied when acquisition is stopped. When you are measuring the frequency or some other value using the frequency module, changes to the offset are not applied when acquisition is stopped. The changed offset will be applied to the next measurement.
- When you are measuring voltage, if you change the probe attenuation, the offset voltage is determined using the new attenuation ratio.
- When you are measuring voltage, the offset will not change even if you change the voltage scale. However, if the offset goes outside the selectable range, the offset is set to the maximum or minimum value for the current voltage scale. If you set the vertical scale back to its original value without changing the offset, the offset returns to its original value.

- The offset does not affect cursor-measurement values, automated measurement values of waveform parameters, or computed values.
- You can change the position of the waveform relative to the vertical position (change the focus of the vertical zoom) by changing the offset.

DC Offset Cancel (DC Offset Cancel)

This function can be used to determine cursor measurement values, automatically measured values of waveform parameters, and computed values by assuming the DC signal voltage measured during offset adjustment to be 0 V. The adjustment range is ±30% of the measurement range. For example, if the vertical scale is set to 1 V/div, up to 3 V can be assumed to be 0 V.
Note that when the offset is adjusted, the measurable range changes.
In addition, if you change the measurement range during offset adjustment, the offset is measured when the range is changed, and this new offset is used to determine the values.
However, if you change the vertical scale and the measured value falls outside ±30% of the measurement range, correct measurement will no longer be possible.
For example, if you are measuring a 5 V DC signal with the vertical scale set to 2 V/div, adjustment is possible because the signal corresponds to 25% the measurement range. But, if you change the vertical scale to 1 V/div, the signal corresponds to 50% the measurement range, and therefore adjustment is not possible.
When DC offset adjustment is enabled, the display range channel number appears highlighted.

- ON
  DC offset canceling is enabled.
- OFF
  DC offset canceling is disabled.
- Execute
  Executes offset adjustment.



- This function can be adjusted when the DC offset/gain adjustment function▶ See here. is turned on.
- The settings (ON state and the value adjusted with Execute) are not retained when the DL850E/DL850EV is turned off. If necessary, save the waveform data and setup data.
- This function can be used on voltage measurement modules 701250 (HS10M12), 720250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 720210(HS100M12), 720211 (HS100M12), and 720254 (4CH 1M16).

Gain Adjustment (Gain)

Gain adjustment is used to adjust measured voltages. The adjustment range is ±5%.
The setting resolution is down to the fourth decimal place on all modules that can use this function.

- This function can be adjusted when the DC offset/gain adjustment function▶ See here. is turned on.
- The setting is retained even when the DL850E/DL850EV is turned off.
- This function can be used on voltage measurement modules 701250 (HS10M12), 720250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 720210(HS100M12), 720211 (HS100M12), and 720254 (4CH 1M16).
- The gain adjustment is reset to 1.0000 when Execute or ON is specified for DC offset adjustment.
- Gain adjustment is not possible when DC offset is set to ON.

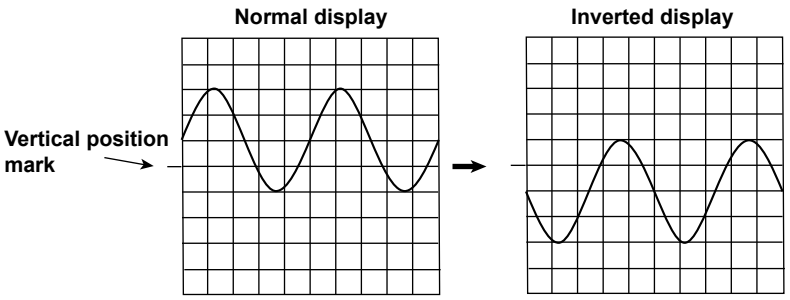
Trace Settings (Trace Setup)

These settings are the same as the display assignment and display color settings in the DISPLAY menu.

▶ See here.

Inverted Waveform Display (Invert)

When measuring voltage and strain, you can invert the waveform display around the vertical position.



- Cursor measurements, automated measurements of waveform parameters, and computations are performed on the inverted waveforms.
- Even when inverted waveforms are displayed, triggering is based on the uninverted waveforms.
- When you are measuring strain, you cannot invert waveforms whose measurement has finished. The inversion setting will be applied when the next measurement starts.

Linear Scaling (Linear Scale)

Linear scaling is a function that converts measured values into physical values and reads them directly. When you measure voltage (current), strain, or frequency (revolutions, periods, duty ratios, power supply frequencies, pulse widths, pulse integration, velocities), you can choose from one of two linear scaling methods: AX + B or P1-P2.

Linear Scaling Modes (Scaling Mode)

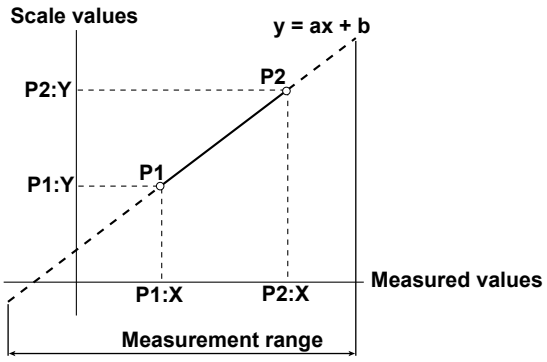
- **OFF**
  Linear scaling is not performed.

- **AX + B**
  Using specified scaling coefficient A and offset B, the DL850E/DL850EV performs the following computation to scale cursor-measurement values and automated measurement values of waveform parameters. You can specify the unit of the linearly scaled results.
  Y = AX + B
  X: Value before scaling
  Y: Value after scaling

  Selectable range for A and B: −9.9999E+30 to +9.9999E+30
  However, coefficient A cannot be set to zero.
  Initial value of A: +25.000E+00
  Initial value of B: −25.000E+00

- **P1-P2**
  You can specify two measured values (P1:X, P2:X) and specify a scale value (P1:Y, P2:Y) for each. The scale-conversion equation (y = ax + b) is determined by these four values.
  - Measured value (P1:X, P2:X) range: Same as the measurement range
  - Scale value (P1:Y, P2:Y) range: −9.9999E+30 to +9.9999E+30
    However, you cannot set measured or scaled values P1 and P2 that would make value a in the scaling equation zero or an incalculable value.
  - Initial scale values
    P1:X +1.0000E+00, P1:Y +0.0000E+00
    P2:X +5.0000E+00, P2:Y +100.00E+00

  Get Value (Get Value)
  Sets P1:X and P2:X to the current values (the values displayed by the level indicator), regardless of whether waveform acquisition is in progress or stopped.



Unit String (Unit String)

You can set the unit using up to four alphanumeric characters.

Display Type (Display Type)

When you measure voltage using a voltage module or measure strain using a strain module, you can display the linearly scaled results using one of the following two methods.
Exponent: Values are displayed in exponential notation.
Floating: Values are displayed as decimal numbers.

For Decimal Number, set the number of digits after the decimal point to Auto or a number from 0 to 3. For SubUnit, set the unit prefix to Auto, p, n, µ, m, None, k, M, G, or T.

- If you set Decimal Number to a number from 0 to 3, the specified number of digits after the decimal point are displayed. If you select Auto, all numbers will be displayed using five digits (for example: 1.0000, 250.00). The default setting is Auto.
- If you set SubUnit to a setting other than Auto, numbers will be displayed with the specified unit prefix. If you select Auto, the DL850E/DL850EV will automatically select appropriate unit prefixes. The default setting is Auto. The DL850E/DL850EV displays values in exponential notation if it is unable to display them as decimal numbers.

Scale Value Display

You can display the linearly scaled values of the upper and lower vertical limits of each channel.
You can turn the scale value display on and off in the DISPLAY menu.

▶ See here.

- Linear scaling cannot be performed for measurements of temperature or acceleration.
- The following waveforms cannot be linearly scaled.
  Accumulated waveforms (except for the most recent)
- You can configure linear scaling for each channel.
- The specified scaling coefficient A and offset B are retained even after linear scaling is set to OFF.
- Computations are performed on the linearly scaled values.

RMS Measurement

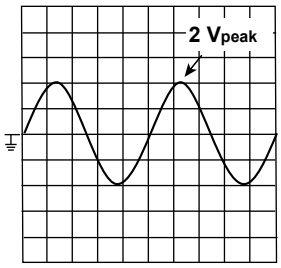
When a 701267 (HV (with RMS)) or 720268 (HV (AAF, RMS)) channel is selected, you can observe the RMS values of the input signal.

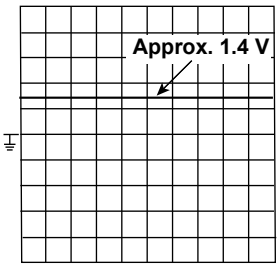
AC-RMS

Use this setting when you only want to observe the RMS values of the input signal without the DC component.

Example

When you measure the RMS values of a 2 Vpeak sine wave, an approximately 1.4 VDC signal appears, as shown in the figure on the right.





RMS values are calculated using the following equation.

$$\sqrt{\frac{1}{T}\int_0^T u(t)^2\,dt}$$ **u(t): Input signal, T: One cycle of the input signal**

Given u(t) = Vmsinωt (where Vm is the peak value and ω is the angular velocity of 2πf, with f being the frequency of the sine wave signal), the RMS value Vrms is:

$$V_{rms} = \sqrt{\text{Average of } u(t)^2 \text{ over one cycle}} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} (V_m \sin wt)^2\,dwt} = \frac{V_m}{\sqrt{2}}$$

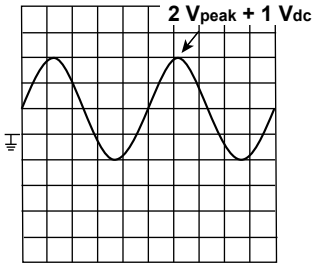
As shown in the example above, if Vm is 2 V, the RMS value Vrms is approximately 1.4 V.

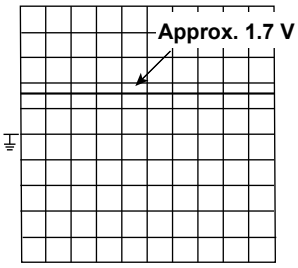
DC-RMS

Use this setting when you want to observe the RMS values of the entire signal, including both the DC and AC components.

Example

When you measure the RMS values of a 2 Vpeak sine wave with a 1 VDC component superimposed on it, an approximately 1.7 VDC signal appears, as shown in the figure on the right.





Given DC component Vdc and AC component u(t) = Vmsinωt, the RMS value Vrms (+ DC) of a sine wave signal with a DC component superimposed on it is:

$$V_{rms}\,(+DC) = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} (V_m \sin wt + V_{dc})^2\,dwt} = \sqrt{\left(\frac{V_m}{\sqrt{2}}\right)^2 + (V_{dc})^2}$$

As shown in the example above, if Vdc is 1 V and Vm is 2 V, the RMS value Vrms (+DC) is approximately 1.7 V.

In RMS measurement mode, when a signal with an AC component below 40 Hz is acquired, because of the characteristics of the RMS circuit, a ripple component is displayed, and the RMS values are not displayed properly. DC signals are measured properly.

Voltage Measurement (For the 16-CH Voltage Input Module)

When you measure voltages using the 720220 16-CH voltage input module, the items that you have to set for each input signal (sub channel 1 to sub channel 16) include vertical scales, vertical positions, input coupling, bandwidth limit, zoom method, offset, waveform inversion, trace settings, and linear scaling.
You can connect wiring to the input terminals of the 16-CH voltage input module to measure voltages on 16 channels.
For information about how to connect the wiring, see section 3.13 in the *Getting Started Guide*, IM DL850E-03EN.

Waveform Display (Display)

You can select whether to display each module's input signal waveforms. You can turn the display of each main channel (CH1, CH3, CH5, CH7, CH9, CH11, CH13, and CH15) on and off.

- ON: Displays the waveform
- OFF: Does not display the waveform

- The 16-CH voltage input module uses only the odd main channels of the slot that it is inserted into. It cannot use the slot's even main channels.
- On the 16-CH voltage input module, turning the display of a waveform on or off turns the displays of all of the module's sub channels on or off. To turn off the display of individual sub channels, turn off their input coupling.

Setting All Sub Channels (All SubChannels Setup)

You can configure the settings of all sub channels while viewing the settings in a list. You can also copy the various vertical axis settings of one sub channel to another sub channel. There are some items that cannot be configured from the All Sub Channels Setup list.

▶ See here.

Sub Channels 1 to 16 (Sub Channel 1 to 16)

The sub channel menu that corresponds to the key you pressed appears. You can set the various vertical axis settings for each sub channel.

Labels (Label)

▶ See here.

Vertical Scale (SCALE knob)

▶ See here.

Waveform Vertical Position (Vertical POSITION knob)

▶ See here.

Input Coupling (Coupling)

You can set the input coupling to DC, GND, or OFF. Sub channels whose coupling is set to OFF are not measured or displayed.

▶ See here.

Bandwidth (Bandwidth)

You can set the bandwidth limit to 500 Hz, or Full.

▶ See here.

Zoom Method (V Scale), Zooming by Setting a Magnification (V Zoom), Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

▶ See here.

Offset (Offset)

▶ See here.

Trace Settings (Trace Setup)

▶ See here.

Inverted Waveform Display (Invert)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

Setting All Sub Channels (All SubChannels Setup)

Input Settings (Setup)

You can configure the settings of all sub channels while viewing the settings in a list. The settings that you can view and configure are listed below. The settings vary depending on the input module.

- **When the Input Coupling Is Set to DC, GND, or OFF**

  Display color, label (Label), coupling (Coupling), vertical scale (V Scale), bandwidth limit (Band Width), zoom method (DIV/SPAN), offset (Offset), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower)

- **When the Input Coupling Is Set to TC**

  Display color, label (Label), coupling (Coupling), thermocouple type (Type), temperature unit (Unit), display range settings (Upper/Lower), reference junction compensation (RJC), burnout (Burn Out)

Linear Scaling (Linear Scale)

You can configure the linear scaling settings of all sub channels while viewing the settings in a list. The settings that you can view and configure are listed below. You cannot configure these settings when the input coupling is set to TC.

Linear scaling (Linear Scale); A and B for AX+B or P1:X, P1:Y, P2:X, and P2:Y for P1-P2; unit string (Unit); display mode (Disp Type); number of decimal places (Decim Num); unit prefix (Sub Unit)

Copy (Copy to)

You can copy the various vertical axis and linear scaling settings of one sub channel to another sub channel.

- **Source sub channel (Source Sub Channel)**

  You can set the source sub channel to a channel from channel 1 to 16.

- **Destination sub channel (DestinationSub Channel)**

  You can set the destination sub channels by using the following options.

  Select ALL ON to select all sub channels, select ALL OFF to unselect all sub channels, and select individual sub channels by selecting numbers 1 to 16.

- **Execute (Execute)**

  Select Execute to copy the settings.

The waveform display color and label settings are not copied.

Temperature Measurement

For temperature measurement, the items that have to be set for each input signal (CH1 to CH16) include input coupling, thermocouple type, the bandwidth limit, trace settings, temperature settings, and the temperature unit.
You can connect a thermocouple to one of the temperature modules, 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), or 720266 (TEMP/HPV), and measure temperatures.
For information about how to connect thermocouples, see section 3.8 in the *Getting Started Guide*, IM DL850E-03EN.

Waveform Display (Display)

Select whether to display each channel's input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

Labels (Label)

▶ See here.

Input Coupling (Coupling)

Set the coupling to TC when you are measuring temperature using the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), or 720266 (TEMP/HPV).
To measure voltage, set the input coupling to an appropriate voltage measurement setting.

▶ See here.

Thermocouple Type (Type)

Select the appropriate thermocouple type for thermocouple that you are using.
You can select thermocouple type from the options listed below.
When the input terminals are open, the displayed value is less than or equal to the lower limit of the measurement range.

Type	Measurement Range
K	−200 to 1300°C
E	−200 to 800°C
J	−200 to 1100°C
T	−200 to 400°C
L	−200 to 900°C
U	−200 to 400°C
R	0 to 1700°C
S	0 to 1700°C
B	400 to 1800°C
N	0 to 1300°C
W	0 to 2300°C
Au7Fe (AuFe-chromel)	0 to 300 K

Bandwidth (Bandwidth)

You can set the bandwidth limit to 2 Hz, 8 Hz, 30 Hz, or Full.

▶ See here.

Display Range (Upper/Lower)

To display the measured waveform on the screen, you need to set upper and lower display range limits that are appropriate for the input.

Maximum Range:

- −5432 to 5432°C (when the resolution is 0.1°C)
- −5432 to 5432 K (when the resolution is 0.1 K)

The minimum span is 2°C (or 2 K).

Temperature Unit (Unit)

You can set the temperature unit to °C or K. The default setting is °C.

Trace Settings (Trace Setup)

▶ See here.

Reference Junction Compensation and Burnout (Temperature Setup)

Reference Junction Compensation (RJC)

The voltage produced by thermocouple is based on the temperature of the point that you are measuring and the temperature of the reference junction. Reference junction compensation (RJC) refers to the act of correcting for the temperature of the measuring instrument and using it as a cold junction.

On the DL850E/DL850EV, you can turn the internal RJC circuit on and off.

- ON: Select ON to use the RJC circuit to perform reference junction compensation.
  There is an RJC circuit inside the 701261, 701262, 701265, and 720266 temperature modules and also inside the 701953 scanner box that is connected to a 720221 16-CH temperature/voltage input module.
- OFF: Select OFF to check measured temperature values or use an external reference junction (0°C).

Normally, you should perform measurements with RJC set to ON.

When you set RJC to OFF and apply a voltage that corresponds to a temperature t to an input terminal, if the measured temperature does not match temperature t, the DL850E/DL850EV or the module may be damaged. Contact your nearest YOKOGAWA dealer.

Burnout (Burn Out)

Sets the operation to perform when thermocouple detects a burnout (circuit break).

- ON: When a burnout is detected, the measured value is fixed at the upper limit of the measurement range of thermocouple.
- OFF: Burnouts are not detected.

The default setting is OFF.

Temperature Measurement (For the 16-CH Temperature/Voltage Input Module)

The 720221 16-CH temperature/voltage input module can perform temperature or voltage measurements on 16 channels. When the input coupling is set to TC, temperature measurements are performed on 16 channels. When the input coupling is set to DC, voltage measurements are performed on 16 channels.

When the input coupling is set to TC, configure settings such as the thermocouple type, display range, temperature unit, trace, reference junction compensation, and burnout.

For details on the settings when input coupling is set to DC, see “Voltage Measurement (For the 16-CH voltage input module).” ▶ See here.
For the 720221 16-CH temperature/voltage input module, the bandwidth limit is set depending on the data update period, so no bandwidth limit setting is displayed.

Scanner Box (built-in reference junction)

Connect the 720221 16-CH temperature/voltage input module to a scanner box with a cable to measure temperature or voltage. You can connect up to 16 thermocouples or wires to a 701953 scanner box. For information about how to make the connections, see section 3.14 in the *Getting Started Guide*, IM DL850E-03EN.

Waveform Display (Display)

You can select whether to display each module’s input signal waveforms. You can turn the display of each main channel (CH1, CH3, CH5, CH7, CH9, CH11, CH13, and CH15) on and off.

- ON: Displays the waveform
- OFF: Does not display the waveform

- The 16-CH temperature/voltage input module uses only the odd main channels of the slot that it is inserted into. It cannot use the slot’s even main channels.
- On the 16-CH temperature/voltage input module, turning the display of a waveform on or off turns the displays of all of the module’s sub channels on or off. To turn off the display of individual sub channels, turn off their input coupling.

Data Update Period (Data update period)

The displayed or saved waveform data is updated at the specified period. The bandwidth limit ▶ See here. varies depending on the data update period.

Data Update Period	Bandwidth Limit
100 ms	600 Hz
300 ms	200 Hz
1 s	50 Hz
3 s	10 Hz

Setting All Sub Channels (All SubChannels Setup)

You can configure the settings of all sub channels while viewing the settings in a list. You can also copy the various vertical axis settings of one sub channel to another sub channel. There are some items that cannot be configured from the All Sub Channels Setup list.

▶ See here.

Sub Channels 1 to 16 (Sub Channel 1 to 16)

The sub channel menu that corresponds to the key you pressed appears. You can set the various vertical axis settings for each sub channel.

Labels (Label)

▶ See here.

Input Coupling (Coupling)

You can set the input coupling to DC, TC, GND, or OFF. Sub channels whose coupling is set to OFF are not measured or displayed.

▶ See here.

The setup menu varies depending on the input coupling that you select.

When the Input Coupling Is Set to DC, GND, or OFF

- **Zoom Method (V Scale), Zooming by Setting a Magnification (V Zoom), Zooming by Setting Upper and Lower Display Limits (Upper/Lower)**

  ▶ See here.
- **Offset (Offset)**

  ▶ See here.
- **Trace Settings (Trace Setup)**

  ▶ See here.
- **Inverted Waveform Display (Invert)**

  ▶ See here.
- **Linear Scaling (Linear Scale)**

  ▶ See here.

When the Input Coupling Is Set to TC

- **Thermocouple Type (Type)**

  ▶ See here.
- **Display Range (Upper/Lower)**

  ▶ See here.
- **Temperature Unit (Unit)**

  ▶ See here.
- **Trace Settings (Trace Setup)**

  ▶ See here.
- **Reference Junction Compensation and Burnout (Temperature Setup)**

  ▶ See here.

  Built-in reference junction in scanner box.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

Strain Measurement

For strain measurement, the items that have to be set for each input signal (CH1 to CH16) include vertical scales, sensor settings, the bandwidth limit, the display range, the range unit, trace settings, waveform inversion, and linear scaling.

To measure strain, connect a strain measurement bridge (bridgehead) or a strain gauge transducer to the 701270 (STRAIN_NDIS) or 701271 (STRAIN_DSUB) strain module.

For information about how to connect a bridgehead, see section 3.9 in the *Getting Started Guide*, IM DL850E-03EN.

Waveform Display (Display)

Select whether to display each channel's input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

Labels (Label)

▶ See here.

Vertical Scale (SCALE knob)

You can select one of the following measurement ranges.

When µSTR Is Selected

500µSTR, 1000µSTR, 2000µSTR, 5000µSTR, 10000µSTR, 20000µSTR

For information about the measurement ranges, see section 6.13 in the *Getting Started Guide*, IM DL850E-03EN.

When mV/V Is Selected

0.25 mV/V, 0.5 mV/V, 1 mV/V, 2.5 mV/V, 5 mV/V, 10 mV/V

For information about the measurement ranges, see section 6.13 in the *Getting Started Guide*, IM DL850E-03EN.

The number that appears to the right of the range display is the maximum input at the current bridge voltage converted into a voltage value. It is the maximum input voltage for the selected range.

Setting the Sensor (Sensor Setup)

Bridge Voltage (Excitation)

You can select the voltage to apply to the bridgehead.

- 2V: When the bridgehead resistance (bridge resistance) is 120 Ω to 1000 Ω
- 5V*: When the bridge resistance is 350 Ω to 1000 Ω
- 10V*: When the bridge resistance is 350 Ω to 1000 Ω

You cannot change the bridge voltage during waveform acquisition.

* The bridge voltage can be set to 5 V or 10 V only when:

- The bridge resistance is 350 Ω or more
- The strain gauge transducer supports a bridge voltage of 5 V or 10 V

Gauge Factor (Gauge Factor)

You can set the gauge factor of the strain gauge.
Selectable range: 1.90 to 2.20 (in steps of 0.01)
The gauge factor is a constant that is unique to the gauge. It should be listed in the manual or other documentation for your gauge. You cannot change the gauge factor during waveform acquisition.

Gauge Factor When mV/V Is Selected (Gauge Factor: K)

On the DL850E/DL850EV, you can specify the gauge factor. If there is no recommended gauge factor for the strain gauge transducer, set the gauge factor to 2.00. For factors other than 2.00, e is computed with in the DL850E/DL850EV using the following equation.

$e = (4/K) \times (V/E)$

e: The measured value of the strain gauge transducer (mV/V).
V: The measured bridge voltage (mV)
E: The applied bridge voltage (V)
K: The gauge factor

When you change the unit of a channel, the units for all the items related to the channel change.

- Upper and lower limits (Upper/Lower)
- Trigger level (Level)
- Automated measurement values of waveform parameters, cursor-measurement values, etc.

Performing Strain Balancing (Exec Balance)

You can automatically compensate for the unbalanced part of the bridge resistance. It takes a few seconds for balancing to be performed.
Range within which balancing is performed:

- ±10000 μSTR (when μSTR is selected)
- ± 5 mV/V (when mV/V is selected)

Bandwidth (Bandwidth)

You can set the bandwidth limit to 10 Hz, 100 Hz, 1 kHz, or Full.

▶ See here.

Display Range (Upper/Lower)

To display the measured waveform on the screen clearly, you can set upper and lower display range limits that are appropriate for the input.
Selectable range:

- −3.0000E+04 to +3.0000E+04 (when μSTR is selected)
- −1.5000E+01 to +1.5000E+01 (when mV/V is selected)

Set the limits so that the upper limit is greater than the lower limit.

Range Unit (Range Unit)

Set the range unit.

- μSTR: Units of strain ($\times 10^{-6}$ strain)
- mV/V: Units of strain-gauge-transducer output*

The default setting is μSTR. The relationship between μSTR and mV/V is shown in the equation below.

(mV/V) = 0.5 × (μSTR)/1000

Example

500 (μSTR) -> 0.5 × 500 (μSTR)/1000 = 0.25 (mV/V)

* A unit that corresponds to the strain gauge transducer's output. It indicates the amount of transducer output in mV that corresponds to 1 V of applied bridge voltage. On the DL850E/DL850EV, the bridge voltage (excitation: applied bridge voltage) can be set to 2 V, 5 V, or 10 V, but the mV/V values are converted and displayed, so the measured values normally remain constant.

Trace Settings (Trace Setup)

▶ See here.

Inverted Waveform Display (Invert)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

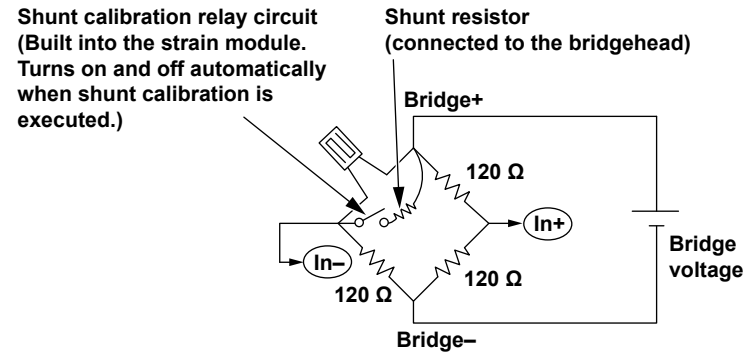
The 701271 (STRAIN_DSUB) supports shunt calibration.

- When you measure strain, be sure to perform balancing.
- Set the bridge voltage to 5 V or 10 V only when the bridge resistance is 350 Ω or greater. The strain will not be measured properly if you apply a bridge voltage of 5 V or 10 V when the bridge resistance is 350 Ω or less.
- When you use a strain gauge transducer, be sure to use it at a bridge voltage that is within the transducer's recommended voltage range.
- Balancing cannot be performed if there is no strain measurement bridge (bridgehead) or strain gauge transducer connected to the channel that you are trying to perform balancing on.
- When you perform balancing on all channels, if balancing fails on even one of the channels, an error message will appear along with information about the channels for which balancing failed.
- After you turn on the power, connect a new strain gauge, or change the measurement range, bridge voltage, or gauge factor, you need to perform balancing again before you perform measurement.
  The scale value is displayed as "imbalance" immediately after you turn on the power or when you change the range. In this kind of situation, perform balancing.
- When you change the unit of a channel, the units for all the items related to the channel change. This includes the upper and lower limits, trigger level, automated measurement values of waveform parameters, and cursor-measurement values.

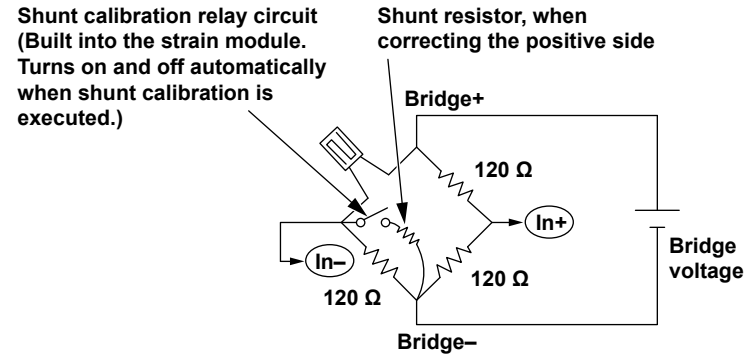
About Shunt Calibration (Only on the 701271(STRAIN_DSUB))

The 701271 (STRAIN_DSUB) strain module supports shunt calibration.
Shunt calibration is a type of scaling in which the strain measurement gain is adjusted through the connection in parallel of a known resistance (the resistance for shunt calibration, hereinafter referred to as the shunt resistance) to the strain gauge. The strain module (701271 (STRAIN_DSUB)) supports shunt calibration with a built-in shunt-calibration relay circuit.
To perform shunt calibration, you need a bridgehead that supports shunt calibration (the 701957 or 701958).

When correcting the gain on the negative side (normal)



When correcting the gain on the positive side



On the DL850E/DL850EV, in addition to performing normal shunt calibration (when the shunt-calibration relay circuit is on), you can also set the zero-point value when the relay circuit is off. The zero-point value is valid when the strain value after balancing is performed is not 0.

Linear Scaling Modes (Scaling Mode)

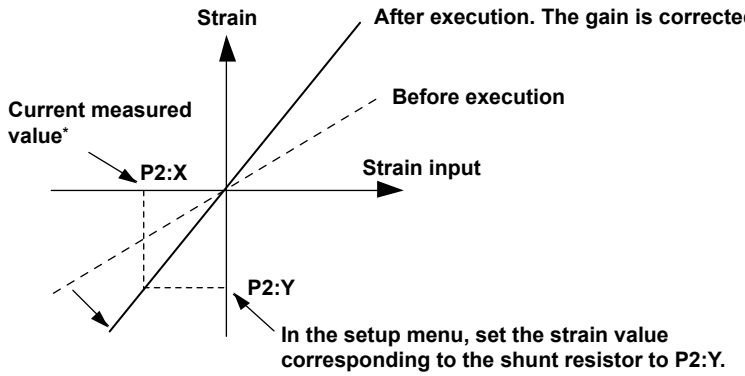
- **Shunt**

  Select this mode to perform shunt calibration.

  The other linear scaling modes are the same as those listed for voltage measurement.
  ▶ See here.

- **P1:X**
  When (Shunt Cal) Exec is performed, the input value when the relay circuit is off is applied.
- **P1:Y**
  Set the value for when the relay circuit is off (normally 0).
- **P2:X**
  When the relay circuit is on and (Shunt Cal) Exec is performed, the input value when the relay circuit is on is applied.
- **P2:Y**
  Set the strain value that corresponds to the shunt resistance when the relay circuit is on.

Shunt calibration



*** Obtained automatically when shunt calibration is performed**

Executing Shunt Calibration (Shunt Cal)

- **Exec**
  Executes shunt calibration.

Unit String (Unit String)

You can set the unit using up to four alphanumeric characters.

Display Type (Display Type)

The same as the linear scaling settings for voltage measurement.
▶ See here.

For details about shunt calibration, see appendix 4.

- When you execute shunt calibration, select an appropriate range so that the measured values will stay within the range when the shunt-calibration relay circuit is on. The DL850E/DL850EV attempts to perform shunt calibration within the current range.
- An error message will appear if shunt calibration fails (because of out-of-range values or some other reason). When this happens, change the range, and perform shunt calibration again.

Acceleration Measurement

For acceleration measurement, the items that have to be set for each input signal (CH1 to CH16) include vertical scales, the vertical positions, input coupling, the bias, the bandwidth limit, the zoom method, the gain, trace settings, sensitivity, and the unit.
The 701275 (ACCL/VOLT) acceleration module (with AAF) can measure acceleration by using the signal from an acceleration sensor. You can connect it directly to an acceleration sensor with a built-in amp.
Load-output-type acceleration sensors without amp circuits cannot be connected directly to the 701275 (ACCL/VOLT). For information about how to connect acceleration sensors, see section 3.11 in the *Getting Started Guide*, IM DL850E-03EN.

Waveform Display (Display)

Select whether to display each channel's input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

Labels (Label)

▶ See here.

Vertical Scale (SCALE knob)

▶ See here.

Waveform Vertical Position (Vertical POSITION knob)

▶ See here.

Input Coupling (Coupling)

To measure acceleration with the 701275 (ACCL/VOLT), set the input coupling to ACCEL.
To measure voltage, set the input coupling to an appropriate voltage measurement setting.

▶ See here.

Bias (Bias)

Select whether to supply bias current to the acceleration sensor.

- ON: Bias current is supplied to the acceleration sensor.
- OFF: Bias current is not supplied to the acceleration sensor.

- Do not connect an acceleration sensor when Bias is set to ON. Doing so may damage the DL850E/DL850EV.
- The bias current is 4 mA.

Bandwidth (Bandwidth)

You can set the bandwidth limit to 40 Hz, 400 Hz, 4 kHz, Auto, or Full.
When you set the bandwidth limit to Auto, an anti-aliasing filter (AAF) and low-pass filter are set in accordance with the sample rate, and high-frequency noise is removed from the input signal. By using an anti-aliasing filter when you measure voltages, you can remove the aliasing in the FFT.

▶ See here.

The filters can be used not just in acceleration measurements, but also in voltage measurements.

Zoom Method (V Scale), Zooming by Setting a Magnification (V Zoom), Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

▶ See here.

Gain (Gain)

You can set the ratio of the output signal to the input signal to a value from 0.1 to 100.
The default setting is 1.

Trace Settings (Trace Setup)

▶ See here.

Sensitivity (Sensitivity)

You can set the sensitivity of the acceleration sensor that you are using to a value between 0.10 mV/Unit and 2000.00 mV/Unit.

Unit (Unit)

Set the unit of acceleration to be displayed using up to four characters. The default setting is m/s^2. Change the unit as necessary.

Frequency Measurement

For frequency measurement, the items that have to be set for each input signal (CH1 to CH16) include vertical scales, the vertical positions, FV settings, the input settings, the zoom method, the offset, trace settings, and linear scaling.

You can connect a sensor or probe to the 701281 (FREQ) or 720281 (FREQ) frequency module and measure frequencies, revolutions, periods, duty ratios, power supply frequencies, pulse widths, pulse integration, and velocities.

For the sensor connection method, see section 3.12 in the *Getting Started Guide*, IM DL850E-03EN. For the probe connection method, see section 3.5.

Waveform Display (Display)

Select whether to display each channel's input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

Labels (Label)

▶ See here.

Vertical Scale (SCALE knob)

▶ See here.

Waveform Vertical Position (Vertical POSITION knob)

▶ See here.

FV Setting (F/V Setup) - frequency measurement

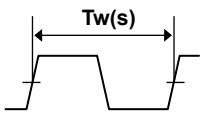
Measured Item (Function)

You can choose one of the following items to measure.

- **Frequency (Frequency)**

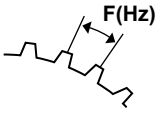
  Frequency (Hz) = 1 ÷ Tw (s)

  Measurable range: 0.01 Hz to 500 kHz



- **Revolutions (rpm)/Revolutions (rps) (Revolution (rpm)/Revolution (rps))**

  Revolutions (rpm) = Frequency (Hz) ÷ pulses per revolution (Nr) × 60
  Measurable range: 0.01 rpm to 100000 rpm
  Revolutions (rps) = Frequency (Hz) ÷ pulses per revolution (Nr)
  Measurable range: 0.001 rps to 2000 rps



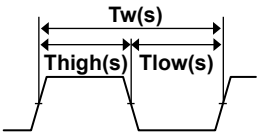
Number of pulses per rotation: Nr

- **Periods (Period)**

  Period (s) = Tw (s)
  Measurable range: 2 µs to 50 s

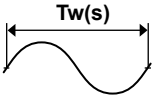
- **Duty Ratios (Duty)**

  Duty (%) = Thigh (s) ÷ Tw (s)
  Or, Duty (%) = Tlow (s) ÷ Tw (s)
  Measurable range: 0% to 100%



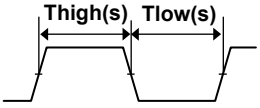
- **Power Supply Frequencies (Power Freq)**

  Power supply frequency (Hz) = 1 ÷ Tw (s)
  Resolution: 0.01 Hz
  Measurable range: (50 Hz, 60 Hz, or 400 Hz) ± 20 Hz



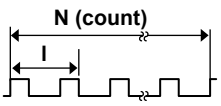
- **Pulse Widths (Pulse Width)**

  Pulse width (s) = Thigh (s)
  Or, pulse width (s) = Tlow (s)
  Measurable range: 1 µs to 50 s



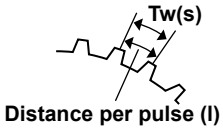
- **Pulse Integration (Pulse Integ)**

  Pulse integration = N (count) × physical amount per pulse (I)
  Set the physical amount per pulse (I) to the distance or flow rate.
  A suitable user-defined unit can be assigned to the specified physical amount.
  Measurable range: Up to 2×10^9 counts



- **Velocity (Velocity)**

  Velocity (km/h) = distance per pulse l (km) ÷ Tw (s) × 3600
  Velocity (m/s) = distance per pulse l (m) ÷ Tw (s)
  You can define unique distances and units (angular velocity and other units).
  Measurable range: F (= 1/Tw) = 0.01 Hz to 500 kHz



Settings for Each Item

When Measuring Revolutions

- **Pulse/Rotation Setting (Pulse/Rotate)**

  Set the number of pulses per revolution to a value from 1 to 99999.

When Measuring Duty Ratios or Pulse Widths

- **Measured Pulse Setting (Measure Pulse)**

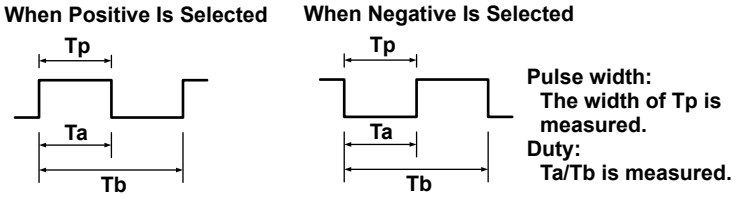
  Set the type of pulse to measure to Positive or Negative.

  When Measuring Duty Ratios

  - Positive: The rising-pulse percentage is measured.
  - Negative: The falling-pulse percentage is measured.

  When Measuring Pulse Widths

  - Positive: The rising-pulse width is measured.
  - Negative: The falling-pulse width is measured.



- **Timeout Period (Time out)**

  Set the timeout period for duty ratio measurement. If the pulse polarity does not change for longer than the specified time, the duty ratio is not measured.

  Selectable range: 0.00001 s (10 µs) to 80 s. The default setting is 10.00100 s.
  Resolution: 0.00001 s (10 µs)

  The duty ratio when a timeout occurs is 0% or 100%.

  - Duty ratio (%) when the type of pulse to measure is positive
    0%: When a timeout occurs with the input signal at low level
    100%: When a timeout occurs with the input signal at high level
  - Duty ratio (%) when the type of pulse to measure is negative
    0%: When a timeout occurs with the input signal at high level
    100%: When a timeout occurs with the input signal at low level

The timeout period can be set on the 701281 (FREQ) (with module version 0x04 and later) and 720281 (FREQ).

When Measuring Power Supply Frequency

- **Center Frequency Setting (Center Frequency)**
  Set the center frequency to 50 Hz, 60 Hz, or 400 Hz.

When Measuring Pulse Integration

- **Unit/Pulse Setting (Unit/Pulse)**
  You can set the physical amount per pulse to a value from −9.9999E+30 to 9.9999E+30.
- **Unit Setting (Unit)**
  You can set the displayed pulse-integration unit as necessary using up to four characters.
- **Over Limit Reset Setting (Over Limit Reset)**
  Select ON to reset the pulse count when the range is exceeded. If you do not want to reset the pulse count, select OFF. The default setting is OFF.
- **Manual Reset (Reset)**
  To manually reset the pulse count, select Exec.

When Measuring Velocity

- **Distance/Pulse Setting (Distance/Pulse)**
  You can set the distance per pulse to a value from −9.9999E+30 to 9.9999E+30.
- **Time Unit Setting (Time Unit)**
  You can set the unit of time to hour, min, or sec.
  The output is automatically converted to the appropriate velocity for the specified time.
- **Unit Setting (Unit)**
  Set the unit of velocity to be displayed using up to four characters. The default setting is m/s.

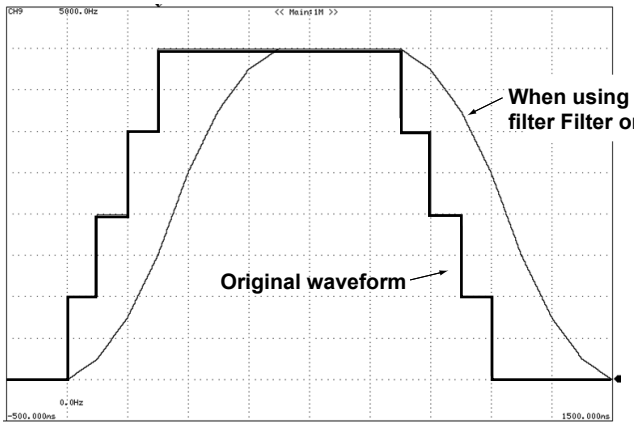
Filter (Filter)

- **Smoothing (Smoothing)**

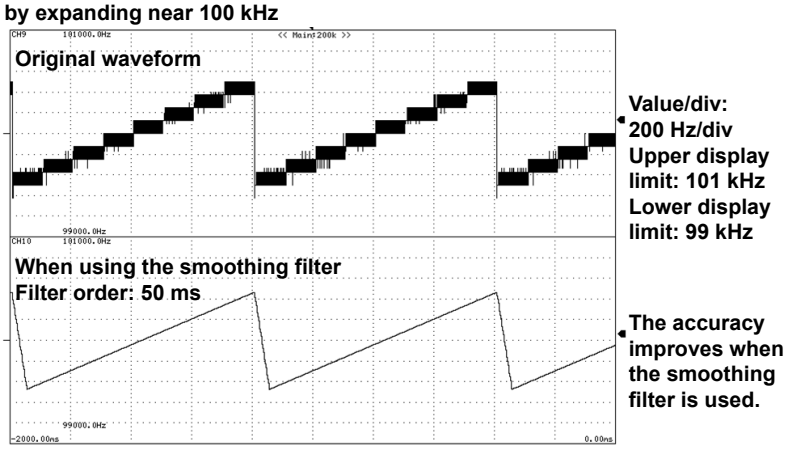
  The frequency module can display waveforms using real-time moving averages of the data. The moving average order can be set through the specification of a time value from 0.1 ms to 1 s (the maximum number of averages is 25000). The number of averages performed (moving average order) = the specified time ÷ 40 µs.

  The smoothing filter has the following characteristics.

  - Smoothes out staircase patterns.
  - Enables you to reduce measurement jitter and increase the resolution. Because of the increased resolution, you can perform high-precision measurements, especially when you measure high frequencies or use the offset feature and enlarge the waveform.
  - Can be used with all frequency-module measurement items.

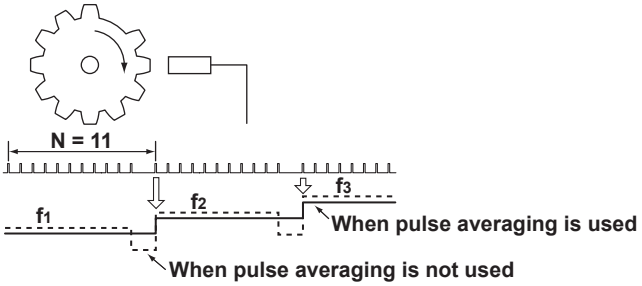


When using the offset function and making measurements by expanding near 100 kHz



- **Pulse Averaging (PulseAverage)**

  The input pulses are divided into groups of a specified number (1 to 4096 pulses) and measured. Pulse averaging has the following characteristics.
  - Enables you to eliminate the effects of missing pulses and inconsistent pulse intervals (inconsistencies in the frequency or period waveform) on measurement.
  - Even if you use pulse averaging, the measured results are displayed as per-pulse values, so there is no need to reperform scaling.
  - Pulse averaging can be used in measurements of frequencies, revolutions, periods, power supply frequencies, pulse integration, and velocities.



Deceleration and Stop Prediction

The 701281 (FREQ) or 720281 (FREQ) automatically performs internal computation and displays waveforms by predicting the deceleration curve and stop point even when the input pulse is suddenly cut off. This function enables the measurement of waveforms of deceleration behavior that are close to the actual physical phenomenon in applications in which the deceleration behavior of an object that has inertia is measured, such as in automobile brake tests.

- **Deceleration Prediction (Deceleration Prediction)**

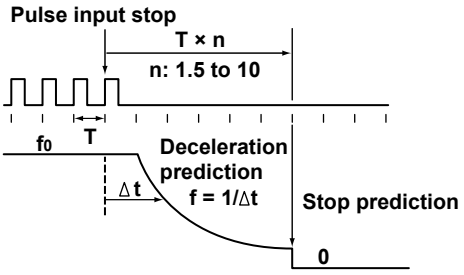
  The deceleration curve is computed according to the following equation using the elapsed time after the pulse input stops (Δt).

  Frequency (f) = 1/elapsed time (Δt)

  The deceleration prediction starts after the pulse input stops and a pulse period (T) of the pulse one period before the pulse input stopped elapses.

- **Stop Prediction (Stop Prediction)**

  The point at a specified time after the pulse input stops is considered a stop point, and the frequency is set to 0. The time from the point when the pulse input stops to the point when the DL850E/DL850EV determines that the object has stopped can be set to 1.5, 2, 3, ..., 9, or 10 times (10 options) the pulse period (T) of the pulse one period before the pulse input stopped.



Input Setup (Input Setup) - frequency measurement

Presets (Preset)

When you select a preset, the DL850E/DL850EV automatically configures appropriate settings for all the signals (for some preset options, there are some settings that you will need to configure). You can select User to set all the settings to user-defined values. There are 10 types of presets. For details about the settings of each preset, see appendix 6.

- **Logic 5V, Logic 3V, Logic 12V, Logic 24V**

  Use this preset when the output from the sensor or other equivalent item changes in the range of 0 V to 5 V (or 3 V, 12 V, or 24 V: supply voltage applied to the sensor). The voltage range is automatically set to the optimum voltage range, and the threshold level is automatically set to one-half the voltage.

- **Pull-up 5V**

  Use this preset when the sensor output is open collector or contact output. The pull-up function is enabled only when this preset is selected. The pull-up voltage is approximately 5 V, and the pull-up resistor is 10 kΩ. If you enable the pull-up function, set the input voltage to a value from 0 V to 5 V. If the input voltage exceeds this range, the protection circuit is tripped, and the pull-up resistor is automatically cut off.

- **Zero Cross (ZeroCross)**

  Use this preset when the input voltage changes around 0 V. The input coupling is automatically set to AC, and the threshold level is automatically set to 0 V. When you set the voltage range, make sure that the maximum amplitude does not exceed the voltage range.

- **AC100V, AC200V**

  Use this preset when measuring the supply voltage of 100 V or 200 V power supply systems. The probe type is automatically set to 10:1, the voltage range is automatically set to a value suitable for the input voltage and probe factor, and the coupling is automatically set to AC. Be sure to use the isolated probe (700929) when measuring the power supply voltage.

- **Electromagnetic Pickup (EM Pickup)**

  Use this preset when connecting an electromagnetic pickup directly. The voltage range is automatically set to ±1 V, and the threshold level is automatically set to 0 V.

- **User-Defined (User)**

  Use this preset to configure user-defined input conditions. The pull-up function cannot be enabled.

- When measuring high voltages exceeding 42 V (AC+DCpeak) on the 701281 (FREQ) or 720281 (FREQ), be sure to use the isolated probe (700929).
- Use EM Pickup only when connecting an electromagnetic pickup.
- When the EM Pickup preset is selected, the LEDs of the frequency module do not illuminate in red, even when the range is exceeded.
- The DL850E/DL850EV does not support electromagnetic pickups that need to have power supplied to them or pickups that require terminators at the output. Handle these types of electromagnetic pickups using sensors.
- Keep the output of the electromagnetic pickup within 42 V_{P-P}. The minimum sensitivity is 0.2 V_{P-P}. If the output is less than the minimum sensitivity, the measured values may be unstable.
- When you use the pull-up function, do not let the voltage go outside the range of 0 to 5 V. If the voltage goes outside of this range, the protection circuit will be tripped, and the pull-up circuit will be cut off.

The following 9 setup items are available.

Voltage Range (V Range)

You can set the input voltage range (±FS) to one of the options below.

- When the probe attenuation (Probe) is set to 1:1
  ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, ±50 V (±FS)
- When the probe attenuation (Probe) is set to 10:1
  ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, ±500 V (±FS)

Input Coupling (Coupling)

You can set the input coupling to DC or AC.

▶ See here.

Probe Type (Probe)

You can set the probe type to 1:1 or 1:10.

▶ See here.

Bandwidth (Bandwidth)

You can set the bandwidth limit to 100 Hz, 1 kHz, 10 kHz, 100 kHz, or Full. You cannot select Full when Preset is set to AC100V or AC200V.

▶ See here.

Threshold Level (Threshold)

You can set the level within the FS of the input voltage range. The resolution is the value that corresponds to 1% of the FS.

Hysteresis (Hysteresis)

You can set the hysteresis to ±1%, ±2.5%, or ±5% of the FS of the input voltage range.

Slope (Slope)

Select ⨍ (rising) or ⨍ (falling).

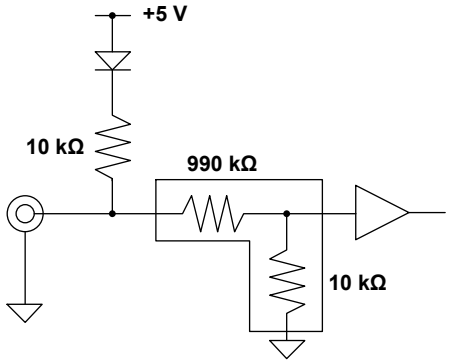
Chattering Elimination (Chatter Elimination)

Eliminates the chattering that occurs in cases such as when the contact input is turned on or off. The changes in the signal over the specified time can be discarded. You can set the interval to a value from 0 to 1000 ms (in 1 ms steps). When 0 ms is selected, chattering elimination is turned off.
Chattering elimination works on both rising and falling edges.

Pull Up (Pull Up)

You can choose whether to enable the pull-up function only when Preset is set to Pull-up 5V. You cannot configure the pull-up setting when another preset is selected.
If you enable the pull-up function, set the input voltage to a value from 0 V to 5 V. If you apply a voltage that is outside of this range, the internal protection circuit will cut off the pull-up circuit.

Internal Equivalent Circuit for When the Pull-up Function Is Enabled



Zoom Method (V Scale), Zooming by Setting a Magnification (V Zoom), Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

▶ See here.

Offset (Offset)

▶ See here.

Trace Settings (Trace Setup)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

Logic Measurement

For logic measurement, the items that have to be set for each input signal (CH1 to CH16) include vertical scales, the logic bit settings, the logic bit mapping, the zoom method, and trace settings.
You can measure logic signals by connecting a logic probe to the 720230 (LOGIC) logic module.
For information about how to connect logic probes, see section 3.10 in the *Getting Started Guide*, IM DL850E-03EN.

Waveform Display (Display)

Select whether to display each channel's input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

Labels (Label)

▶ See here.

Waveform Vertical Position (Vertical POSITION knob)

▶ See here.

Logic Bit Settings (Logic Bit Setup)

Bit Display (Display)

You can set whether to display the waveform of each bit.
Bit1 to Bit8, All Bits On, All Bits Off

Bit Name (Bit Name)

You can assign labels to bits using up to sixteen characters.

Depending on the display and zoom formats, label names may not appear when the waveform display is narrow.

Chattering Elimination (Chatter Elimination)

For each bit, you can set whether to eliminate chattering. To eliminate chattering, select an elimination time.
OFF, 5 msec, 10 msec, 20 msec, 50 msec, 100 msec

Bit Mapping (Bit Mapping)

- Fixed: Spaces are allocated for bits that are turned off.
- Auto: Spaces are not allocated for bits that are turned off. Only the bits that are turned on are displayed. The bits are displayed in order from the top.

Fixed (When bit 7 is off)

A1
A2
A3
A4
A5
A6
A8

Auto (When bit 7 is off)

A1
A2
A3
A4
A5
A6
A8

Zooming by Setting a Magnification (V Zoom)

▶ See here.

Trace Settings (Trace Setup)

▶ See here.

Note about Logic Measurement

In the logic settings in the preferences, you can set the display format (Bit or Hex), the cursor order, and the bit order.

▶ See here.

CAN and CAN FD Bus Signal Monitoring (Applies to the DL850EV)

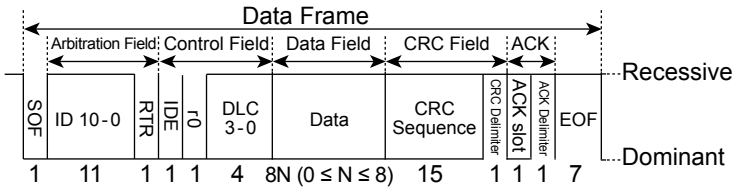
CAN and CAN FD bus signal monitoring is available only on the DL850EV.

- You can monitor CAN bus signals using the 720240 CAN bus monitor module or the 720241 CAN & LIN bus monitor module.
- You can monitor CAN/CAN FD bus signals using the 720242 CAN/CAN FD monitor module.

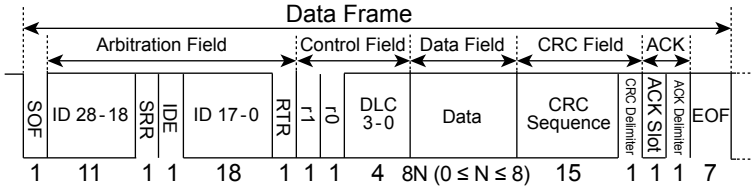
CAN Frame Formats

Data Frames

- **Standard format**

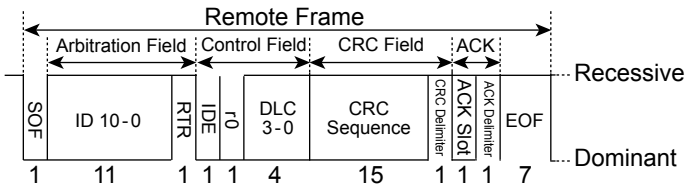


- **Extended format**

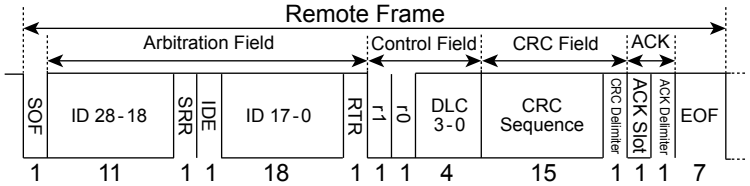


Remote Frames

- **Standard format**



- **Extended format**



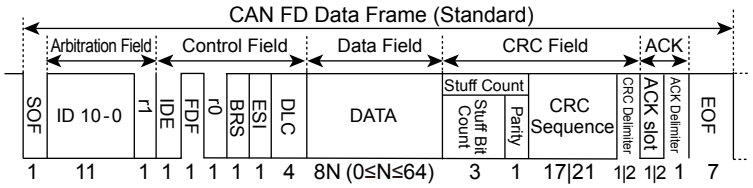
Motorola's Forward format setting is not supported.

CAN FD Frame Formats

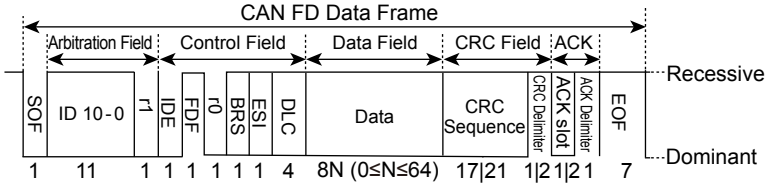
Data Frames

- **Standard format**

CAN FD (ISO 11898-1: 2015)

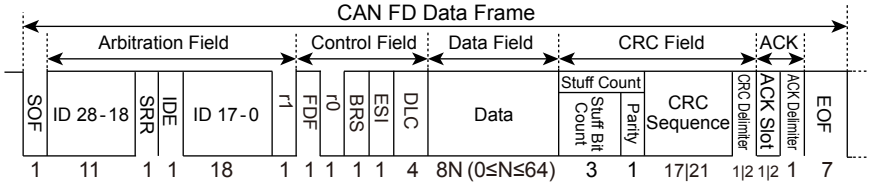


CAN FD (non-ISO)

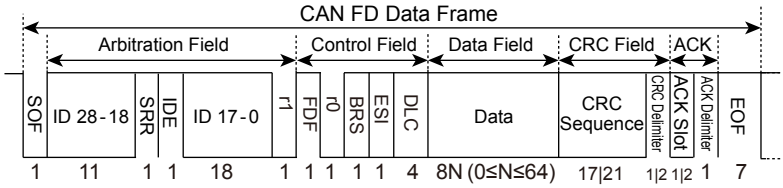


- **Extended format**

CAN FD (ISO 11898-1: 2015)



CAN FD (non-ISO)



The module can be connected as a node to an ISO-11898 CAN bus. The DL850EV uses the module to read the data frames transferred on the CAN bus and then extracts the specified portion of the data field (CAN data), converts it to time series data, and displays its waveform. Up to 60 sub channel waveforms can be displayed for each port of the module. You can specify (define) the CAN data using Vector Informatik CANdb database files. Both the standard and extended formats are supported.
In addition, you can output single data frames or remote frames to a CAN bus at a specific time (one-shot output).
For CAN/CAN FD signal monitoring, the items that have to be set include port settings, data extraction conditions, the sub channel display range, the unit of measurement, trace settings, and scaling.

- You can install a total of two 720240 CAN bus monitor modules, 720242 CAN/CAN FD monitor modules, or 720241 CAN & LIN Bus Monitor Modules. These monitor modules can only be installed in slots 7 and 8.
- The DL850EV requires the following processing times to read data frames transferred on the CAN bus. New data frames that the DL850EV receives during these processing times may be discarded.
  - 720240 or 720241

Number of Channels Used per Port	One Port in Operation	Two Ports in Operation
1	40 µs	80 µs
8	60 µs	120 µs
16	80 µs	160 µs
32	120 µs	240 µs
60	200 µs	400 µs

  - 720242

    The processing time is 40 µs, regardless of the number of channels or the number of ports.

Waveform Display (Display)

You can select whether to display each port's input signal waveforms. Each port corresponds to one of the CH13 to CH16 keys.

- ON: Displays the waveform
- OFF: Does not display the waveform

Reading Data Frames (CAN Port Configuration)

Port Settings (Port Setup)

- **Bit Rate (Bit Rate)**

  Select the CAN bus signal transmission speed.
  10k, 20k, 33.3k, 50k, 62.5k, 66.7k, 83.3k, 100k, 125k, 200k, 250k, 400k, 500k, 800k, 1Mbps

- **Sample Point (Sample Point)**

  Select the sample point for each bit.
  720240 (CAN MONITOR), 720241 (CAN & LIN): 71%, 78%, 85%
  720242 (CAN/CAN FD): 65% to 90%

- **Resynchronization Jump Width (Sync Jump Width)**

  This option appears when a 720240 (CAN MONITOR) or 720241 (CAN & LIN) is installed in a slot.
  Set the correction value used to synchronize the bit timing between sending and receiving nodes.
  1 to 4 in units of Tq (Time Quantum)

- **Number of Samples (Bit Sample Num)**

  This option appears when a 720240 (CAN MONITOR) or 720241 (CAN & LIN) is installed in a slot.
  You can set the number of samples at each bit's sample point.
  1: The sample point data is sampled once. We recommend that you use this setting for high-speed busses.
  3: The sample point data is sampled three times. We recommend that you use this setting for slow and medium speed busses.

- **CAN FD**

  CAN FD Standard (FD Standard)

  This option appears when a 720242 (CAN/CAN FD) is installed in a slot.
  Select the compliant standard for the CAN FD bus signal to be applied.
  ISO: ISO 11898-1: 2015
  non-ISO: Standard before 2015

  Data Bit Rate (Data Bit Rate)

  This option appears when a 720242 (CAN/CAN FD) is installed in a slot.
  Select the CAN FD bus signal's data phase data transfer rate from one of the settings below.
  10k, 20k, 33.3k, 50k, 62.5k, 66.7k, 83.3k, 100k, 125k, 200k, 250k, 400k, 500k, 800k, 1M, 2M, 3M, 4M, 5Mbps

  Data Sample Point (Data Sample Point)

  This option appears when a 720242 (CAN/CAN FD) is installed in a slot.
  Select the sample point of the CAN FD bus signal's data phase bits.
  65% to 90%

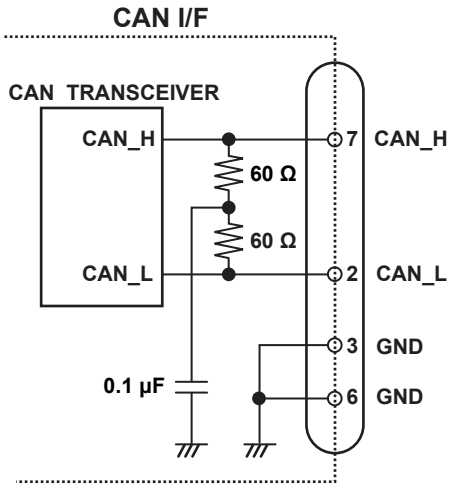
- **Listen Only (Listen Only)**

  ON: The ACK bit is not transmitted.
  OFF: The ACK bit is transmitted.

  One-shot output is not possible when Listen Only is set to ON.

- **Terminator (Terminator)**

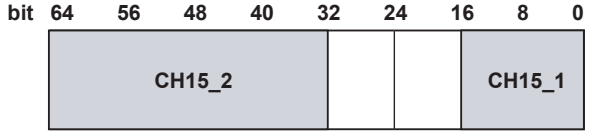
  ON: The 120 Ω terminator between CAN_H and CAN_L on the CAN bus line is turned on.
  OFF: The terminator between CAN_H and CAN_L on the CAN bus line is turned off.



CAN Data Extraction Conditions

Set the extraction conditions for the CAN data that is in the data field. You can configure the settings for each sub channel. There are up to 60 sub channels for each port.

When the data field contains two units of data



- Start Bit = 0, Bit Count = 16bit → 2-byte integer (CH15_1)
- Start Bit = 32, Bit Count = 32bit → 4-byte integer (CH15_2)
  4-byte real numbers can be extracted by modules whose firmware version is 1.20 and later.

Input (Input)

ON: The data is monitored.

OFF: The data is not monitored or displayed.

Labels (Label)

▶ See here.

Message Format

Select the message format of the collected data frames.

STD: Standard format

XTD: Extended format

ID (Hex)

Set the message ID of the collected data frames.

Standard format (11 bits): 0x000 to 0x7ff

Extended format (29 bits): 0x00000000 to 0x1fffffff

Byte Count

Set the method for extracting the data area of the collected data frames.

Auto: All data is extracted. Normally use this option.

1 to 8: The specified number of bytes of data are extracted. Data is extracted starting from the start of the data. Byte Count is enabled when big endian byte order is in use. When little endian byte order is in use, Byte Count is always set to Auto.

Start Bit

Specify the bit number of the data extraction starting point.

0 to 63

Bit Count

Set the number of data bits to extract. The range that you can specify varies depending on the data type.

Unsigned, Signed: 2 to 32

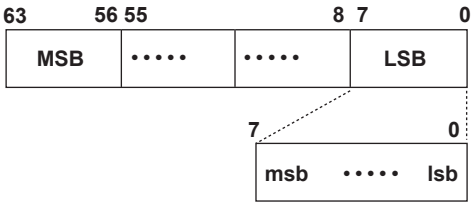
Float: the bit length that can be set is only 32

Logic: 1 to 8

Byte Order

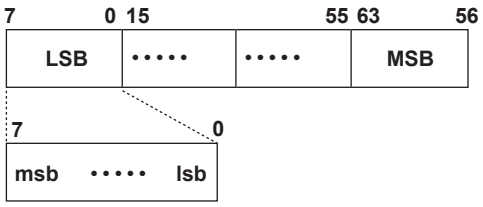
Select the method (endian) to use to store the data in the acquisition memory.

Big Endian



MSB: Most significant byte
LSB: Least significant byte
msb: Most significant bit
lsb: Least significant bit

Little Endian



MSB: Most significant byte
LSB: Least significant byte
msb: Most significant bit
lsb: Least significant bit

Value Type

Select the data type to extract.
Unsigned: Unsigned integer
Signed: Signed integer
Float: Real number
Logic: Boolean

You can monitor up to 60 sub channels with a single port. If the input is turned on for all the sub channels and the bit length of each sub channel is 16 bits or less, you can monitor all 60 sub channels. However, the amount of memory is limited, so each time that the length of a sub channel is set longer than 16 bits, the DL850EV turns the input of sub channels off (sets them so that they cannot be monitored) in decreasing order starting with sub channel number 60 until the memory usage is within the memory limitations.

CAN Data Conversion Conditions

Factor/Offset

Configure these settings when the data type is set to Unsigned, Signed or Float. The DL850EV uses the factor and offset values that you set here to convert extracted data to physical values
Factor: Scaling coefficient (value per bit)
Offset: Offset value
Selectable range: −10.000E+30 to +10.000E+30

Unit

Using up to 16 characters, enter the unit to display for the waveform.

Loading a CAN/CAN FD Data Definition File (Symbol File Load)

You can configure the CAN/CAN FD data extraction conditions by loading a CAN/CAN FD data definition file (an SBL file).* Data that has been edited using Symbol Editor* is assigned to DL850EV sub channels 1 to 60 according to the order in the definition list (you can change the order in the Symbol Editor's definition list).*

* An SBL file (.SBL extension) is a CANdb file (.dbc extension) that has been converted and edited into a physical value/symbol definition file using YOKOGAWA's free Symbol Editor software. You can obtain Symbol Editor from the YOKOGAWA website (http://www.yokogawa.com/ymi/).
CANdb files (.dbc) are signal definition database files created using the CANdb or CANdb++ software produced by Vector Informatik.

Sub Channels 1 to 60 (Sub Channel 1 to 60)

Configure the display label, zoom magnification, scaling method, and display range settings of the specified sub channel.

Labels (Label)

▶ See here.

Zooming by Setting a Magnification (V Zoom)

Configure this setting when Value Type is set to Logic.
Selectable range: x0.1 to x3.33

▶ See here.

Scaling (Scale)

Configure this setting when Value Type is not set to Logic.
Auto: The upper and lower display range limits are set automatically.
Default: To the greatest extent possible within the settable range, the maximum and minimum values are used to set the display range setting (which is explained below) of the specified sub channel.

Display Range (Upper/Lower)

Specify the upper and lower limits of the waveform display range.
Selectable range: −30.000E+30 to +30.000E+30

Trace Settings (Trace Setup)

▶ See here.

Display Groups (Select Display Gr.)

▶ See here.

One-Shot Output Settings (One shot out Setup)

A single specified data frame or remote frame is output at the specified time.

Message Type

This option appears when a 720242 (CAN/CAN FD) is installed in a slot.
Select the message type.
CAN, CAN FD

Message Format

Select the message format.
STD: Standard format
XTD: Extended format

ID (Hex)

Set the message ID of the output data frame.
Standard format (11 bits): 0x000 to 0x7ff
Extended format (29 bits): 0x00000000 to 0x1fffffff

Frame

Select the frame type.
Remote: Remote frame
Data: Data frame

DLC

Set the byte size of the data area of the data frame.
Selectable range: 0 to 15

Data (Hex)

Configure this setting when the frame type (Frame) is set to Data.
In hexadecimal notation, specify the data frame value to output.

Output

Output the data.

You cannot output the data when in the Port Setup menu, Listen Only is set to ON.

Configuring the Scales of All Sub Channels (All SubChannel Scale)

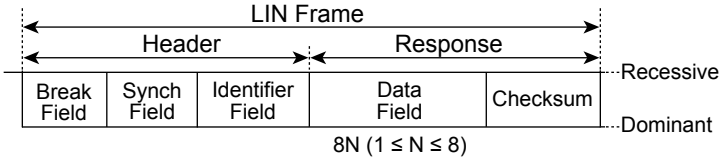
Configure the scales of all sub channels.
All SubChannel Auto: The upper and lower display range limits are set automatically.
All SubChannel Default: To the greatest extent possible within the settable range, the maximum and minimum values are used to set the upper and lower limits of all sub channels.

LIN Bus Signal Monitoring (Applies to the DL850EV)

You can monitor CAN and LIN bus signals using the 720241 CAN & LIN bus monitor module. CAN and LIN bus signal monitoring is available only on the DL850EV.
For details on the CAN bus signal monitoring feature, see “CAN Bus Signal Monitoring (Applies to the DL850EV).”

▶ See here.

LIN Frame Format



This section explains the LIN bus signal monitoring feature.
The DL850EV uses the module to read the ISO-9141 signal, that is transferred on the LIN bus and then extracts the specified portion of the LIN frame (LIN data), converts it to time series data, and displays its waveform. The waveforms of up to 60 sub channels can be displayed. You can also use the LIN descriptor files (LDF) that are described in the LIN configuration language specification to specify (define) LIN data.

For LIN bus signal monitoring using a CAN & LIN bus monitor module, the items that have to be set include port settings, frame settings, data extraction conditions, sub channel display range, unit of measurement, trace settings, and scaling.

- You can install up to two 720241 CAN & LIN bus monitor modules in slots 7 and 8. If you install this module together with a 720240 CAN bus monitor module or CAN/CAN FD monitor module, you can still only install a total of two modules.
- The DL850EV requires the following processing times to read data frames transferred on the LIN bus. New frames that the DL850EV receives during these processing times may be discarded.

Number of Channels Used per Port	Only LIN Port in Operation	CAN Port in Operation at the Same Time
1	40 µs	80 µs
8	60 µs	120 µs
16	80 µs	160 µs
32	120 µs	240 µs
60	200 µs	400 µs

Waveform Display (Display)

You can select whether to display each port’s input signal waveforms. Each port corresponds to one of the CH13 to CH16 keys.

- ON: Displays the waveform
- OFF: Does not display the waveform

Reading LIN Frames (LIN Port Configuration)

Port Settings (Port Setup)

- **Bit Rate (Bit Rate)**

  Select the LIN bus signal transmission speed.
  2400, 9600, 19200 bps

Frame Settings (Frame Setup)

Set the data length and checksum method for LIN frames. You can configure these settings for each ID.

Data Length

Set the data length of the data field.
1 to 8

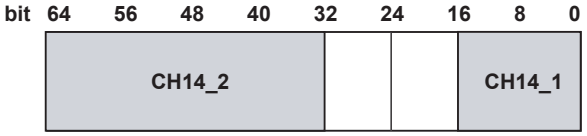
Checksum

Select the checksum method.
Classic, Enhanced

LIN Data Extraction Conditions

Set the extraction conditions for the LIN data that is in the data field. You can configure the settings for each sub channel. There are up to 60 sub channels for each port.

When the data field contains two units of data



- Start Bit = 0, Bit Count = 16bit → 2-byte integer (CH14_1)
- Start Bit = 32, Bit Count = 32bit → 4-byte integer (CH14_2)

Input (Input)

ON: The data is monitored.
OFF: The data is not monitored or displayed.

Labels (Label)

▶ See here.

ID (Hex)

Set the ID (6bits) of the LIN frame to acquire.
0x00 to 0x3f

Start Bit

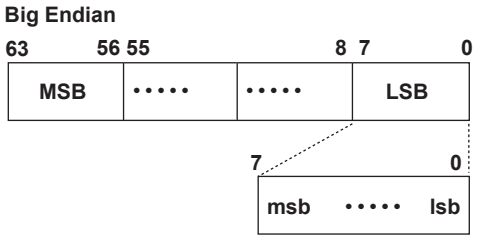
Specify the bit number of the data extraction starting point.
0 to 63

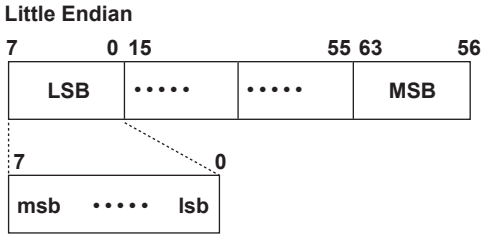
Bit Count

Set the number of data bits to extract. The range that you can specify varies depending on the data type.
Unsigned, Signed: 2 to 32
Logic: 1 to 8

Byte Order

Select the method (endian) to use to store the data in the acquisition memory.





Value Type

Select the data type to extract.
Unsigned: Unsigned integer
Signed: Signed integer
Logic: Boolean

You can monitor up to 60 sub channels with a single port. If the input is turned on for all the sub channels and the bit length of each sub channel is 16 bits or less, you can monitor all 60 sub channels. However, the amount of memory is limited, so each time that the length of a sub channel is set longer than 16 bits, the DL850EV turns the input of sub channels off (sets them so that they cannot be monitored) in decreasing order starting with sub channel number 60 until the memory usage is within the memory limitations.

LIN Data Conversion Conditions

Factor/Offset

Configure these settings when the data type is set to Unsigned or Signed. The Factor and Offset values that you set here are used to convert the extracted data to physical values.
Factor: Scaling coefficient (value per bit)
Offset: Offset value
Selectable range: −10.000E+30 to +10.000E+30

Unit

Using up to 16 characters, enter the unit to display for the waveform.

Loading a LIN Data Definition File (Symbol File Load)

You can configure the LIN data extraction conditions by loading a LIN data definition file (an SBL file).*
Data that has been edited using Symbol Editor is assigned to DL850EV sub channels 1 to 60 according to the order in the definition list (you can change the order in the Symbol Editor's definition list).*

* An SBL file (.SBL extension) is an LDF file that has been converted and edited into a physical value/symbol definition file using YOKOGAWA's free Symbol Editor software. You can obtain Symbol Editor from the YOKOGAWA website (http://www.yokogawa.com/ymi/).
A LDF file is a definitions file that has been written according to the LIN configuration language specification.

Trace Settings (Trace Setup)

▶ See here.

Display Groups (Select Display Gr.)

▶ See here.

Sub Channels 1 to 60 (Sub Channel 1 to 60)

Configure the display label, zoom magnification, scaling method, and display range settings of the specified sub channel.

Labels (Label)

▶ See here.

Zooming by Setting a Magnification (V Zoom)

Configure this setting when Value Type is set to Logic.
Selectable range: x0.1 to x3.33

▶ See here.

Scaling (Scale)

Configure this setting when Value Type is not set to Logic.
Auto: The upper and lower display range limits are set automatically.
Default: To the greatest extent possible within the settable range, the maximum and minimum values are used to set the display range setting (which is explained below) of the specified sub channel.

Display Range (Upper/Lower)

Set the upper and lower limits of the waveform display range.
Selectable range: −30.000E+30 to +30.000E+30

Configuring the Scales of All Sub Channels (All SubChannel Scale)

Configure the scales of all sub channels.
All SubChannel Auto: The upper and lower display range limits are set automatically.
All SubChannel Default: To the greatest extent possible within the settable range, the maximum and minimum values are used to set the upper and lower limits of all sub channels.

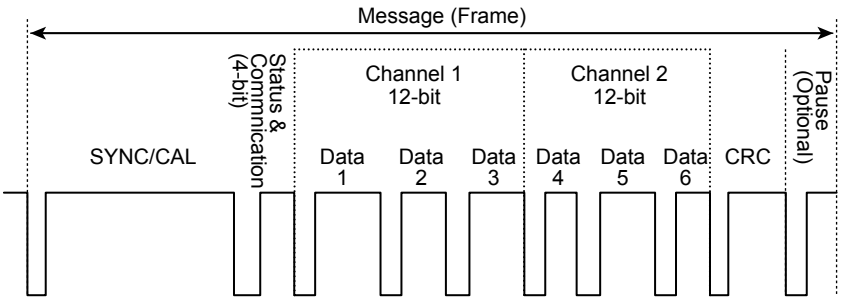
SENT Signal Monitoring (Applies to the DL850EV)

You can monitor SENT signals using the 720243 SENT monitor module. This feature is available only on the DL850EV.

SENT Message Format

Fast CH

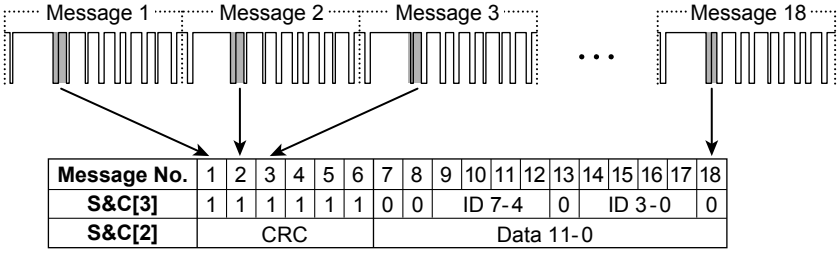
- Up to 6 nibbles (24 bits) of data can be sent.
- The size of the value is expressed with the pulse width. 0: 12 ticks to 15: 27 ticks



Example of 12-bit data x 2

Slow CH

- Composed of bits 2 and 3 of the S&C (Status & Communication) nibble of multiple Fast CH data.
- Sends data that changes slowly and error information.
- Three types of formats (data size 8-bit, 12-bit, 16-bit) are available.



Message No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
S&C[3]	1	1	1	1	1	1	0	0	ID 7-4				0	ID 3-0				0
S&C[2]	CRC						Data 11-0											

Example of Enhanced (ID 8bit + Data 12bit)

This module reads SENT signals based on SAE J2716, extracts the specified portion of the SENT message, converts it to time series data, and displays its waveform. This module has two ports. For each port, the waveforms of up to 11 sub channels can be displayed.

For SENT signal monitoring using a SENT monitor module, the items that have to be set include format, error channel, probe, data extraction conditions, sub channel display range, unit of measurement, trace settings, and scaling.

You can install up to four 720243 SENT monitor modules in slots 5 to 8

- Waveform Display (Display)
- Reading SENT Messages (SENT Port Configuration)
  Frame settings (SENT Format Setup), Error channel settings (Error Channel Setup), Probe settings (Input Setup)
- SENT Data Extraction Conditions
  Common settings, data type FastCH extraction conditions, data type SlowCH extraction conditions
- SENT Data Conversion Conditions
- SENT Data Display Settings
  Trace settings (Trace Setup), display group (Select Display Gr.), sub channel 1: FastCH to 11: Error Count display settings

Waveform Display (Display)

You can select whether to display each port's input signal waveforms. Each port corresponds to one of the CH9 to CH16 keys.

- ON: Displays the waveform
- OFF: Does not display the waveform

Reading SENT Messages (SENT Port Configuration)

Format Settings (SENT Format Setup)

Set the message format for SENT signals

ClockTick (Clock Tick)

Set the reference clock period of SENT signals. The time between consecutive falling edges of the signal is counted using this period. The clock tolerance is fixed at ±20.0%.
Selectable range: 1.00 µs to 100.00 µs. The default setting is 3.00 µs.
Resolution: 0.01 µs

Data Nibble Number (Data Nibble Number)

Set the number of data nibbles of Fast CH messages.
Selectable range: 1 to 8. The default setting is 6.

Pause Pulse (Pause Pulse)

Select whether to include pause pulses in Fast CH messages.

CRC Type (CRC Type)

Select the CRC type.
Legacy: CRC is added using the type recommended in version FEB2008 and older.
Recommended: CRC is added using the type recommended in version JAN2010.

Slow CH Type (SlowCH Type)

Select the Slow CH message format.
Short (ID 4bit + Data 8bit): 4 bit message ID and 8 bit data field
Enhanced (ID 8bit + Data 12bit): 8 bit message ID and 12 bit data field
Enhanced (ID 4bit + Data 16bit): 4 bit message ID4 and 16 bit data field

Fast Channel Multiplexing (Fast Channel Multiplexing)

Select whether to handle (ON) or not handle (OFF) fast channel multiplexing.
ON: You can specify FC and set the data type of sub channels 5 to 9 to Fast CH.
OFF: The FC setup menu does not appear. The data type of sub channels 5 to 9 is fixed to Slow CH.

Fast channel multiplexing can be handled when the 720243 (SENT) module version is 0x07 or later.

Error Channel Settings (Error Channel Setup)

For each of the following error types, set whether to detect them as errors, whether to display triggers, and whether to count them as errors. By default, the error detection of Successive Calibration Pulses (Option2) is off, and all other items are on

Error Type	Error Detection (Detect)	Trigger Display (Error Trigger)	Error Count (Error Count)
Fast Channel CRC	Always ON	ON/OFF	ON/OFF
Slow Channel CRC	Always ON	ON/OFF	ON/OFF
Nibble Value	Always ON	ON/OFF	ON/OFF
Successive Calibration Pulses (Option2)	ON/OFF	ON/OFF	ON/OFF
Pulse Number	Always ON	ON/OFF	ON/OFF

ON: enable, OFF: disable

Error Detection

- **Fast Channel CRC**

  An error is detected when the CRC Nibble value of the Fast CH message is different from the value calculated using the specified CRC type (explained earlier). If an error is detected, the data in the Fast CH message is not used to update the Fast CH data. Nor is the Slow CH data that includes a Fast CH message updated.

- **Slow Channel CRC**

  An error is detected when the CRC value of the Slow CH data obtained from the Fast CH message S&C Nibble value is not correct. If an error is detected, the Slow CH data is not updated.

- **Nibble Value**

  An error is detected when the nibble length of S&C, data, or CRC is outside the 12 to 27 tick range after a SYNC/CAL pulse of the Fast CH message is detected. If an error is detected, the data in the Fast CH message is not used to update the Fast CH data. Nor is the Slow CH data that includes a Fast CH message updated.

- **Successive Calibration Pulses (Option2)***

  An error is detected, when as a result of comparing the SYNC/CAL pulse of the current Fast CH message to the last preceding valid SYNC/CAL pulse, their difference is 1/64 tick or greater. If an error is detected, the data in the Fast CH message is not used to update the Fast CH data.
  However, if three consecutive errors are detected, the third SYNC/CAL pulse is considered as valid, and the third Fast CH message data is used to update the Fast CH data.

* The DL850E/DL850EV uses the “Option 2” detection method as defined in SAE J2716.

- **Pulse Number**

  An error is detected when the number of SYNC/CAL pulses of the current Fast CH message and the number of the next SYNC/CAL pulses are different from the specified value (the number of data nibbles explained earlier, Pause Pulse ON/OFF). If no other errors are detected, the data in the Fast CH message is used to update the Fast CH data. The Slow CH data that includes a Fast CH message is also updated.

If a SYNC/CAL pulse is not detected for the timeout value described later or longer, all Fast CH and Slow CH data are set to zero.
This is not detected as an error.

Trigger Display (Error Trigger)

If an error is detected, the pulse waveform is displayed for two sampling periods of the SENT module.

Error Count (Error Count)

An error is counted when any of the error types is detected. This shows the total number of errors.
Maximum count: 65535

Error Count Reset (Error Count Reset on Start)

Set whether to reset the error count to zero when waveform acquisition is started with the START/STOP key on the front panel.
ON: The count is reset.
OFF: The count is not reset.

Manual Error Count Reset (Error Count Reset on Start)

You can manually reset the error count to zero.
The setup menu that appears when you press a CH key corresponding to a port on the SENT module shows an Error Count Reset soft key. You can press this soft key to reset the error count to zero.

Input Settings (Input Setup)

Set the probe attenuation and the timeout value for SENT signal input. The threshold level is fixed.

Probe Attenuation (Probe)

Select the attenuation of the probes connected to SENT ports.
1:1, 10:1

Threshold Level (Threshold H, Threshold L)

The threshold levels for determining whether the SENT signal is high or low level are fixed.
Threshold H: 3.5 V
Threshold L: 1.5 V

* The SENT module voltage range is fixed at ±20 V.

Timeout Value (Time Out)

Set the timeout value for SYNC/CAL pulse detection.
If a SYNC/CAL pulse is not detected within the specified time, all Fast CH and Slow CH data are set to zero.
Selectable range: 0.1 ms to 2000.0 ms. The default setting is 2000.0 ms
Resolution: 0.1 ms

SENT Data Extraction Conditions

Set the extraction conditions for each data type.

SENT Data Acquisition Destination

SENT data is extracted and acquired in each sub channel. The types of data acquired in sub channels are as follows.

- **Fast Channel Multiplexing Is Set to OFF**

Sub Channel	Data Type
1:FastCH	FastCH
2:FastCH	FastCH
3:FastCH	FastCH
4:S&C	S&C (Status & Communication)
5:SlowCH	SlowCH
6:SlowCH	SlowCH
7:SlowCH	SlowCH
8:SlowCH	SlowCH
9:SlowCH	SlowCH
10:Error Trigger	Error Trigger
11:Error Count	Error Count

- **Fast Channel Multiplexing Is Set to ON**

Sub Channel	Data Type
1:FastCH	FastCH
2:FastCH	FastCH
3:FastCH	FastCH
4:S&C	S&C (Status & Communication)
5:SlowCH	SlowCH or FastCH
6:SlowCH	SlowCH or FastCH
7:SlowCH	SlowCH or FastCH
8:SlowCH	SlowCH or FastCH
9:SlowCH	SlowCH or FastCH
10:Error Trigger	Error Trigger
11:Error Count	Error Count

Common Settings

Input (Input)

Set the input for data type FastCH, S&C (Status & Communication), SlowCH, Error Trigger, and Error Count.
ON: The data is monitored.
OFF: The data is not monitored. Nor is it displayed.

Display Label (Label)

You can set the label for data type FastCH, S&C (Status & Communication), SlowCH, Error Trigger, and Error Count. You can also set the label for bits 0 to 3 of S&C.

▶ See here.

Data Type FastCH Settings

FC

Data from messages with the specified FC (frame control) is acquired in the acquisition memory. When fast channel multiplexing is set to ON, you can specify FC.
Selectable range: 0x00 to 0x0F
The default setting is 0x00.

Endian

Select the method (endian) to use to store the data in the acquisition memory.
Big: Big endian
Little: Little endian

Start Bit

Set the data extraction start position in terms of the bit position (bit number) from the beginning of the data nibble. Set it in terms of the number of data nibbles N of Fast CH messages, explained earlier.
Selectable range: 0 to (4× N)−1
The default settings are 0 for sub channel 1:FastCH, 12 for 2:FastCH and 0 for 3:FastCH.
To set the start bit to the most significant bit of each data nibble, specify 4×(n−1) where n is the data nibble number.

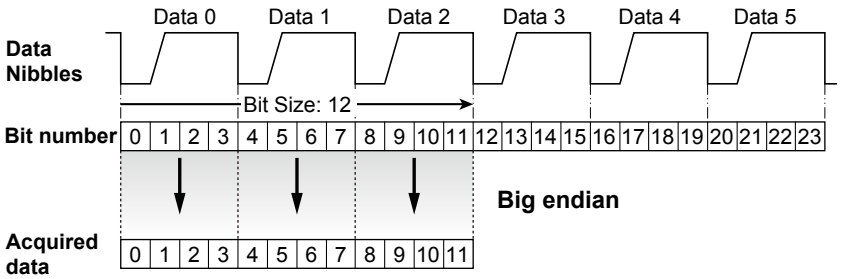
Bit Size

Set the number of data bits to extract. Data is extracted from the start bit towards the back of the data. Set it in terms of the number of data nibbles N of Fast CH messages, explained earlier.
Selectable range: 1 to {(4× N)−(Start Bit value)}, except FastCH3 is up to 16
The default setting is 12 for all sub channel FastCH.

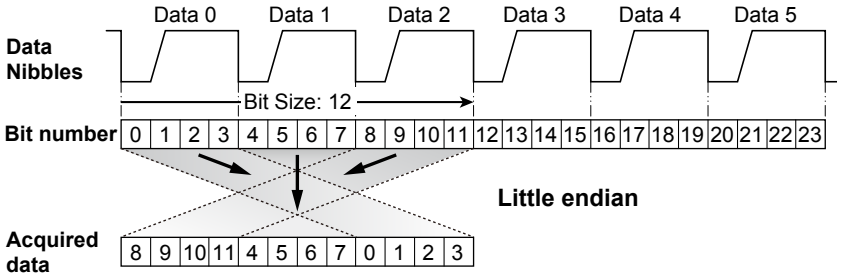
If the number of bits of 1:FastCH is set to 17 or higher, the memory area of 2:FastCH will be used. Therefore, to set the number of bits of 1:FastCH to 17 or higher, set the 2:FastCH input to OFF. To set 2:FastCH input to ON, set the number of bits of 1:FastCH to 16 or less.

Data Type FastCH Extraction Example

If Endian: Big, Start Bit: 0, Bit Size: 12



If Endian: Little, Start Bit: 0, Bit Size: 12



Value Type

Select the type of data to extract.
Unsigned: Unsigned integer
Signed: Signed integer

Data Type SlowCH Settings

ID

Data whose message ID matches the specified ID is acquired in acquisition memory. Configure the settings according to the Slow CH message format explained earlier.

Slow CH Message Format	Selectable Range
Short(ID 4bit + Data 8bit)	0x00 to 0x0F
Enhanced(ID 8bit + Data 12bit)	0x00 to 0xFF
Enhanced(ID 4bit + Data 16bit)	0x00 to 0x0F

The default setting is 0x00.

Start Bit

Set the least significant bit position for starting extraction as a position (bit number) from the least significant bit of the data field. Configure the settings according to the Slow CH message format explained earlier.

Slow CH Message Format	Selectable Range
Short(ID 4bit + Data 8bit)	0 to 7
Enhanced(ID 8bit + Data 12bit)	0 to 11
Enhanced(ID 4bit + Data 16bit)	0 to 15

The default setting is 0.

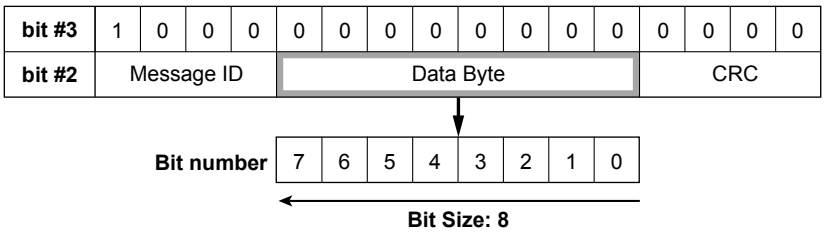
Bit Size

Set the number of data bits to extract. Data is extracted from the start bit towards the front of the data. Configure the settings according to the Slow CH message format explained earlier.

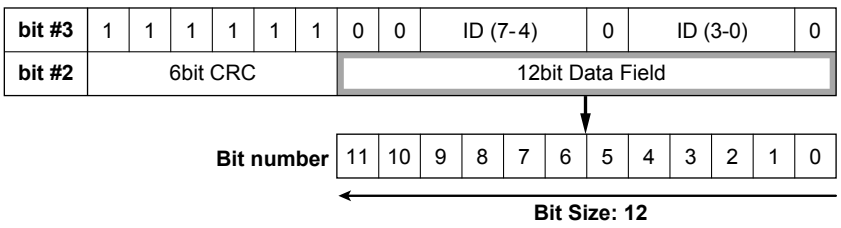
Slow CH Message Format	Selectable Range	Default Setting
Short(ID 4bit + Data 8bit)	1 to {8−(Start Bit value)}	8
Enhanced(ID 8bit + Data 12bit)	1 to {12−(Start Bit value)}	12
Enhanced(ID 4bit + Data 16bit)	1 to {16−(Start Bit value)}	

Data Type SlowCH Extraction Example

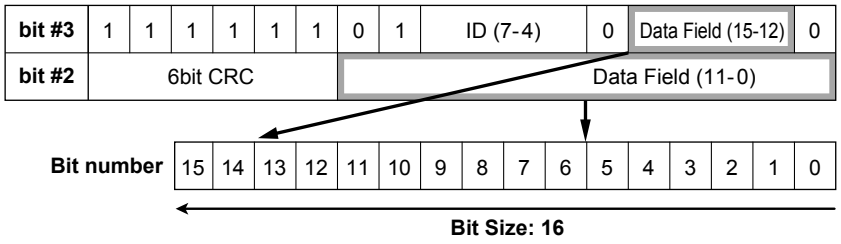
If Slow CH message format: Short (ID 4bit + Data 8bit), Start Bit: 0, Bit Size: 8



If Slow CH message format: Enhanced (ID 8bit + Data 12bit), Start Bit: 0, Bit Size: 12



If Slow CH message format: Enhanced (ID 4bit + Data 12bit), Start Bit: 0, Bit Size: 16



Value Type

Select the type of data to extract.
Unsigned: Unsigned integer
Signed: Signed integer

SENT Data Conversion Conditions

Set the conversion conditions for data type Fast CH and SlowCH.

Factor/Offset

The Factor and Offset values that you set here are used to convert the extracted data to physical values.
Factor: Scaling coefficient (value per bit)
Offset: Offset value
Selectable range: −10.000E+30 to +10.000E+30

Unit

Using up to 16 characters, enter the unit to display for the waveform.

SENT Data Display Settings

Trace Settings (Trace Setup)

▶ See here.

Display Groups (Select Display Gr.)

▶ See here.

Sub Channel 1:FastCH to 11:Error Count (Sub Channel 1:FastCH to 11:Error Count)

Configure the display label, zoom magnification, scaling method, and display range settings of the specified sub channel.
For the association of each sub channel and the data type, see “SENT Data Acquisition Destination.”

Display Label (Label)

▶ See here.

Zooming by Setting a Magnification (V Zoom)

Configure this setting when the data type is set to S&C (Status & Communication) and Error Trigger.
Selectable range: x0.1 to x3.33

▶ See here.

Scaling (Scale)

Configure this setting when the data type is set to Fast CH, SlowCH, or Error Count.
Auto: The upper and lower display range limits are set automatically.
Default: To the greatest extent possible within the settable range, the maximum and minimum values are used to set the display range setting (which is explained below) of the specified sub channel.

Display Range (Upper/Lower)

Set the upper and lower limits of the waveform display range. Configure this setting when the data type is set to Fast CH, SlowCH, or Error Count.
Selectable range: −30.000E+30 to +30.000E+30

Error Count Reset (Error Count Reset)

You can reset the error count to zero.
The Error Channel Setup dialog box also has a key for resetting the error count to zero.

Displaying the Menu for Configuring All Channels (ALL CH)

Input Settings (Setup)

You can configure the settings of all channels while viewing the settings in a list. You can also copy the various vertical axis settings of one channel to another channel. There are some items that cannot be configured from the ALL CH menu.

Measurement Type	Settings
Voltage	Waveform display color, waveform display (Disp), label (Label), coupling (Coupling), vertical scale (V Scale), bandwidth limit (Band Width), zoom method (DIV/Scale), offset (Offset), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower), probe attenuation and current-to-voltage conversion ratio (Probe)
Voltage (for the 16-CH voltage input module)	Waveform display color, waveform display (Disp), label (Label), coupling (Coupling), vertical scale (V Scale), bandwidth limit (Band Width), zoom method (DIV/Scale), offset (Offset), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower)
Temperature	Waveform display color, waveform display (Disp), label (Label), coupling (Coupling), thermocouple type (Type), bandwidth limit (Band Width), display range settings (Upper/Lower), reference junction compensation (RJC), burnout (Burn Out)
Temperature (for the 16-CH temperature/ voltage input module)	Waveform display color, waveform display (Disp), label (Label), coupling (Coupling), thermocouple type (Type), bandwidth limit (Band Width), display range settings (Upper/Lower), reference junction compensation (RJC), burnout (Burn Out), vertical scale (V Scale), zoom method (DIV/Scale), offset (Offset), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower)
Strain	Waveform display color, waveform display (Disp), label (Label), range unit (Range Unit), measurement range (Range), bandwidth limit (Band Width), display range settings (Upper/ Lower), gauge factor (Gauge Factor), bridge voltage (Excitation)
Acceleration	Waveform display color, waveform display (Disp), label (Label), coupling (Coupling), gain (Gain), bandwidth limit (Band Width), zoom method (DIV/Scale), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower), sensitivity (Sensitivity)
Frequency	Waveform display color, waveform display (Disp), label (Label), measured item (Function), vertical scale (V Scale), zoom method (DIV/Scale), offset (Offset), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower), center frequency (CenterFreq), input settings (Input)
Logic	Waveform display color, waveform display (Disp), label (Label), bit display (Bit Display), chattering elimination (Chatter Elim.), position (Position), magnification for zooming (V Zoom), bit mapping (Mapping)

* In the setup menu for configuring all channels, for channels that correspond to CAN bus monitor modules, CAN/CA FD monitor modules, CAN & LIN bus monitor modules, or SENT monitor modules, you can only set the Display setting, which determines whether waveforms are displayed.

Linear Scaling (Linear Scale)

You can configure the linear scaling settings of all channels while viewing the settings in a list. The settings that you can view and configure are listed below. This function is the same as the linear scaling function for voltage measurement.

Linear scaling (Linear Scale); A and B for AX+B or P1:X, P1:Y, P2:X, and P2:Y for P1-P2; unit string (Unit); display mode (Disp Type); number of decimal places (Decim Num); unit prefix (Sub Unit)

▶ See here.

The 701271 (STRAIN_DSUB) strain module supports shunt calibration.

Copy (Copy to (Module))

You can copy the various vertical axis and linear scaling settings from one channel to other channels whose modules are of the same type as the source channel.

Source Channel (Source Channel)

Set the source channel to a channel from CH1 to CH16 or to 16chVOLT or 16chTEMP/VOLT.*

* When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

Destination Channels (Destination Channel)

You can set the destination channels by selecting ALL ON, ALL OFF, and CH1 to CH16.

Execute (Execute)

Select Execute to copy the settings.

- When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed, you can also copy the settings of the sub channels. You can specify only channels as copy destinations.
- The waveform display color and label settings are not copied.

Strain Balance (Strain Balance)

You can perform strain balancing on multiple installed strain modules.

CH1 to CH16

Select the modules that you want to perform strain balancing on.

Balance (Balance): Execute (Execute)

Select to perform strain balancing.
For information about strain balancing, see the section on strain measurement.

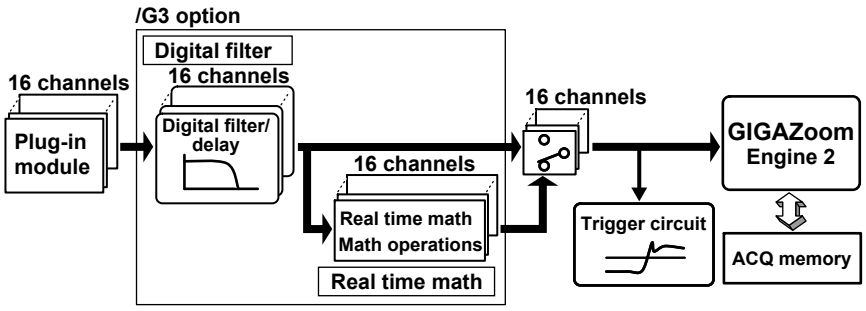
▶ See here.

You cannot select channels in which strain modules are not installed.

Digital Filter and Real Time Math (Optional)

The digital filter, delay, and real time math features can be used on DL850E/DL850EVs with the /G3 option. The /G5 option expands the real time math feature to include power math and harmonic analysis.

- You can set a digital filter or delay on input channel waveforms (A/D converted data). You can also perform real time math operations in which the waveforms of input channels or the results of other real time math operations are used as the math source waveforms.
- The results of filtering and math operations are acquired in acquisition memory—the same place that input channel waveforms are acquired.
- You can perform filtering and math operations on up to 16 channels at the same time.
- By setting the waveform that results from filtering or math operations as a trigger source, you can trigger the DL850E/DL850EV on the results.



Digital Filter and Delay (Filter/Delay Setup)

You can set digital filters and delays on input channel waveforms (A/D converted data). This is one of the features of the /G3 option. The other feature is real time math.

- Configure the settings for each channel. You can perform filtering on up to 16 channels at the same time.
- Even during waveform acquisition, you can set the filter type, filter band, and cutoff frequency.
- The digital filter/delay setup menu is displayed when the real time math menu is turned off.
- To enable the digital filter/delay feature and the real time math feature at the same time, you have to first configure the digital filter/delay settings, and then turn the real time math menu on.
- You cannot set digital filters or delays on the bits or input channels of a logic, 16-CH voltage input, 16-CH voltage/temperature input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, SENT monitor, and 4-CH modules.
- By setting the waveform that results from filtering as a trigger source, you can trigger the DL850E/DL850EV on the results.
- For details on the digital filter characteristics, delay, and settings, see the appendix in the *Real Time Math (/G3 option) User's Manual*, IM DL850E-51EN.

Bandwidth (Bandwidth)

When you set a filtering feature, it takes effect immediately.

- Digital (Digital): Select this item to display a menu for configuring the optional digital filter.
- LPF: Select this item to display a menu for configuring the standard filter.

▶ See here.

Filter Type (Filter Type)

The following digital filter types are available: Gauss, Sharp, IIR, and Mean. The features of each filter are listed below.

Filter Type	Features	Operation Type
Gauss	• Frequency characteristics with a smooth attenuation slope • Linear phase and constant group delay • No ripples present in the passband • No overshoot in the step response • Low order and short delay	FIR
Sharp	• Frequency characteristics with a sharp attenuation slope (−40 dB at 1 oct) • Linear phase and constant group delay • Ripples present in the passband • Comb-shaped stopband	FIR
IIR	• Attenuation slope steepness between those of the SHARP and GAUSS filters • Non-linear phase and non-constant group delay • No ripples present in the passband and stopband • Characteristics similar to those of analog filters • Compared to Sharp and Gauss filters, lower cutoff frequency possible	IIR
Mean	• Comb-shaped frequency characteristics • Linear phase and constant group delay • No overshoot in the step response	FIR
IIR-LowPass	• Computes at 10 MS/s regardless of the setting.	IIR

Filter Band (Filter Band)

When the filter type is set to Gauss, Sharp, or IIR, you can select the filter band. The type of filter band that you can select depends on the filter type.

Filter Type	Filter Band
Gauss	Low-Pass
Sharp	Low-Pass, High-Pass, Band-Pass
IIR	Low-Pass, High-Pass, Band-Pass

Cutoff Frequency (CutOff)

When the filter type is set to Sharp, Gauss, or IIR and the filter band is set to Low-Pass or High-Pass, you can set the cutoff frequency. The ranges and resolutions are indicated below.

Filter Type	Filter Band	Range	Resolution
Gauss	Low-Pass	0.002 kHz to 300 kHz Default value: 300 kHz	0.0002 kHz (0.002 kHz to 0.0298 kHz range)
			0.002 kHz (0.03 kHz to 0.298 kHz range)
			0.02 kHz (0.30 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)
Sharp	Low-Pass	0.002 kHz to 300 kHz Default value: 300 kHz	0.0002 kHz (0.002 kHz to 0.0298 kHz range)
			0.002 kHz (0.03 kHz to 0.298 kHz range)
			0.02 kHz (0.30 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)
	High-Pass	0.20 kHz to 300 kHz Default value: 300 kHz	0.02 kHz (0.20 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)
IIR	Low-Pass	0.002 kHz to 300 kHz Default value: 300 kHz	0.002 kHz (0.002 kHz to 0.298 kHz range)
			0.02 kHz (0.30 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)
	High-Pass	0.02 kHz to 300 kHz Default value: 300 kHz	0.02 kHz (0.02 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)

Filter Type	Filter Band	Range	Resolution
IIR-LowPass	Low-Pass	128 kHz, 64 kHz, 32 kHz, 16 kHz, 8 kHz, 4 kHz, 2 kHz, 1 kHz, 500 Hz, 250 Hz, 125 Hz, 62.5 Hz Default value: 128 kHz	–

Center Frequency (Center Frequency)

When the filter type is set to Sharp or IIR and the filter band is set to Band-Pass, set the center frequency. The ranges and resolutions are indicated below.

Filter Type	Range	Resolution
Sharp	0.30 kHz to 300 kHz Default value: 300 Hz	0.02 kHz (0.30 kHz to 2.98 kHz range)
		0.2 kHz (3 kHz to 29.8 kHz range)
		2 kHz (30 kHz to 300 kHz range)
IIR	0.06 kHz to 300 kHz Default value: 300 Hz	0.02 kHz (60 Hz to 1.18 kHz range)
		0.2 kHz (1.2 kHz to 11.8 kHz range)
		2 kHz (12 kHz to 300 kHz range)

Bandwidth (Pass Band)

When the filter type is set to Sharp or IIR and the filter band is set to Band-Pass, set the bandwidth. The bandwidth options vary depending on the center frequency that you have set. For details about these options, see the appendix in the *Real Time Math (/G3 option) User's Manual*, IM DL850E-51EN.

Tap (Tap)

When the filter type is set to Mean, select the number of taps (number of levels) from the following options. The larger the number of taps, the sharper the filter characteristics become.

2, 4, 8, 16, 32, 64, 128

Mean Sample Rate (Mean Sample)

When the filter type is set to Mean, select the sample rate from the following options. The specified sample rate is used to sample waveforms and to filter them.

1 M, 100 k, 10 k, 1 k (unit: S/s)

Interpolation On and Off (Interpolate)

Select whether to perform data interpolation when the filter type is Gauss, Sharp, IIR, or Mean (moving average). Select whether to perform data interpolation. Up to 10 M samples of data can be interpolated from the data of waveforms that pass through the digital filter. The interpolation method is linear interpolation.

- ON: Data is interpolated.
- OFF: Data is not interpolated.

Delay (Delay)

You can set a delay on waveforms that pass through the digital filter.

The sampling data is decimated in a simple manner to produce the data delay. Consequently, if you set a large delay, data updating automatically becomes slower. The default value is 0.0 µs.

Range	Resolution	Data Update Frequency
0.0 µs to 100 µs	0.1 µs	10 MHz
101 µs to 1.00 ms	1 µs	1 MHz
1.01 ms to 10.00 ms	0.01 ms	100 kHz

The delay is valid even if you are not using the digital filter. However, if you set a delay, the sampling data automatically passes through the digital filter circuit. Therefore, the actual delay when you are not using the digital filter is 1.4 µs (the minimum math delay) + the set delay.

Real Time Math (RealTime Math)

Turning Real Time Math On and Off

Select whether to use real time math.

- ON: Select this item to display a menu for configuring real time math. At the same time, real time math execution begins.
- OFF: Select this item to display a menu for configuring the standard model. Real time math is not executed.

▶ See here.

You can perform real time math operations in which the waveforms of input channels or the results of other real time math operations are used as the math source waveforms. This is one of the features of the /G3 option. The other feature is the digital filter and delay.

- Configure the settings for each channel. You can perform math operations on up to 16 channels at the same time.
- When you turn real time math on, the real time math results are output to the real time math channels (the channels that you have turned math on for). The waveforms of input channels whose math is turned on are not used for displaying, saving, triggering, or analyzing (cursor measurement, automated measurement of waveform parameters, math computation, FFT, GO/NO-GO, search, history, power math of the /G5 option, etc.). For example, if you turn real time math on for input channel CH2, CH2 becomes the RMath2 real time math channel, and the math results are displayed on the screen. The data that is saved is that of the math result. If you want to display, save, trigger on, or analyze the waveform of the input channel, set the real time math to a channel that has no input.
- Waveforms of real time math channels (real time math results) are used for displaying, saving, triggering, and analyzing (except for power math).
- Other real time math channels can be used as source waveforms of real time math. If you set the real time math channel to RMathX, you can select the RMath waveforms on channels up to RMathX – 1. If the real time math channel is RMath1, you cannot use any other RMath waveforms as math source waveforms.
- You cannot set the channel that the real time math result is output on to an input channel of a 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module (there is no menu for turning real time math on).
- The input channel of a 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, SENT monitor, or 4CH* module can be used as a source waveform of real time math.
  * 4-CH module input channels have sub channels 1 and 2. If real time math is turned off, both sub channels 1 and 2 can be selected. If real time math of a 4-CH module is turned on, either sub channel 1 or 2 of that module becomes the output destination of the real time math results. For example, if sub channel 1 is set to CH3_1 and sub channel 2 to CH3_2 and real time math is turned on, the channel becomes a single real time math channel named RMath3, and only CH3_1 is displayed for the source waveform option.
- Of the power math of the /G5 option, CH13 and CH14 if power analysis is in use and CH15 and CH16 if harmonic analysis is in use cannot be used as real time math channels or sources.
- For details on the modules whose channels you can set as real time math sources, see “Notes Regarding Using the Digital Filter and Real Time Math”

  ▶ See here.
- Even during waveform acquisition, you can set various math conditions, such as the operator or function (the operation definition), the source waveforms, and the coefficients. However, if you change the conditions, the measurement count (waveform acquisition count) is reset. The measurement count is displayed in the lower left of the screen.
- For details on the math expressions, delay, and settings, see the appendix in the *Real Time Math (/G3 option) User’s Manual*, IM DL850E-51EN.

Labels (Label)

▶ See here.

Real Time Math Setup (RealTime Math Setup)

Select an operator or function (operation definition), and then set its corresponding items.

Operators and Functions (Operation)

- S1+S2: Adds the waveforms assigned to Source1 and Source2
- S1−S2: Subtracts the waveform assigned to Source2 from the waveform assigned to Source1
- S1*S2: Multiplies the waveforms assigned to Source1 and Source2
- S1/S2: Divides the waveform assigned to Source1 by the waveform assigned to Source2
- A(S1)+B(S2)+C: Performs addition with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)−B(S2)+C: Performs subtraction with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)*B(S2)+C: Performs multiplication with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)/B(S2)+C: Performs division with coefficients on the waveforms assigned to Source1 and Source2
- Diff(S1): Performs differentiation on the waveform assigned to Source using a fifth order Lagrange interpolation formula
- Integ1(S1): Performs integration on the positive component of the waveform assigned to Source
- Integ2(S1): Performs integration on the positive and negative components of the waveform assigned to Source
- Rotary Angle: Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to calculate the angle of rotation. This can be used to calculate the angle of rotation or the displacement of an encoder.
- DA: Converts the logic signals that have been assigned to Source1 (the least significant digits) and Source2 (the most significant digits) into an analog waveform and scales the results
- Polynomial: Performs a quartic polynomial calculation on the waveform that has been assigned to Source
- RMS: Calculates the RMS value of the waveform that has been assigned to Source
- Power: Calculates the effective power of the waveforms that have been assigned to Source1 and Source2.
- Power Integ: Integrates the effective power of the waveforms that have been assigned to Source1 and Source2.
- Log1: Calculates the common logarithm of the waveforms that have been assigned to Source1 and Source2 (the calculation is performed on “Source1/Source2”)
- Log2: Calculates the common logarithm of the waveform that has been assigned to Source
- Sqrt1: Calculates the square root of the sum (or difference) of the squares of the waveforms that have been assigned to Source1 and Source2. This can be used to analyze displacement and tolerance.
- Sqrt2: Calculates the square root of the waveform that has been assigned to Source
- Cos: Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to determine the angle, and then calculates the cosine of this angle. You can use this to convert the angle to displacement.
- Sin: Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to determine the angle, and then calculates the sine of this angle. You can use this to convert the angle to displacement.
- Atan: Calculates the arc tangent of the waveforms that have been assigned to Source1 and Source2 (the calculation is performed on “Source1/Source2”). You can use this to convert the displacement to an angle.
- Electrical Angle: Calculates the phase difference between (1) the angle that was determined from the logic signals that were specified for phases A, B, and Z, and (2) the fundamental component that was determined from the discrete Fourier transform of the waveform that was specified as the target. You can calculate the phase difference (electrical angle) between the motor’s angle of rotation and the motor drive current.
- Knock Filter (can be set only on the DL850EV): When the signal level of the waveform that has been set to Source is less than or equal to the elimination level, the signal of this waveform is set to 0. You can select whether to perform differentiation. You can use this to extract knocking.
- Poly-Add-Sub: Performs addition or subtraction or both on the waveforms that have been set to Source1, Source2, Source3, and Source4. You can add or subtract the result of the power calculation, to calculate the multi-phase power.
- Frequency: Calculates the frequency of the waveform that has been assigned to Source
- Period: Calculates the period of the waveform that has been assigned to Source
- Edge Count: Counts the number of slope edges of the waveform that has been assigned to Source. You can use this to count the number of events in consecutive tests.

- Resolver: Calculates the angle of rotation from the sine signal and cosine signal that are generated from the detection coils of the resolver depending on the angle of the rotor.
- IIR Filter: This can be used to filter the waveform that has been set to Source with the same characteristics of the IIR filter of the digital filter. You can set the frequency to values over a wider range than is available with the IIR filter of a digital filter.
- PWM: Integrates a pulse width modulation signal and demodulates it to an analog signal.
- Reactive Power(Q): Calculates the reactive power from apparent power and effective power.
- CAN ID: Detects the fram of the CAN bus signal with the specified ID.
- Torque: Measures the frequency of the pulse frequency output torque sensor and calculates the torque using the specified coefficient.
- S1−S2 (Angle): Determines the angle difference by subtracting the Source 2 angle from the Source 1 angle.
- 3 Phase Resolver: Calculates the angle of rotation from the two sine signals that are generated from the detection coil of the 3 phase resolver depending on the angle of the rotor.

Turning the Mean On and Off (Mean)

Select whether to perform the mean. This mean is the same feature as the one in the digital filter. However, the number of taps is fixed to 32. The sampling frequency is the same as the DL850E/DL850EV sample rate. The maximum sampling frequency is 10 MHz.

- ON: The mean is performed.
- OFF: The mean is not performed.

Optimizing Value/Div (Optimize Value/Div)

Press the Optimize Value/Div soft key to automatically set the value/div that the DL850E/DL850EV determines is the most appropriate for the math source waveform range and the expression. The selected value is from among the 123 value/div options for vertical axis sensitivity.

- The automatically selected option does not line up with the input values and math results, so you need to use the SCALE knob to change the value/div.
- There are a total of 123 value/div options within the following range: 500.0E+18 to 10.00E−21 (in steps of 1, 2, or 5).

Waveform Vertical Position (Vertical POSITION knob)

▶ See here.

Zoom Method (V Scale), Zooming by Setting a Magnification (V Zoom), Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

▶ See here.

Offset (Offset)

▶ See here.

Trace Settings (Trace Setup)

▶ See here.

Unit (Unit)

You can assign a unit of up to four characters in length to the math results. The specified unit is reflected in the scale values.

All Channels Setup Menu

There is a menu (ALL CH) that is used to configure the settings for all channels for real time math. The menu is operated in the same way as the all channels setup menu on the standard model.

- You can configure the real time math settings of all channels while viewing the settings in a list.
- You can turn real time math on and off for all channels at once.
- There are some items that cannot be configured from the ALL CH menu.

Basic Arithmetic (S1+S2, S1−S2, S1*S2, and S1/S2)

Performs addition, subtraction, multiplication, or division on the two waveforms assigned to Source1 and Source2.

Math Source Waveforms (Source1 and Source2)

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] RMath1 to RMath15[4]

1 You can select the input channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.

2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. Even if the data type is not set to Logic, you cannot use data that exceeds 16 bits in length. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

4 You can use other RMath waveforms as math source waveforms. If you set the real time math channel to RMathX, you can select the RMath waveforms on channels up to RMathX−1. If the real time math channel is RMath1, you cannot use any other RMath waveforms as math source waveforms.

▶ See here.

Basic Arithmetic with Coefficients (A(S1)+B(S2)+C, A(S1)−B(S2)+C, A(S1)*B(S2)+C, A(S1)/B(S2)+C)

Performs addition, subtraction, multiplication, or division with coefficients on the two waveforms assigned to Source1 and Source2.

Math Source Waveforms (Source1 and Source2)

The options are the same as were described above for basic arithmetic.

▶ See here.

Coefficients (A, B, and C)

Set the scaling coefficients (A and B) and the offset (C).
Range: −9.9999E+30 to +9.9999E+30
Default value of A and B: 1.0000
Default value of C: 0.0000

Differentiation (Diff(S1))

Performs differentiation on the waveform assigned to Source using a fifth order Lagrange interpolation formula. For details on the differentiation characteristics, see the appendix in the *Real Time Math (/G3 option) User's Manual*, IM DL850E-51EN.

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic.

▶ See here.

Integration (Integ1(S1) and Integ2(S1))

Integration is performed on the waveform that has been assigned to Source.

- Integ1(S1): Performs integration on the positive component of the waveform assigned to Source
- Integ2(S1): Performs integration on the positive and negative components of the waveform assigned to Source

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic.

▶ See here.

Reset Condition (Reset Condition)

Select the condition for resetting integration from one of the settings below.

- Start (Start): When the waveform acquisition starts
- Overlimit (Overlimit): When “Value/Div” exceeds +10 div or falls below −10 div
- Zero crossing (ZeroCross): When the math source waveform signal crosses zero
  Set the slope direction (positive or negative) and the hysteresis when the signal crosses zero. The hysteresis level is the same as the trigger hysteresis. ▶ See here.

Manual Reset (Manual Reset)

To manually reset the integration, select Execute.

Angle of Rotation (Rotary Angle)

Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to calculate the angle of rotation. This can be used to calculate the angle of rotation or the displacement of an encoder.

Type (Type)

You can select the type of the encoding from the following options.

- Incremental ABZ (Incremental ABZ): The angle of rotation is calculated from the A, B, and Z phase signals.
- Incremental AZ (Incremental AZ): The angle of rotation is calculated from the A and Z phase signals.
- Absolute 8 bit (Absolute 8bit): The angle of rotation is calculated from an 8-bit logic signal (binary code).
- Absolute 16 bit (Absolute 16bit): The angle of rotation is calculated from a 16-bit logic signal (binary code).
- Gray code (Gray Code): The angle of rotation is calculated from a logic signal (gray code) consisting of 2 to 16 bits.

Source Conditions (Source Condition)

Set the conditions of the source whose pulses you want to count.

If the type of the encoding is ABZ or AZ

- **Turning the logic source on and off (Logic Source)**
  - ON: You can set the A, B, and Z phase signals to the signals of logic modules.
  - OFF: You can set the A, B, and Z phase signals to the signals of analog waveform modules.
    The options are the same as were described above for basic arithmetic. However, you cannot select input channels of frequency modules or real time math channels (RMath). ▶ See here.

- **When logic sources are turned on**
  - Source (Source): Select an input channel of a logic module.
  - Phase A (Phase A): Select the bit that you want to use for the phase A signal from among the logic signals of the selected input channel.
  - Phase B (Phase B): Select the bit that you want to use for the phase B signal from among the logic signals of the selected input channel.
  - Phase Z (Phase Z): Select the bit that you want to use for the phase Z signal from among the logic signals of the selected input channel. You can also select whether the phase Z input is inverted.

- **When logic sources are turned off**

  Set the input channels for the phase A, B, and Z signals,[1] the signal level of each signal that you will count as a pulse,[2] and the hysteresis of each signal.[3]
  - Phase A (Phase A): Set the input channel, signal level, and hysteresis of the phase A signal.
  - Phase B (Phase B): Set the input channel, signal level, and hysteresis of the phase B signal.
  - Phase Z (Phase Z): Set the input channel, signal level, and hysteresis of the phase Z signal. You can also select whether the phase Z input is inverted.

  To set the timing that pulses are counted and the timing that the pulse count is reset for the signal level that you set here, see “Encoding Conditions” later in this section. ▶ See here.

1 The options are the same as were described above for basic arithmetic. However, you cannot select input channels of frequency modules or real time math channels (RMath). ▶ See here.
2 The signal level range is the same as the trigger level range. ▶ See here.
3 The hysteresis level is the same as the trigger hysteresis. ▶ See here.

If the type of the encoding is absolute 8 bit, absolute 16 bit, or gray code

Select the input channel of the logic module. For absolute 16 bit and gray code encoding, set the logic channel for the least significant digits to Source1 and the logic channel for the most significant digits to Source2.

* When the bit length of Gray Code is 8 or less, the Source2 setting is ignored.

Negative Logic ON/OFF (Negative logic)

Select which bit state will be recognized to be logic I.

- ON: Negative logic (low state is logic I)
- OFF: Positive logic (high state is logic I)

Pulses per Rotation (Pulse/Rotate)

Set the number of pulses per rotation.

Range: 1 to 500000. The default value is 180.

However, if the encode type is absolute 8 bit, the maximum number is 256. If the type is absolute 16 bit, the maximum is 65536.

Bit Length (Bit Length)

When the bit length (Bit Length) encoding type is set to Gray Code, set the bit length.

Selectable range: 2 to 16

Scaling (Scaling)

Select the unit that is used on the vertical scale.

- Radian: Radian
- Degree: Degrees
- User-defined (User Define): Set K, the size of the scale.
  Range: −9.9999E+30 to +9.9999E+30. The default value is 1.0000.

Encoding Conditions (Encode Condition)

If the type of the encoding is ABZ or AZ, set the encoder’s pulse multiplier and the timing (edge) for counting pulses.

Count Conditions (Count Condition)

You can select the encoder’s pulse multiplier from the following options.

×4, ×2, ×1

When the multiplier is ×4, regardless of the timing setting made in the next section, pulses are counted on all the edges of the signal.

Timing1 (Timing1)

Select the edges that are counted as pulses when the multiplier is ×1.

- A ⎍: Rising edge of the phase A signal
- A ⎎: Falling edge of the phase A signal
- B ⎍: Rising edge of the phase B signal
- B ⎎: Falling edge of the phase B signal

  Rising edge: The point where the signal rises from a low level and passes through the specified signal level
  Falling edge: The point where the signal falls from a high level and passes through the specified signal level

If the signal is that of an analog waveform, turn the logic sources off as shown earlier this manual in “Source Conditions,” and then set the signal level that is counted as a pulse and the hysteresis. ▶ See here.

Timing2 (Timing2)

Select the edges that are counted as pulses when the multiplier is ×2. The options are the same as were described above for Timing1.

When the multiplier is ×2, if you select the same edges as in Timing1, the pulse count conditions are the same as were explained for multiplier ×1.

Reset Timing (Reset Timing)

Select the timing (edge) at which the pulse count will be reset.

- A ⎍: Rising edge of the phase A signal
- A ⎎: Falling edge of the phase A signal
- B ⎍: Rising edge of the phase B signal
- B ⎎: Falling edge of the phase B signal
- Z level (Z Level): When the Z phase signal is at a high level.

Reverse (Reverse)

Set the direction that the angle of rotation increases in.

- ON: The rotation is counter-clockwise.
- OFF: The rotation is clockwise.

Manual Reset (Manual Reset)

To manually reset the angle of rotation, select Execute.

Logic Signal to Analog Waveform Conversion (DA)

Converts the logic signals that have been assigned to Source1 (the least significant digits) and Source2 (the most significant digits) into an analog waveform and scales the results.

Math Source Waveforms (Source1 and Source2)

You can select input channels of an installed logic module. Set the logic channel for the least significant digits to Source1 and the logic channel for the most significant digits to Source2.

You cannot select the input channels of CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor modules.

Type (Type)

Select the type of the logic signal.

- Unsigned: Unsigned integer
- Signed: Signed integer
- Offset Binary: Offset binary

Bit Length (Bit Length)

Set the bit length that will be converted to an analog signal. The length that you specify will be counted from the least significant bit.

Range: 2 to 16. The default value is 16.

Coefficient (K)

Set scaling coefficient K.

Range: −9.9999E+30 to +9.9999E+30. The default value is 1.0000.

Quartic Polynomial (Polynomial)

Performs a quartic polynomial calculation on the waveform that has been assigned to Source.

$As^4+Bs^3+Cs^2+Ds+E$

A, B, C, and D: Scaling coefficients

s: Sampling data

E: Offset

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic.

▶ See here.

Coefficients (A, B, C, D, and E)

Set the scaling coefficients (A, B, C, D, and E) and the offset (E).

Range: −9.9999E+30 to +9.9999E+30

Default value of A and B: 1.0000

Default value of C, D, and E: 0.0000

RMS Value (RMS)

Calculates the RMS value of the waveform that has been assigned to Source.

$$\sqrt{\frac{1}{N}\sum_{n=1}^{N} s(n)^2}$$

s: Sampling data

N: Number of samples

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. However, you cannot select an input channel of a frequency module.

▶ See here.

Calculation Period (Calc Period)

Select the method that is used to determine the RMS calculation period.

- Edge: Rising or falling edge of the selected signal or both edges
- Time: Specified time

If the Calculation Period Is Edge

- **Edge detection source (Edge Source)**

  Select the input channel of the signal that is used to determine the calculation period.

  If you want to use the same channel as the math source waveform, select Own. You can also select other channels.

  ▶ See here.

- **Level (Level), Slope (Slope), and Hysteresis (Hysteresis)**

  Set the signal level,[1] the slope (rising or falling), and the hysteresis[2] of the edges that separate the calculation periods.

  1 The signal level range is the same as the trigger level range. ▶ See here.

  2 The hysteresis level is the same as the trigger hysteresis. ▶ See here.

If the Calculation Period Is Time

- **Time (Time)**

  Set the calculation period time.
  Range: 1 ms to 500 ms. Default value: 1 ms. Resolution: 1 ms.

Effective Power (Power)

Calculates the effective power of the waveforms that have been assigned to Source1 and Source2.

$$\frac{1}{T}\int_0^T (s1 \cdot s2)dt$$

T: 1 period (calculation period)
s1 and s2: Sampling data
dt: Sampling period

Math Source Waveforms (Source1 and Source2)

Set the voltage and current input channels to use to calculate the effective power to Source1 and Source2. The options are the same as were described above for basic arithmetic. However, you cannot select input channels of a frequency module.

▶ See here.

Calculation Period (Calc Period)

Set the calculation period for the effective power calculation.

Edge Detection Source (Edge Source)

Select the input channel of the signal that is used to determine the calculation period.
If you want to use the same channel as the math source waveform, select Source1 or Source2. You can also select other channels. ▶ See here.

Level (Level), Slope (Slope), and Hysteresis (Hysteresis)

Set the signal level, the slope, and the hysteresis of the edges that separate the calculation periods. These settings are shared with the RMS operation.

Effective Power Integration (Power Integ)

Integrates the effective power of the waveforms that have been assigned to Source1 and Source2.

$$\int_0^T (s1 \cdot s2)dt$$

T: Integration time
s1 and s2: Sampling data
dt: Sampling period

Math Source Waveforms (Source1 and Source2)

Set the voltage and current input channels to use to integrate the effective power to Source1 and Source2. The options are the same as were described above for basic arithmetic. However, you cannot select input channels of a frequency module.

▶ See here.

Reset Condition (Reset Condition)

Select the condition for resetting integration from one of the settings below.

- Start (Start): When the waveform acquisition starts
- Overlimit (Overlimit): When “Value/Div” exceeds +10 div or falls below −10 div

Manual Reset (Manual Reset)

To manually reset the integration, select Execute.

Scaling (Scaling)

Select the unit that is used on the vertical scale.

- Seconds (Second): The unit is seconds.
- Hours (Hour): The unit is hours.

Common Logarithm (Log1 and Log2)

- Log1: Calculates the common logarithm of the waveforms that have been assigned to Source1 and Source2 (the calculation is performed on “Source1/Source2”).
  $\mathbf{K \cdot \log_{10}(s1/s2)}$ K: Coefficient. s1 and s2: Sampling data.
- Log2: Calculates the common logarithm of the waveform that has been assigned to Source.
  $\mathbf{K \cdot \log_{10}(s)}$ K: Coefficient. s: Sampling data.

Math Source Waveforms (Source1, Source2, and Source)

The options are the same as were described above for basic arithmetic.

▶ See here.

Coefficient (K)

Set scaling coefficient K.

Range: −9.9999E+30 to +9.9999E+30. The default value is 1.0000.

Square Root (Sqrt1 and Sqrt2)

- Sqrt1: Calculates the square root of the sum (or difference) of the squares of the waveforms that have been assigned to Source1 and Source2. This can be used to analyze displacement and tolerance.
  $\sqrt{s1^2 \pm s2^2}$ s1 and s2: Sampling data
- Sqrt2: Calculates the square root of the waveform that has been assigned to Source
  $\sqrt{s}$ s: Sampling data

Math Source Waveforms (Source1, Source2, and Source)

The options are the same as were described above for basic arithmetic.

▶ See here.

Sign (Sign)

Set the operator between $s1^2$ and $s2^2$ in Sqrt1.

- +: Addition
- −: Subtraction

Cosine (Cos) and Sine (Sin)

Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to determine the angle, and then calculates the cosine or sine of this angle. You can use this to convert the angle to displacement.

Type (Type)

Select the type of the encoding. The settings other than the Resolver Ch setting are shared with the Rotary Angle operation. You can specify the Resolver Ch setting when there is a channel that has been defined with the resolver function of real time math.

- If there are multiple channels that have been defined with the resolver function, select Resolver Ch, and then select the channel.
- If Resolver Ch has been selected, the setup menu explained later is not displayed.

Source Conditions (Source Condition)

Set the conditions of the source whose pulses you want to count. This setting is shared with the Rotary Angle operation.

▶ See here.

Pulses per Rotation (Pulse/Rotate) and Bit Length (Bit Length)

Set the number of pulses per rotation. When the encoding type is set to Gray Code, set the bit length. This setting is shared with the Rotary Angle operation.

Encoding Conditions (Encode Condition)
If the type of the encoding is ABZ or AZ, set the encoder's pulse multiplier and the timing (edge) for counting pulses. This setting is shared with the Rotary Angle operation.

Manual Reset (Manual Reset)
To manually reset the computed value, select Execute.

Arc Tangent (Atan)
Calculates the arc tangent of the waveforms that have been assigned to Source1 and Source2 (the calculation is performed on "Source1/Source2"). You can use this to convert the displacement to an angle.

atan(s1/s2) s1 and s2: Sampling data

Math Source Waveforms (Source1 and Source2)
The options are the same as were described above for basic arithmetic.

▶ See here.

Scaling (Scaling)
Select the unit that is used on the vertical scale. This setting is shared with the Rotary Angle operation. However, there are no user-defined settings.

Quadrant Range (Quadrant)
Select the quadrant range to use for converting displacements to angles. This can be used on models with firmware version 2.05 and latyer.

- Quadrant-2: −90° to +90° (−π/2 to +π/2)
  Even if calculated result is between −180° and −90° or between +90° and +180°, it is converted to an angle between −90° to +90°.
- Quadrant-4: −180° to +180° (−π to +π)

Electrical Angle (Electrical Angle)
Calculates the phase difference between (1) the angle that was determined from the logic signals that were specified for phases A, B, and Z, and (2) the fundamental component that was determined from the discrete Fourier transform of the waveform that was specified as the target. You can calculate the phase difference (electrical angle) between the motor's angle of rotation and the motor drive current.

Type (Type)
Select the type of the encoding. The settings other than the Resolver Ch setting are shared with the Rotary Angle operation. You can specify the Resolver Ch setting when there is a channel that has been defined with the resolver function of real time math.

- If there are multiple channels that have been defined with the resolver function, select Resolver Ch, and then select the channel.
- If Resolver Ch has been selected, set the scaling and the target on the setup menus explained later.

Source Conditions (Source Condition)
Set the conditions of the source whose pulses you want to count. This setting is shared with the Rotary Angle operation. However, you can specify only the input channels of logic modules as math source waveforms.

▶ See here.

Pulses per Rotation (Pulse/Rotate) and Bit Length (Bit Length)
Set the number of pulses per rotation. When the encoding type is set to Gray Code, set the bit length. This setting is shared with the Rotary Angle operation.

Scaling (Scaling)
Select the unit that is used on the vertical scale. This setting is shared with the Rotary Angle operation. However, there are no user-defined settings.

Encoding Conditions (Encode Condition)
If the type of the encoding is ABZ or AZ, set the encoder's pulse multiplier and the timing (edge) for counting pulses. This setting is shared with the Rotary Angle operation.

Target (Target)

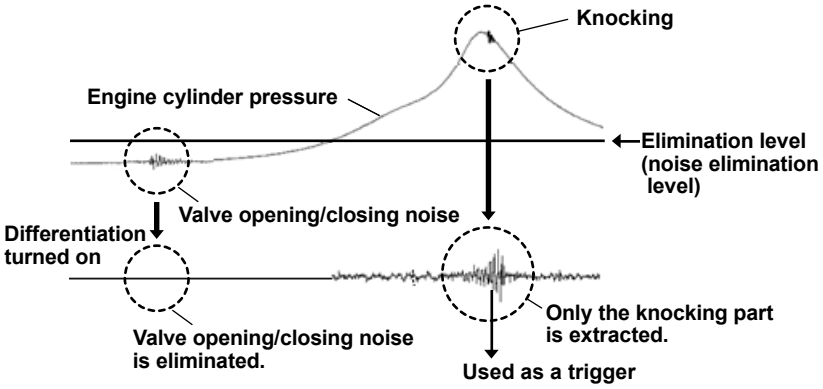
The fundamental component of the waveform that you specify here is determined through a discrete Fourier transform. If the angle is the motor's angle of rotation and the target is the motor's drive current, the electrical angle can be determined.

The options are the same as were described above for basic arithmetic. However, you cannot select an input channel of a frequency module.

▶ See here.

Knocking Filter (Knock Filter; only on the DL850EV)

When the signal level of the waveform that has been set to Source is less than or equal to the elimination level, the signal of this waveform is set to 0. You can select whether to perform differentiation. You can use this to extract knocking.



Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. However, you cannot select an input channel of a frequency module or a real time math channel (RMath).

▶ See here.

Elimination Level

Set the elimination level, which is used to set the input signal to 0.

The range of the elimination level is the same as that of the trigger level. ▶ See here.

Differential

Select whether to differentiate the waveform after elimination. A fifth order Lagrange interpolation formula is used to perform differentiation. For details on the differentiation characteristics, see the appendix in the *Real Time Math (/G3 option) User's Manual*, IM DL850E-51EN.

- ON: Differentiation is performed.
- OFF: Differentiation is not performed.

Polynomial with a coefficient (Poly-Add-Sub)

Performs addition or subtraction or both on the waveforms that have been set to Source1, Source2, Source3, and Source4. You can add or subtract the result of the power calculation, to calculate the multi-phase power.

K (±s1 ±s2 ±s3 ±s4) K: Coefficient. s1, s2, s3, and s4: Sampling data.

Math Source Waveforms (Source1, Source2, Source3, and Source4)

The options are the same as were described above for basic arithmetic.

▶ See here.

Sign

You can set the sign of the sampling data of the math source waveforms to positive or negative.

Coefficient (K)
Set scaling coefficient K.
Range: −9.9999E+30 to +9.9999E+30. The default value is 1.0000.

Frequency (Frequency)
Calculates the frequency of the waveform that has been assigned to Source.

Math Source Waveform (Source)
The options are the same as were described above for basic arithmetic. However, you can select an input channel of a logic module (select the channel, and then select the bit). You cannot select an input channel of a frequency module.
▶ See here.

Slope (Slope), Level (Level), Hysteresis (Hysteresis)
Set the signal level,[1] the slope (rising or falling), and the hysteresis[2] of the edges that are used to detect the periods. If the math source is the signal of a logic module, set only the slope.
1 The signal level range is the same as the trigger level range. ▶ See here.
2 The hysteresis level is the same as the trigger hysteresis. ▶ See here.

Scaling (Scaling)
Select the unit that is used on the vertical scale.
- Hz: The unit is hertz.
- Rpm: The unit is revolutions per minute.

Pulses per Rotation (Pulse/Rotate)
If scaling is set to Rpm, set the number of pulses per rotation.
Selectable range: 1 to 99999. The default setting is 1.

Deceleration Prediction (Deceleration Prediction)
Set whether to compute the decelaration curve from the elapsed time after the pulse input stops.
- ON: Deceleration prediction is performed.
- OFF: Deceleration prediction is not performed.

▶ See here.

Stop Prediction (Stop Prediction)
Set the time from the point when the pulse input stops to the point when the DL850E/DL850EV determines that the object has stopped.
- 2, 4, 8, 16: Stop prediction is performed on the basis of the specified number of times the pulse period (T) of the pulse one period before the pulse input stopped.
- OFF: Stop prediction is not performed.

▶ See here.

Offset (Hz/Rpm) (Offset (Hz/Rpm))
Offset can be added to display only the changes in the frequency at a higher resolution.
Selectable range: −9.9999E+30 to +9.9999E+30.The default value is 0.0000

Period (Period)
Calculates the period of the waveform that has been assigned to Source.

Math Source Waveform (Source)
The options are the same as were described above for basic arithmetic. However, you can select an input channel of a logic module (select the channel, and then select the bit). You cannot select an input channel of a frequency module.
▶ See here.

Slope (Slope), Level (Level), Hysteresis (Hysteresis) Deceleration Prediction (Deceleration Prediction), Stop Prediction (Stop Prediction)
Set the slope (rising or falling), signal level, and hysteresis of the edges that are used to detect the periods as well as the deceleration prediction and stop prediction. These settings are shared with the Frequency operation.

Edge Count (Edge Count)

Counts the number of slope edges of the waveform that has been assigned to Source. You can use this to count the number of events in consecutive tests.

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. However, you can select the input channel of a logic module (select the bit after selecting the channel) or select the S&C and Error Trigger sub channels of a SENT module. You cannot select an input channel of a frequency module.

▶ See here.

Slope (Slope), Level (Level), Hysteresis (Hysteresis)

Set the slope (rising or falling), the signal level, and the hysteresis of the edges that you want to count. These settings are shared with the Frequency operation.

Reset Condition (Reset Condition)

Select the condition for resetting the count from one of the settings below.

- Start (Start): When the waveform acquisition starts
- Overlimit (Overlimit): When “Value/Div” exceeds +10 div or falls below −10 div

Manual Reset (Manual Reset)

To manually reset the count, select Execute.

Resolver (Resolver)

Calculates the angle of rotation from the sine signal and cosine signal that are generated from the detection coils of the resolver depending on the angle of the rotor.

Sine Phase Signal and Cosine Phase Signal (Sin Ch, Cos Ch)

Select the sine signal and the cosine signal that are generated from the detection coil of the resolver. The options are the same as were described above for basic arithmetic.

▶ See here.

Excitation Signal (Carrier Ch)

Select the resolver’s excitation signal. The options are the same as were described above for basic arithmetic.

▶ See here.

Hysteresis (Hysteresis)

Set the rising edge hysteresis of the excitation, sine, and cosine signals. When the sample point mode in detail settings is set to Auto, this setting is applied to all signals. When the sample point mode is set to Manual, this setting is applied to the excitation signal.

Tracking Filter (Tracking Filter)

If the sine signal and cosine signal data is changing in a staircase pattern, select a filter that will smooth out the data that is used to calculate the angle of rotation.
OFF, 2 kHz, 1 kHz, 250 Hz, 100 Hz

Detail Setting (Detail)

Sample Point (Sample Point)

- **Mode (Mode)**

  To enable more accurate calculations of the angle of rotation, set the mode that is used to sample the peak values of sine and cosine signals.
  - Auto: The rising edges of the excitation, sine, and cosine signals are detected, and the peak values of sine signals and cosine signals are sampled automatically.
    - The Auto setting can be applied when the time difference of the sine and cosine signals in reference to the excitation signal is less than ±90°(π/2).
    - Turn the SCALE knob to set the vertical scale (V/div) so that the amplitudes of the excitation, sine, and cosine signals are all ±1.5 div or greater. If the amplitudes are less than ±1.5 div, the Auto function will not operate.

- Manual: The rising edge of the excitation signal is detected, and sine and cosine signals at the specified time (Time) after this detected rising edge are sampled.
  Time Setting
  Selectable range: 0.1 µs to 1000.0 µs, Default value: 0.1 µs, Resolution: 0.1 µs.

Scaling (Scaling)

Select how the upper and lower limits of the vertical scale are displayed.
−180° to +180°, 0° to 360°, −π to +π, 0 to 2π

Offset (°) (Offset (°))

An offset can be added to set the initial phase of the rotation angle.
Selectable range: −180.00° to +180.00°. The default setting is 0.00°, and the resolution is 0.01°.

- To improve the calculation accuracy, set the vertical axis sensitivity for each signal so that the signal amplitude is as large as possible.
- Set the vertical axis sensitivity to the same value for sine signals and cosine signals. If you specify different values, the DL850E/DL850EV cannot perform calculations correctly.

IIR Filter (IIR Filter)

This can be used to filter the waveform that has been set to Source with the same characteristics of the IIR filter of the digital filter. You can set the frequency to values over a wider range than is available with the IIR filter of the digital filter.

Math Source Waveforms (Source)

The options are the same as were described above for basic arithmetic.

▶ See here.

Filter Band (Filter Band)

Select the filter band.
Low-Pass, High-Pass, Band-Pass

Cutoff Frequency (CutOff)

When the filter band is set to Low-Pass or High-Pass, set the cutoff frequency. The ranges and resolutions are indicated below.

Filter Band	Range	Resolution
Low-Pass	0.2 Hz to 3.00 MHz Default value: 0.30 MHz	0.2 Hz (0.2 Hz to 29.8 Hz range)
		2 Hz (30 Hz to 298 Hz range)
		0.02 kHz (0.30 kHz to 2.98 kHz range)
		0.2 kHz (3.0 kHz to 29.8 kHz range)
		2 kHz (30 kHz to 298 kHz range)
		0.02 MHz (0.30 MHz to 3.00 MHz range)
High-Pass	0.02 kHz to 3.00 MHz Default value: 0.30 MHz	0.02 kHz (0.02 kHz to 2.98 kHz range)
		0.2 kHz (3.0 kHz to 29.8 kHz range)
		2 kHz (30 kHz to 298 kHz range)
		0.02 MHz (0.30 MHz to 3.00 MHz range)

Center Frequency (Center Frequency)

When the filter band is set to Band-Pass, set the center frequency. The ranges and resolutions are indicated below.

Range	Resolution
0.06 kHz to 3.00 MHz Default value: 0.30 kHz	0.02 kHz (0.06 kHz to 1.18 kHz range)
	0.2 kHz (1.2 kHz to 11.8 kHz range)
	2 kHz (12 kHz to 118 kHz range)
	0.02 MHz (0.12 MHz to 3.00 MHz range)

Bandwidth (Pass Band)

When the filter band is set to Band-Pass, select the bandwidth. The bandwidth options vary depending on the center frequency that you have set. For details on the options, see the appendix in the Real Time Math (/G3 option) User's Manual, IM DL850E-51EN.

Interpolation On and Off (Interpolate)

Select whether to perform data interpolation. Up to 10 M samples of data can be interpolated from the data of waveforms that pass through the real time math IIR filter. The interpolation method is linear interpolation.

- ON: Data is interpolated.
- OFF: Data is not interpolated.

Demodulation of the Pulse Width Modulated Signal (PWM)

Integrates a pulse width modulation signal and demodulates it to an analog signal.

Math Source Waveforms (Source)

The options are the same as were described above for basic arithmetic.

▶ See here.

Period of the Pulse Width Modulated Signal (Period)

Set the period of the pulse width modulated signal. The pulse width modulation signal is repeatedly integrated over the set period and demodulated to an analog signal.

Selectable range: 0.1 µs to 5000.0 µs, Default value: 0.1 µs, Resolution: 0.1 µs.

Reactive Power (Reactive Power(Q))

Calculates the reactive power from apparent power and effective power.

To calculate the reactive power, you must use the real time math feature to calculate the apparent power and effective power by following the procedure below.

Apparent Power Calculatiom

1. Calculate the RMS voltage and current (RMS) that are used to derive the reactive power.
2. Take the product of the RMS voltage and current (S1*S2) that were calculated in step 1. The result is the apparent power.

Effective Power Calculation

Calculate the effective power of the RMS voltage and current (Power) that are used to derive the reactive power.

Apparent Power (Apparent Power(S))

Select the real time math channel (RMath channel) used to calculate the apparent power.

Effective Power (Effective Power(P))

Select the real time math channel (RMath channel) used to calculate the effective power.

Reactive Power Polarity

Determine the reactive power polarity from the phases of the voltage and current used to derive the reactive power.

Voltage (Voltage)

Select the voltage channel used to derive the reactive power.
The options are the same as were described above for basic arithmetic. However, you cannot select input channels of frequency modules.

▶ See here.

Hysteresis (Hysteresis)

Select the hysteresis used to detect the zero crossing of the selected voltage.
The hysteresis level is the same as the trigger hysteresis.

▶ See here.

Current (Current)

Select the current channel used to derive the reactive power.
The options are the same as were described above for basic arithmetic. However, you cannot select input channels of frequency modules.

▶ See here.

CAN ID Detection (CAN ID)

Detect the frame of the CAN bus signal with the specified ID. A pulse waveform whose detection point is at high level is displayed.

Detection Source Waveforms (Source)

CH1 to CH16,[1] RMath1 to RMath[2]

1 You can select an input channel of an installed module. However, you cannot select an input channel of a logic, frequency, 16-CH voltage, 16-CH temperature/voltage, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.
2 You can use other RMath waveforms as math source waveforms. If you set the real time math channel to RMathX, you can select the RMath waveforms on channels up to RMathX−1. If the real time math channel is RMath1, you cannot use any other RMath waveforms as math source waveforms

▶ See here.

Bit Rate (Bit Rate)

Select the transmission speed of the CAN bus signal to detect.
10k, 20k, 33.3k, 50k, 62.5k, 66.7k, 83.3k, 100k, 125k, 250k, 500k, 800k, or 1Mbps

Message Format

Select the data frame message format of the CAN bus signal to detect.
STD: Standard format
XTD: Extended format

ID (Hexadecimal (Hex))

Set the data frame message ID of the CAN bus signal to detect.
Standard format (11 bits): 0x000 to 0x7ff
Extended format (29 bits): 0x00000000 to 0x1fffffff

Torque (Torque)

Measures frequency f of the waveform specified as the source and calculate the torque.
A(f+c) f: Measuring frequency A and C: Coefficients

Math Source Waveforms (Source)

The options are the same as were described for basic arithmetic. However, you can select the input channels of logic modules (select the channel, and then select the bit).
You cannot select the input channel of a frequency module.
▶ See here.

Slope (Slope), Level (Level), Hysteresis (Hysteresis)

Set the signal level1, the slope (rising or falling), and the hysteresis2 of the edges that are used to detect the periods.
If the math source is the signal of a logic module, set only the slope.
1 The signal level range is the same as the trigger level range.▶ See here.
2 The hysteresis level is the same as the trigger hysteresis.▶ See here.

Deceleration Prediction (Deceleration Prediction)

Set whether to compute the deceleration curve from the elapsed time after the pulse input stops.
- ON: Deceleration prediction is performed.
- OFF: Deceleration prediction is not performed.

▶ See here.

Stop Prediction (Stop Prediction)

Set the time from the point when the pulse input stops to the point when the DL850E/DL850EV determines that the object has stopped.
- 2, 4, 8, 16: Stop prediction is performed on the basis of the specified number of times the pulse period (four settings) of the pulse one period before the pulse input stopped.
- OFF: Stop prediction is not performed.

▶ See here.

Coefficients (A and C)

Set the scaling coefficient (A) and the frequency reference (C).

Angle Difference (S1−S2(Angle))

Determines the angle difference in the range of −180° to +180° by subtracting the Source2 angle from the Source1 angle.
If the computed value is in the range of −360° to −180° or +180° to +360°, this function calculates its supplement.

Math Source Waveforms (Source1 and Source2)

Select the input channels to assign to Source1 and Source2 for calculating the angle difference.
The options are the same as were described for basic arithmetic. However, you cannot select input channels of frequency modules.
▶ See here.

Scaling (Scaling)

Select the unit that is used on the vertical scale.
- Radian: Radian
- Degree: Degrees

3 Phase Resolver (3 Phase Resolver)

Calculates the angle of rotation from the two sine signals that are generated from the detection coil of the 3 phase resolver depending on the angle of the rotor.

Sine Signal Phase (Phase)

Select the phases of the two sine signals that are generated from the detection coil of the 3 phase resolver.
0° to 120°, 0° to 240°, 120° to 240°

Sin Signal (Sin Ch)

In accordance with the phases selected in the previous section, select the sine signals that are generated from the detection coil of the 3 phase resolver. The options are the same as were described for basic arithmetic.

▶ See here.

Excitation Signal(Carrier Ch)

Select the 3 phase resolver's excitation signal. The options are the same as were described for basic arithmetic.

▶ See here.

Hysteresis (Hysteresis)

Set the rising edge hysteresis of the excitation, and sine signals. When the sample point mode in detail settings is set to Auto, this setting is applied to all signals. When the sample point mode is set to Manual, this setting is applied to the excitation signal.

Tracking Filter (Tracking Filter)

If the sine signal and cosine signal data is changing in a staircase pattern, select the cutoff frequency of the tracking filter that will smooth out the data that is used to calculate the angle of rotation.
OFF, 2 kHz, 1 kHz, 250 Hz, 100 Hz

Detail Setting (Detail)

Sample Point (Sample Point)

- **Mode (Mode)**

  To enable more accurate calculations of the angle of rotation, set the mode that is used to sample the peak values of sine signals.

  - Auto: The rising edges of the excitation and sine signals are detected, and the peak values of sine signals are sampled automatically.
    - The Auto setting can be applied when the time difference of the sine signals in reference to the excitation signal is less than ±90° (π/2).
    - Turn the SCALE knob to set the vertical scale (V/div) so that the amplitudes of the excitation, and sine signals are all ±1.5 div or greater. If the amplitudes are less than ±1.5 div, the Auto function will not operate.
  - Manual: The rising edge of the excitation signal is detected, and sine signals at the specified time (Time) after this detected rising edge are sampled.
    Time setting
    Selectable range: 0.1 µs to 1000.0 µs. The default setting is 0.1 µs, and the resolution is 0.1 µs.

Scaling (Scaling)

Select how the upper and lower limits of the vertical scale are displayed.
−180° to +180°, 0° to 360°, −π to +π, 0 to 2π

Offset (°) (Offset (°))

An offset can be added to set the initial phase of the rotation angle.
Selectable range: −180.00° to +180.00°. The default setting is 0.00°, and the resolution is 0.01°.

- To improve the calculation accuracy, set the vertical axis sensitivity for each signal so that the signal amplitude is as large as possible.
- Set the vertical axis sensitivity to the same value for sine signals and cosine signals. If you specify different values, the DL850E/DL850EV cannot perform calculations correctly.

Notes Regarding Using the Digital Filter and Real Time Math

Real Time Math Source Modules and Channels

The modules and channels that you can select as real time math source waveforms (source) are shown below.

Operators and Functions		Input Module Model and RMath (Real Time Math Channel) (Yes: Can be selected, No: Cannot be selected)				
		701250, 720250, 701251, 701255, 701267, 720268, 701261, 701262, 701265, 720266, 701270, 701271, 701275, 720210, 720211, 720220[1] 720221[1] 720254	701281 720281	720230	720240[1, 2] 720241[1, 2] 720242[1, 2] 720243[1, 2] (Usable only on the DL850EV)	RMath[3]
S1+S2, S1sS2, S1*S2, S1/S2		Yes	Yes	No	Yes	Yes
A(S1)+B(S2)+C, A(S1)−B(S2)+C, A(S1)*B(S2)+C, A(S1)/B(S2)+C		Yes	Yes	No	Yes	Yes
Diff(S1), Integ1(S1), Integ2(S1)		Yes	Yes	No	Yes	Yes
Rotary Angle		Yes[4]	No	Yes[4]	Yes	No
DA		No	No	Yes	No	No
Polynomial		Yes	Yes	No	Yes	Yes
RMS, Power	Math source	Yes	No	No	Yes	Yes
	Edge source	Yes	No	Yes	Yes[2]	Yes
Power Integ		Yes	No	No	Yes	Yes
Log1, Log2		Yes	Yes	No	Yes	Yes
Sqrt1, Sqrt2		Yes	Yes	No	Yes	Yes
Cos, Sin		Yes[4]	No	Yes[4]	Yes	No
Atan		Yes	Yes	No	Yes	Yes
Electrical Angle	Math source	No	No	Yes	No	No
	Target	Yes	No	No	Yes	Yes
Knock Filter (Settable only on the DL850EV)		Yes	No	No	Yes	No
Poly-Add-Sub		Yes	Yes	No	Yes	Yes
Frequency, Period		Yes	No	Yes	Yes	Yes
Edge Count		Yes	No	Yes	Yes[2]	Yes
Resolver		Yes	Yes	No	Yes	Yes
IIR Filter		Yes	Yes	No	Yes	Yes
PWM		Yes	Yes	No	Yes	Yes
Reactive Power(Q)		Yes	No	No	Yes[2]	Yes
CAN ID		Yes[5]	No	No	No	Yes
Torque		Yes[5]	No	Yes	Yes	Yes
S1−S2(Angle)		Yes[5]	No	No	Yes	Yes
3 Phase Resolver		Yes	Yes	No	Yes	Yes

For the names of the input modules, see the *Getting Started Guide*, IM DL850E-03EN.

1 To set the input channels of a 720220 16-CH voltage input module or a 720221 temperature/voltage input module as the source waveforms of real time math, you have to set the input coupling (Coupling) to DC or GND. To set the input channels of a 720240 CAN bus monitor module, CAN/CAN FD monitor 720242, 720241 CAN & LIN bus monitor module, or 720243 SENT monitor module as the source waveforms of real time math, you have to turn the input (Input) on.
2 Input channels of a 720240 CAN bus monitor, CAN/CAN FD monitor 720242, or 720241 CAN & LIN bus monitor module cannot be selected if the data type (Value Type) is set to Logic. Even if the data type is not set to Logic, you cannot use data that exceeds 16 bits in length. On a 720243 SENT monitor module, S&C and Error Trigger sub channels cannot be selected. However, if the function is Edge Count, these channels can be selected.
3 If you set the real time math channel to RMathX, you can select the RMath waveforms on channels up to RMathX−1. If the real time math channel is RMath1, you cannot use any other RMath waveforms as math source waveforms.
4 If you have turned logic sources on, select an input channel of a 720230 logic module. If logic sources have been turned off, select an input channel of an analog waveform module.
5 The input channels of a 16-CH voltage input module (720220) or 16-CH temperature/voltage input module (720221) cannot be selected.

Math Delay

The real time math delay is “1.4 µs + the digital filter delay + the math delay.”
The digital filter and math delays vary depending on the type of filter and math operation.

- If you are using the result of a real time math channel as the source waveform for another real time math operation, the math delays accumulate.
- For details, see the appendix in the *Real Time Math (/G3 option) User’s Manual*, IM DL850E-51EN.

Internal Processing of Real Time Math

The math source waveforms are 16-bit binary data. If they are only 12 bits long, they are converted to 16 bits. Internally, the waveforms are converted to floating-point numbers and calculated.

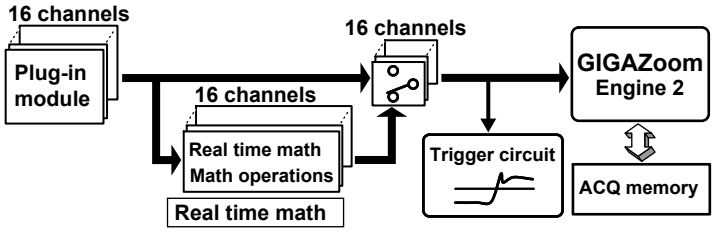
- The math results are converted to 16-bit data in relation to the range (value/div) and are then recorded in acquisition memory.
- The basic display is 2400 LSB/div (the same as the 16-bit analog waveform module).
- For details on the internal math expressions, see the appendix in the *Real Time Math (/G3 option) User’s Manual*, IM DL850E-51EN.

Differences between Real Time Math and Standard Math

This section explains the differences between the real time math operations that you configure by pressing CH (/G3 option) and the standard math operations that you configure by pressing MATH.

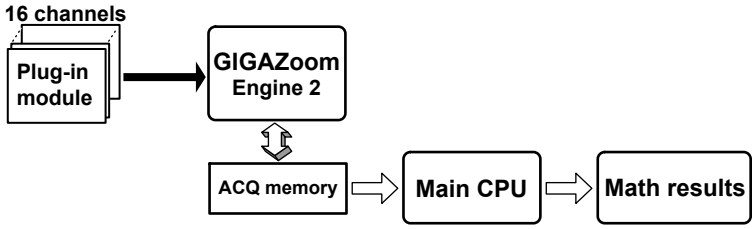
Real Time Math

- Math operations can be performed in real time on waveforms (A/D converted data) that are applied to the input channels of each of the modules.
- Even when the display is in roll mode, you can view the real time math results.
- There are no limits on the record length. Because the data of normal input channels is switched with the real time math results and acquired in acquisition memory, you can specify the same record length as that of the normal input channels.
- You can trigger the DL850E/DL850EV on real time math results.
- Regardless of the DL850E/DL850EV sample rate, math operations are always performed on the data that is output from each module at a maximum math rate of 10 MS/s.
- Real time math can be used in all acquisition modes (including the dual capture mode).



Standard Math

- Because waveforms are processed after they are acquired, the waveform update period is long.
- Math cannot be performed when the display is in roll mode.
- Math is performed on data that was acquired into acquisition memory at the DL850E/DL850EV sample rate.
- Because math results are stored in the main memory of the main CPU, there are limits on the record length (for one channel, the maximum is 1 Mpoint).
- You can not trigger the DL850E/DL850EV on math results.
- Because math is performed by a general-purpose CPU, a wide variety of expressions are available.

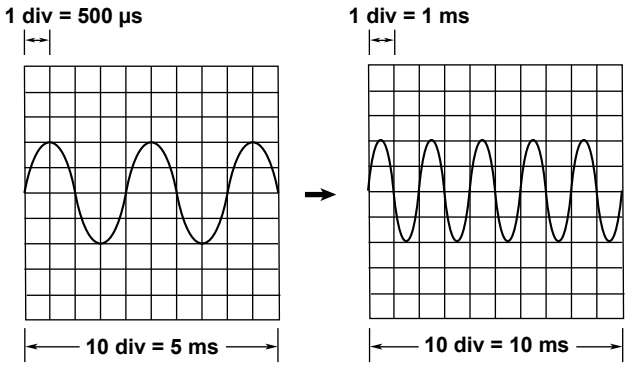


3 Horizontal Axis

Time Axis Setting (TIME/DIV)

When the internal clock is being used, the time axis scale is set as a length of time per grid division (1 div). The time axis scale can be set within the following ranges: 100 ns/div* to 30 s/div, 1 min/div to 30 min/div, 1 hour/div to 12 hour/div, and 1 day/div to 20 day/div. The transition from seconds to minutes to hours to days occurs automatically. Because the horizontal display range is 10 div, the amount of time on the waveform that is displayed is equal to the time axis setting × 10.

* If a 720210 (HS100M12) or 720211 (HS100M12) module is installed, the lowest setting is 100 ns/div. Otherwise, it is 1 µs/div.



Internal and External Clocks (Time base selection)

Under the initial settings, the DL850E/DL850EV samples the waveform data using the clock signal produced by its internal time-base circuit (internal clock).

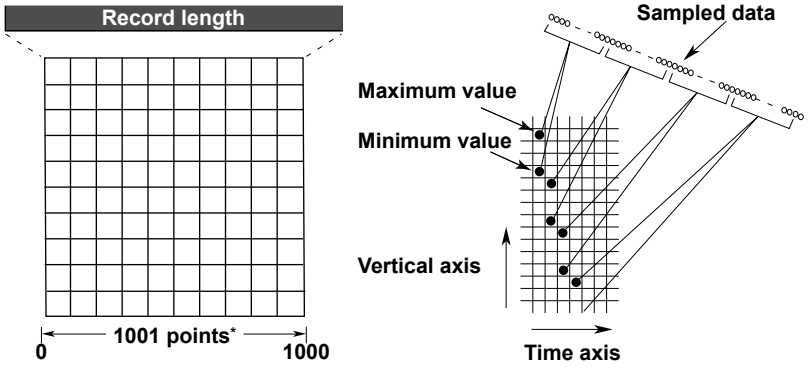
You can also use an external clock signal to control sampling. Apply the external clock signal to the external-clock input terminal on the left panel of the DL850E/DL850EV. This external clock input is useful for synchronizing to the clock signal of the waveform that is being measured.

When you control sampling using an external clock, you cannot change the time axis setting. To change the time-axis display range, change the record length or zoom in on the time axis.

▶ See here.

How the Time Axis Relates to the Display of the Waveform

There are 10 div along the time axis, and 1001 points (logical number of points, not the dots on the screen) are used to draw the waveforms. Therefore, if the display record length is exactly 1 kpoint (the number of acquired data points is 1001), the waveform is displayed using 1001 points. However, if the display record length is greater than or equal to 2 kpoint, as shown in the figure on the right, the DL850E/DL850EV draws the waveform by determining the maximum and minimum values at each fixed interval (P-P compression) and aligning them vertically at the same time position (total number of points: 2002).



*** 1001 is the logical number of points. On the screen, the data is compressed to 800 or 500 dots (1000 dots in the full-screen waveform display).**

<P-P compression display>

Zooming Horizontally and Drawing Waveforms

The DL850E/DL850EV can expand (zoom) the waveform horizontally. When the zoom factor of the waveform is increased, the number of displayed points decreases. The DL850E/DL850EV displays the waveform using P-P compressed until the number of displayed points falls to 2002, but it cannot display the waveform using continuous lines when the number of displayed points falls below 1001. When this happens, the DL850E/DL850EV interpolates the display data so that the number of displayed points is 1001.

Dot Display

Under the initial settings, display interpolation is performed automatically, but you can also disable display interpolation (set it to OFF) and display the waveform using dots. When interpolation is disabled, up to 2002 points or 100100 points (whichever is selected) of all the acquired data are displayed without P-P compression. For example, if the number of displayed points is set to 100 kpoint and the display record length is 10 kpoint (the number of acquired data points is 10010 points), the DL850E/DL850EV draws all the points of the waveform by aligning 10 points vertically at the same time axis position. If the number of acquired data points exceeds 2002 or 100100, to display the waveform, the DL850E/DL850EV reduces the amount of data to 2002 or 100100 points (whichever is selected) by removing the data between displayed points.

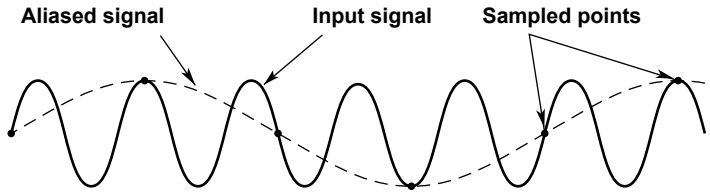
Relationship between the Time Axis Setting, Record Length, and Sample Rate

If you change the time axis setting, the sample rate and the acquisition-memory record length also change. For details, see appendix 1, “Relationship between the Time Axis Setting, Record Length, and Sample Rate” in the *Getting Started Guide*, IM DL850E-03EN.

Sample Rate

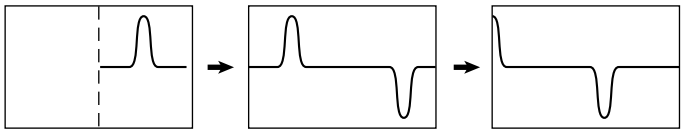
If you change the time axis setting, the sample rate also changes. The sample rate is the number of samples-per-second (S/s).

* If the sample rate is comparatively low with respect to the input signal frequency, the harmonics contained in the signal are lost. When this happens, some of the harmonics will be misread as low-frequency waves due to the effects described by the Nyquist sampling theorem. This phenomenon is called aliasing. You can avoid aliasing by acquiring waveforms with the acquisition mode set to Envelope.



Time Axis Setting and Roll Mode Display

When the trigger mode is Auto, Auto Level, Single, or On Start and the time axis setting is 100 ms/div or longer, instead of updating waveforms through triggering (update mode), the DL850E/DL850EV displays the waveforms in roll mode. In roll mode, waveforms scroll from right to left as new data is captured and the oldest values are deleted from the screen.



This allows waveforms to be observed in the same way as on a pen recorder. Roll mode is useful for observing signals with long repeating periods and signals that change slowly. It is also effective when you want to detect occasional glitches (pulse signals in the waveform).

You can use auto setup to automatically configure the appropriate settings (such as vertical axis, horizontal axis, and trigger settings) for the input signal. This feature is useful when you are not sure what type of signal will be applied to the DL850E/DL850EV. The auto setup feature will not work properly on some input signals. Also, there are some modules with which the auto setup feature cannot be used.

▶ See here.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

4 Triggering

A trigger is a cue used to display the waveform on the screen. A trigger occurs when the specified trigger condition is met, and a waveform is displayed on the screen.

Trigger Mode (MODE)

The trigger mode determines the conditions for updating the displayed waveforms. There are six trigger modes.

Auto Mode (Auto)

If the trigger conditions are met before an approximately 50 ms timeout, the DL850E/DL850EV updates the displayed waveforms on each trigger occurrence. If not, the DL850E/DL850EV automatically updates the displayed waveforms. Even when Auto mode is specified, the DL850E/DL850EV operates in Normal mode when the trigger source is set to Time and a simple trigger is used.
If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled.

Auto Level Mode (AutoLevel)

If a trigger occurs before a timeout (which is approximately 1 second), the DL850E/DL850EV updates the waveform in the same way that it does in Auto mode. If a trigger does not occur, the DL850E/DL850EV detects the center value of the trigger source amplitude, automatically changes the trigger level to the center value, triggers on that value, and updates the displayed waveform. Auto-level mode is valid only if the trigger source is an analog waveform on a channel between CH1 and CH16 (including sub channels, excluding real time math waveforms). For all other cases, Auto Level mode operates in the same way as Auto mode.
If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled.

Normal Mode (Normal)

The DL850E/DL850EV updates the waveform display only when the trigger conditions are met. If no triggers occur, the display is not updated. If you want to view waveforms that the DL850E/DL850EV cannot trigger on, or if you want to check the ground level, use Auto mode.

Single Mode (Single)

When the trigger conditions are met, the DL850E/DL850EV updates the displayed waveform once and stops waveform acquisition.
If the time axis is set to a range that causes the display to switch to roll mode, the roll mode display will be enabled. When the DL850E/DL850EV triggers, it begins recording data. When data has been acquired up to the amount specified by the set record length, the waveform display stops.

N Single Mode (SingleN)

The DL850E/DL850EV acquires waveforms each time the trigger conditions are met until a specified number of waveforms have been acquired, and then displays all the acquired waveforms. If no triggers occur, the display is not updated.

Instant Start Mode (On Start)

Regardless of the trigger settings, when you press the START key, the DL850E/DL850EV updates the displayed waveforms once and stops signal acquisition.
If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled. When data has been acquired up to the amount specified by the set record length, the waveform display stops.

- The trigger mode setting applies to all trigger types.
- When waveforms are being acquired, the trigger condition appears in the center of the bottom of the screen.

Trigger Types (Type)

The following trigger types are available.

Simple (Simple)

- Simple trigger: Simply triggers on a trigger source edge.
  In addition to using the signals (analog signals and logic signals) applied to the modules installed in the slots as trigger sources, you can also use the time, an external signal (the signal applied to the TRIG IN terminal), or the power line signal as a trigger source.

Enhanced (Enhanced)

- A -> B(N) trigger: After state condition A is met, the DL850E/DL850EV triggers when the state condition B is met N times.
- A Delay B trigger: After state condition A is met and the specified amount of time elapses, the DL850E/DL850EV triggers when the state condition B is first met.
- Edge On A trigger: While state condition A is met, the DL850E/DL850EV triggers on the OR of multiple trigger source edges.
- OR trigger: The DL850E/DL850EV triggers on the OR of multiple trigger source edges.
- AND trigger: The DL850E/DL850EV triggers on the AND of multiple trigger source conditions.
- Period trigger: The DL850E/DL850EV triggers on a specified period of occurrence of state condition B.
- Pulse Width trigger: The DL850E/DL850EV triggers after state condition B has been met for a specified duration (width).
- Wave Window trigger: The DL850E/DL850EV creates real-time templates (Wave Window) using a number of cycles directly preceding the current waveforms. The DL850E/DL850EV compares the current waveforms to the real-time templates and triggers if one of the current waveforms falls outside of its real-time template.

* A state condition is a condition that is met when the levels of specified trigger sources are High or Low relative to a specified trigger level. If you set a signal to X (Don't Care), the state of the specified signal is not used to determine whether the state condition is met.

Manual Trigger (Manual Trigger)

Regardless of the trigger settings, you can make the DL850E/DL850EV trigger by pressing the MANUAL TRIG key on the front panel.

Signal Type and Trigger Type Combinations

The signal type (analog or logic) determines what trigger types you can use.

	CH1 to CH16		
	Analog Signal (including sub channels)	Logic Signal Bit 1 to Bit 8	Mixed
Simple	Yes	Yes	–
A -> B(N)	Yes	Yes	Yes
A Delay B	Yes	Yes	Yes
Edge On A	Yes	Yes	Yes
OR	Yes	Yes	Yes
AND	Yes	Yes	Yes
Period	Yes	Yes	Yes
Pulse Width	Yes	Yes	Yes

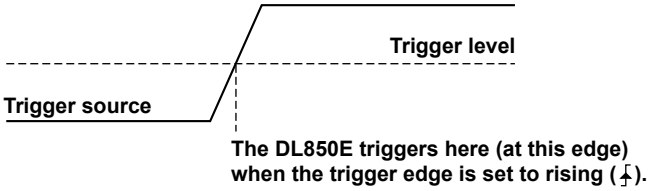
About the Wave Window Trigger ▶ See here.

Basic Trigger Settings

- Trigger source: The trigger source signal.
- Trigger slope: Specifies which edge, rising or falling, the DL850E/DL850EV will trigger on.
- Trigger level: The trigger determination level.
- Trigger hysteresis: The trigger level margin (the DL850E/DL850EV does not trigger on changes in the signal level within this margin).
- Trigger hold-off: The amount of time to wait before the next trigger detection (applies to all triggers except for the simple trigger when the trigger source is Time, the period trigger, and the manual trigger).
- Trigger position: The position where the trigger point will be displayed (applies to all trigger types).
- Trigger delay: The delay from the trigger point (applies to all trigger types).

Simple Trigger (Simple)

The DL850E/DL850EV triggers on trigger source edges (rising or falling edges). *Edge* refers to a point where the trigger source passes through the trigger level.



Trigger Source (Source)

The trigger source is the signal that is used to check for the trigger condition. You can set the source waveform to one of the waveforms below.

Analog Signal (CH1 to CH16)

Select a channel from CH1 to CH16 to use the analog signal being applied to the corresponding terminal as the trigger source.

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT[3]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.

2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. However, you cannot select a sub channel whose Input setting is set to OFF. ▶ See here.

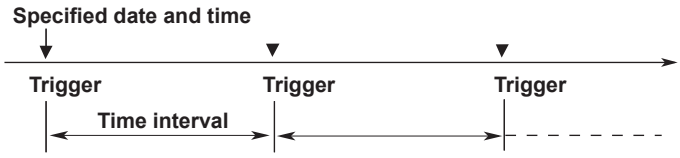
Logic Signal (Bit 1 to Bit 8)

Select a bit from 1 to 8 to use the logic signal being applied to the port of a logic input module as the trigger source. When a logic input module is installed in a slot, bits 1 to 8 appear as options below the channel that corresponds to that slot (CH1 to CH16).

Time (Time)

Select Time to use the date and time as the trigger source. The trigger occurs at the specified date and time and at specified intervals afterwards.

- Specify the year, month, day, hour, minute, and second.
- You can select one of the time intervals listed below.
  10 sec, 15 sec, 20 sec, 30 sec, 40 sec, 50 sec, 1 min, 2 min, 3 min, 4 min, 5 min, 6 min, 7 min, 8 min, 9 min, 10 min, 15 min, 20 min, 25 min, 30 min, 40 min, 45 min, 50 min, 1 hour, 2 hour, 3 hour, 4 hour, 5 hour, 6 hour, 7 hour, 8 hour, 9 hour, 10 hour, 11 hour, 12 hour, 18 hour, 24 hour



- Depending on the specified time interval, a trigger may occur while the waveform is being acquired or in the pre-trigger section (the section before the trigger that is acquired for observation). When this happens, the trigger is ignored.
- If the specified date and time fall within the pre-trigger section, a trigger occurs at the end of the pre-trigger section.
- If the specified date and time are in the past, triggers occur at the points in the present defined by the function (specified date and time) + (time interval × integer N).
- If you set the number of acquisitions, the specified number of waveforms are acquired. When the specified number of acquisitions is infinite, waveform acquisition continues until you press START/STOP.

External Signal (External)
Select External to use the signal that is received through the left-panel TRIG IN input terminal as the trigger source.

Power Line Signal (Line)
Select Line to use the power line signal received by the DL850E/DL850EV as the trigger source. The DL850E/DL850EV triggers only on the rising edge. This option enables you to observe waveforms in synchronization with the power supply frequency (50 Hz or 60 Hz).

Real Time Math Result (RMath1 to RMath16)
Select a result from RMath1 to RMath16 to use it as a trigger source.

Trigger Level (Level)

Trigger level refers to the signal level used as a reference for detecting a signal's rising and falling edges or high and low states. With simple triggers such as the edge trigger, the DL850E/DL850EV triggers when the trigger source level passes through the specified trigger level.
The range and resolutions that you can use to set the trigger level vary depending on the type of signal being measured.

When Measuring Voltage
Selectable range: ±10 div (two times the display range)
Resolution: 0.01 div. (Example: when the probe attenuation is 1:1 and the voltage scale is 2 mV/div, the resolution is 0.02 mV.)

When Measuring Temperature
Selectable range: The range of thermocouple being used
Resolution: 0.1°C or 0.1 K

When Measuring Strain
Selectable range: The range of the strain module being used
Resolution: 1 µSTR or 0.0005 mV/V

When Measuring Acceleration
Selectable range: ±10.00 div
Resolution: 0.01 unit

When Measuring Frequency (Revolutions, periods, duty ratios, power supply frequencies, pulse widths, pulse integration, velocities)
See section 6.13 in the *Getting Started Guide*, IM DL850E-03EN.

When Monitoring CAN Bus, LIN Bus or SENT Signals
When the data type (Value Type) is Unsigned or Signed
Selectable range: The settable value is determined from the bit length (Bit Count) of the relevant sub channel.
Resolution: Scaling factor (Factor)
When the data type (Value Type) is Float
Selectable range: (The span between the upper (Upper) and lower (Lower) limits of the display range) × 2
Resolution: (Span × 2)/48000

You can normally set the trigger level using the jog shuttle and arrow keys. If you press the NUM LOCK key so that it illuminates, you can also enter numbers by pressing the CH key.

Trigger Slope (Slope)

Slope refers to the movement of the signal from a low level to a high level (rising edge) or from a high level to a low level (falling edge). When a slope is used as one of the trigger conditions, it is called a trigger slope.
The following trigger slope settings are available for triggering the DL850E/DL850EV.

↗	The DL850E/DL850EV triggers when the trigger source changes from a level below the trigger level to a level above the trigger level (rising).
↘	The DL850E/DL850EV triggers when the trigger source changes from a level above the trigger level to a level below the trigger level (falling).
↗↘	The DL850E/DL850EV triggers on both rising and falling edges.

* ↗↘ can be selected only when a simple trigger is used with an analog trigger source.

Trigger Hysteresis (Hysteresis)

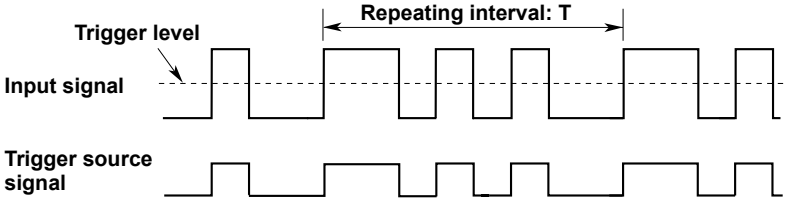
Noise rejection establishes a trigger level margin (hysteresis) so that the DL850E/DL850EV does not trigger if the signal level change is within the margin.
For each type of measured signal, you can set the hysteresis around the trigger level to one of the options listed below. You cannot set hysteresis when the trigger source is set to Time, External, Line, or a logic signal.

Voltage	Approx. ±0.1 div	Approx. ±0.5 div	Approx. ±1 div
Temperature	Approx. ±0.5°C (K)	Approx. ±1°C (K)	Approx. ±2°C (K)
Strain	Approx. ±2.5% of the range	Approx. ±12.5% of the range	Approx. ±25% of the range
Acceleration	Approx. ±0.1 div of the range	Approx. ±0.5 div of the range	Approx. ±1 div of the range
Frequency, CAN, LIN	Approx. ±0.01 div of the range	Approx. ±0.5 div of the range	Approx. ±1 div of the range

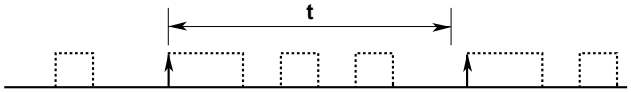
* The above values are approximate values. They are not strictly warranted.

Trigger Hold-Off (Hold Off)

The trigger hold-off feature temporarily stops the detection of the next trigger once a trigger has occurred. This feature is useful in cases when you want to change the waveform acquisition interval, such as when you are observing a PCM (pulse code modulation) code or other pulse train signal or when you are using the history feature.



Trigger signals that have been suppressed over the hold-off period t (when the trigger slope is set to rising)

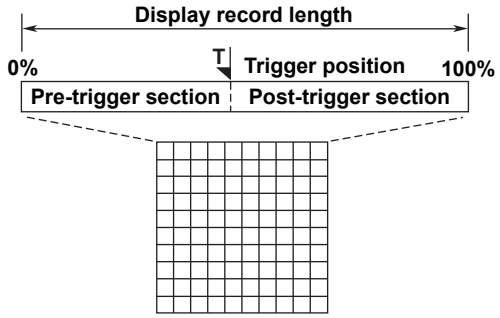


Selectable range: 0.00 µs to 10000000.00 µs (10 s). The default settings is 0.00 µs
Resolution: 0.01 µs

- To trigger with the hold-off time set to 50 ms or longer, set the trigger mode to Normal.
- For the A -> B(N) and A Delay B triggers, the hold-off time applies only to state condition B.
- The trigger hold-off time does not apply to the simple trigger when the trigger source is Time, to the period trigger, or to the manual trigger.

Trigger Position (Position)

When you move the trigger position, the ratio of the displayed data before the trigger point (the pre-trigger section) to the data after the trigger point (the post-trigger point) changes. When the trigger delay is 0 s, the trigger point and trigger positions coincide.



Selectable range: 0.0 to 100% of the display record length.
Resolution: 0.1%

- When waveform acquisition is stopped, if you change the trigger position, the setting is not applied until you start waveform acquisition and update the waveforms.
- If you change the time axis setting (using the TIME/DIV knob), the location of the trigger position does not change.

Time Reference Point

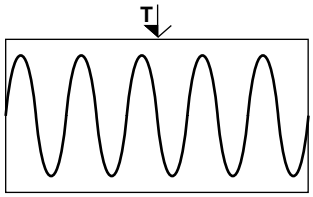
In addition to the trigger position, a time reference point is indicated. The times that appear in the lower left and right of the screen are the times from this time reference point. The cursor time-measurement values are also based on this reference point.
When waveform acquisition is stopped the displayed location of the time reference point varies as indicated below.

- **In Update Mode**

  When the displayed waveform is updated by the trigger, the time reference point is displayed as indicated below. The time reference point and the trigger point are the same.

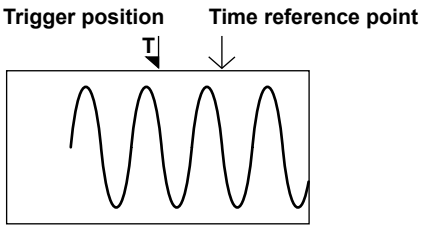
  - Under Normal Waveform Update Conditions When All Pre-Trigger and Post-Trigger Data Has Been Acquired

    The trigger position and the time reference point are displayed at the same position.



  - When Waveform Acquisition Is Stopped before All Pre-Trigger and Post-Trigger Data Has Been Acquired

    The trigger position and the time reference point are displayed separately.

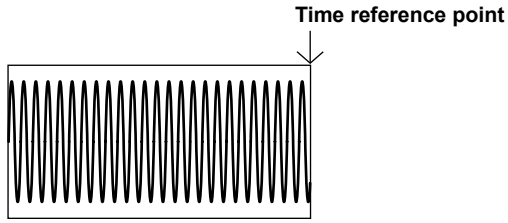


- **In Roll Mode**

  In roll mode, in which waveforms scroll from right to left, the time reference point is displayed as indicated below.

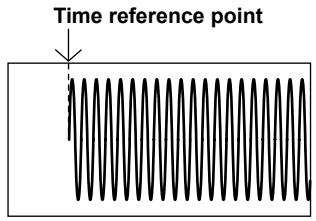
  - When the Trigger Mode Is Auto Mode or Auto Level Mode

    The point in time when waveform acquisition was stopped is the time reference point (right side of the screen).

  - When the Trigger Mode Is Instant Start Mode (On Start)

    The point in time when waveform acquisition was started is the time reference point.

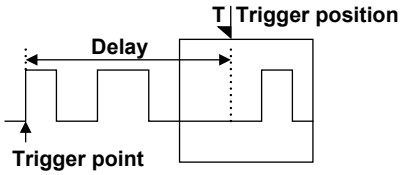
    

Trigger Delay (Delay)

The DL850E/DL850EV normally displays waveforms before and after the trigger point. You can set a trigger delay to display waveforms that the DL850E/DL850EV has acquired a specified amount of time after the trigger occurrence.

Selectable range: 0.00 µs to 10000000.00 µs (10 s). The default settings is 0.00 µs

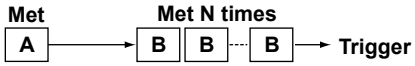
Resolution: 0.01 µs



- If you change the time axis setting (using the TIME/DIV knob) so that the unit becomes larger, because of display-digit limitations, the delay time that you set when the unit was small will not appear in the setup menu, but it is retained.
- You cannot specify a trigger delay when an external clock is being used as the time base.

A -> B(N) Trigger (Enhanced)

After state condition A is met, the DL850E/DL850EV triggers when state condition B is met N times.



Trigger Source

You can use CH1 to CH16 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when a logic input module is installed in a slot.

▶ See here.

State Conditions (A State, B State)

To set state conditions A and B, select the states of the trigger sources in relation to the trigger level.

Example

	State Condition A	State Condition B
CH1	H	H
CH2	L	L
CH3-		
Bit 1	L	H
Bit 2	H	X
……	…	…
Bit 8	X	L
CH4	X	X
……	…	…
CH16	X	H

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

State Condition Achievement Condition (A Condition, B Condition)

Select how the result of comparing the trigger source states to their specified conditions must change for a state condition to be considered met.

Enter	The result must change from not being met to being met.
Exit	The result must change from being met to not being met.

Number of Times State Condition B Must Be Met

Set the number of times that state condition B must be met.
Selectable range: 1 to 10000. The default setting is 1.

Trigger Level (Level) and Trigger Hysteresis (Hys)

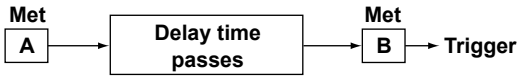
Set these items for each trigger source.
These items are the same as the trigger level ▶ See here. and hysteresis ▶ See here. of the simple trigger.

Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off ▶ See here., trigger position ▶ See here., and trigger delay ▶ See here. of the simple trigger.

A Delay B Trigger (Enhanced)

After state condition A is met and the specified amount of time elapses, the DL850E/DL850EV triggers when state condition B is first met.



Trigger Source

You can use CH1 to CH16 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when a logic input module is installed in a slot.

▶ See here.

State Conditions (A State, B State)

To set state conditions A and B, select the states of the trigger sources in relation to the trigger level.

Example

	State Condition A	State Condition B
CH1	H	H
CH2	L	L
CH3-		
Bit 1	L	H
Bit 2	H	X
……	…	…
Bit 8	X	L
CH4	X	X
……	…	…
CH16	X	H

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

State Condition Achievement Condition (A Condition, B Condition)

Select how the result of comparing the trigger source states to their specified conditions must change for a state condition to be considered met.

Enter	The result must change from not being met to being met.
Exit	The result must change from being met to not being met.

Delay Time

Set the amount of time that must pass after state condition A is met.
Selectable range: 0.0 µs to 10000000.0 µs (10 s). The default settings is 0.0 µs.
Resolution: 0.1 µs

Trigger Level (Level) and Trigger Hysteresis (Hys)

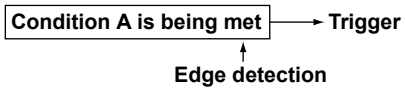
Set these items for each trigger source.
These items are the same as the trigger level ▶ See here. and hysteresis ▶ See here. of the simple trigger.

Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off ▶ See here., trigger position ▶ See here., and trigger delay ▶ See here. of the simple trigger.

Edge On A Trigger (Enhanced)

While state condition A is met, the DL850E/DL850EV triggers on the OR of multiple trigger source edges.



Trigger Source

You can use CH1 to CH16 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when a logic input module is installed in a slot.

▶ See here.

State Condition (A State)

To set state condition A, select the states of the trigger sources in relation to the trigger level.

Example

	State Condition A
CH1	H
CH2	L
CH3-	
Bit 1	L
Bit 2	H
……	…
Bit 8	X
CH4	X
……	…
CH16	X

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

State Condition Achievement Condition (Condition)

Select whether the result of comparing the trigger source states to their specified conditions must be true or false for the state condition to be considered met.

True	The result must be true.
False	The result must be false.

Edge Detection Condition (Edge)

Set the condition for detecting the trigger source edge.

⤴	An edge is detected when the trigger source changes from a level below the trigger level to a level above the trigger level (rising).
⤵	An edge is detected when the trigger source changes from a level above the trigger level to a level below the trigger level (falling).
–	The signal is not used as a trigger condition.

Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

These items are the same as the trigger level ▶ See here. and hysteresis ▶ See here. of the simple trigger.

Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off ▶ See here., trigger position ▶ See here., and trigger delay ▶ See here. of the simple trigger.

OR Trigger (Enhanced)

The DL850E/DL850EV triggers on the OR of multiple trigger source edges.

Trigger Source

You can use CH1 to CH16, Ext*, and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when a logic input module is installed in a slot. Select External to use the signal that is received through the left-panel TRIG IN input terminal as the trigger source.

* The signal that is received through the left-panel TRIG IN input terminal as the trigger source.

▶ See here.

Edge Detection Condition (Edge)

Set the conditions for detecting each trigger source edge.

⤴	An edge is detected when the trigger source changes from a level below the trigger level to a level above the trigger level (rising).
⤵	An edge is detected when the trigger source changes from a level above the trigger level to a level below the trigger level (falling).
IN	An edge is detected when the trigger source enters the specified level range.
OUT	An edge is detected when the trigger source leaves the specified level range.
−	The signal is not used as a trigger condition.

* IN and OUT are selectable only when the trigger source is an analog signal (CH1 to CH16).

Trigger Level (Level)

Set these items for each trigger source.

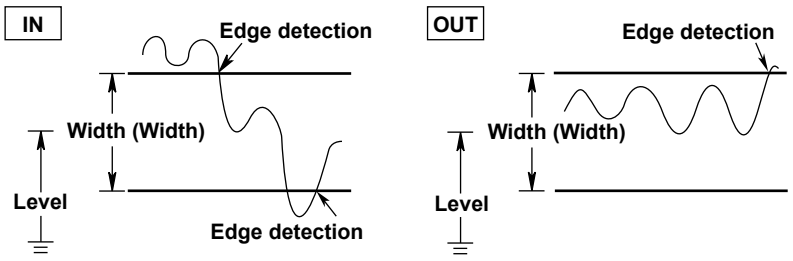
When the Edge Detection Condition Is ⤴ or ⤵

Set the level used to detect the trigger source's rising or falling edge.

▶ See here.

When the Edge Detection Condition Is IN or OUT

An edge is detected when the trigger source enters (IN) or leaves (OUT) the specified level range. You can specify the level range settings for each analog signal trigger source.



Setting	Selectable Range	Resolution
Level (center value) Width (Width)	Same as the trigger level	

Trigger Hysteresis (Hys)

Set this item for each trigger source.

This item is the same as the hysteresis ▶ See here. of the simple trigger.

Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off ▶ See here., trigger position ▶ See here., and trigger delay ▶ See here. of the simple trigger.

AND Trigger (Enhanced)

The DL850E/DL850EV triggers on the AND of multiple trigger source conditions. The DL850E/DL850EV triggers when all the specified conditions are met at a single point.

Trigger Source

You can use CH1 to CH16 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when a logic input module is installed in a slot.

▶ See here.

Achievement Condition (Condition)

Set the achievement condition for each trigger source.

H	The signal level must be high.
L	The signal level must be low.
IN	The signal must be within the specified level range.
OUT	The signal must be outside of the specified level range.
–	The signal is not used as a trigger condition.

* IN and OUT are selectable only when the trigger source is an analog signal (CH1 to CH16).

Trigger Level (Level)

Set this item for each trigger source.

When the Achievement Condition Is H or L

Set the level for determining whether the trigger sources are high or low.

▶ See here.

When the Achievement Condition Is IN or OUT

An edge is detected when the trigger source enters (IN) or leaves (OUT) the specified level range. You can specify the level range settings for each analog signal trigger source.

▶ See here.

Trigger Hysteresis (Hys)

Set this item for each trigger source.

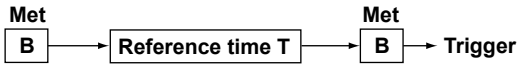
This item is the same as the hysteresis ▶ See here. of the simple trigger.

Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off ▶ See here., trigger position ▶ See here., and trigger delay ▶ See here. of the simple trigger.

Period Trigger (Enhanced)

The DL850E/DL850EV triggers on a specified period of occurrence of state condition B. The DL850E/DL850EV triggers when state condition B occurs again.



Trigger Source

You can use CH1 to CH16 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when a logic input module is installed in a slot.

▶ See here.

State Condition (B State)

To set state condition B, select the states of the trigger sources in relation to the trigger level.

Example

	State Condition B
CH1	H
CH2	L
CH3-	
Bit 1	L
Bit 2	H
……	…
Bit 8	X
CH4	X
……	…
CH16	X

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

Determination Mode (Mode)

Set what kind of relationship must be established between period T and the specified reference times (Time or T1 and T2) for the DL850E/DL850EV to trigger.

T < Time	Period T must be shorter than the reference time (Time).
T > Time	Period T must be longer than the reference time (Time).
T1 < T < T2	Period T must longer than reference time T1 and shorter than reference time T2.
T < T1, T2 <T	Period T must be shorter than reference time T1 or longer than reference time T2.

Reference Times (Time, T1, T2)

You can set the reference times (Time, T1, and T2) within the following ranges.

Setting	Selectable Range	Default	Resolution
Time	0.02 µs to 10000000.00 µs (10 s)	0.02 µs	0.01 µs
T1	0.02 µs to 9999999.99 µs	0.02 µs	
T2	0.03 µs to 10000000.00 µs (10 s)	0.03 µs	

Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

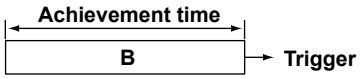
These items are the same as the trigger level ▶ See here. and hysteresis ▶ See here. of the simple trigger.

Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off ▶ See here., trigger position ▶ See here., and trigger delay ▶ See here. of the simple trigger.

Pulse Width Trigger (Enhanced)

The DL850E/DL850EV triggers according to a specified duration (achievement time) for which state condition B has been met. The timing of the triggering varies depending on the determination mode.



Trigger Source

You can use CH1 to CH16 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when a logic input module is installed in a slot.

▶ See here.

State Condition (B State)

To set state condition B, select the states of the trigger sources in relation to the trigger level.

Example

	State Condition B
CH1	H
CH2	L
CH3-	
Bit 1	L
Bit 2	H
……	…
Bit 8	X
CH4	X
……	…
CH16	X

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

Determination Mode (Mode)

Set what kind of relationship must be established between the state condition B achievement time and the specified reference times (Time or T1 and T2) for the DL850E/DL850EV to trigger.

B < Time	The DL850E/DL850EV triggers when the achievement time is shorter than the reference time (Time), and the state condition changes to not met.
B > Time	The DL850E/DL850EV triggers when the achievement time is longer than the reference time (Time), and the state condition changes to not met.
B TimeOut	The DL850E/DL850EV triggers when the achievement time is longer than the reference time (Time).
B Between	The DL850E/DL850EV triggers when the achievement time is longer than reference time T1 and shorter than reference time T2, and the state condition changes to not met.

Reference Times (Time, T1, T2)

You can set the reference times (Time, T1, and T2) within the following ranges.

Setting	Selectable Range	Default	Resolution
Time	0.02 µs to 10000000.00 µs (10 s)	0.02 µs 0.01 µs for B TimeOut	0.01 µs
T1	0.01 µs to 9999999.99 µs	0.01 µs	
T2	0.02 µs to 10000000.00 µs (10 s)	0.02 µs	

Triggering may not function properly when the interval between achievement times is less than 0.01 µs or when the duration of the achievement time is less than 0.01 µs (Typical).

Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

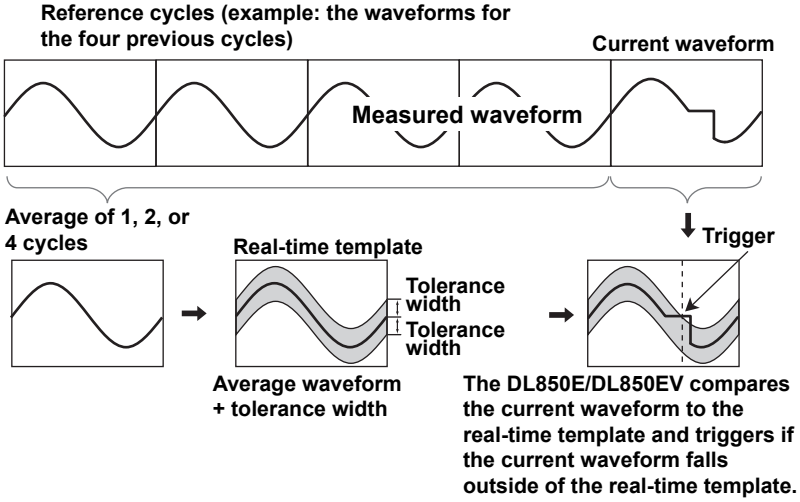
These items are the same as the trigger level ▶ See here. and hysteresis ▶ See here. of the simple trigger.

Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off ▶ See here., trigger position ▶ See here., and trigger delay ▶ See here. of the simple trigger.

Wave Window Trigger (Enhanced)

The DL850E/DL850EV creates real-time templates (Wave Window) using a number of cycles directly preceding the current waveforms. The DL850E/DL850EV compares the current waveforms to the real-time templates and triggers if one of the current waveforms falls outside of its real-time template.



Trigger Source

You can select the trigger sources from CH1 to CH16. The modules that you can use as sources for the Wave Window trigger are listed below. You cannot use other modules or temperature-measurement channels as sources.

701250 (HS10M12)	720250 (HS10M12)
701251 (HS1M16)	701255 (NONISO_10M12)
701267 (HV (with RMS))	720268 (HV (AAF, RMS))
701261 (UNIVERSAL) (only voltage measurement)	701262 (UNIVERSAL (AAF)) (only voltage measurement)
701270 (STRAIN_NDIS)	701271 (STRAIN_DSUB)
701275 (ACCL/VOLT)	720210 (HS100M12)
720211 (HS100M12)	720254 (4CH 1M16) sub channel

Template Channels (Condition)

Select which trigger sources to use to make real-time templates. The DL850E/DL850EV triggers if the condition of even one of the channels is met.

ON	Use
OFF	Don't use

Tolerance Width (Width)

To create a real-time template for a channel, set the distance from the averaged waveform (of 1, 2, or 4 cycles before the current waveform) that will be tolerated. The range within which you can set the distance varies depending on the type of signal being measured.

Signal Type	Selectable Range	Default	Resolution
Voltage	0.01 × the voltage scale to 10 × the voltage scale	0.01 div	Same as the trigger level resolution ▶ See here.
Strain	1 μSTR to (measurement range) × 2 or 0.0005 mV/V to (measurement range) × 2	1 μSTR 0.0005 mV/V	
Acceleration	0.01 Unit to (Unit/div) × 10	10 mUnit	

For example, when Width is set to 2 V, the tolerance width is ±2 V around the averaged waveform.

Cycle Frequency (Cycle Frequency)

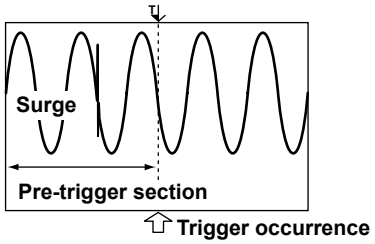
Set the trigger source frequency. If the actually frequency is within ±10% of the specified value, it is automatically tracked.
Selectable range: 40 to 1000 Hz. The default setting is 50 Hz.
Resolution: 1 Hz

Reference Cycles (Reference Cycle)

Select how many waveforms before the current waveform are used to create the real-time templates. When the sample rate is 500 kS/s and the number of channels used to make real-time templates is 9 or more, you can set only the number of cycles to 2. Even if you select 4 cycles, only two are used.

1	One previous waveform is used.
2	Two previous waveforms are used.
4	Four previous waveforms are used.

If a surge or other abnormal waveform occurs in the reference cycle, the abnormal waveform will be included in the averaged waveform, so the DL850E/DL850EV will trigger on the next normal waveform. This may make it appear is if the trigger has been delayed by a few cycles.



When you use the wave window trigger, we recommend that you set a pre-trigger length that is longer than the reference cycle so that you can observe waveform abnormalities that occur in the reference cycle.

Sync Channel (Sync. Ch)

Select the channel used to detect the points at which waveform comparison for the wave window trigger starts and stops. Select the synchronization channel by selecting Auto or a channel from CH1 to CH16 that has a module that the wave window trigger can be used with.

Auto

Of the modules that the wave window trigger can be used with, the module with the smallest number is automatically selected.
Level for detecting the start and end points: The center of the amplitude of the sync-channel signal measured for 0.5 seconds after the start of waveform acquisition.
Detection hysteresis: Same as the edge trigger hysteresis ▶ See here.

CH1 to CH16

Select a channel whose module can be used with the wave window trigger. If triggering does not function properly when you select Auto, you can specify an appropriate channel.
For the selected channel, you need to set the level for detecting the start and end points and set the detection hysteresis.

Level for Detecting the Start and End Points (Level) and Detection Hysteresis (Hysteresis)

If you set the sync channel to a channel from CH1 to CH16, you need to set the level for detecting the start and end points and set the detection hysteresis. These items are the same as the trigger level ▶ See here. and hysteresis ▶ See here. of the simple trigger.

Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off ▶ See here., trigger position ▶ See here., and trigger delay ▶ See here. of the simple trigger.

Operating Conditions of the Wave Window Trigger

You can use the wave window trigger with the following waveforms and settings. You cannot use the wave window trigger when the record length is 25 kpoint or less and the time axis setting is shorter than 10 ms/div.

Waveforms	AC waveforms and triangular waveforms between 40 kHz and 1 kHz. (The trigger cannot be used with rectangular waveforms, such as inverter waveforms, or waveforms with fast rising edges.)
Sample rate	10 kS/s to 500 kS/s
Acquisition mode	Normal
Trigger mode	Normal, Single, Single(N) When the trigger mode is Auto or Auto Level, it is difficult for the wave window trigger to occur.
Dual capture feature	OFF

5 Waveform Acquisition

Based on the data that has been stored in the acquisition memory, the DL850E/DL850EV performs various operations, such as displaying waveforms on the screen, computing, measuring cursors, and automatically measuring waveform parameters.
This chapter explains how to set the number of data points to store in the acquisition memory (the record length), how to enable or disable the sample data averaging feature, and so on.

Record Length (Record Length)

Record length refers to the number of data points that are stored to the acquisition memory for each channel. *Display record length* refers to the data points from the data stored in the acquisition memory that are displayed on the screen. Normally, the acquisition-memory record length and display record length are the same, but the time axis setting may cause them to differ. When you change the time axis setting, the sample rate and record length also change.
On the standard model of the DL850E/DL850EV, you can set the record length to a value between 1 kpoint and 250 Mpoint. On models with the /M2 option, you can set the length to up to 2 Gpoint. On models with the /HD0 option or /HD1 option and the /M2 option, when you enable hard disk recording, you can set the record length to up to 50 Gpoint. For details about the record lengths that can be set, see appendix 2 in the *Getting Started Guide*, IM DL850E-03EN.
Use a long time axis setting when you want to observe a phenomenon over a long period of time. When you want to observe a phenomenon at a high time resolution, set a long record length, and raise the sample rate. When the record length is long, computation and measurement processing take longer than when the record length is short.
The amounts of time for which you can record data to the acquisition memory when the record length is 2 Gpoint are listed below.

Sample Rate	In Seconds	In Minutes	In Hours	In Days
100 MS/s	20	0.33	0.0056	0.00023
10 MS/s	200	3.33	0.056	0.0023
1 MS/s	1800	30	0.50	0.021
100 kS/s	18000	300	5.0	0.21
10 kS/s	180000	3000	50	2.1
1 kS/s	1728000	28800	480	20
500 S/s	2593000	43217	720	30

The following limitations on waveform acquisition conditions and the number of waveforms that can be stored in the acquisition memory (the number of history waveforms) apply depending on the set record length.
▶ See here.

Notes about Setting the Record Length

- Increasing the record length automatically limits the number of channels that can be used. When some channels are unavailable, the number of channels that can be used appears in the record length setup menu.
- When the acquisition mode is set to Average, the maximum record length is 5 Mpoint on standard models, 10 Mpoint on models with the /M1 option, and 25 Mpoint on models with the /M2 option.
- When the dual capture feature is being used, the maximum record length is 100 Mpoint on standard models, 500 Mpoint on models with the /M1 option, and 1 Gpoint on models with the /M2 option.
- The maximum record length during hard disk recording is 50 Gpoint (one channel).
- When the trigger mode is Auto, Auto Level, Normal, or N Single and the display is not in roll mode, you can select only a record length that is less than 5 Mpoint on standard models, 10 Mpoint on models with the /M1 option, or 25 Mpoint on models with the /M2 option.
- On the DL850E/DL850EV, record lengths are expressed in units of points. There are some products, such as the DL750, for which record lengths are expressed in units of words.

Acquisition Mode (Acquisition Mode)

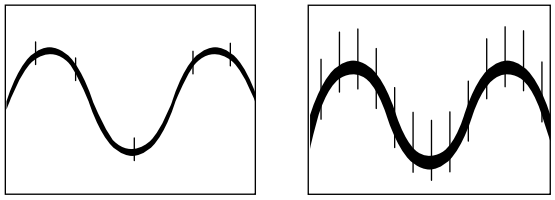
You can set the acquisition mode to one of the options below.

Normal Mode (Normal)

Displays waveforms without processing the sampled data.

Envelope Mode (Envelope)

The DL850E/DL850EV determines the maximum and minimum values among the data sampled at the maximum sample rate for each module at a time interval that is twice the sampling period (the inverse of the sample rate) of Normal mode, saves the values as pairs in the acquisition memory, and uses the saved value pairs to display the waveforms. This mode is effective when you want to avoid aliasing, because the sample rate is essentially kept high regardless of the time axis setting. It is also effective when you want to detect glitches (narrow pulse signals) or when you want to display the envelope of a modulated signal.

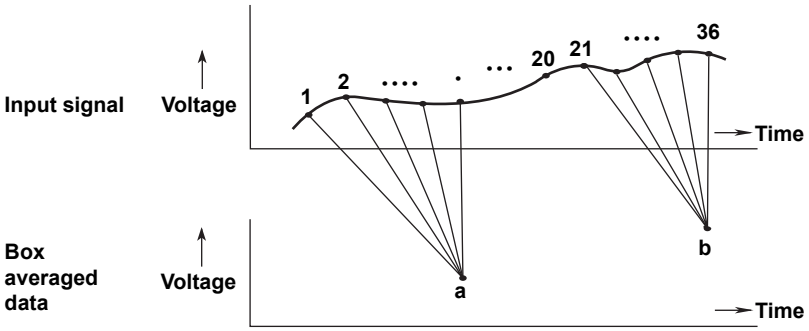


Normal mode　　Envelope mode

When the dual capture feature is used, captured waveforms cannot be displayed as envelope waveforms.

Box Average Mode (BoxAverage)

This mode can be used with the 701250 (HS10M12), 720250 (HS10M12), 701255 (NONISO_10M12), and 720210 (HS100M12). The DL850E/DL850EV determines the moving averages of the data sampled at the maximum sample rate, saves them to the acquisition memory, and uses them to display waveforms. This mode is useful for removing small levels of noise from the input signal. It is also useful for removing the noise from a single-shot signal.



The number of data points that are averaged varies as indicated below depending on the sample rate.

Sample Rate (S/s)	Number of Data Points
100 M*	1 point
50 M	2 points
20 M	4 points out of 5
10 M	8 points out of 10
5 M	16 points out of 20
2 M	32 points out of 50
1 M	64 points out of 100
500 k	128 points out of 200
200 k	256 points out of 500
100 k or less	256 points out of the number of points equivalent to (100 M ÷ sample rate)

* The same as Normal mode

Averaging Mode (Average)

The DL850E/DL850EV acquires waveforms multiple times, averages the same time points relative to the trigger point, saves them in the acquisition memory, and uses them to display averaged waveforms. Averaging mode is useful when you want to remove random noise from waveforms.

The averaging method varies depending on the acquisition count.

When Acquisition Count Is Set to Infinity

Exponential average

$$An = \frac{1}{N}\{(N - 1)An - 1 + Xn\}$$

An: n^{th} averaged value
Xn: n^{th} measured value
N: Attenuation constant (2 to 256 in 2^n steps)

When Acquisition Count Is Set to a Value between 2 and 65536 (in 2^n steps)

Linear average

$$AN = \frac{\sum_{n=1}^{N} Xn}{N}$$

Xn: n^{th} measured value
N: Average count = acquisition count

- When waveforms are acquired in averaging mode, they are saved to the acquisition memory as a single record. This means that the history feature cannot be used.
- You cannot select averaging mode when:
  - The display is in roll mode.
  - The trigger mode is Single, N Single, or On Start.
  - The dual capture feature is being used.
  - Data is being recorded to a hard disk.
- To average waveforms that have been acquired in N Single mode, set the acquisition mode to Normal, and set the history feature's display mode to Averaging.
- Waveforms of logic, CAN bus monitor, LIN bus monitor, or SENT monitor modules cannot be averaged.

Acquisition Count (Acquisition Count)

The ranges within which you can set the waveform acquisition count are indicated below. If you select Infinite, the DL850E/DL850EV continues waveform acquisition until you stop it using the START/STOP key. The default setting is Infinite. Changes to the number of acquisitions are not applied during waveform acquisition. They are applied after acquisition stops.

- When the acquisition mode is set to Normal, Envelope, or BoxAverage.
  1 to 65536 (in steps of 1) or Infinite
- When the acquisition mode is set to Average.
  2 to 65536 (in 2^n steps) or Infinite

- The number of waveforms that have been stored to the acquisition memory appears in the lower left of the screen.
- If the trigger mode is set to Single or On Start, you can set the acquisition count only when the action mode is on. ▶ See here.
- When the destination that data is saved to when an action is performed is set to OFF ▶ See here., the maximum value that the acquisition count can be set to is 1000.

Trigger Mode (Trigger Mode)

▶ See here.

Hard Disk Recording (HD RecordCondition; optional)

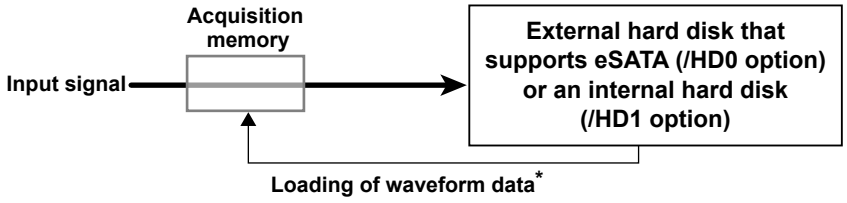
When measurement starts, you can record data an external hard disk that supports eSATA (external Serial ATA; /HD0 option) or to an internal hard disk (/HD1 option).* The recorded data is saved to files automatically. You can load the data that has been saved.

* Models with the /HD0 option are equipped with eSATA connectors. You need to purchase a hard disk that supports eSATA separately. Note that hard disks that can be used are those whose disk partition is in MBR format and whose format is FAT32. For information about supported hard disks, contact your nearest YOKOGAWA dealer. A single DL850E/DL850EV cannot be equipped with both the /HD0 and /HD1 option.

- The DL850E/DL850EV stops acquiring waveforms after it has acquired the amount of data that corresponds to the set record length. The maximum record length is 200 days.
- When you enable hard disk recording, the trigger mode is automatically set to On Start.
- Hard disk recording is possible for the numbers of channels, sample rates, set record lengths, and time axis settings listed below.

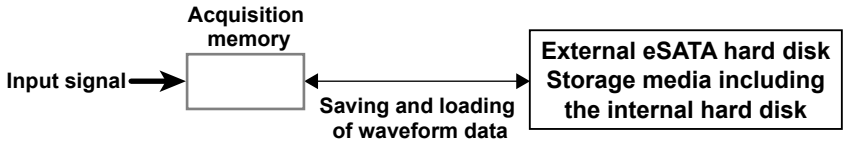
Number of Channels	Maximum Sample Rate	Set Record Length	Time Axis Setting
1	1 MS/s	1 Mpoint or more	1 s/div or more (the roll mode display area)
3	500 kS/s		
8	200 kS/s		
16	100 kS/s		

Hard disk recording



*: Loaded waveform data cannot be saved.

Normal measurement



Recorded Data File (HD Recording Setup)

You can save data to a specific file name on a hard disk and add comments to it.

In hard disk recording, a folder for the current date is created on the specified drive, and the recorded-data files are saved to that folder.

- **File Name (File Name) and Comment (Comment)**

  You can set file names and comments. You can also use the auto naming feature to automatically assign file names.

  ▶ See here.

- **File Division (Data File Divide)**

  You can specify the number of files that the recorded data is divided into. You can use this feature to avoid creating large files that take time to process. You can specify the number of divisions, but the actual number of files that will actually be saved is a number close to the specified number.

- Before you turn on the DL850E/DL850EV, connect the external hard disk to the DL850E/DL850EV, and turn on the external hard disk. If you connect a hard disk or turn it on after you turn on the DL850E/DL850EV, the hard disk will not be detected. Also, when the external hard disk is on, do not disconnect its cable.
- Hard disk recording cannot be performed when the record length is less than 1 Mpoint.
- Hard disk recording cannot be performed when the action mode is on.
- When you enable hard disk recording, the trigger mode is automatically set to On Start.
- When hard disk recording is enabled, you cannot use an external clock as the time base.
- During hard disk recording, only starting and stopping of hard disk recording, the zoom display settings, and the protect feature are valid.
- The upper limit of the time axis zoom factor during hard disk recording is the maximum zoom factor that can be displayed during hard disk recording.
- During hard disk recording, you cannot display history waveforms, loaded waveforms, or computed waveforms.
- You can perform the following operations on data that has been recorded to a hard disk. You cannot use the history feature.
  Cursor measurement, automated measurement of waveform parameters (up to 100 Mpoint), waveform zooming, computation and printing
- During hard disk recording, the DL850E/DL850EV may respond more slowly to operations.
- The maximum number of files that can be saved to a single folder is 1000.
- Do not store more than 512 files in the root directory of the internal hard disk. Doing so will slow the file access operations to all files. In addition, we cannot guarantee the operation of the hard disk recording feature when the DL850E/DL850EV is in this state.
- Do not connect USB storage media to the DL850E/DL850EV during hard disk recording or when you will start hard disk recording.
- If data recorded on the hard disk is loaded into the DL850E/DL850EV, it cannot be saved again.

Time Base (Time Base)

Under the initial settings, the DL850E/DL850EV samples the measured signals using the clock signal produced by its internal time-base circuit (internal clock). You can also use an external clock signal to control sampling. One data sample is stored to the acquisition memory at every pulse in the external clock signal. The external clock input is useful when you want to monitor the waveform using a clock signal that is in sync with the signal being measured.

Apply the external clock signal to the external-clock input terminal (EXT CLK IN) on the left panel. For the specifications of the external-clock input terminal, see the *Getting Started Guide*, IM DL850E-03EN.

Int	The internal clock signal is used as the time base (the TIME/DIV time axis setting is valid).
Ext	An external clock signal is used as the time base (the TIME/DIV time axis setting is invalid).

Pulses per Rotation (Pulse/Rotate)

When the time base is an external clock, you can specify how many pulses of the external clock signal (how many sampled data acquisitions) correspond to one mechanical rotation (or period). For example, if you set Pulse/Rotate to 100 pulses, when the record length is 1 kpoint, 10 rotations worth of sampled data will be acquired. When Pulse/Rotate is set to 1 pulse, each point of sampled data corresponds to a single rotation. The Pulse/Rotate setting only affects the horizontal-cursor measurement values and how the time axis is displayed on the screen. For example, if you set Pulse/Rotate to 100 pulses, when the record length is 1 kpoint, 1 div will correspond to 1 rotation. With these settings, if you move the cursor by 1 div, the measured horizontal value will increase or decrease by 1.

Selectable range for pulses: 1 to 24000

Notes about Sampling Using an External Clock Signal

- You cannot acquire waveforms when the acquisition mode is set to Envelope or BoxAverage.
- You cannot display waveforms in roll mode.
- There is no function for dividing the frequency of the clock signal.
- The time axis cannot be changed. To change the time-axis display range, change the record length, or zoom in on the time axis.
- The measured time values in cursor measurements and automated measurements of waveform parameters indicate the number of clock signal pulses. For these measurements, units are not displayed.
- Hard disk recording cannot be used.
- The dual capture feature cannot be used.
- The trigger settings listed below are invalid.
  Hold-off, trigger delay, period trigger, pulse width trigger

Maximum Sample Rates for Each Module

If you set the sample rate of the DL850E/DL850EV to a rate that is higher than a module's maximum sample rate, because the data is updated at the module's maximum sample rate, all the data within the module's data update interval will be the same. The maximum sample rates for each module are listed below.

Module		Maximum Sample Rate	
		Internal Clock	External Clock
701250/720250/701255		10 MS/s	9.5 MS/s
701251		1 MS/s	1 MS/s
701267/701270/701271/701275		100 kS/s	100 kS/s
720268		1 MS/s	1 MS/s
701261/701262	(when measuring voltage)	100 kS/s	100 kS/s
	(when measuring temperature)	500 S/s	500 S/s
701281/720281		1 MS/s	1 MS/s
701265		500 S/s	500 S/s
720266		125 kS/s	125 kS/s
720210/720211		100 MS/s	9.5 MS/s
720220		200 kS/s	200 kS/s
720221		0.1 S/s	0.1 S/s
720230		10 MS/s	9.5 MS/s
720240/720241/720242/720243		100 kS/s	100 kS/s
720254		1 MS/s	1 MS/s

Notes about Using the 16-CH Voltage Input Module (720220)

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

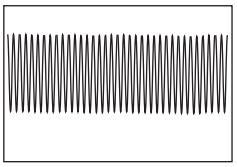
▶ See here.

Dual Capture (DUAL CAPTURE)

You can use dual capturing to simultaneously acquire waveform data (main waveform) in low-speed roll mode and at a high sample rate (captured waveform). Dual capturing is useful during low-speed sampling when you are observing waveforms over a long period of time and want to capture fast phenomena at a high sample rate.

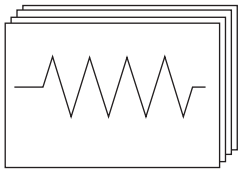
- When the waveform data is saved, captured waveforms are saved along with the main waveforms. When you load the main waveforms, the captured waveforms are also loaded.
- When the window for displaying captured waveforms (the dual capture window) is displayed, cursor measurement, automated measurement of waveform parameters, and statistical processing can be performed on the captured waveforms. Measured captured-waveform values are displayed in italics. When captured waveforms are not displayed, the measurement and processing are performed on the main waveforms. When the waveforms that are measured and processed change, the measured values are reset.

Main waveforms
(low-speed sampling)
Roll mode display (up to 1 Gpoint)

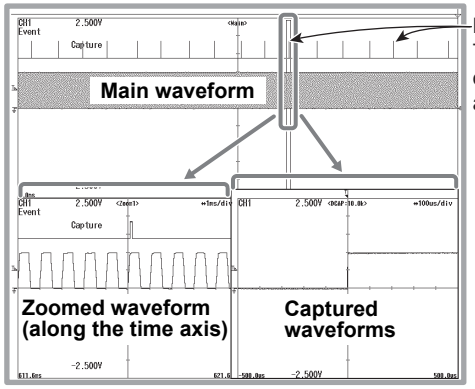


Sample rate:
100 kS/s or less

Captured waveforms
(high-speed sampling)
Update mode display



Sample rate:
Faster than that of the main waveform



Events
The points where triggering occurred during dual capturing are displayed as events.

Because there is not enough sampled data, the shape of the waveform may not be displayed correctly.

Because the data is sampled at a high speed, the correct shape of the waveform is displayed.

Channels That Dual Capturing Is Performed On

Normally, dual capturing is performed on all the channels detected by the DL850E/DL850EV. However, under the following conditions, dual capturing is performed only on channels whose displays are turned on.

- When hard disk recording is enabled
- When an increase in the record length of the main waveforms places a limitation on the number of channels that can be used

In both cases, dual capturing is not performed on 16-CH voltage input module and 16-CH temperature/voltage input module sub channels whose input coupling is set to OFF.

Turning Dual Capturing On and Off (Mode)

Set whether to enable or disable dual capturing.

- ON: Dual capturing is enabled.
- OFF: Dual capturing is disabled.

Main Waveform Acquisition Settings

- Time axis setting: A value from 100 ms/div to 20 days/div
  ▶ See here.
- Main waveform sample rate: 100 kS/s or slower
  ▶ See here.
- Acquisition mode: Normal, Envelope, or BoxAverage
  ▶ See here.

Captured-Waveform Acquisition Settings (Capture Setup)

- Time axis setting (Time/div): A value from 1 µs/div to 500 ms/div (in 1-2-5 steps, when the 100M module is not installed), 100 ns to 500 ms/div (in 1-2-5 steps, when the 100M module is installed), or 1 sec/div to 1 min/div
- Capture length (Capture Length): 5 kpoint, 10 kpoint, 25 kpoint, 50 kpoint, 100 kpoint, 250 kpoint, or 500 kpoint
- Capture mode (Capture Mode): Auto or On Start

Auto (Auto)	The DL850E/DL850EV continues waveform acquisition until you stop it using the START/STOP key.
Instant start (On Start)	After the amount of data that corresponds to the set record length or 10 div worth of data is acquired, waveform acquisition stops.

- Main-waveform sample rate < captured-waveform sample rate
  The sample rates must be set so that the sample rate of the captured waveforms is faster than the sample rate of the main waveforms.

Trigger Condition

When dual capturing is enabled, the trigger conditions apply to the captured waveforms. When the trigger conditions are met, the DL850E/DL850EV triggers and acquires the captured waveforms.

Action (Action Setup)

You can make the DL850E/DL850EV perform a specified action when it triggers and acquires captured waveforms. The time when an action starts varies depending on the selected action as follows:

Saving of waveform data (Save Waveform): Starts when a measurement is stopped

Other actions: Starts each time a waveform is captured

▶ See here.

Notes on resaving data

If captured data saved using dual capture is loaded into the DL850E/DL820EV, the data can be resaved. However, captured data obtained in auto (Auto) mode with data existing in an area in which 10 divisions of main waveform data cannot be retained cannot be resaved if it is loaded.

Captured-Waveform Display Number (Select Number)

You can select the number of a captured waveform and display it. The trigger time of the selected waveform appears to the lower left of the waveform display area.

When Capture Mode Is Set to Auto

The numbers that you can select vary as indicated below. You can select and display the numbers when waveform acquisition is stopped.

Current, −1, −2, ...

Current: the most recent waveform, −1: one waveform before the most recent waveform, −2: two waveforms before the most recent waveform, ...

When Capture Mode Is Set to On Start

The numbers that you can select vary as indicated below. You can select and display the numbers even during waveform acquisition.

Current, 1, 2, ...

Current: the most recent waveform, 1: the oldest waveform, 2: the second oldest waveform, ...

Displaying a List of Captured Waveforms (List)

When waveform acquisition is stopped, you can display a list of captured-waveform numbers and trigger times. You can select a waveform that you want to display from the list and display it.

Zooming Captured Waveforms (Mag, Position)

Zooms the displayed captured waveforms.

Zoom Factor (Mag)

You can set the zoom factor to a value between the time axis setting at the time when the captured waveform was acquired to the minimum captured-waveform time-axis setting of 1 µs/div.

Position (Position)

The captured waveform is zoomed around the position that you set here.

Turning the Display of the Capture Window On and Off (Window ON and OFF)

You can set whether to display the dual capture window. When the dual capture window is displayed, cursor measurement, automated measurement of waveform parameters, and statistical processing are performed on the captured waveforms. When the dual capture window is not displayed, measurement and processing are performed on the main waveforms.

- ON: The dual capture window is displayed.
- OFF: The dual capture window is not displayed.

Display Ratio of the Main Window (Main Ratio)

▶ See here.

Window Layout (Window Layout)

Set the display position of the dual capture window.

- Side: Horizontal
- Vertical: Vertical

Format (Format)

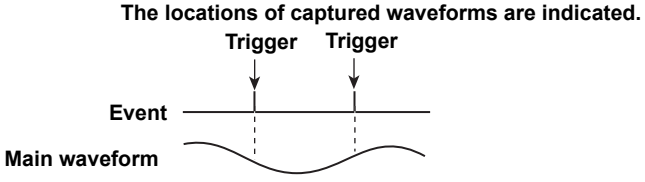
Select the display format of the dual capture window from the following options. If you select a value, the dual capture window is divided equally to display waveforms.

Main (Main): Same as the display format of the main window of each display group.

1, 2, 3, 4, 5, 6, 8, 12, 16: The dual capture window is broken up into the specified number of divisions.

Event Display (Event Display)

You can display the points where triggering occurred during dual capturing as events. When the waveform data is saved, the event data is saved along with the main waveforms. When you load the main waveforms, the events are also loaded.



Waveforms That Are Captured (Allocation)

The waveforms of the channels whose check boxes are selected in the allocation window and whose displays are turned on are displayed.

- When the main waveform acquisition mode is Average, dual capturing cannot be executed.
- Dual capturing action cannot be executed during hard disk recording.
- During dual capturing, the DL850E/DL850EV may respond more slowly to operations.
- Use the internal clock as the time base when you perform dual capturing. You cannot perform dual capturing when an external clock is being used.
- When you perform dual capturing, all the previous waveform data is deleted.
- Dual capturing cannot be performed on X-Y waveforms.
- The accumulate function cannot be used.
- Computation cannot be performed on captured waveforms.
- When the automated measurement of waveform parameters is enabled, the time it takes for the DL850E/DL850EV to enter the trigger-ready state may become longer after a captured waveform is acquired.
- The history feature cannot be used on waveform data acquired through dual capturing.

Waveform Acquisition (START/STOP)

When you start waveform acquisition, the DL850E/DL850EV stores waveform data to the acquisition memory and updates the displayed waveforms each time it triggers. The acquisition memory is divided into many areas based on the set record length, and the maximum number of acquirable waveforms are stored in the memory. You can recall past waveforms that are stored in the memory by using the history feature when waveform acquisition is stopped.

DL850E/DL850EV Operation When the Acquisition Mode Is Set to Averaging

- Averaging stops when you stop acquisition.
- If you start acquisition again, averaging starts from the beginning.

START/STOP Key Operations during Accumulation

- Accumulation stops when you stop waveform acquisition.
- When you start acquisition again, the displayed waveforms up to that point are cleared, and accumulation restarts from the beginning.

The START/STOP Key Is Disabled:

- When the DL850E/DL850EV is in remote mode.
- When the DL850E/DL850EV is printing to a printer, when it is being set up automatically, or when it is accessing a storage medium.

- If you change the waveform acquisition conditions and start waveform acquisition, the past data stored in the acquisition memory is cleared.
- You can use the snapshot feature to retain the displayed waveform on the screen. This feature allows you to update the display without having to stop waveform acquisition.
- Regardless of the trigger settings, you can make the DL850E/DL850EV trigger by pressing the MANUAL TRIG key on the front panel.

6 Display

Window Types (DISPLAY)

The DL850E/DL850EV has the following types of windows.

T-Y (Time axis) Waveform Display Window

- Main window
  Displays normal waveforms, which are not magnified
- Zoom window (Zoom1 and Zoom2)
  Displays zoomed waveforms according to the settings specified using the ZOOM key

X-Y Window (Window 1 and Window 2)

Displays X-Y waveforms according to the settings specified using the X-Y key

FFT Window (FFT1 window and FFT 2 window)

Displays FFT waveforms according to the settings specified using the FFT key

Dual Capture Window

Appears when the dual capture feature is used

Extra Window

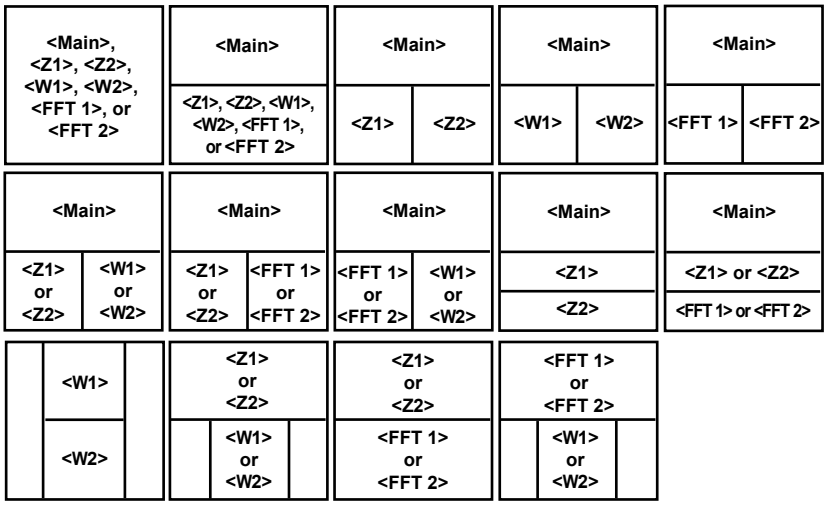
This window displays cursor-measurement values, automated measurement values of waveform parameters, and so on. It can be used when values overlap with waveforms and are difficult to see.

Switching the Menu Area Display

You can switch between the full-screen waveform display, the channel information display, and the waveform numeric-monitor display.

Display Pattern Examples

The main display patterns are shown in the figure below.



- Zoom1 and Zoom2 are abbreviated to Z1 and Z2.
- You can create patterns in which the main window is not displayed.
- The dual capture window is also displayed as shown in the patterns above.

Under the following conditions, a total of 64 waveforms can be displayed on the main, Zoom1, and Zoom2 windows.

Trigger mode: Auto

TIME/DIV: 100 ms/div or 200 ms/div

Display Format (Format)

You can evenly divide the T-Y waveform display window so that you can easily view input waveforms and computed waveforms. You can set the number of divisions to one of the values listed below.

Group 1,* 1, 2, 3, 4, 5, 6, 8, 12, or 16

* Group 1 is an option that appears when display group #2 to #4 are selected. Select Group 1 to set the display groups #2 to #4 to the same format as group 1. This can be used on models with firmware version 2.05 and later.

The number of displayed points in each division varies depending on the number of divisions. Even if the number of displayed points changes, the vertical resolution does not change. The number of displayed points when only the Main window is displayed is as follows:

Divisions	Displayed Points	Divisions	Displayed Points	Divisions	Displayed Points
1	656 points	4	164 points	8	82 points
2	328 points	5	131 points	12	54 points
3	218 points	6	109 points	16	41 points

Extra Window (Extra Window)

When waveforms and measured values overlap and are difficult to see, you can use the extra window to display them separately. The extra window appears below the T-Y waveform display window. The following values appear in the extra window.

- Cursor-measurement values
- Automated measurement values of waveform parameters
- The digital values of each channel (only during roll mode display)

Height of the Extra Window

Set the height of the extra window.

OFF: The extra window is not displayed.

1 to 8: The extra window is set to the selected height.

Auto: The extra window appears automatically when you perform cursor measurements and automated measurements of waveform parameters.

- The number of displayed points on the T-Y waveform display window varies depending on the height of the extra window. Even if the number of displayed points changes, the vertical resolution does not change.
- When the extra window is displayed, depending on the Zoom Format, the scale values may overlap and be difficult to read.

Grid (Graticule)

You can set the window grid to one of the following options.

- : Displays the grid using broken lines
- : Displays the grid using crosshairs
- : Displays a frame

Turning the Scale Value Display On and Off (Scale Value)

You can display the upper and lower limits (scale values) of each waveform's vertical or horizontal axes.

- ON: Displays the scale values
- OFF: Does not display the scale values

Waveform Arrangement, Color, and Display Gr. (Trace Setup)

You can set the following items for the input channels (CH1 to CH16) of the modules installed in the slots and for the computation channels (Math1 to Math8).

Mapping Mode (Mapping Mode)

Set how to map channels to the divided screens on the mapping list.

- **Auto**

  The waveforms whose displays are turned on are arranged by number from the top of the window.

  * For sub channels, even if the waveform display (Display) is set to ON. if the input coupling (Coupling) or input (Input) is set to OFF, the sub channels will be deleted from the mapping list when the Auto Grouping soft key is pressed.

- **User**

  The waveforms are arranged according to the user-specified Map.

Moving Input Channels (CH)

You can move input and computation channels. To move a channel, remove it from the list, and then select it in the location that you want to move it to.

Display Color (Color)

You can set the display color of each of the waveforms to one of 16 colors.
You can assign all waveforms regardless of whether their displays are turned on.

- This can be set for each sub channel for the 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, SENT monitor, and 4-CH modules.
- Because logic input modules are not displayed as individual bits but are instead displayed as single channels, a logic input channel can have only one color assigned to it.

Map (Map)

When the mapping mode is set to User, you can set how to map each waveform to the divided screens. You can assign all waveforms regardless of whether their displays are turned on.

- This can be set for each sub channel for the 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, SENT monitor, and 4-CH modules.
- Because logic input modules are not displayed as individual bits but are instead displayed as single channels, a logic input module can be assigned only to one zone.

Display Groups (Select Display Gr.)

Only the waveforms of the selected group are displayed on the screen.
All the channels (CH, Math, and sub channels) are automatically assigned to groups 1 to 4. You can change these assignments. P and H are displayed on models with the /G5 option.

Group 1 to 4 (Group #1 to #4)

Specify the channels (CH, Math, and sub channels) that are assigned to each group. You can also automatically reassign just the waveforms of the channels (CH, Math, and sub channels) whose displays are turned on to groups 1 to 4.

- You can assign the same channel to multiple groups.
- You cannot assign the following channels to separate groups.
  The bits of a single logic input module

Trace Label Display (Trace Label)

You can display waveform labels next to the displayed waveforms. If the waveform display is narrow because of the display format settings, labels may not be displayed.

- ON: Displays labels
- OFF: Does not display labels

Level Indicator

A level indicator that shows the levels of the waveforms whose displays are turned on appears on the right side of the waveform display area. It shows the current levels of the sampled data.

Interpolation Method (Dot Connect)

When the number of data points is within the interpolation zone of the T-Y waveform display,* the DL850E/DL850EV displays waveforms by interpolating between sampled data points.

* Interpolation zone refers to the condition in which a given number of data points are not contained in the 10 div along the time axis. The number of data points that define the interpolation zone varies depending on the display record length and zoom ratio.

You can set the interpolation method to one of the options below.

- **OFF**

  Displays the data using dots without interpolation.
- **Sine Interpolation (Sine)**

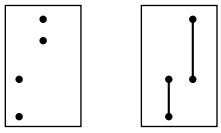
  Interpolates a sine curve between two points using the (sinx)/x function. This method is suitable for the observation of sine waves.
- **Linear Interpolation (Line)**

  Linearly interpolates between two points.
- **Pulse Interpolation (Pulse)**

  Interpolates between two points in a staircase pattern.

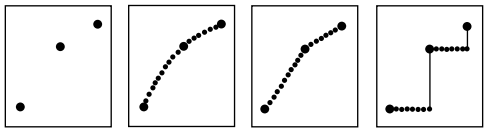
Outside of the Interpolation Zone

If the interpolation method is set to Sine, Line, or Pulse, the dots are connected vertically.
If the number of data points is 2002 or greater, the DL850E/DL850EV determines the P-P compression values (the maximum and minimum sampled-data values in a given interval), and displays vertical lines (rasters) connecting each pair of maximum and minimum P-P compression values.



OFF **Sine/Line/Pulse**

In the Interpolation Zone



OFF **Sine** **Line** **Pulse**

The interpolation method is set to Pulse when:

- The input signal is a logic signal.
- The acquisition mode is Envelope.

Setting the Number of Data Points to Use for Waveform Display (Decimation)

When the T-Y waveform display is not in the interpolation zone and the interpolation method is not set to OFF, P-P compressed values are displayed.
When the T-Y waveform display is not in the interpolation zone and the interpolation method is set to OFF or when the X-Y waveform display is shown, the DL850E/DL850EV displays the acquired data without P-P compression by removing the data between fixed intervals. You can set the number of points to use to display waveforms to one of the options listed below.
2k, 100k

- **When 2k Is Selected**

  When the record length exceeds 2 kpoint, the DL850E/DL850EV removes data until there are only 2 kpoint and displays two points on each vertical line. When the record length is less than 2 kpoint, all the points are displayed.

- **When 100k Is Selected**

  When the record length exceeds 100 kpoint, the DL850E/DL850EV removes data until there are only 100 kpoint and displays 100 points on each vertical line. When the record length is less than 100 kpoint, all the points are displayed.

During hard disk recording and roll mode display, if there are more than 100 points of data per div, the maximum and minimum values for specified intervals of data are displayed through linear interpolation.

Accumulation (Accumulate)

Ordinarily, momentary waveform anomalies are difficult to recognize because the displayed waveform is updated whenever the trigger is activated. In waveform accumulation, older waveforms remain on the screen for a period of time that is longer than the waveform update period, so that older waveforms remain while new waveforms continue to appear. The specified number of accumulated waveforms are displayed with gradually decreasing intensity.

- ON: Waveforms are accumulated.
- OFF: Waveforms are not accumulated.

Count (Count)

Set the number of accumulated waveforms to display. Waveforms will accumulate infinitely if you choose Infinite.
Selectable range: 2 to 128 waveforms (in 2^n steps). The default setting is 16.

Clearing Accumulated Waveforms

You can clear accumulated waveforms by pressing the CLEAR TRACE key.

- Automated measurement of waveform parameters and GO/NO-GO determination are performed on the most recent waveform.
- If you press START/STOP to stop waveform acquisition, accumulation stops. When you restart waveform acquisition, accumulation resumes from the condition that it was in when it was stopped.
- The built-in printer does not show the intensity differences between accumulated waveforms.
- When Accumulate is set to ON, you cannot change the settings of the history feature.
- When Accumulate is set to ON, even if you change the display format, the waveforms that are currently on the screen are not cleared. To clear waveforms, press CLEAR TRACE.
- You cannot set accumulate to ON in the roll mode display.
- When you set accumulate to OFF, the accumulated waveforms are cleared. To redisplay the waveforms, use the history feature, and select the record number of the waveforms that you want to display. You can select only waveforms that have record numbers. You cannot display earlier waveforms.
- If the DL850E/DL850EV does not trigger when the trigger mode is set to Normal, the waveform intensity is retained until the next time the DL850E/DL850EV triggers.

Manual Event (Manual Event)

Indicates the positions of manually input events. You can input manual events only during hard disk recording or when the dual capture feature is enabled. You can input manual events by applying a low edge to the external start/stop input (EXT I/O) terminal. You can enter up to 100 events. For the specifications of the EXT I/O terminal, see section 5.5 in the *Getting Started Guide*, IM DL850E-03EN.

Switching the Menu Area Display

When the setup menu is displayed and you press the ESC key, the menu disappears, and the display switches to the full-screen waveform display. If you press the ESC key again, the channel information of the waveforms whose displays are turned on appears. If you press the ESC key yet again, the numeric monitor for the waveforms whose displays are turned on appears. Each time you press the ESC key, the display switches between the full-screen waveform display, the channel information display, and the numeric-monitor display.

Full-Screen Waveform Display

The menu disappears, and the waveform display area expands horizontally.

Channel Information

The following items are displayed.
However, as the number of displayed channels increases, some items may be omitted.

- Voltage measurement: V/div, input coupling, probe attenuation (type), bandwidth limit
- Temperature measurement: Temperature/div, thermocouple type, bandwidth limit
- Strain measurement: μSTR/div (or [mV/V]/div), measurement range, bandwidth limit
- Acceleration measurement: Acceleration/div, gain, input coupling, bias
- Frequency measurement: Value/div, measurement mode, preset

Numeric Monitor

The level indicator values for each channel appear in the numeric monitor display. The numeric monitor display is updated at approximately every 0.5 s.

Size of the Channel-Information and Numeric-Monitor Display Area (Ch. Information)

You can set the size of the display area that appears when you switch from the menu to the channel-information or numeric-monitor display.

- Full: Full screen
- Narrow: Width of the menu (displayed in the location of the menu)
- Wide: Displayed on the right half of the screen

7 Displaying X-Y Waveforms

You can view the correlation between two waveform levels by assigning the level of one waveform to the X-axis (horizontal axis) and the level of the other waveform to the Y-axis (vertical axis). There are two X-Y waveform windows, and you can display four pairs of waveforms in each window (for a total of eight pairs).
You can perform cursor measurements on the displayed X-Y waveforms. You can also observe T-Y (time axis) waveforms and X-Y waveforms simultaneously.

Turning the X-Y Window Display On and Off (Display)

You can select whether to display each X-Y window.

- ON: Displays the X-Y window
- OFF: Does not display the X-Y window

Eight Pairs of X-Y Waveforms (Setup)

You can display XY1 to XY4 in window 1 and XY5 to XY8 in window 2. You can configure the display settings of a total of 8 X-Y waveforms. You can configure the following settings for each X-Y waveform.

Display (DISPLAY)

You can select whether to display each X-Y waveform.

- ON: Displays the X-Y waveform
- OFF: Does not display the X-Y waveform

X Trace and Y Trace (X Trace and Y Trace)

For XY1 to XY4 and XY5 to XY8, you can select which waveforms to assign to the X and Y axes from the following options.
CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

- An X-Y waveform cannot be displayed if the waveforms assigned to its X and Y axes have different sample rates.
- An X-Y waveform cannot be displayed if it is a combination of a sub channel on the 16-CH voltage input module and a normal channel. You can display an X-Y waveform of two sub channels that have the same sample rate. The same limitation applied to 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, SENT monitor modules.
- An X-Y waveform can be displayed if it is a combination of a sub channel on the 16-CH voltage input module and a sub channel on a CAN bus monitor module and if the two sub channels have the same sample rate. This is also true for the combination of a 16-CH temperature/voltage input module and a CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.
- X-Y waveforms can be created from normal T-Y waveforms. They cannot be created from zoomed waveforms.
- Logic waveforms and event waveforms cannot be used to make X-Y waveforms.
- You cannot create an X-Y waveform using one trace whose horizontal-axis unit is time and another trace whose horizontal-axis unit is frequency.

Start Point and End Point (Start Point and End Point)

You can set the start and end points of the X-Y waveforms on the T-Y waveforms. You can set different start and end points for each X-Y window.

Selectable range: ±5 div from the center of the T-Y waveform window

Pen Marker (Pen Marker)

You can display a pen marker on an X-Y waveform whose display is turned on. It shows the current sampled point of the waveform.

Clearing Waveforms at Acquisition Start (Trace clear on Start)

Choose whether to clear the current X-Y waveforms when waveform acquisition is started through the pressing of the START/STOP key.

- ON: X-Y waveforms are cleared.
- OFF: X-Y waveforms are not cleared.

Display Ratio of the Main Window (Main Ratio)

▶ See here.

Window Layout (Window Layout)

Set the display position of the X-Y window.

- Side: Horizontal
- Vertical: Vertical

Combine Display (Combine Display)

Choose whether to combine the two X-Y windows into one window.

- ON: The windows are combined.
- OFF: The windows are not combined.

Interpolation Method (Dot Connect)

When the number of data points is within the interpolation zone of the X-Y waveform display,* the DL850E/DL850EV displays waveforms by interpolating between sampled data points.

* Interpolation zone refers to the condition in which a given number of data points are not contained in the X-Y waveform display. The number of data points that define the interpolation zone varies depending on the display record length.

You can set the interpolation method to one of the options below.

- **OFF**

  Displays the data using dots without interpolation.
- **Linear Interpolation (Line)**

  Linearly interpolates between two points.

Diagram Explaining the Interpolation Method

▶ See here.

Setting the Number of Data Points to Use for Waveform Display (Decimation)

In the X-Y waveform display, the DL850E/DL850EV displays the acquired data by removing the data between fixed intervals. You can set the number of points to use to display waveforms to one of the options listed below.
2k, 100k

Detailed Explanation

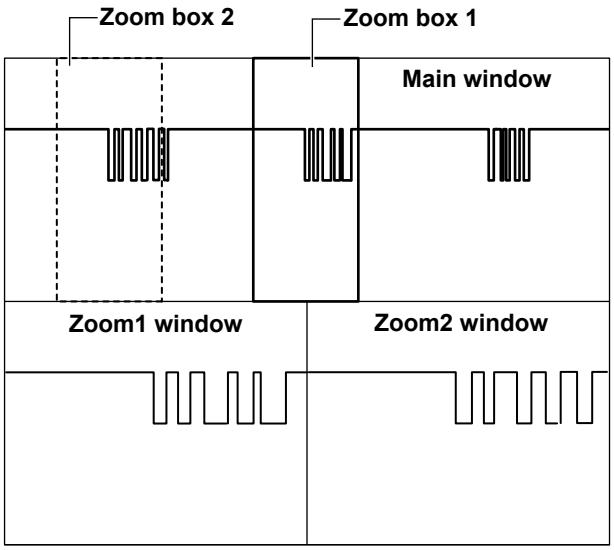
▶ See here.

- To zoom in or out on an X-Y waveform, change the upper and lower limits (Upper and Lower) of the channel that you want to zoom, or change the vertical zoom (V Zoom).
- On voltage input modules, to change the displayed position of an X-Y waveform, change the positions of the channels that it is based on.

8 Zooming in on Waveforms

You can magnify displayed waveforms along the time axis. The zoomed waveforms of two locations can be displayed simultaneously (the dual zoom feature). You can also specify which channel you want to zoom in on. You cannot zoom if the number of displayed points on the screen is less than or equal to 100.

Example of the Dual Zoom Display



If the Zoom1 or Zoom2 waveform window and the main waveform window (Main) are displayed at the same time, a zoom box appears in the Main window so that you can check the zoom position.

Vertical Zoom

You can magnify displayed waveforms along the vertical axis by using the menu that appears when you press a CH key.

▶ See here.

Zoom Window Display (Display)

You can set whether to display each of the zoom windows, Zoom1 and Zoom2. When a zoom window is displayed, a zoom bar appears at the top of the screen. This bar indicates what part of Main window is being zoomed in on.

- ON: Displays the zoom windows
- OFF: Does not display the zoom windows

Zoom Source Window (Zoom2 Source)

Select the waveforms that you want to enlarge in the Zoom2 window.

- Main (Main): Main window waveforms
- Zoom1: Zoom1 window waveforms

Zoom Factor (MAG knob)

Use the Mag knob to set the zoom factor. You can set separate horizontal zoom factors for Zoom1 and Zoom2. The zoom-window time-axis setting changes automatically based on the specified zoom factor.

Selectable Range

Two times the time axis setting (TIME/DIV) of the Main window to the point where the number of data points in the zoom window reaches 10 points per div.

- When an external clock signal is being used as the time base, you can select one of the following magnifications. You can select any magnification up to the point where the number of data points in the zoom window reaches 10 points per div.
  Up to 1000000 in 1-2.5-5 steps (× 2, × 2.5, × 5, × 10, × 25, × 50, × 100, × 250, × 500, × 1000, × 2500, and so on)
- The upper limit of the zoom factor during hard disk recording is the maximum zoom factor that can be displayed during hard disk recording.

Position (Zoom POSITION knob, Zoom1 Position, Zoom2 Position)

You can set the zoom position (position) using the zoom POSITION knob or the jog shuttle. Taking the horizontal center of the main window to be 0 div, set the center position of the zoom boxes in the range of −5 to 5 div. In the Main window, the box with solid lines is for Zoom1, and the box with dashed lines is for Zoom2. Waveforms are magnified around the centers of the zoom boxes.

The Z1 or Z2 indicator on the front panel illuminates to show when the Zoom1 or Zoom2 window can be moved by the Mag or zoom POSITION knob.

Zoom Link

If you press the Mag knob or zoom POSITION knob so that the Z1 and Z2 indicators both light, you can move the zoom boxes while maintaining the spatial relationship between them. The relationship between the zoom factors is also maintained.

Display Ratio of the Main Window (Main Ratio)

Set the size of the main window in relation to the overall waveform display area.

- 50%: The main window appears in the upper half of the screen.
- 20%: The main window appears in the upper 20% screen.
- 0%: The main window is not displayed.

Window Layout (Window Layout)

You can select the layout of the two zoom windows.

- Side: Horizontal
- Vertical: Vertical

Display Format (Format Zoom1 and Format Zoom2)

Select how to display the zoom windows from one of the options listed below. If you select a number, the zoom windows are divided evenly, and waveforms are displayed within the divisions.

- Main: Same as the display format of the main window of each display group.
- 1, 2, 3, 4, 5, 6, 8, 12, 16: The dual capture window is broken up into the specified number of divisions.

Moving the Zoom Position to the Latest Position (Move Zoom1 to Front and Move Zoom2 to Front)

You can move the position of one of the zoom boxes to the right side of the screen (where the most recent data is). When the waveform flows from the right to the left of the screen, as in roll mode, you can zoom in on the waveform where it starts from, on the right side of the screen. These menu items do not appear when the source waveform of the Zoom2 window is set to Zoom1.

Auto Scroll (Auto Scroll)

This feature automatically moves the zoom position in the specified direction. You can view the waveform and stop scrolling at the appropriate position.

⏮	Zooms in on the left edge of the Main window
⏭	Zooms in on the right edge of the Main window
◀	Starts scrolling to the left
▶	Starts scrolling to the right
■	Stops scrolling

Speed (Speed)

You can select the auto scrolling speed.
Selectable range: 1 to 10. The default setting is 4.

Waveforms That Are Zoomed (Allocation)

The waveforms of the channels whose check boxes are selected in the allocation window and whose displays are turned on are displayed.

Changing the Range of the Automated Measurement of Waveform Parameters (Fit Measure Range)

Sets the range of the automated measurement of waveform parameters to the zoom range of Zoom1 or Zoom2. This is valid even if the automated measurement of waveform parameters is turned OFF.

9 Cursor Measurement

You can move cursors on the waveforms displayed on the screen to view the measured values at the points where the cursors intersect the waveforms. You can select whether to measure the P-P compressed data values on the screen or the data values that have been acquired in the acquisition memory.

▶ See here.

Window Selection (Select Window)

Select the window to perform cursor measurement in. This option appears when X-Y or FFT waveforms are being displayed.

- T-Y: Displays T-Y waveform cursor-measurement values.
- X-Y: Displays the cursor-measurement values for the waveform in an X-Y window.
- FFT: Displays the cursor-measurement values for the waveform in an FFT window.

T-Y Waveforms

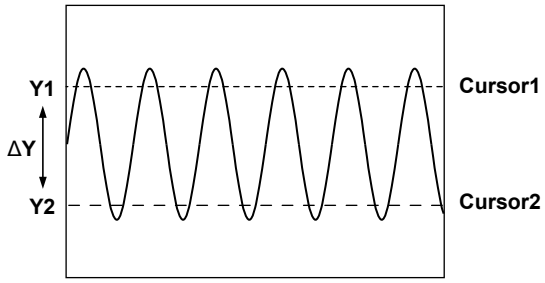
Cursor Types (Type)

The following types of T-Y waveform cursors are available.

- OFF: Cursor measurement is not performed.
- Horizontal cursors (Horizontal): Two horizontal cursors are used to measure vertical values.
- Vertical cursors (Vertical): Two vertical cursors are used to measure time values.
- Horizontal and vertical cursors (H & V): Two horizontal cursors and two vertical cursors are used to measure vertical and time values.
- Marker cursors (Marker): Four marker cursors that move on the waveform are used to measure waveform values.
- Angle cursors (Degree): Two angle cursors are used to measure angles.

Horizontal Cursors (Horizontal) - T-Y waveforms

Two dashed lines (horizontal cursors) appear on the horizontal axis. You can measure the vertical value at the position of each horizontal cursor and measure the level difference between the horizontal cursors.



Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.

2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in 0.01 div steps.

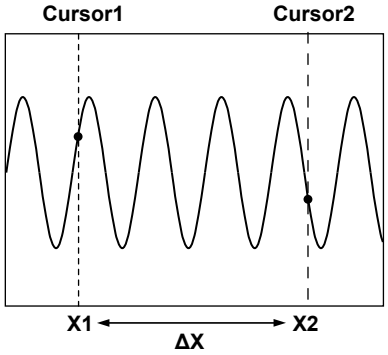
Measurement Items (Item Setup)

You can measure the following vertical values at the cursor positions.

Y1	Vertical value at Cursor1
Y2	Vertical value at Cursor2
ΔY	Difference between the vertical values of Cursor1 and Cursor2

Vertical Cursors (Vertical) - T-Y waveforms

Two straight dashed lines appear on the vertical axis (these are the vertical cursors). You can measure the time between the trigger position and each cursor, the time difference between the two cursors, and the reciprocal of the time difference between the two cursors. You can also measure the vertical signal value at each cursor position and the level difference between the two cursors.



Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8, All[4]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.
4 Cursor measurement is performed on all channels. However, measured values that do not fit on the screen are not displayed.

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div. The setting resolution is 0.01 div when the record length is 1 kpoint and 0.005 div otherwise.

Cursor Jumping (Cursor Jump)

You can make Cursor1 and Cursor2 jump to the center of the specified zoom window.
Cursor1 to Zoom1: Cursor1 jumps to the Zoom1 window.
Cursor1 to Zoom2: Cursor1 jumps to the Zoom2 window.
Cursor2 to Zoom1: Cursor2 jumps to the Zoom1 window.
Cursor2 to Zoom2: Cursor2 jumps to the Zoom2 window.

Measurement Items (Item Setup)

You can measure the following horizontal values at the cursor positions.

X1	Time value at Cursor1
X2	Time value at Cursor2
ΔX	Difference between the time values of Cursor1 and Cursor2
1/ΔX	Reciprocal of the difference between the time values of Cursor1 and Cursor2
Y1	Vertical value at the intersection of Cursor1 and the waveform[1]
Y2	Vertical value at the intersection of Cursor2 and the waveform[2]
ΔY	Difference between the vertical values at the intersections of the waveform with Cursor1 and Cursor2[2]

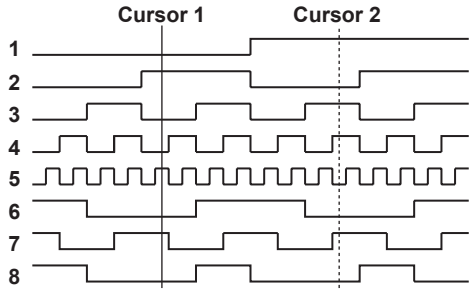
1 When Trace is set to All, the values for the channels of all installed modules, the sub channels, and the Math channel are measured.

2 This option does not appear when Trace is set to All.

Example of Logic Signal Measurement

When you measure logic waveforms using vertical cursors, the measured values of Y1 and Y2 are determined in the manner shown below.

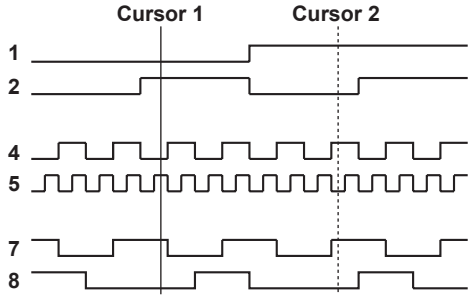
When No Bits Are Turned Off



• When the cursor order is 1->8
Bit Y1: 01001010
Y2: 10110010
Hex Y1: 4A
Y2: B2

• When the cursor order is 8->1
Bit Y1: 01010010
Y2: 01001101
Hex Y1: 52
Y2: 4D

When Some Bits Are Turned Off



• When the cursor order is 1->8
Bit Y1: 01-01-10
Y2: 10-10-10
Hex Y1: 16
Y2: 2A

• When the cursor order is 8->1
Bit Y1: 01-10-10
Y2: 01-01-01
Hex Y1: 1A
Y2: 15

In the logic settings in the preferences, you can set the display format (Bit or Hex), the cursor order (Cursor Order), and the bit order (Bit Order).

▶ See here.

Horizontal and Vertical Cursors (H & V) - T-Y waveforms

Displays the horizontal and vertical cursors simultaneously.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

Moving the Cursors (V Cursor1/V Cursor2, H Cursor1/H Cursor2)

Use V-Cursor1, V-Cursor2, H-Cursor1, and H-Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div. The vertical cursor's setting resolution is 0.01 div when the record length is 1 kpoint and 0.005 div otherwise.

Cursor Jumping (Cursor Jump)

You can make V-Cursor1 and V-Cursor2 jump to the center of the specified zoom window.
Cursor1 to Zoom1: Cursor1 jumps to the Zoom1 window.
Cursor1 to Zoom2: Cursor1 jumps to the Zoom2 window.
Cursor2 to Zoom1: Cursor2 jumps to the Zoom1 window.
Cursor2 to Zoom2: Cursor2 jumps to the Zoom2 window.

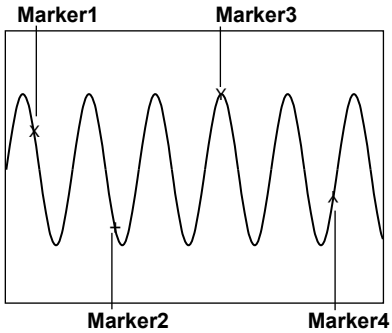
Measurement Items (Item Setup)

You can measure the following horizontal and vertical values at the cursor positions.

Horizontal Axis	
X1	Time value at V-Cursor1
X2	Time value at V-Cursor2
ΔX	Difference between the time values of V-Cursor1 and V-Cursor2
1/ΔX	Reciprocal of the difference between the time values of V-Cursor1 and V-Cursor2
Vertical Axis	
Y1	Vertical value of H-Cursor1
Y2	Vertical value of H-Cursor2
ΔY	Difference between the vertical values of H-Cursor1 and H-Cursor2
ΔY/ΔX	The amount of change in the vertical value per unit time in the cursor range

Marker Cursors (Marker) - T-Y waveforms

Four markers are displayed on the selected waveform. You can measure the level at each marker, the amount of time from the trigger position to each marker, and the level and time differences between markers.



Markers (Marker1 through 4)

Select the markers, from Marker1 to 4, that you want to display. You can assign each marker to a different waveform.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.

- OFF: Disables the marker
- CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.

2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

3 On a DL850EV when a CAN bus monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

Position (Position)

Set the position of the selected marker.
Taking the center of the waveform display window to be 0 div, you can move the markers within the range of −5 to 5 div. The setting resolution is 0.01 div when the record length is 1 kpoint and 0.005 div otherwise.

Cursor Jumping (Cursor Jump)

You can make Marker1 to Marker4 jump to the center of the specified zoom window.
To Zoom1: The selected marker jumps to the Zoom1 window.
To Zoom2: The selected marker jumps to the Zoom2 window.

Marker Shape (Marker Form)

Set the shape of the displayed marker to one of the options below.

- Mark: A dot
- Line: A crosshair

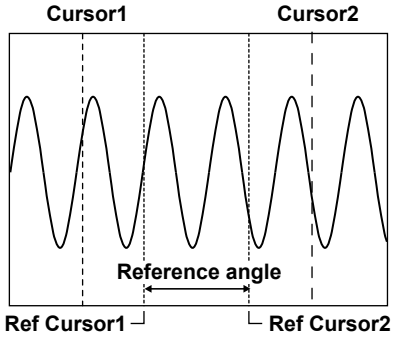
Measurement Items (Display Item)

Marker cursors move on the waveform data. You can measure the following values at the markers.

X1	Time value at Marker1
X2	Time value at Marker2
X3	Time value at Marker3
X4	Time value at Marker4
Δ(X2-X1)	Difference between the time values of Marker1 and Marker2
Δ(X3-X1)	Difference between the time values of Marker1 and Marker3
Δ(X4-X1)	Difference between the time values of Marker1 and Marker4
Δ(X3-X2)	Difference between the time values of Marker2 and Marker3
Δ(X4-X2)	Difference between the time values of Marker2 and Marker4
Δ(X4-X3)	Difference between the time values of Marker3 and Marker4
Y1	Vertical value at Marker1
Y2	Vertical value at Marker2
Y3	Vertical value at Marker3
Y4	Vertical value at Marker4
Δ(Y2-Y1)	Difference between the vertical values of Marker1 and Marker2
Δ(Y3-Y1)	Difference between the vertical values of Marker1 and Marker3
Δ(Y4-Y1)	Difference between the vertical values of Marker1 and Marker4
Δ(Y3-Y2)	Difference between the vertical values of Marker2 and Marker3
Δ(Y4-Y2)	Difference between the vertical values of Marker2 and Marker4
Δ(Y4-Y3)	Difference between the vertical values of Marker3 and Marker4

Angle Cursors (Degree) - T-Y waveforms

You can measure time values and convert them to angles. On the time axis, set the zero point (Ref Cursor1 position), which will be the measurement reference, the end point (Ref Cursor2 position), and the reference angle that you want to assign to the difference between Ref Cursor1 and Ref Cursor2. Based on this reference angle, you can measure the angle between two angle cursors (Cursor1 and Cursor2).



Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8, All[4]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.
4 Cursor measurement is performed on all channels.

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div. The setting resolution is 0.01 div when the record length is 1 kpoint and 0.005 div otherwise.

Cursor Jumping (Cursor Jump)

You can make Cursor1 and Cursor2 jump to the center of the specified zoom window.
Cursor1 to Zoom1: Cursor1 jumps to the Zoom1 window.
Cursor1 to Zoom2: Cursor1 jumps to the Zoom2 window.
Cursor2 to Zoom1: Cursor2 jumps to the Zoom1 window.
Cursor2 to Zoom2: Cursor2 jumps to the Zoom2 window.

Reference Angle (Ref Value)

Set the reference angle you want to assign to the range defined by Ref Cursor1 and Ref Cursor2.
Selectable range: 1 to 720

References (Ref1/Ref2)

Set the zero point (Ref Cursor1) and the end point (Ref Cursor2).
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div. The setting resolution is 0.01 div when the record length is 1 kpoint and 0.005 div otherwise.

Measurement Items (Item Setup)

The DL850E/DL850EV measures the angle cursor (Cursor1 and Cursor2) positions as angles.

X1	Angle of Cursor1 from Ref Cursor1
X2	Angle of Cursor2 from Ref Cursor1
ΔX	Angle difference between Cursor1 and Cursor2
Y1	Vertical value at the intersection of Cursor1 and the waveform[1]
Y2	Vertical value at the intersection of Cursor2 and the waveform[2]
ΔY	Difference in the vertical values at the points where Cursor1 and Cursor2 intersect the waveforms[2]

1 When Trace is set to All, the values for the channels of all installed modules, the sub channels, and the Math channel are measured.
2 This option does not appear when Trace is set to All.

X-Y Waveforms

Cursor Types (Type)

The following types of X-Y waveform cursors are available.

- OFF: Cursor measurement is not performed.
- Horizontal cursors (Horizontal): Two horizontal cursors are used to measure vertical (Y axis) values.
- Vertical cursors (Vertical): Two vertical cursors are used to measure horizontal (X axis) values.
- Horizontal and vertical cursors (H & V): Two horizontal cursors and two vertical cursors are used to measure vertical (Y axis) and horizontal (X axis) values.
- Marker cursors (Marker): Four marker cursors that move on the waveform are used to measure waveform values.

Horizontal Cursors (Horizontal)

Two dashed lines (horizontal cursors) appear on the horizontal axis. You can measure the vertical (Y axis) value at the position of each horizontal cursor and measure the level difference between the horizontal cursors.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1 to XY8

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in 0.01 div steps.

Measurement Items (Item Setup)

You can measure the following vertical (Y axis) values at the cursor positions.

Y1	Vertical (Y axis) value at Cursor1
Y2	Vertical (Y axis) value at Cursor2
ΔY	Difference between the vertical (Y axis) values of Cursor1 and Cursor2

Vertical Cursors (Vertical)

Two dashed lines (vertical cursors) appear on the vertical axis. You can measure the horizontal (X axis) value at the position of each vertical cursor and measure the level difference between the vertical cursors.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1 to XY8

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in 0.01 div steps.

Measurement Items (Item Setup)

You can measure the following horizontal (X axis) values at the cursor positions.

X1	Horizontal (X axis) value at Cursor1
X2	Horizontal (X axis) value at Cursor2
ΔX	Difference between the horizontal (X axis) values of Cursor1 and Cursor2

Horizontal and Vertical Cursors (H & V)

You can display the horizontal and vertical cursors simultaneously and measure vertical (Y axis) and horizontal (X axis) values.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1 to XY8

Moving the Cursors (V Cursor1/V Cursor2, H Cursor1/H Cursor2)

Use V-Cursor1, V-Cursor2, H-Cursor1, and H-Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in 0.01 div steps.

Measurement Items (Item Setup)

You can measure the following horizontal (X axis) and vertical (Y axis) values at the cursor positions.

Horizontal Axis (X axis)	
X1	Horizontal (X axis) value at V-Cursor1
X2	Horizontal (X axis) value at V-Cursor2
ΔX	Difference between the horizontal (X axis) values of V-Cursor1 and V-Cursor2
ΔX/ΔY	Amount of change on the horizontal axis corresponding to the amount of change on the vertical axis
Vertical Axis (Y axis)	
Y1	Vertical (Y axis) value at H-Cursor1
Y2	Vertical (Y axis) value at H-Cursor2
ΔY	Difference between the vertical (Y axis) values of H-Cursor1 and H-Cursor2
ΔY/ΔX	Amount of change on the vertical axis corresponding to the amount of change on the horizontal axis

Marker Cursors (Marker)

Four markers are displayed on the selected waveform. You can measure the level at each marker, the amount of time from the trigger position to each marker, and the level and time differences between markers.

Markers (Marker1 through 4)

Select the markers, from Marker1 to 4, that you want to display. You can assign each marker to a different waveform.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1 to XY8

Position (Position)

Set the position of the selected marker.
Taking the center of the waveform display window to be 0 div, you can move the markers within the range of −5 to 5 div. The setting resolution is 0.01 div when the record length is 1 kpoint and 0.005 div otherwise.

Marker Shape (Marker Form)

Set the shape of the displayed marker to one of the options below.

- Mark: A dot
- Line: A crosshair

Measurement Items (Item Setup)

Marker cursors move on the waveform data. You can measure the following values at the markers.

X1	Horizontal (X axis) value at Marker1
X2	Horizontal (X axis) value at Marker2
X3	Horizontal (X axis) value at Marker3
X4	Horizontal (X axis) value at Marker4
Y1	Vertical (Y axis) value at Marker1
Y2	Vertical (Y axis) value at Marker2
Y3	Vertical (Y axis) value at Marker3
Y4	Vertical (Y axis) value at Marker4
T1	Time from the trigger position at Marker1
T2	Time from the trigger position at Marker2
T3	Time from the trigger position at Marker3
T4	Time from the trigger position at Marker4
Δ(T2-T1)	Time difference between Marker1 and Marker2
Δ(T3-T1)	Time difference between Marker1 and Marker3
Δ(T4-T1)	Time difference between Marker1 and Marker4

FFT Waveforms

Cursor Types (Type)

The following types of FFT waveform cursors are available.

- OFF: Cursor measurement is not performed.
- Marker cursors (Marker): You can use four marker cursors to measure frequencies, levels, and the distances between markers.
- Peak cursors (Peak): You can use peak cursors to measure peak frequency and level values.

Marker Cursors (Marker)

You can measure the frequency and level at each marker and the frequency and level differences between markers. You can select a measurement source waveform for each cursor.

Markers (Marker#)

The selected markers appear on the measurement source waveforms.

Measurement Source Waveform (Trace)

Set the measurement source waveform for each marker to one of the waveforms below.

- OFF: Disables measurement.
- FFT1: The waveform in the FFT1 window is measured.
- FFT2: The waveform in the FFT2 window is measured. You can make measurements in the FFT2 window on models equipped with the /G2 option.

Position (Position)

Set the position of the selected marker.
You can move the markers within the range of −5 to 5 div of the frequency axis in 0.01 div steps.

Marker Shape (Marker Form)

Set the shape of the displayed marker to one of the options below.

- Mark: A dot
- Line: A crosshair

Measurement Items (Item Setup)

Marker cursors move on the waveform data. You can measure the following values at the markers.

X1	Frequency at Marker1
X2	Frequency at Marker2
X3	Frequency at Marker3
X4	Frequency at Marker4
Δ(X2-X1)	Frequency difference between Marker1 and Marker2
Δ(X3-X1)	Frequency difference between Marker1 and Marker3
Δ(X4-X1)	Frequency difference between Marker1 and Marker4
Δ(X3-X2)	Frequency difference between Marker2 and Marker3
Δ(X4-X2)	Frequency difference between Marker2 and Marker4
Δ(X4-X3)	Frequency difference between Marker3 and Marker4
Y1	Level at Marker1
Y2	Level at Marker2
Y3	Level at Marker3
Y4	Level at Marker4
Δ(Y2-Y1)	Level difference between Marker1 and Marker2
Δ(Y3-Y1)	Level difference between Marker1 and Marker3
Δ(Y4-Y1)	Level difference between Marker1 and Marker4
Δ(Y3-Y2)	Level difference between Marker2 and Marker3
Δ(Y4-Y2)	Level difference between Marker2 and Marker4
Δ(Y4-Y3)	Level difference between Marker3 and Marker4

Peak Cursors (Peak)

In the frequency range defined by FFT1 Range1 and Range2 and the frequency range defined by FFT2 Range1 and Range 2, the DL850E/DL850EV detects peaks (Peak1 and Peak2*) and measures their frequencies and levels. You can set the two frequency ranges in the range of −5 to 5 div.

* You can set this item on models equipped with the /G2 option.

Measurement Items (Item Setup)

The following values at the peaks are measured. F2 and Y2 are items that can be measured on models with the /G2 option.

F1	Frequency at Peak1
F2	Frequency at Peak2
Y1	Level at Peak1
Y2	Level at Peak2

Notes about Cursor Measurement

Cursor Measurement

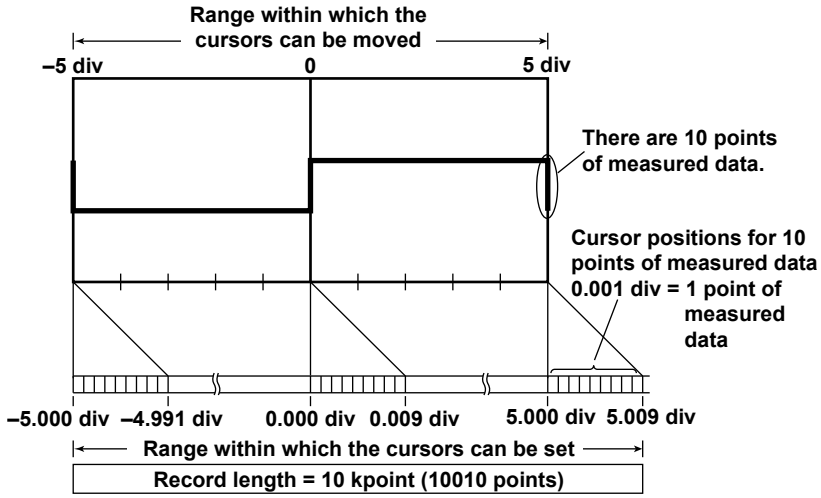
- You cannot perform cursor measurement on snapshot waveforms or accumulated waveforms that have been acquired in the past. You can perform cursor measurement on the most recent accumulated waveform.
- For history waveforms, cursor measurement is performed on the waveform whose record number is selected.
- The measured time values are based on the trigger position.
- The measured value for data that cannot be measured appears as "***."
- The pulse/rotate setting affects only the X-axis (horizontal) cursor measurement values.
- While the dual capture window is displayed, you can perform cursor measurements on captured waveforms. To perform cursor measurements on the main waveform, on the DUAL CAPTURE menu, turn the display of the dual capture window off (Window: OFF).
- The results of measuring captured waveforms are displayed in italics.

Selectable Range of Cursor Positions

When Cursor Read Mode is set to ACQ, in cursor measurements, measurement is performed on the data stored in the acquisition memory, not on the displayed data. Because 1001 points are displayed along the time axis, the number of acquired data points is equal to the set record length × 1.001. For example, if the record length is set to 10 kpoint, the number of acquired data points is 10010. This means that there will be 10 points of measured data at the same display point on the screen. If there is a single point of measured data at each display point, all measured data can be measured by moving the cursor at 0.01 div steps.

On the main window, if there are several points of measured data at each display point, the cursor movement step is set to 0.005 div, and the maximum and minimum values of the measured data points at the display point can be measured.In this case, the cursor's selectable range on the positive side is 5.005 div, making it possible to measure the maximum and minimum values of the several points of measured data at the right-most display point.

Further, if you use the zoom feature to expand the waveform so that the number of displayed points of measured data is 1 kpoint or less, cursor measurement will be possible on all measured data. In this case, the several points of measured data at the +5 div position will also be displayed, and the cursor's selectable range on the positive side will be expanded. The selectable range varies depending on the record length. For example, if the above set record length is 10 kpoint, there are 10 points of measured data at the +5 div position. Therefore, the cursor's selectable range on the positive side is +5.009 div.



Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

10 Automated Measurement of Waveform Parameters

The DL850E/DL850EV can automatically measure various parameters of the displayed waveform, such as the maximum and minimum values. It can also compute statistics for the automatically measured data.

Mode Settings (Mode)

The following types of statistical processing are available for the automatically measured values of waveform parameters.

- OFF: Automated measurement is not performed.
- Automated measurement of waveform parameters (ON): Automated measurement is performed.
- Normal statistical processing (Statistics): Normal statistical processing is performed.
- Cyclic statistical processing (Cycle Statistics): Statistical processing is performed for each period (cyclic statistical processing).
- Statistical processing of history waveforms (History Statistics): Statistical processing is performed on history waveforms.

Automated Measurement of Waveform Parameters (ON)

The DL850E/DL850EV automatically measures the specified measurement items on the source waveform.

Measurement Items (Measure Setup)

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8, XY1 to XY8

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. Logic module channels are valid only for Frequency, Pulse, AvgFreq, Period, and Duty parameter measurements.

2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

Measurement Item (Item)

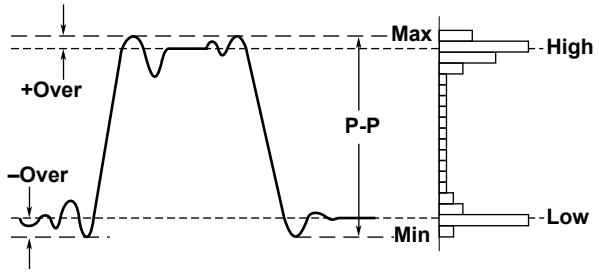
You can choose from the 28 measurement items and delay measurement items listed below. The DL850E/DL850EV can store a total of up to 64000 data values for all waveforms (CH1 through CH16, 16chVOLT, 16chTEMP/VOLT, CAN, LIN, SENT, and Math1 to Math8). A total of up to 32 measurement items can be displayed on the screen.

- **Voltage Measurement Items**

Peak to Peak(P-P)	P-P value (Max − Min) [V]
Amplitude(Amp)	Amplitude (High − Low) [V]
Maximum(Max)	Maximum voltage [V]
Minimum(Min)	Minimum voltage [V]
High	High voltage [V]
Low	Low voltage [V]
Average(Avg)	Average voltage ((1/n)Σxi) [V]
Middle(Mid)	(Max + Min)/2 [V]
RMS[1]	Rms voltage $((1/(\sqrt{n}))(\Sigma(xN^2))^{1/2})$ [V]
Std.Deviation(SDev)	Standard deviation $(1/n(\Sigma xi^2 - (\Sigma xi)^2/n)^{1/2})$ [V]
+Overshoot(+Over)	Overshoot ((Max − High)/(High − Low) × 100) [%]
−Overshoot(−Over)	Undershoot ((Low − Min)/(High − Low) × 100) [%]

1 On a channel that has been set to power spectrum computation (PS or PSD), if RMS is set to ON, “Rms = overall value” appears on the screen.

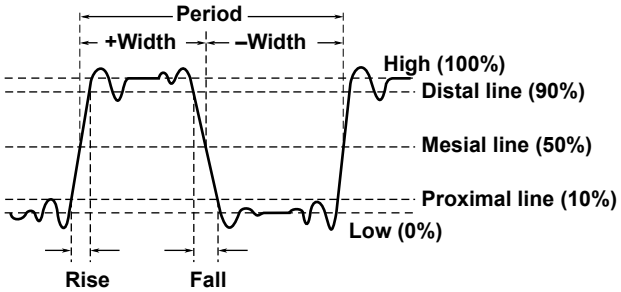
* The names in parentheses are the measurement item names that appear when the measured values are displayed.



- **Time Measurement Items**

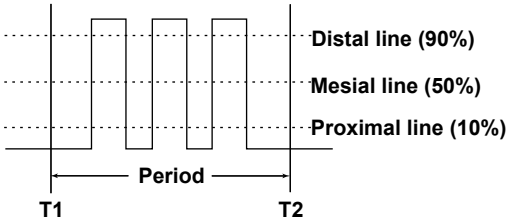
Rise	Rise time [s]
Fall	Fall time [s]
Frequency(Freq)	Frequency [Hz]
Period	Period [s]
+Width	Time width of the portion that is greater than the mesial value [s]
−Width	Time width of the portion that is less than the mesial value [s]
Duty	Duty cycle (+Width/Period × 100) [%]
Avg.Frequency(Avg.F)	Average frequency in the measurement time period [Hz]
Avg.Period(Avg.P)	Average period in the measurement time period [s]

* The names in parentheses are the measurement item names that appear when the measured values are displayed.

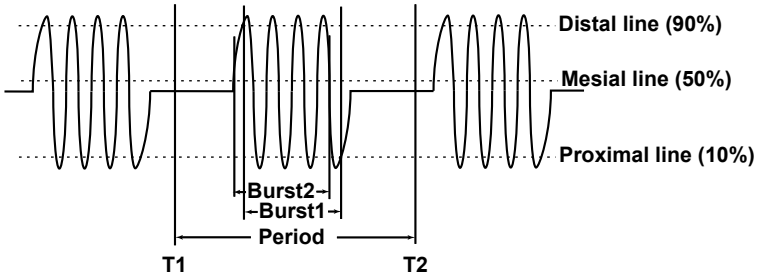


Pulse	Pulse count Set the measurement time period (Time Range) to a value appropriate for the pulse that you want to measure.

When Pulse = 3



Burst1 and Burst2	Burst period [s] Set the measurement time period (Time Range) to a value appropriate for the burst period that you want to measure.



- **Other Measurement Items**

When Trace Is Set to CH, Sub Channel, or Math	
Integ1TY(Integ1)	Area of the positive amplitude
Integ2TY(Integ2)	Area of the positive amplitude − area of the negative amplitude
When Trace Is Set to XY	
Integ1XY(Integ1)	Total triangular area of the X-Y waveform
Integ2XY(Integ2)	Total trapezoidal area of the X-Y waveform

* The names in parentheses are the measurement item names that appear when the measured values are displayed.

For detailed information about how the area of the X-Y waveform is computed, see Appendix 1, “How to Calculate the Area of a Waveform.”
▶ See here.

All Clear (All Clear)
You can turn off all the items for the waveform selected for Trace at once.

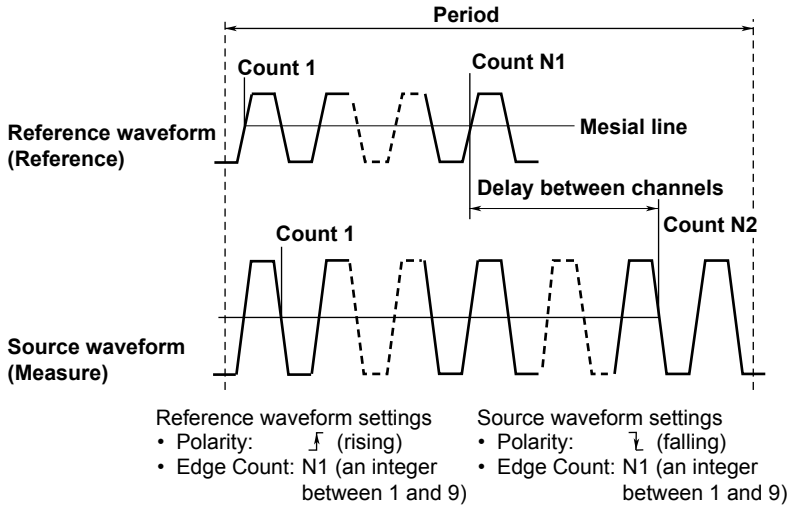
Copy (Copy to)
You can copy the settings of the waveform selected for Trace to other traces.

- You can turn the following channels on and off separately: CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8.
  1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. For logic modules, settings are copied between logic modules.
  2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
  3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.
- All ON: All traces are turned on.
- All OFF: All traces are turned off.
- Execute: Select Execute to copy the settings.

When Trace is set to XY, All Clear and Copy to are not available.

Setting the Delay (Delay Setup)

The time difference between traces or the time difference from the trigger point to a rising or falling edge is called the delay between channels.



- **Mode**

  Select a delay measurement mode.
  - OFF: Delay measurement is not performed.
  - Time: The delay between channels is displayed as a time.
  - Degree: The delay between channels is displayed as an angle.

- **Polarity**

  Select the slope of the edge you want to detect.
  - : Rising
  - : Falling

- **Edge Count**

  Sets which edge counted from the start point (T Range1) of the measurement time period to use as a detected point (measured point).
  Selectable range: 1 to 9

- **Reference**

  Select whether to use a trace or trigger as the reference for the reference waveform.
  - Trace: A trace is used.
  - Trigger: A trigger is used.

- **Reference Waveform (Reference Trace)**

  When Reference is set to Trace, set the reference waveform.
  - Trace: Select a reference waveform. CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math8
    1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
    2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
    3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.
  - Polarity: Select the slope of the edge you want to detect (: rising, : falling).
  - Edge Count: Sets which edge counted from the start point (T Range1) of the measurement time period to use as a detected point (reference point). Selectable range: 1 to 9

- The voltage level of the detected point is the mesial line.
- The measurement item name that appears when the measured values are displayed is (Delay).
- If Mode is set to Degree and Reference is set to Trigger, the measured value is displayed as '*****'.
- If you set the delay measurement's Reference to Trace, measurements will not be performed when the sample rates of the base waveform and the measurement source waveform are different. The measured value is displayed as '*****'.

Detail Parameter (Detail Parameter)

Set the reference level that is used to measure various parameter values, such as the rise and fall times, for each measurement source waveform.

- **Distal, Mesial, and Proximal Unit Setting (Mode)**
  Set the method for setting the three levels that are used as references in the measurement of various parameter values, such as the rise and fall times.
  - %
    You can set the distal, mesial, and proximal values as percentages of the specified trace (CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] or Math1 to Math8). The high value of the specified trace is equal to 100%, and the low value is equal to 0%.
  - Unit
    You can set the distal, mesial, and proximal values of the specified trace (CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] or Math1 to Math8) by specifying physical values, such as voltages or temperatures.
    1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
    2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
    3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

- **Distal, Mesial, and Proximal Settings (Distal, Mesial, Proximal)**
  You can set the distal, mesial, and proximal values.
  Selectable range: 0.0 to 100.0% (in 0.1% steps) or voltage or temperature values that correspond to ± 10 div (the steps that you can set voltage and temperature values in vary depending on the module. See Range of V/div).

- **High/Low Specification Method (High/Low)**
  The high and low levels are the 100% and 0% levels used to measure various parameter values, such as the rise and fall times. You can choose one of the following methods for setting the high and low levels.
  - Auto
    The DL850E/DL850EV sets the high value to the high amplitude level and the low value to the low amplitude level based on the voltage level frequency of the waveform in the measurement time period while taking into account the effects of ringing, spikes, etc. This method is suitable for measuring square waves and pulse waves.
  - Max-Min
    The DL850E/DL850EV sets the high and low values to the maximum and minimum values in the measurement time period. This method is suitable for measuring sinusoidal and saw waves. It is not suitable for waveforms that have ringing and spikes.

Measurement Time Period (Time Range1/Time Range2)

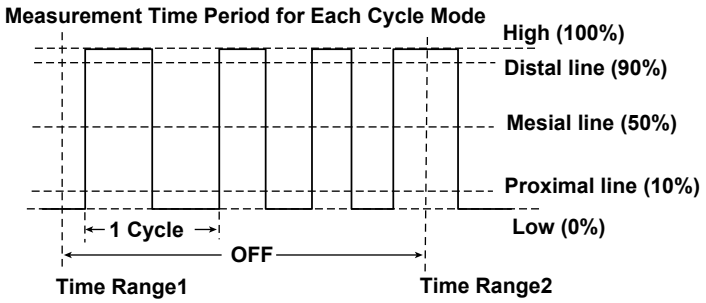
Set the measurement time period using two vertical cursors. The position of the thin dashed line (Time Range1) is the measurement start point. The position of the thick dashed line (Time Range2) is the measurement end point. The number of data points for hard disk recording waveforms can be up to 100 Mpoint from the measurement start point.
The measurement time period is similar to the selectable range of the cursor display position in cursor measurement.
For details, see "Selectable Range of Cursor Positions."
▶ See here.

1-Cycle Mode (1-Cycle Mode)

Instead of automatically measuring the measurement time period specified by Time Range1 and Time Range2, you can automatically measure the first period after Time Range1.
The method of determining the period is the same as the method for determining the Period measurement item.

In this mode, after the period is determined, the values of the measurement items related to voltage and area are computed. This mode is effective for measurement items, such as Rms or Avg, that may result in errors depending on the measurement time period setting.
The measurements of time axis items and X-Y areas are not affected.

- OFF: 1-cycle mode is disabled.
- ON: 1-cycle mode is enabled.



If the space between Time Range1 and Time Range2 is less than one period, "*****" is displayed for the measured value.

Notes about Automated Measurement of Waveform Parameters

- Measurements cannot be made on a snapshot waveform or an accumulated waveform that is not the most recent waveform.
- When an item is impossible to measure its measured value is displayed as '*****'.
  - When the measurement time period exceeds 100 Mpoint on a hard disk recording waveform
  - When the delay measurement mode is Degree and the trigger source is set to the reference of the reference waveform
- The DL850E/DL850EV may not measure correctly if the waveform amplitude is small.
- If there are two or more waveform periods within the measurement time period, the time-axis parameters are measured on the first period.
- When automated measurement is performed on a waveform that has been recorded to a hard disk, extra time will be required for hard disk access.
- Automated measurement may require additional time depending on settings such as the memory length, the number of measurement items, and the input waveform. During automated measurement, appears in the center of the screen.
- To cancel automated measurement, set Mode to OFF. Measurement stops immediately.
- Only the Max and Min items can be measured for FFT waveforms. Only the overall rms power spectrum value can be measured.
- While the dual capture window is displayed, you can perform automated measurements of waveform parameters on captured waveforms.
  To perform automated measurement of the waveform parameters in the main window, turn the display of the dual capture window off.
- The automated measurement results of captured waveforms are displayed in italics.

Normal Statistical Processing (Statistics)

While acquiring waveforms, the DL850E/DL850EV calculates the statistics of the waveforms that it has acquired so far. If you stop waveform acquisition and then restart it, the DL850E/DL850EV will continue statistical processing and include the data from before waveform acquisition was stopped. The DL850E/DL850EV also performs statistical processing for selected automatically measured items that are not displayed. The number of measured values used to calculate statistics (Count) is equal to the number of waveforms that have been acquired up to that point.
If you add an additional automatically measured item to apply statistical processing to, the number of measured values used to calculate the statistics (Cnt) is reset to 1 regardless of whether the DL850E/DL850EV is acquiring waveforms.

Measurement Items (Measure Setup)

Statistical processing is performed on the same measurement items that the automated measurement of waveform parameters is performed on. The following five statistics are computed for the measurement items whose measurement has been turned on. The maximum number of measurement items that can be displayed on the screen is 3.

- Maximum: Maximum value
- Minimum: Minimum value
- Average: Average value
- SDev: Standard deviation
- Count: Number of measured values used to calculate statistics

The measurement items are the same as those for the automated measurement of waveform parameters.
▶ See here.

If you select CH1 P-P as the automatically measured item, the number of measured values used to calculate the maximum, minimum, mean, and standard deviation values for CH1 P-P appear at the bottom of the screen.
The DL850E/DL850EV can display the statistical results of three automatically measured items. If four or more automatically measured items are selected, the DL850E/DL850EV displays the first three items ordered by ascending channel number and the order that the items appear in the Item Setup automated-measurement-item selection menu (P-P, Amp, Max, Min, ..., Init1XY, and Init2XY).
Example 1:
When CH1: P-P, Amp; CH2: Min; CH3: Max, Min are selected, the following items are displayed: CH1: P-P; CH2: Min; CH3:Max.
Example 2:
When CH1: Max, Min; CH2: P-P, Amp are selected, the following items are displayed: CH1: Max, Min; CH2: P-P.
You can view the statistics of other items in the following way.

- Load the items into a PC using the communication feature.
- Save the statistical items as automated measurement values of waveform parameters, and load the data into a PC.
- Scroll through the list of calculated statistics using the arrow keys.

Measurement Time Period (Time Range1/Time Range2)

This setting is the same as the measurement time period setting for the automated measurement of waveform parameters.
▶ See here.

1-Cycle Mode (1-Cycle Mode)

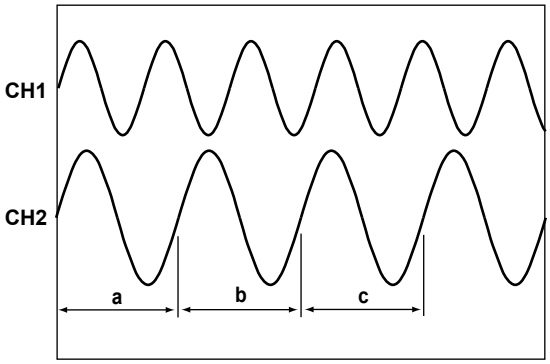
This setting is the same as the 1-cycle mode setting for the automated measurement of waveform parameters.

▶ See here.

Cyclic Statistical Processing (Cycle Statistics)

The DL850E/DL850EV determines periods in order from the oldest data of the displayed waveform, measures the selected automatically measured items within each period, and performs statistical processing on the results of automated measurement. The method used to determine the period in cyclic statistical processing is the same as the method used to determine the Period waveform parameter. You can choose whether to determine the period for the selected waveform and use it on all source waveforms or to determine individual periods for each waveform.

Example in Which Cycle Trace Is Set to CH2



Measures the items in ranges a, b, and c, and calculates statistics on the items in the order a, b, and c.
The items of other channels are also measured in ranges a, b, and c.
If you select Own, the items are measured over each waveform's period.

Measurement Items (Measure Setup)

These items are the same as those for the normal statistical processing of automated measurement parameters.

▶ See here.

The following items are not measured:

- For waveforms that are used in period determination
  Avg.Frequency, Avg.Period, Pulse (pulse count), Integ1XY (area), Integ2XY (area), Delay
- For other waveforms
  Integ1XY (area), Integ2XY (area), Delay

Measurement Time Period (Time Range1/Time Range2)

This setting is the same as the measurement time period setting for the automated measurement of waveform parameters.

▶ See here.

Cycle Trace (Cycle Trace)

Selects the source waveform used to determine the period.

- **CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math to Math8**

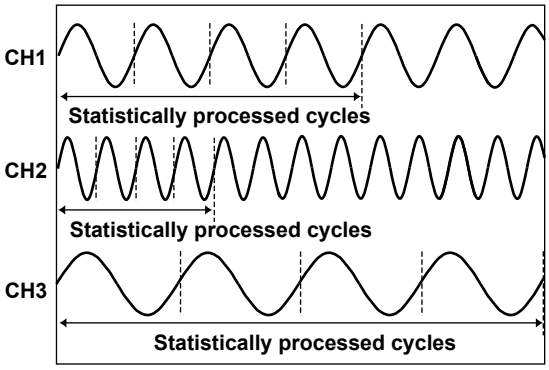
  The period of the specified waveform is applied to all waveforms.

  1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
  2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
  3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

- **Own**

  A period is determined for each source waveform. However, if signals that have different periods are applied to multiple channels, the number of iterations of automated measurement and statistical processing for each signal is equal to the number of periods in the slowest signal.

When Cycle Trace Is Set to Own



The number of cycles in the channel with the slowest cycle (CH3) is four, so statistical processing is performed on the four oldest cycles of the data for CH1 and CH2. The remaining data is not used for statistical processing.

Statistical processing is performed in periods that are determined in order from the oldest data of the displayed waveform. It cannot be used at the same time as 1-cycle mode.

Execution of Measurement (Execute Measure)

Executes statistical processing. You can select Execute Measure when Mode is set to Cycle Statistics or History Statistics.

Press Abort to stop statistical processing.

- The number of cycles being used for the cyclic statistical processing is displayed in the statistical display's Count column.
- The number of cycles that can be used in cyclic statistical processing varies depending on the number of measured items that the DL850E/DL850EV is calculating the statistics of.
  64000/(the number of measured items that the DL850E/DL850EV is calculating the statistics of)
- If the sample rates of the cycle trace and the displayed waveform are different, the displayed waveform will not be measured. The measured value and statistical processing value are both displayed as '*****.'

Result Display (Display Result)

Displays a list of calculated statistics. You can display the list of statistics when Mode is set to Cycle Statistics or History Statistics.
Numbers are assigned to the data in order from the oldest cycle data or history data, and the automated measurement results for each number are displayed.
The maximum and minimum values for each parameter are indicated on the list by ↑ (maximum value) and ↓ (minimum value). If the same value appears in multiple locations, the oldest occurrence of the value is marked as the maximum or minimum value.
The number of data points that can be listed is 64000. If the number of data points exceeds 64000, the most recent data points in the history waveform or automatically measured item data are displayed. If the number of data points exceeds 64000, the maximum and minimum values may be outside of range of the displayed list. When this happens, ↑ (maximum value) and ↓ (minimum value) will not appear.

- **Sort**
  Sorts the list in the specified order.
  Forward (from the oldest) or Reverse (from the latest)
- **Statistics Max**
  Moves to the maximum value (↑) for the selected measurement item.
- **Statistics Min**
  Moves to the minimum value (↓) for the selected measurement item.

In cyclic statistical processing, you can select a waveform number (one period) with the jog shuttle and press the SET key to zoom in on it.

Statistical Processing of History Waveforms (History Statistics)

In the statistical processing of history waveforms, the DL850E/DL850EV measures automatically measured items on the acquired waveform using the history feature and performs statistical processing on them. Statistical processing is performed on older waveform data first. The waveforms that statistical processing is performed on are those waveforms shown in the List that can be accessed from the HISTORY menu. Statistical processing of history waveforms can be used with 1-cycle mode and the delay feature.

Measurement Items (Measure Setup)

These items are the same as those for the normal statistical processing of automated measurement parameters.
▶ See here.

Measurement Time Period (Time Range1/Time Range2)

This setting is the same as the measurement time period setting for the automated measurement of waveform parameters.
▶ See here.

Execution of Measurement (Execute Measure)

This item is the same as the Execute Measure item for cyclic statistical processing.
▶ See here.

- In the statistical processing of history waveforms, the number of history waveforms that processing is performed on is indicated in the Count column of the statistical value display.
- The number of history waveforms that can be used in the statistical processing of history waveforms varies depending on the number of measured items that the DL850E/DL850EV is calculating the statistics of. 64000/(the number of measured items that the DL850E/DL850EV is calculating the statistics of)

Result Display (Display Result)

This item is the same as the Display Result item for cyclic statistical processing.

▶ See here.

In the statistical processing of history waveforms, you can select a waveform with the jog shuttle and press the SET key to zoom in on it.

Notes about Statistical Processing

- During statistical processing,  appears in the center of the screen. All soft keys except for Abort are invalid.
- Statistical processing cannot be performed:
  - On waveforms that have been recorded to a hard disk.
  - On FFT waveforms.
  - On Math waveforms.
- The starting and stopping of statistical processing may require additional time depending on settings such as the record length, the number of statistical processing items, and the input waveform.
- While the dual capture window is displayed, you can perform statistical processing on captured waveforms. To perform statistical processing on the waveforms in the main window, turn the display of the dual capture window off.
- The automated measurement results of captured waveforms are displayed in italics.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

11 Computation

You can perform various computations on up to 1 Mpoint of data. (When more than 1 Mpoint of waveform data is displayed, computation is performed on the first 1 Mpoint of data from the computation start point.)
The results of computation are displayed in Math1 to Math8. Waveforms stored through hard disk recording cannot be computed.

Turning Computation On and Off (Mode)

Select whether to use computation.

- ON: Computation is used.
- OFF: Computation is not used.

Digital Filter and Real Time Math (Optional) ▶ See here.

Computation Waveform Selection (Select Math Trace)

Select a computed waveform to use to display the computation results.
Math1 to Math8

Computation Settings (Math Setup)

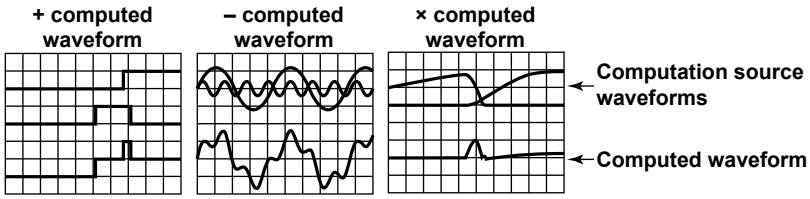
Operators and Functions (Operation)

Select an operator or function (operation definition) from the options below.

- OFF: Computation is not performed.
- S1+S2: Adds the waveforms assigned to Source1 and Source2
- S1−S2: Subtracts the waveform assigned to Source2 from the waveform assigned to Source1
- S1*S2: Multiplies the waveforms assigned to Source1 and Source2
- S1/S2: Divides the waveform assigned to Source1 by waveform assigned to Source2
- Bin(S1): Converts the waveform assigned to Source to binary
- PS(S1): Computes the power spectrum of the waveform assigned to Source
- Shift(S1): Shows the waveform assigned to Source with its phase shifted
- User Define: Performs user-defined computation (/G2 option).

Basic Arithmetic (S1+S2, S1−S2, S1*S2, and S1/S2)

Performs addition, subtraction, multiplication, or division on the two waveforms assigned to Source1 and Source2.



Computation Source Waveforms (Source1 and Source2)

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math7[4]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.
4 You can use other computed waveforms as computation source waveforms. If the waveform that you are configuring is MathX, you can use a computation waveform up to MathX − 1 as the computation source waveform. You cannot use another computation waveform as the computation source waveform for Math1.

When computation is performed on a linearly scaled channel, the scaled values are used.

Unit (Unit)

You can assign a unit of up to four characters in length to the computed results. The specified unit is reflected in the scale values.

Label (Label)

You can create a label of up to eight characters in length. The labels that you create are displayed on the screen.

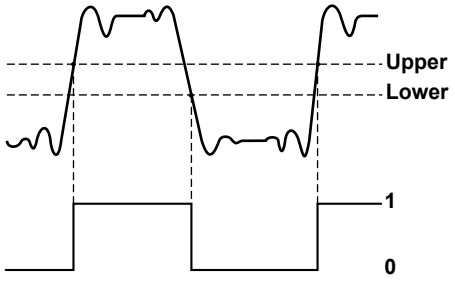
Turning the Display On and Off (Display)

Select whether to display the computed waveform.

- ON: Displays the computed waveform
- OFF: Does not display the computed waveform

Binary Conversion (Bin (S1))

Using the specified threshold levels, you can convert the waveform assigned to Source to a digital waveform.



Computation Source Waveform (Source), Unit (Unit), Label (Label), and Turning the Display On and Off (Display)

These settings are the same as those for basic arithmetic.

▶ See here.

Upper and Lower Thresholds (Thr. Upper/Thr. Lower)

Set the upper and lower threshold values. All values above the upper threshold on the computation source waveform are converted to ones, and all values below the threshold are converted to zeros.

Power Spectrum (PS (S1))

Performs an FFT (fast Fourier transform) on the waveform assigned to Source, and displays a power spectrum. You can use this function to view the frequency distribution of an input signal.

Computation Source Waveform (Source), Unit (Unit), Label (Label), and Turning the Display On and Off (Display)

These settings are the same as those for basic arithmetic.

▶ See here.

FFT Settings (FFT Setup)

Select the data points and window function to use for the FFT.

- **Number of FFT Points (FFT Points)**

  You can set the number of points from the start of computation on the T-Y waveform to one of the options below.

  1k, 2k, 5k, 10k, 20k, 50k, or 100k

- **Window Function (Window)**

  You can select the window function from the following options.

  Rect, Hanning, Flat Top, Hamming

  ▶ See here.

Phase Shift (Shift (S1))

You can shift the phase of the waveform assigned to Source, display the resulting waveform, and use the phase-shifted data in computations.

Computation Source Waveform (Source), Unit (Unit), Label (Label), and Turning the Display On and Off (Display)

These settings are the same as those for basic arithmetic.

▶ See here.

Shift (Shift)

You can shift waveforms within the following ranges.

- **When an Internal Clock Is Being Used as the Time Base**

  Selectable range: The time values between −(record length/2) points to (record length/2 points)

  Step: 1 ÷ sample rate

  The sample rate varies depending on how the record length and Time/div settings are configured. For details, see appendix 1, “Relationship between the Time Axis Setting, Record Length, and Sample Rate” in the *Getting Started Guide*, IM DL850E-03EN.

- **When an External Clock Is Being Used as the Time Base**

  Selectable range: −(record length/2) points to (record length/2 points)

  Step: 1

Scaling Mode (Scaling Mode)

Set the method used to set the vertical display range of computed waveforms to one of the following options.

- Auto: The upper and lower limits are set automatically.
- Manual: The upper and lower limits must be set manually.

Upper and Lower Limits (Upper/Lower)

Set the upper and lower limits when Scaling Mode is set to Manual.

The selectable range is −9.9999E+30 to 9.9999E+30.

Start Point and End Point (Start Point/End Point)

Set the range of computation by specifying a computation start and end point. The default settings are −5 div and +5 div.

The maximum range from the computation start point to the computation end point varies as indicated below depending on the number of computations.

- One computation: Up to 1 Mpoint
- Two computations: Up to 500 kpoint
- Three or four computations: Up to 250 kpoint
- Five to eight computations: Up to 125 kpoint

The computation range points are similar to the settable range of the cursor display position in cursor measurement.

For details, see “Selectable Range of Cursor Positions.”

▶ See here.

An icon ( ) appears in the center of the top of the screen when computations are being executed.

User-Defined Computation (Optional)

You can perform user-defined computation on models with the /G2 option.

Operators and Functions (Operation)

Select User Define.

Expression (Expression) - user-defined

Create an expression by combining computation source waveforms, variables, constants, functions, and operators.

Computation Source Waveforms and Variables

You can use the following waveforms and variables.

Menu Item	Description
C1 to C16	Waveforms from CH1 to CH16
Cn_1 to Cn_16	• The waveforms of sub channels 1 to 16 on a 16-CH voltage input module or a 16-CH temperature/voltage input module. • Channel number where n = 1, 3, 5, 7, 9, 11, 13, 15
Cn_1 to Cn_60	• The waveforms of sub channels 1 to 60 on a CAN bus monitor module • The waveforms of sub channels 1 to 60 on a CAN/CAN FD monitor module • The waveforms of sub channels 1 to 60 on a CAN & LIN bus monitor module • Channel number where n = 13 to 16 • If the data type (Value Type) is set to Logic, you will not be able to select it.
Cn_1 to Cn_11	• The waveforms of sub channels 1 to 11 on a SENT monitor module • Channel number where n = 9 to 16 • S&C and Error Trigger sub channels cannot be selected.
Cn_1 to Cn_8	• Logic module waveforms • Channel number where n = 1 to 16 Specify using the following syntax: Cn_1, upper limit, lower limit.
Cn_1 or Cn_2	• The waveforms of sub channels 1 and 2 on a 4-CH module • Channel number where n = 1 to 16
M1 to M7	Math waveforms
T	Total number of data points in the time direction

When computation is performed on a linearly scaled channel, the scaled values are used.

Operators and Functions

You can use the following operators and functions.

Menu Item	Example	Description
+, −, *, /	C1+C2	Displays the result of performing basic arithmetic on two specified waveforms
SHIFT	SHIFT(C1, Time)	Displays the result of shifting the specified waveform's phase (for internal clock). The unit is seconds.
	SHIFT(C1, Count)	Displays the result of shifting the specified waveform's phase (for external clock).
ABS	ABS(M1)	Displays the absolute values of the specified waveform
SQRT	SQRT(C2)	Displays the square root of the specified waveform
LOG	LOG(C1)	Displays the log of the specified waveform
EXP	EXP(C1)	Displays the exponent of the specified waveform
NEG	NEG(C1)	Displays the specified waveform inverted around 0
SIN	SIN(T)	Displays the sine of the specified waveform
COS	COS(C1)	Displays the cosine of the specified waveform
TAN	TAN(C1)	Displays the tangent of the specified waveform
ATAN	ATAN(C1)	Displays the arc tangent of the specified waveform (a value within ±π)
PH	PH(C1, C2)	Displays the phase difference between the two specified waveforms
DIF	DIF(C1)	Displays the derivative of the specified waveform
DDIF	DDIF(C1)	Displays the 2nd order derivative of the specified waveform
INTG	INTG(C1)	Displays the integral of the specified waveform
IINTG	IINTG(C1)	Displays the double integral of the specified waveform
BIN	BIN(C1, Up, Lo)	Displays the result of converting specified waveform to binary[1]
P2	P2(C1)	Displays the square of the specified waveform
P3	P3(C1)	Displays the cube of the specified waveform
F1	F1(C1, C2)	Displays the result of computing $\sqrt{\lvert C1^2+C2^2 \rvert}$ for the specified waveforms
F2	F2(C1, C2)	Displays the result of computing $\sqrt{\lvert C1^2-C2^2 \rvert}$ for the specified waveforms
FV	FV(C1, Up, Lo)	Displays the inverse of the PWHH of the pulse width[1]
PWHH	PWHH(M1, Up, Lo)	Displays the computation of the pulse widths between a rising edge and the next rising edge[1]
PWHL	PWHL(C2, Up, Lo)	Displays the computation of the pulses width between a rising edge and the next falling edge[1]
PWLH	PWLH(C1, Up, Lo)	Displays the computation of the pulse widths between a falling edge and the next rising edge[1]
PWLL	PWLL(C1, Up, Lo)	Displays the computation of the pulse widths between a falling edge and the next falling edge[1]
PWXX	PWXX(C2, Up, Lo)	Displays the computation of the pulse widths from a rising or falling edge to the next rising or falling edge[1]
DUTYH	DUTYH(C1, Up, Lo)	Positive (high) duty cycle within each cycle of the specified waveform[1]
DUTYL	DUTYL(C1, Up, Lo)	Negative (low) duty cycle within each cycle of the specified waveform[1]
FILT1	FILT1(C1)	Displays the result of applying a filter to the specified waveform
FILT2	FILT2(C1)	Displays the result of applying a filter to the specified waveform
HLBT	HLBT(C1)	Displays the Hilbert transform of the specified waveform
MEAN	MEAN(C1)	Displays the 10th-order moving average of the specified waveform
LS-	LS-MAG(C1)	Displays the magnitude of the specified waveform's linear spectrum
	LS-LOGMAG(C1)	Displays the logarithmic magnitude of the specified waveform's linear spectrum
	LS-PHASE(C1)	Displays the phase of the specified waveform's linear spectrum
	LS-REAL(C1)	Displays the real part of the specified waveform's linear spectrum
	LS-IMAG(C1)	Displays the imaginary part of the specified waveform's linear spectrum
RS-	RS-MAG(C1)	Displays the magnitude of the specified waveform's RMS spectrum[2]
	RS-LOGMAG(C1)	Displays the logarithmic magnitude of the specified waveform's RMS spectrum[2]
PS-	PS-MAG(C1)	Displays the magnitude of the specified waveform's power spectrum
	PS-LOGMAG(C1)	Displays the logarithmic magnitude of the specified waveform's power spectrum
PSD-	PSD-MAG(C1)	Displays the magnitude of the specified waveform's power spectrum density
	PSD-LOGMAG(C1)	Displays the logarithmic magnitude of the specified waveform's power spectrum density

Menu Item	Example	Description
CS-	CS-MAG(C1, C2)	Displays the magnitude of the cross spectrum of the two specified waveforms
	CS-LOGMAG(C1, C2)	Displays the logarithmic magnitude of the cross spectrum of the two specified waveforms
	CS-PHASE(C1, C2)	Displays the phase of the cross spectrum of the two specified waveforms
	CS-REAL(C1, C2)	Displays the real part of the cross spectrum of the two specified waveforms
	CS-IMAG(C1, C2)	Displays the imaginary part of the cross spectrum of the two specified waveforms
TF-	TF-MAG(C1, C2)	Displays the magnitude of the transfer function of the two specified waveforms
	TF-LOGMAG(C1, C2)	Displays the logarithmic magnitude of the transfer function of the two specified waveforms
	TF-PHASE(C1, C2)	Displays the phase of the transfer function of the two specified waveforms
	TF-REAL(C1, C2)	Displays the real part of the transfer function of the two specified waveforms
	TF-IMAG(C1, C2)	Displays the imaginary part of the transfer function of the two specified waveforms
CH-	CH-MAG(C1, C2)	Displays the magnitude of the coherence function of the two specified waveforms

1 Set the source waveform and the upper and lower threshold levels (Up and Lo). These are the only functions that can be used on logic module waveforms.
2 The RS function canbe used on models with firmware version 2.05 and later.

Constants

Menu Item	Description
K1 to K8	▶ See here.
0 to 9	−
Exp	E notation. Selectable range: −30 to +30 Use this constant to enter values in E notation (1E+3 = 1000, 2.5E−3 = 0.0025). It is displayed as “E” in expressions to distinguish it from the “EXP” operator.

Automated Measurement Values of Waveform Parameters (Measure)

You can use the automated measurement values of waveform parameters in expressions. The DL850E/DL850EV cannot retrieve waveform parameter values when the display of the measurement source waveform is off.

Combinations of Operators That Are Not Allowed

- An expression cannot be used in another expression with a smaller number.
  Example: Math5 = M6 + M3
- Expressions containing only constants (K1 to K8) are not allowed.
  Example: Math5 = K1 + K8
- An expression can contain only up to two FILT1 or FILT2 functions.
  Example: FILT1(C1)+FILT1(C2)+FILT1(C3)
- A single FFT expression can contain only one operator.
  Example: PS−MAG(C1+C2)
- Additional computations cannot be performed on FFT results.
  Example: PS−MAG(C1)+C2
- Additional computations cannot be performed on pulse width computations.
  Example: PWHH(C1)+C2
- Only one operator can be used in a single phase-shift computation, pulse-width computation, or binary-conversion expression.
  Example: SHIFT(C1+C2), BIN(C1−C2), PWHH(C1*C1)

If you want to perform an FFT, phase-shift, pulse-width, or binary-conversion computation on the computed results of an expression such as C1+C2, create expressions like these: M1=C1+C2, M2=PS−MAG(M1).

Unit (Unit), Label (Label), and Turning the Display On and Off (Display)

These settings are the same as those for basic arithmetic.

▶ See here.

Scaling Mode (Scaling Mode), Upper and Lower Limits (Upper/Lower), and Start and End Points (Start Point/End Point)

▶ See here.

Averaging Settings (Average Setup) - user-defined

You can average and compute the peak values of the results of user-defined computation.

Averaging Modes (Average Mode)

The following types of averaging are available.

- OFF: Averaging is not performed.
- Linear averaging (Linear): Values are averaged linearly.
- Exponential averaging (Exp): Values are averaged exponentially.
- Cycle averaging (Cycle): Values are averaged across cycles.
- Peak computation (Peak): Peak values are computed.

Linear Averaging (Linear)

The number of values specified by the average count are added and divided by the average count, and the resulting values are used to display the waveform. For the equation, see the equation for linear averaging in Averaging Mode.

- **Average Domain (Average Domain)**

  Select what to average.
  - Time: A time-domain waveform is averaged.
  - Freq: A frequency-domain waveform is averaged.

- **Linear Count (Linear Count)**

  Set the average count.
  Selectable range: 2 to 128 in 2^n steps

Exponential Averaging (Exp)

Using the specified attenuation constant, the DL850E/DL850EV attenuates the influence of previous computed data to produce averaged values, and uses the results to display the waveform. For the equation, see the equation for exponential averaging in Averaging Mode.

- **Average Domain (Average Domain)**

  ▶ See here.

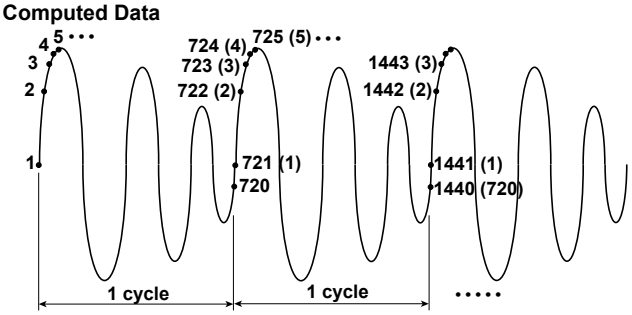
- **Attenuation Constant (Average Weight)**

  Set the attenuation constant.
  Selectable range: 2 to 256 in 2^n steps

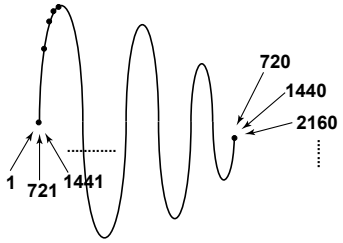
Cycle Averaging (Cycle)

The data from the computation start point to the computation end point is divided into the number of data points (Cycle Count) that is specified as being a single cycle, and equivalent points in each divided cycle are averaged with each other. The resulting values are used to display the waveform.
The figure below shows the results of cycle averaging when Cycle Count is set to 720.

Computed Data



Cycle Averaging Results
Equivalent points in each divided cycle are linearly averaged, and the resulting values are used to display the waveform.



- **Cycle Count (Cycle Count)**

  Set the number of data points in one cycle.
  Selectable range: 10 to 1800

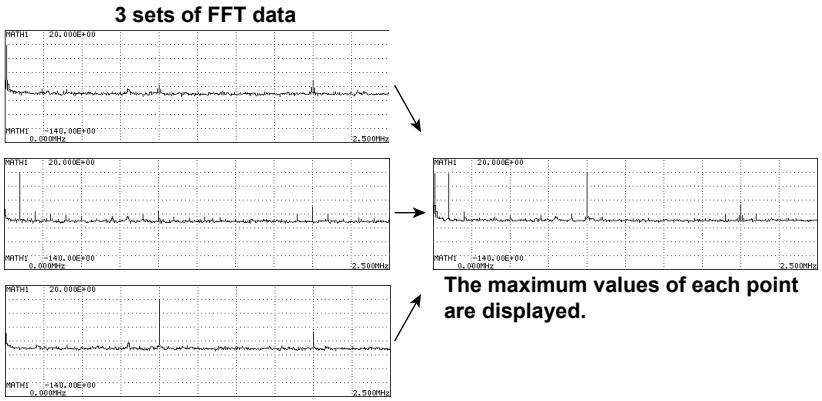
- All the data between the computation start and end points can be computed. If the data cannot be divided evenly by the specified cycle count, the remaining data is ignored.
- Cycle averaging cannot be performed on an FFT waveform.

- **Cycle Averaging Example**

  When the record length is 10 kpoint, the cycle count is 720, the computation start point is −5.000 div, and the computation end point is +5.000 div
  10 k/720 = 13.88... : 13 cycles are used for the computation.
  13 × 720 = 9360 : The data from the computation start point (point 1) to point 9360 is included in the cycle average computation.

Peak Computation (Peak)

The maximum value at each point of the computed data is determined, and the resulting values are used to display the waveform. For each computation, the new computed value is compared with the past value, and the larger value is kept.



- The DL850E/DL850EV normally performs scaling by using the computed data at the beginning (auto scaling). For coherence functions and in other cases where the amplitude of the averaged waveform changes significantly, use manual scaling.
- When you execute averaging, after measurement is stopped, computation cannot be restarted. However, computation can be restarted if the number of data points for cycle averaging is changed.
- If you measure an averaged waveform with auto scaling enabled, you cannot change the scaling by switching to manual scaling after measurement has stopped. Changes to the scaling settings are applied to the next measurement.
- In user-defined computation, averaging cannot be performed on pulse width computation.
- If you change the computation conditions during averaging, the computed data up to that point is deleted, and averaging starts over.

FFT Settings (FFT Setup) - user-defined

FFT computation is performed when you specify an operator that uses FFT computation (LS, PS, PSD, CS, TF, or CH). Set the number of FFT points, the window function, the damping rate, and Force1 and Force2.
The results of the FFT appear in the selected computation waveform. Other than the fact that no FFT window is displayed, this is the same as the FFT computation that can be performed from the FFT menu.

▶ See here.

Filter Settings (Filter Setup) - user-defined

When using FILT1 and FILT2 in user-defined computation, set the digital filter type, filter band, and cutoff frequency for each of the two filters (Filter1 and Filter2).

Filter Type (Filter Type) and Filter Band (Filter Band)

Filter Type (Filter Type)	Filter Band (Filter Band)
Gauss	Low-Pass
Sharp	Low-Pass, High-Pass, Band-Pass
IIR (Butterworth)	Low-Pass, High-Pass, Band-Pass

CutOff1 and CutOff2 (CutOff1/CutOff2)

Set the cutoff frequency. When Filter Band is set to Low-Pass or High-Pass, set CutOff1; when Filter Band is set to Band-Pass, set CutOff1 and CutOff2.
Selectable range: 2.0 to 30.0% of the sample rate
Resolution: Steps of 0.2% of the sample rate

Constant Settings (Constant Setup) - user-defined

Set values for K1 to K8.
The selectable range is −9.9999E+30 to 9.9999E+30.

Notes about Computation

- FFT computation can be performed through the configuration of settings in the Math menu or the FFT menu (▶ See here.). In the FFT menu, you can set the display format and choose a linear or logarithmic frequency domain (horizontal axis) scale. The data point , window function and unit settings are shared for the Math and FFT menus. When you change the settings in one menu, the settings in the other menu are also changed.
- On models that do not have user-defined computation (/G2 option), when you enter the FFT menu and turn FFT computation on, the Math7 operators become invalid and Math7 cannot be used. On models that do have user-defined computation, when you enter the FFT menu and set FFT 1 and FFT 2 to ON, Math7 and Math8 cannot be used.
- When you perform FFT computation on 50 kpoint or more of data using the FFT menu, you cannot use computed waveforms.
- An icon () appears in the center of the top of the screen when user-defined computation is being executed.
- Waveforms stored through hard disk recording cannot be computed.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

12 FFT

You can display the power spectrum of an input waveform in the FFT window. On models with user-defined computation (/G2 option), you can display up to two FFT waveforms, and you can analyze the following spectrums in addition to the power spectrum. However, FFT analysis cannot be performed on waveforms stored through hard disk recording.

Linear spectrums, power spectrum densities, cross spectrums, transfer functions, and coherence functions

Turning the FFT On and Off (Display)

Set whether to perform FFT analysis. If you set this to ON, the FFT window appears.

- ON: FFT analysis is performed.
- OFF: FFT analysis is not performed.

Analysis Source Waveform (Source)

Set the analysis source waveform to one of the waveforms below.

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] Math1 to Math6[4]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.

2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

4 You cannot select Math7 or Math8.

When analysis is performed on a linearly scaled channel, the scaled values are used.

Start Point and Number of FFT Points (Start Point and FFT Points)

Start Point (Start Point)

Set the computation start point. The default setting is −5 div.

Selectable range: −5 div to +5 div

The start point is similar to the settable range of the cursor display position in cursor measurement.

For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Number of FFT Points (FFT Points)

You can set the number of points from the start of computation on the T-Y waveform to one of the options below.

1k, 2k, 5k, 10k, 20k, 50k, or 100k

Window Function (Window)

You can select the window function from the following options.

Rect (Rectangular window)

The rectangular window is suited to transient signals, such as impulse waves, which attenuate completely within the time window.

Hanning (Hanning window)

The Hanning window encourages continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, it is suited to continuous signals. The Hanning window has a higher frequency resolution than the flattop window.

FlatTop (Flattop window)

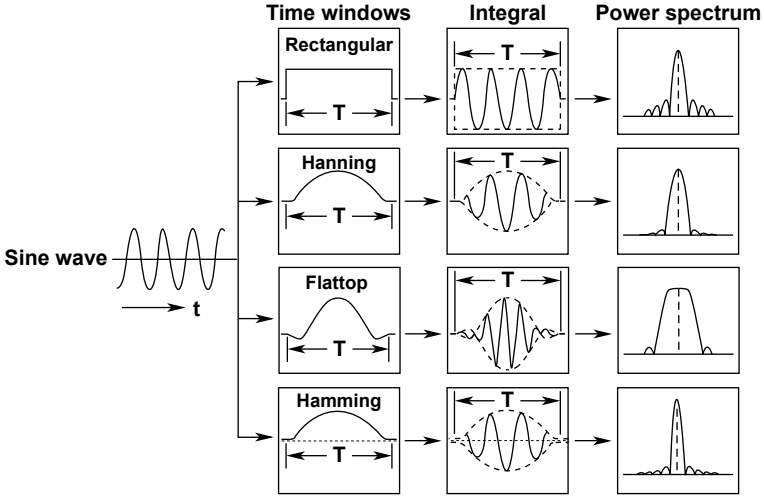
The flattop window encourages continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, it is suited to continuous signals. The flattop window has a higher spectral level accuracy than the flattop window.

Hamming (Hamming window)

In the Hanning window, the values at the ends become 0 and the signal components there do not affect the spectrum. The Hamming window is a corrected Hanning window. Its characteristics are similar to those of the Hanning window, but the frequency resolution of its main beam is greater than that of the Hanning window. The Hamming window is suited for dividing close signals.

Exponential (Exponential)

The exponential window removes noise from the signal. It can be selected only on models with the user-defined computation option. The exponential window is suited for the signals of impulse-excitation frequency-response tests and other similar signals.



Rectangular : $W(t) = u(t) - u(t - T)$ u(t): Step function

Hanning : $W(t) = 0.5 - 0.5\cos(2\pi\frac{t}{T})$

Flattop : $W(t) = \{0.54 - 0.46\cos(2\pi\frac{t}{T})\}\frac{\sin\{2\pi(1 - 2t/T)\}}{2\pi(1 - 2t/T)}$

Hamming : $W(t) = 0.54 - 0.46\cos(2\pi\frac{t}{T})$

For details about the exponential window, see appendix 2.

Vertical Scale (Vert. Scale Mode)

You can select the method for setting the vertical scale from the following options.

- Auto: The center and scale of the vertical axis are set automatically.
- Manual: The center and scale of the vertical axis must be set manually.

Center/Scale (Center/Sensitive)

When Vert. Scale Mode is set to Manual, set the center and scale of the vertical axis.

Display Ratio of the Main Window (Main Ratio)

▶ See here.

Window Layout (Window Layout)

Set the display position of the FFT window.

- Side: Horizontal
- Vertical: Vertical

Horizontal Scale (Horiz. Axis)

Select one of the following horizontal scale types.

- Hz: A normal (linear) scale is used.
- Log Hz: A logarithmic scale is used.

Unit (Unit)

▶ See here.

Horizontal Zoom (Horiz. Scale)

Select one of the following horizontal display ranges.

- Auto: The horizontal center point and span are set automatically (the entire range is displayed).
- Left/Right: You must set the left and right ends of the display range manually.
- Center/Span: You must set the horizontal center point and span manually. You can select this only when the horizontal scale is set to Hz.

Horizontal Range (Left/Right, Center/Span)

Horizontal Range (Left/Right)

When the horizontal zoom is set to Left/Right, set the left and right ends of the horizontal display range.
Selectable range: 0.00 kHz to the maximum frequency

Horizontal Range (Center/Span)

When the horizontal zoom is set to Center/Span, set the center point and span of the horizontal display range.
Selectable range of the center: 0.00 kHz to the maximum frequency
Selectable range of the span: the frequency resolution x10 to the maximum frequency

FFT Analysis with User-Defined Computation (Optional)

You can analyze the following types of spectrums on models with user-defined computation (/G2 option).

Linear spectrums, power spectrum densities, cross spectrums, transfer functions, and coherence functions

Turning FFT 1 and FFT 2 On and Off (Display)

Set whether to perform FFT analysis. If you set this to ON, the FFT windows appear. You can display separate FFT analysis results in the FFT 1 and FFT 2 windows.

- ON: FFT analysis is performed.
- OFF: FFT analysis is not performed.

FFT Settings (FFT Setup)

Set the spectrum type, the window function, and the type of averaging.

Spectrum Type (Type/Sub Type)

Set the spectrum type.

Type	Sub Type	Description
LS	MAG	Magnitude of the specified waveform's linear spectrum
LS	LOGMAG	Logarithmic magnitude of the specified waveform's linear spectrum
LS	PHASE	Phase of the specified waveform's linear spectrum
LS	REAL	Real part of the specified waveform's linear spectrum
LS	IMAG	Imaginary part of the specified waveform's linear spectrum
RS	MAG	Magnitude of the specified waveform's RMS spectrum
RS	LOGMAG	Logarithmic magnitude of the specified waveform's RMS spectrum
PS	MAG	Magnitude of the specified waveform's power spectrum
PS	LOGMAG	Logarithmic magnitude of the specified waveform's power spectrum
PSD	MAG	Magnitude of the specified waveform's power spectrum density
PSD	LOGMAG	Logarithmic magnitude of the specified waveform's power spectrum density
CS	MAG	Magnitude of the cross spectrum of the specified two waveforms
CS	LOGMAG	Logarithmic magnitude of the cross spectrum of the specified two waveforms
CS	PHASE	Phase of the cross spectrum of the specified two waveforms
CS	REAL	Real part of the cross spectrum of the specified two waveforms
CS	IMAG	Imaginary part of the cross spectrum of the specified two waveforms
TF	MAG	Magnitude of the transfer function of the specified two waveforms
TF	LOGMAG	Logarithmic magnitude of the transfer function of the specified two waveforms
TF	PHASE	Phase of the transfer function of the specified two waveforms
TF	REAL	Real part of the transfer function of the specified two waveforms
TF	IMAG	Imaginary part of the transfer function of the specified two waveforms
CH	MAG	Magnitude of the coherence function of the specified two waveforms

Analysis Source Waveforms (Source1 and Source2)[1]

Set the analysis source waveform to one of the waveforms below.

CH1 to CH16,[2] 16chVOLT,[3] 16chTEMP/VOLT,[3] CAN,[4] LIN,[4] SENT,[4] Math1 to Math6[5]

1 You can set Trace2 when Type is set to CS, TF, or CH.
2 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
3 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
4 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.
5 You cannot select Math7 or Math8.

When analysis is performed on a linearly scaled channel, the scaled values are used.

Window Function (Window)

▶ See here.

- **Damping Rate (Damping Rate)**

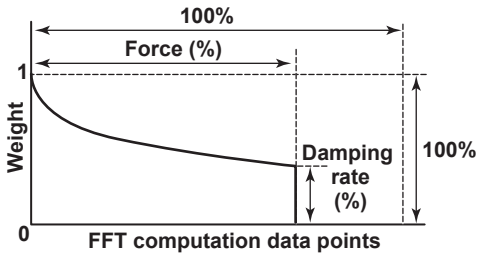
  You can configure this setting when Window is set to Exponential. You can set the value in the range of 1 to 100% (1% resolution). The weight of the last data point is used as a damping rate, with the weight of the first data point of the FFT computation taken to be 100% (= 1). When the damping rate is set to 100%, the window functions like a rectangular window. This setting applies to the input and output (response) signals.

- **Force1**

  You can configure this setting when Window is set to Exponential. Set the area over which computation is performed in terms of a percentage from the first FFT point, taking the number of FFT points to be 100%. You can set the area to a value from 1 to 100% (in 1% steps). When the area is set to 100%, the window functions like a rectangular window. The outer area is the average of the results of the window function for the data outside the area. This setting applies to the input signals (first parameter) of one-waveform and two-waveform FFTs.

- **Force2**

  You can configure this setting when Window is set to Exponential. This setting applies to the output (response) signal (second parameter) of a two-waveform FFT. It can be set in the same manner as Force1.



Average (Average)

FFT analysis data can be linearly or exponentially averaged, and its peak values can be computed. These settings are the same as those for user-defined computation.

▶ See here.

Notes about FFT Computation

Notes about Displaying Power Spectrums

- You cannot display a power spectrum if the display record length is less than the number of computed data points.
- The following settings are shared for all computation channel: FFT Points, Window, and Start Point.
- When using the commands in the menu that appears when you press the ZOOM key to zoom FFT waveforms horizontally, you cannot set the number of displayed waveform points to 50 or less.

Notes about Computation

- Computation is normally performed on the sampled data in the acquisition memory. For waveforms that are acquired in Envelope mode, computation is performed on the maximum and minimum values at each acquisition interval.
- FFT computation can be performed through the configuration of settings in the Math menu or the FFT menu. The data point , window function and unit settings are shared for the Math and FFT menus. When you change the settings in one menu, the settings in the other menu are also changed.
- On models that do not have user-defined computation (/G2 option), when you enter the FFT menu and turn FFT computation on, the Math7 operators become invalid, and Math7 cannot be used. On models that do have user defined computation, when you enter the FFT menu and set FFT 1 and FFT 2 to ON, Math7 and Math8 cannot be used.
- When you perform FFT computation on 50 kpoint or more of data using the FFT menu, you cannot use computed waveforms.
- An icon () appears in the center of the top of the screen when FFT computation is being executed.
- FFT analysis cannot be performed on waveforms stored through hard disk recording.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

13 GO/NO-GO Determination

The DL850E/DL850EV determines whether the acquired waveform meets the reference condition (GO result) or not (NO-GO result). When the DL850E/DL850EV produces a GO or NO-GO result, it executes the specified actions.

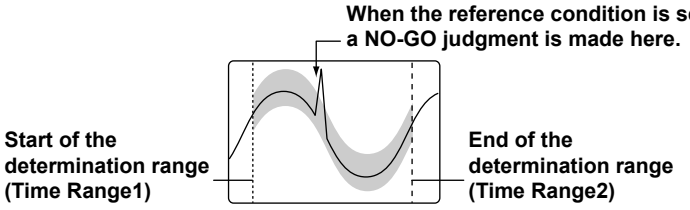
Mode (Mode)

Set the method for GO/NO-GO determination.

- OFF: GO/NO-GO determination is not performed.
- Waveform zone (Wave Zone): GO/NO-GO determination is performed using a waveform zone configured on the screen.
- Waveform parameter (Parameter): GO/NO-GO determination is performed through the use of the specified waveform parameters.

Waveform Zone (Wave Zone)

The DL850E/DL850EV returns GO/NO-GO results based on whether waveforms leave or enter the zone that you create using a base waveform.



Editing a Waveform Zone (Edit Zone)

Select the number of the waveform zone you want to edit from the range indicated below. If a zone has already been created for that number, the zone will be displayed. If no zone has been created for a number, select a base waveform from the base waveform editing menu (New), and then edit the zone.

Zone 1 to Zone 6 (Zone1 to Zone6), Cancel[1]

1 The selected menu closes.

Editing a Base Waveform (New)

When you create a new waveform zone, you need to select the waveform that you will base it on (the base waveform). Select a waveform whose display is on.

CH1 to CH16[1], Math1 to Math8, Cancel (Cancel)[2]

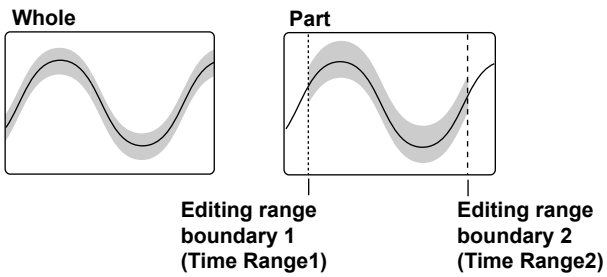
1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. However, you cannot select the channel of a logic module, 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.

2 The selected menu closes.

Specifying the Editing Range (Edit)

Select the part of the base waveform that you want to edit.

- Whole (Whole): The whole waveform is within the editing range.
- Part (Part): A portion of the waveform is within the editing range.



Zone Settings

When Edit is set to Whole, you can set the upper, lower, left, and right boundaries of the waveform zone. When Edit is set to Part, you can set the upper and lower boundaries of the zone.

- Upper and lower boundaries (Upper and Lower)
  Selectable range: ±10 div vertically from the base waveform
  When Edit is set to Part, you can set the upper and lower boundaries of the area between Time Range1 and Time Range2.
- Left and right sides (Left and Right): These settings can be configured only when Edit is set to Whole.
  Selectable range: ±5 div from the center of the screen
- Time range 1 and time range 2 (Time Range1 and Time Range2): These settings can be configured only when Edit is set to Part.
  Selectable range: ±5 div on the time axis

Save Destination (Store as)

You can select one of the following save destinations for the waveform zone.

- Zone 1 to zone 6 (Zone1 to Zone6): The save destination is changed to the selected zone number.
- Cancel (Cancel): The save destination is not changed.

Saving a Waveform Zone (Execute Store)

Save the waveform zone.

Ending Editing (Quit)

Exit the waveform zone editor. If you do not press the Execute Store soft key to save the zone that you have edited, it will be lost.

Judgment Conditions (Judgement Setup)

For each of 16 judgment conditions, you can set the source waveform, zone number, and judgment criterion. You can also set the judgment logic, action condition, sequence, and acquisition count and enable or disable synchronization with a remote signal.

Judgment Criterion (Mode)

Select the judgment criterion from the following options.

- X: The condition is not used for GO/NO-GO determination.
- IN: The DL850E/DL850EV returns a GO result when the source waveform is within the GO/NO-GO determination zone. If even part of the source waveform is outside of the determination zone, the DL850E/DL850EV returns a NO-GO result.
- OUT: The DL850E/DL850EV returns a GO result when the entire source waveform is outside the GO/NO-GO determination zone. If even part of the source waveform is inside the determination zone, the DL850E/DL850EV returns a NO-GO result.

Source Waveform (Trace)

Set the waveform to use for GO/NO-GO determination to one of the waveforms below.
CH1 to CH16[1], Math1 to Math8

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. However, you cannot select the channel of a logic module, 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.

Zone Number (Zone No.)

Select the number of the waveform zone you want to use for GO/NO-GO determination from the range indicated below.
Zone 1 to zone 6 (Zone1 to Zone6)

Determination Logic (Logic)

You can select the determination logic from the following options.

- AND: The actions are performed when all the conditions from 1 to 16 are met.
- OR: The actions are performed when a condition from 1 to 16 is met.

Action Condition (ActCondition)

Set the action condition to one of the settings below.

- Always (Always): The actions are always performed. The actions will be executed each time that the DL850E/DL850EV triggers.
- At failure (Fail): The actions are executed when the specified GO conditions are not met.
- At success (Success): The actions are executed when the specified GO conditions are met.

Sequence (Sequence)

Select the sequence for executing actions.

- Single (Single): Execution stops after the actions are performed once.
- Continue (Continue): Actions are executed repeatedly. However, the actions stop repeating after the number of specified waveform acquisitions (the Acquisition Count setting). If Acquisition Count is set to Infinite, the actions continue until waveform acquisition is stopped by the pressing of the START/STOP key.

Acquisition Count (Acquisition Count)

Set the number of waveform acquisitions.

- Infinite: Waveform acquisition continues until it is stopped by the pressing of the START/STOP key.
- 1 to 65536: The DL850E/DL850EV stops waveform acquisition after it acquires the specified number of waveforms.

External Start (Ext Start)

You can perform GO/NO-GO determination and output the results in sync with an external signal applied to the GO/NO-GO I/O terminal of the DL850E/DL850EV.

- OFF: GO/NO-GO determination is not performed through the use of an external signal.
- ON: GO/NO-GO determination is performed through the use of an external signal.

Action (Action)

▶ See here.

Determination Period (Time Range1 and Time Range2)

You can set the determination period by setting Time Range1 and Time Range2. The default settings are −5 div and +5 div.

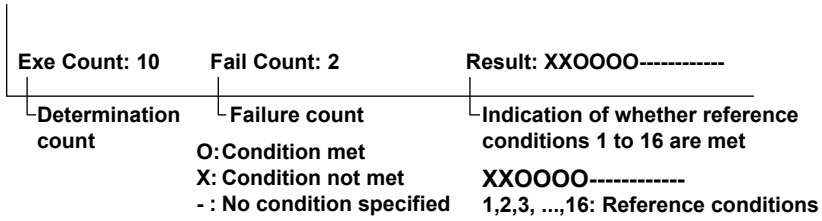
Selectable range: −5 div to +5 div

The determination period is similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

GO/NO-GO Determination Results

The results of GO/NO-GO determination (and the numbers of determinations and failures) appear at the bottom of the screen.



In this example, reference conditions 1 and 2 are not met while the conditions defined by base waveforms 3 to 6 are met.

Waveform Parameters (Parameter)

Set the upper and lower limits for automated measurement values of waveform parameters, and perform GO/NO-GO determination based on whether the values are within or outside of the limits.

Judgment Conditions (Judgement Setup)

For each of 16 judgment conditions, you can set the source waveform, waveform parameter, and upper and lower waveform parameter limits. You can also set the judgment logic, action condition, sequence, and acquisition count and enable or disable synchronization with an external start signal.

Judgment Criterion (Mode)

Select the judgment criterion from the following options.

- X: The condition is not used for GO/NO-GO determination.
- IN: The DL850E/DL850EV returns a GO result when the parameter is within the specified limits. The DL850E/DL850EV returns a NO-GO result when the parameter is outside the specified limits.
- OUT: The DL850E/DL850EV returns a GO result when the parameter is outside the specified limits. The DL850E/DL850EV returns a NO-GO result when the parameter is inside the specified limits.

Source Waveform (Trace)

Set the waveform to use for GO/NO-GO determination to one of the waveforms below.
CH1 to CH16[1], Math1 to Math8

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. However, you cannot select the channel of a 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.

Waveform Parameter (Item)

You can use all automatically measured waveform parameters as reference conditions. You can perform GO/NO-GO determination on up to 16 parameters at the same time.

▶ See here.

Upper and Lower Parameter Limit Settings (Upper/Lower)

Selectable range: −9.9999E+30 to 9.9999E+30.

Judgment Logic (Logic), Action Condition (ActCondition), Sequence (Sequence), Acquisition Count (Acquisition Count), and External Start (Ext Start)

▶ See here.

Action (Action)

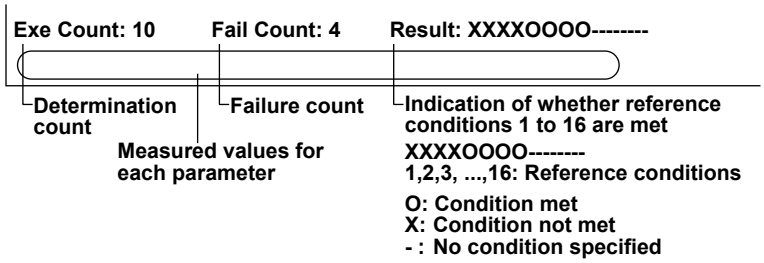
▶ See here.

Determination Period (Time Range1 and Time Range2)

▶ See here.

GO/NO-GO Determination Results

The results of GO/NO-GO determination (number of determinations, number of failures) appear at the bottom of the screen.



In this example, reference conditions 1 and 4 are not met while reference conditions 5 to 8 are met.

Notes about GO/NO-GO Determination

- During determination, all keys other than START/STOP are invalid.
- When performing GO/NO-GO determination with waveform zones you cannot start measurement if the number of data points (record length) to be acquired of the waveform is less than 2000.
- The determination interval is synchronized to the trigger. However, while actions are being performed after determination, the DL850E/DL850EV will not trigger.
- While you are accessing the DL850E/DL850EV through the FTP or Web server, if one of the following operations is performed, actions cannot be executed until you finish accessing the DL850E/DL850EV.
  Printing and saving of screen capture data and saving of waveform data

Notes about the “Save Data” and “Save Image” Actions

▶ See here.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

14 Action

If Mode is set to ON, the specified action (operation) is performed in the following situations. However, if the trigger mode is set to N Single, the DL850E/DL850EV cannot start waveform acquisition when Mode has been set to ON.

- When the DL850E/DL850EV triggers, and the corresponding waveform acquisition stops
- When the action condition of GO/NO-GO determination is met
- When waveform acquisition stops

Mode (Mode)

Select whether to use the actions.

- OFF: The actions are not used.
- ON: The actions are executed.

Action (Action Setup)

You can select the actions from the options below.

Beep (Beep)

The DL850E/DL850EV sounds an alarm.

Screen Capture Printing (Print Image)

The DL850E/DL850EV prints a screen capture to the specified printer. You can specify a printer in the PRINT menu by setting “Print to” to BuiltIn (built-in printer) or Network (network printer).

▶ See here.

Waveform Data Saving (Save Waveform)

The DL850E/DL850EV saves the waveform data to the specified destination (SD card, internal or external HD [option], USB storage device, or network drive).

File Path (File Path)

Specify where to save the file.

▶ See here.

Auto Naming (Auto Naming), File Name (File Name), Data Format (Data Type)

These settings are the same as the auto-naming, file-name, and data-format settings for saving waveform data.

▶ See here.

Changing the auto-naming, file-name, and data-format settings for saving waveform data will change the auto-naming, file-name, and data-format settings under Waveform(SAVE) in the FILE menu.

Screen Capture Saving (Save Image)

The DL850E/DL850EV saves the screen capture data to the specified destination (SD card, internal or external HD [option], USB storage device, or network drive).

File Path (File Path), Auto Naming (Auto Naming), File Name (File Name)

▶ See here.

Changing the auto-naming and file-name settings for saving image data will change the auto-naming and file-name settings under Others(SAVE) in the FILE menu.

Email Sending (Send Mail)

The DL850E/DL850EV sends an email to the specified address. Set the email address by pressing UTILITY and then selecting Network > Mail.

▶ See here.

Email Send Count (Mail Count)

Set the number of email transmissions.

- Infinite: Email continues to be transmitted until you stop the action.
- 1 to 1000: Email transmission stops when the number of sent emails reaches the specified count.

Notes about Action

- You cannot change settings while the action feature is active.
- The actions may be slow if there is network access while the following operations are being performed.
  Printing and saving of screen capture data and saving of waveform data
- When hard disk recording to an external or internal hard disk is enabled, the action feature cannot be used.

Notes about the “Save Data” and “Save Image” Actions

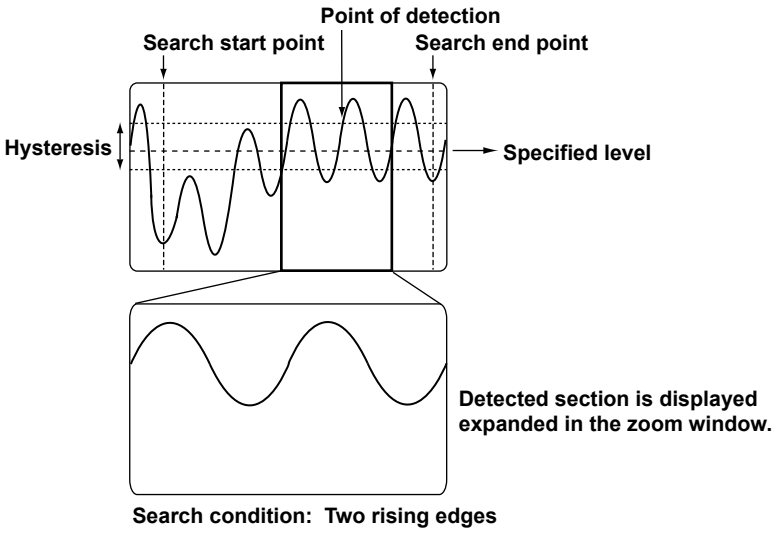
- Do not set the storage medium’s root folder as the save destination. The DL850E/DL850EV can store only 512 files to the root folder of a storage medium that the DL850E/DL850EV has formatted. A file whose name is longer than eight characters will be counted as two files. If such files exist, the number of files that can be stored will decrease.
- The maximum number of files that can be created in a single folder is 1000. Make sure that there are no files in the destination folder before you start the action feature.
- If you select waveform data saving (Save Waveform) and screen capture saving (Save Image) at the same time, use the FILE menu to specify separate folders to save to.
- In the FILE menu, if you set Auto Naming to Numbering, as the number of saved files increases, the amount of time required to save a file will also increase.
- Save Destination during Action Execution
  In the specified drive, a folder is automatically created with the date (year, month, and day) as its name, and data is saved to that folder using file names specified by the auto naming feature. If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.
  You can configure the DL850E/DL850EV so that data is saved to the specified folder, not to the folder that is automatically created with the date. ▶ See here.
- Action for dual capture
  You can make the DL850E/DL850EV perform a specified action when it triggers and acquires captured waveforms. The time when an action starts varies depending on the selected action as follows:
  Saving of waveform data (Save Waveform): Starts when a measurement is stopped
  Other actions: Starts each time a waveform is captured

Select whether to enable the action feature when the power is turned on.

▶ See here.

15 Searching Waveforms

You can search the displayed waveforms for locations that match the specified conditions. You can zoom-in on the detected locations. You can search the waveforms within the specified search range over up to 10 Gpoint.



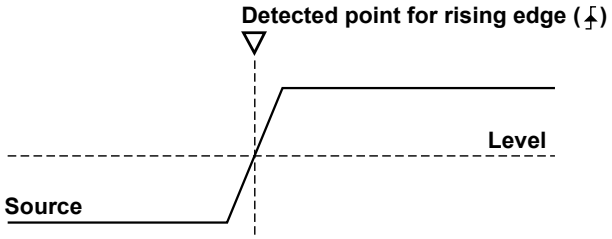
Search Type (Type)

Set the search type to one of the options below.

- Edge: The DL850E/DL850EV searches for edges.
- Event: The DL850E/DL850EV searches for an event.
- Logic Pattern: The DL850E/DL850EV searches for logic patterns. This setting is valid only for logic signals.
- Time: The DL850E/DL850EV searches for a time.

Edge Search (Edge)

Search for positions where the rising or falling slope of the specified waveform passes through the specified level.



Search Conditions (Setup)

Set the search conditions, such as the waveforms to search, judgment level, polarity, hysteresis, count, and bit settings.*

* Only on the channel of a logic module

Source Waveform (Trace)

Select the waveforms to search from the options listed below.

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT[3]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.

Judgment Level (Level)

Set the level used to detect the rising or falling edges of the waveforms. You can set the level to a value within the 10 div of the screen. The resolution at which you can set the level varies depending on the module.

Polarity (Polarity)

Select which type of edge to detect from the options listed below.

- ↑: Rising
- ↓: Falling
- ↕: Rising or falling

Hysteresis (Hysteresis)

You can set a range (hysteresis) within which level changes are not treated as edges. You can set the hysteresis to one of the settings below. The hysteresis widths vary depending on the input module.

- Low hysteresis
- Medium hysteresis
- High hysteresis

Bit Settings (Bit Setting)

For each bit from Bit1 to Bit8, you can select which type of edge to detect from the options listed below. This setting is available only for the channels of logic modules. The DL850E/DL850EV searches based on the OR of each bit.

- ↑: Rising
- ↓: Falling
- ↕: Rising or falling
- −: The signal is not used as a trigger condition.

Count (Count)

Set the number of times the specified edge (↑, ↓, or ↕) must repeat. You can select a number from 1 to 1000000.

Searched Waveform Display (Result Window)

You can select whether to display the zoomed area around the point specified by Pattern No. in Zoom1 or Zoom2.
You need to make this selection only when both the Zoom1 and Zoom2 displays are turned on.

If the Zoom1 and Zoom2 displays are both off and you press SEARCH, the Zoom1 display turns on.

Detected Point Number (Pattern No.)

Specify the number of the detected point to display in the zoom window. The maximum detected point number is 1000.
If the search does not yield any results, “No Match” appears.

Search Range (Start Point and End Point)

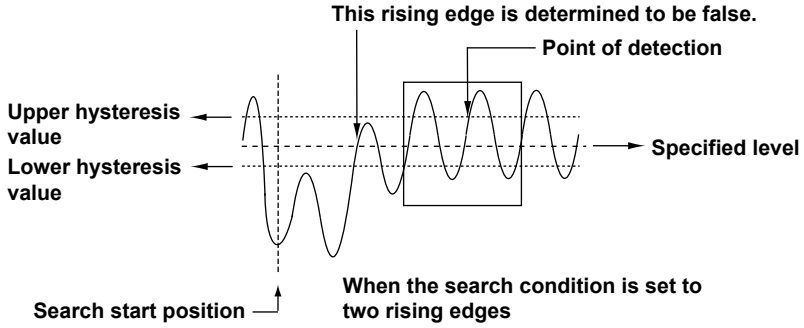
Set the search start and end points (Start Point and End Point). The default settings are −5 div and +5 div.
Selectable range: −5 div to +5 div
The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”
▶ See here.

Executing a Search (Execute)

The DL850E/DL850EV searches for positions where the specified search conditions are met. Then, the DL850E/DL850EV displays the waveforms expanded in the zoom window with the detected point that corresponds to the number you specify at the center.
Up to 1000 points can be detected.

Edge Search Determination

If the peak is below the upper limit of the hysteresis immediately after a rising edge or above the lower limit of the hysteresis immediately after a falling edge, the DL850E/DL850EV will not count the edge.



Event Search (Event)

You can search for an event number that was assigned during measurement.

Event Number (Select Number)

Select the event number that you want to search for. You can select a number from 1 to 100.
When searching manual events, the selectable range is 1 to 100 (maximum number of input events).
When searching capture events, the selectable range is 0 to 5000 (maximum number of captures).
If set to 0, the most recent capture event is searched for.

Searched Waveform Display (Result Window)

▶ See here.

Event Type (Select Event)

Select the type of event that you want to detect.

- Capture: A dual-capture event
- Manual: A manual event assigned through the application of a signal to the EXT I/O terminal.

Executing a Search (Execute)

The DL850E/DL850EV displays the waveforms of the area around the selected event number expanded in the zoom window.

▶ See here.

Logic Pattern Search (Logic Pattern)

The DL850E/DL850EV searches for the specified logic pattern. This setting is valid only for logic modules.

Search Conditions (Setup)

Set the following search conditions: the waveforms to search, bit settings, and count.

Source Waveform (Trace)

Select the waveforms to search from the options listed below.
CH1 to CH16*

* You can select only the following channels.

- Channels of logic modules
- Sub channels of CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor modules whose data types are set to Logic.
- S&C and Error Trigger sub channels of SENT monitor modules

Bit Settings (Bit Setting)

To set the logic signal pattern that you want to detect, set the signal states for Bit1 to Bit8. The DL850E/DL850EV searches based on the AND of each bit.

- H: High level
- L: Low level
- X: The state of the bit is not used as a condition.

Count (Count)

Set the number of times the specified pattern must repeat. You can select a number from 1 to 1000000.

Searched Waveform Display (Result Window), Detected Point Number (Pattern No), Search Range (Start Point and End Point), Executing a Search (Execute)

▶ See here.

Time Search (Time)

Search for a specific year, month, day, and time.

Search Conditions (Setup)

Specify the time that you want to search for.
Set the year (Year), month (Month), day (Day), hour (Hour), minute (Minute), second (Second), and microsecond (µSecond).

Searched Waveform Display (Result Window)

▶ See here.

Executing a Search (Execute)

The DL850E/DL850EV displays the waveforms of the area around the specified time expanded in the zoom window.

▶ See here.

Notes about Searching Waveforms

- You cannot search during data acquisition.
- The search results are invalid after you:
  - Start data acquisition.
  - Change the settings.
- If you invert or change the offset voltage of a waveform that has been selected as a waveform to search, the search is performed on the new waveform.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

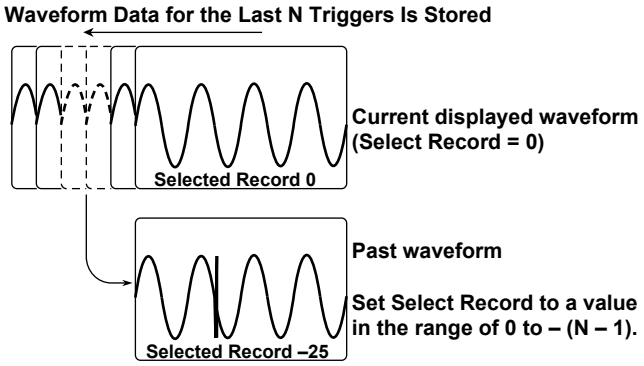
▶ See here.

16 Displaying and Searching History Waveforms

Acquisition memory stores waveforms that are displayed on the screen and waveform data that have been acquired in the past. The history feature allows you to display or search past waveforms (history waveforms). You can perform the following operations on history waveforms:

Display

You can display any single waveform or display all waveforms (and highlight only the specified waveform). You can also list the timestamps (the times at the time references) of all history waveforms.

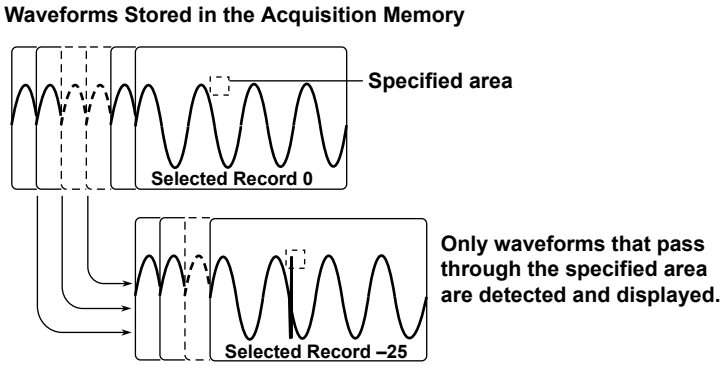


Search

You can search for waveforms that meet the specified conditions, display the detected history waveforms, and list the timestamps of the waveforms.

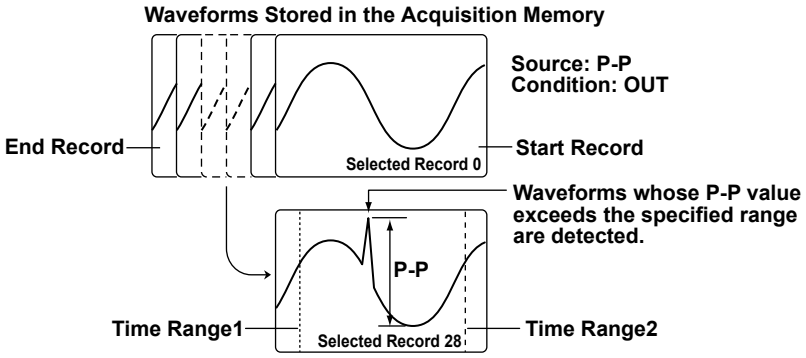
Zone Search

You can search for history waveforms that did or did not pass through a specified search zone.



Parameter Search

You can search for history waveforms that do or do not meet specified search parameter conditions.



History Waveform Search Range

The search range is from Start Record to End Record.

Search Method

The DL850E/DL850EV starts searching in order from the newest waveform.

Calculation, Cursor Measurement, Automated Measurement, Statistical Processing, and FFT

You can perform calculations, cursor measurement, automated measurement of waveform parameters, or FFT analysis on the history waveform that you specified with Selected Record. You can also calculate statistics of automatically measured values on all history waveforms.

Displaying and Analyzing XY Waveforms

You can display XY waveforms and perform analysis on the history waveform you specified with Selected Record. If the display mode is set to All, XY waveforms of all history waveforms are displayed.

Display Mode (Display Mode)

Selects how history waveforms are displayed.

- One waveform (1 Record): Only the waveform that corresponds to the selected record number is displayed.
- All waveforms (All Record): All history waveforms from the specified start (Start Record) to stop (End Record) number are overlaid. All waveforms other than the highlighted one are displayed in an intermediate color.
- Averaged waveform (Average Record): Linear averaging is performed on all history waveforms from the specified start (Start Record) to stop (End Record) number, and the results are displayed as a single waveform.

An averaged waveform cannot be displayed for the following history waveforms.

Waveforms with record lengths of 250 kpoint or greater on the standard model, 1 Mpoint or greater on models with the /M1 option, or 2.5 Mpoint or greater on models with the /M2 option.

Highlighting (Selected Record)

The latest history waveform is assigned the record number zero, and older waveforms are assigned numbers in descending order (−1, −2, −3, and so on).

The waveform and timestamp that correspond to the record number you specify here are highlighted.

Selectable range: 0 to −(the number of waveform acquisitions − 1)

Maximum Number of Waveform Acquisitions

(Maximum number of history waveforms that can be stored in the acquisition memory)

The number of history waveforms that can be stored varies depending on the selected record length and the installed memory options as follows:

Record Length	Number of Waveforms		
	No options (250 Mpoint)	/M1 Option (1 Gpoint)	/M2 Option (2 Gpoint)
1 kpoint	5000	5000	5000
2.5 kpoint	5000	5000	5000
5 kpoint	2976	5000	5000
10 kpoint	1487	5000	5000
25 kpoint	593	2381	5000
50 kpoint	295	1189	2381
100 kpoint	144	583	1168
250 kpoint	57	236	474
500 kpoint	28	116	235
1 Mpoint	13	54	111
2.5 Mpoint	4	22	46
5 Mpoint	1	10	22
10 Mpoint	1	4	10
25 Mpoint	1[1]	1	3
50 Mpoint	1[2]	1	1
100 Mpoint	1[3]	1[1]	1
250 Mpoint	1[4]	1[2]	1[1]
500 Mpoint	−	1[3]	1[2]
1 Gpoint	−	1[4]	1[3]
2 Gpoint	−	−	1[4]

1 Only eight channels' worth of history waveforms are acquired.
2 Only four channels' worth of history waveforms are acquired.
3 Only two channels' worth of history waveforms are acquired.
4 Only one channel's worth of history waveforms are acquired.
− This record length cannot be set.

Display Range (Start and End Record)

Using record numbers, set the range of history waveforms to display when the display mode is set to All or Average.

Selectable range: 0 to −(the number of waveform acquisitions −1)

List of History Waveforms (List)

The history waveform record numbers and the timestamps when the waveforms were acquired are listed.

History Waveform Search Mode (Search Mode)

When waveform acquisition is stopped, you can search for history waveforms that meet the specified conditions.

- OFF: Searching is not performed. All history waveforms are displayed.
- Zone: The DL850E/DL850EV searches for history waveforms that did or did not pass through a specified search zone.
- Parameter: The DL850E/DL850EV searches for history waveforms that do or do not meet specified search parameter conditions.

Search Condition Settings for Zone Searching (Search Setup)

Search Zone (Select Zone)

You can register four search zones to Zone1 to Zone4. For each search zone, set the channels to search, the search condition, and the search range.

Search Condition (Condition)

- IN: The DL850E/DL850EV searches for waveforms that pass through the specified search window.
- OUT: The DL850E/DL850EV searches for waveforms that do not pass through the specified search window.
- OFF: The DL850E/DL850EV does not search for waveforms.

Source Waveforms (Source)

The DL850E/DL850EV searches through the waveforms that you select for Source. You can select waveforms from CH1 to CH16. The waveforms of channels that have not been specified as search source channels are also displayed. However, you cannot search through the waveforms of a logic module, 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.

Search Window Upper and Lower Limits (Upper and Lower)

You can set the limits within ±5 div. You can set them in 0.01 div steps.
You cannot set the upper limit to a value that is less than the lower limit.

Left and Right Sides of the Search Window (Left and Right)

You can set the left and right sides within the range of ±5 div. The resolution is 10 div/display record length.
You cannot set the left side to a value that is greater than the right side.

Search Logic (Logic)

- AND: The DL850E/DL850EV searches for waveforms that meet all the search conditions specified for Zone1 to Zone4.
- OR: The DL850E/DL850EV searches for waveforms that meet at least one of the search conditions specified for Zone1 to Zone4.

Search Condition Settings for Waveform Parameter Searching (Search Setup)

Search Parameter (Select Param)

You can register four search conditions to Param1 to Param4. For each search condition, you can change the channels to search, the search condition, and the search range.

Search Condition (Condition)

- IN: The DL850E/DL850EV searches for waveforms in which the specified parameter is within the specified range.
- OUT: The DL850E/DL850EV searches for waveforms in which the specified parameter is outside the specified range.
- OFF: The DL850E/DL850EV does not search for waveforms.

Source Waveforms and Parameters (Source)

The DL850E/DL850EV searches through the specified parameter of the specified trace (Trace). You can specify one type of automatically measured waveform parameter. However, you cannot search through the waveforms of a 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.

Search Condition Upper and Lower Limits (Upper and Lower)

Specify the range used to determine the condition of the specified parameter.

Search Logic (Logic)

- AND: The DL850E/DL850EV searches for waveforms that meet all the search conditions specified for Param1 to Param4.
- OR: The DL850E/DL850EV searches for waveforms that meet at least one of the search conditions specified for Param1 to Param4.

Parameter Measurement Time Period (Time Range1/Time Range2)

You can set the measurement time period for the specified parameter by setting Time Range1 and Time Range2.
The default settings are −5 div and +5 div.
Selectable range: −5 div to +5 div
The measurement time period is similar to the settable range of the cursor display position in cursor measurement.
For details, see “Selectable Range of Cursor Positions.”
▶ See here.

Search Execution (Execute Search)

Searches for waveforms that meet the specified search conditions and displays only the waveforms and timestamps that are detected.

Notes about Using the History Feature

- You can start waveform acquisition when the History menu is displayed. However, you cannot change the history feature settings while waveform acquisition is in progress.
- When the acquisition mode is set to Average, you cannot use the history feature.
- You cannot use the history feature when you are using the dual capture feature or during hard disk recording.
- If you stop waveform acquisition, even if one complete screen’s worth of waveform data has not been acquired, the waveform at which the trigger occurred is displayed as a single history waveform.
- If you stop waveform acquisition and then start it again without changing the waveform acquisition conditions, the waveform data continues to be stored in the acquisition memory.
- If you change the waveform acquisition conditions and start waveform acquisition, the past data stored in the acquisition memory is cleared.

- An averaged waveform cannot be displayed for the following waveforms.
  Waveforms with record lengths of 250 kpoint or greater on the standard model, 1 Mpoint or greater on models with the /M1 option, or 2.5 Mpoint or greater on models with the /M2 option.
- The settings are restricted so that the following relationship is retained: Last record (End Record) ≤ Selected Record ≤ first record (Start Record).
- When you load waveform data from the specified storage medium, history waveforms up to that point are cleared. The loaded waveform data is placed in record number zero. If you load a file containing multiple history waveforms, the latest waveform is placed in zero, and earlier waveforms are placed in order to record numbers −1, −2, and so on.
- Computation and automated measurement of waveform parameters are performed on the waveform of the record number specified by Selected Record. You can analyze old data as long as you do not overwrite the acquisition memory contents by restarting waveform acquisition. If Display Mode is set to Average Record, analysis is performed on the averaged waveform.
- The times that are listed are the times at the time references. When the waveform display is in update mode, the time references are the trigger times. Furthermore, these times vary as indicated below depending on the trigger mode.

Trigger Mode	Condition	Time Displayed in the List
Auto/Auto Level	Roll mode	Stop time
Single	Roll mode, no trigger	Stop time
On Start	−	Start time

- When all the waveforms are displayed, if a large number of records are selected, it may take time for them to be displayed completely. When the display is not complete,  appears in the center of the screen. If you want to stop the operation, set Display Mode to 1 Record.
- History waveforms are cleared when you turn the power off.

17 Power Math

Digital Monitor Mode (Digital Monitor Mode)

Only the numeric monitor of the selected group is displayed on the screen.
Display Group: Only the numeric monitor of the group selected with Select Display Gr of Display Groups (DISPLAY) is displayed on the screen.
Power: Only the numeric monitor of the power analysis measurement functions is displayed on the screen.
Harmonic: Only the numeric monitor of the harmonic analysis measurement functions is displayed on the screen.

Power Analysis (Power)

The voltage and current measured on separate input channels can be used as math sources to calculate various power parameters for power analysis. This is a feature available on the /G5 option.

- Power analysis can be performed when any of the following modules is installed in a slot other than slot 7.
  701250 (HS10M12), 720250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 701267 (HV (with RMS)), 720268 (HV (AAF, RMS)), 720210 (HS100M12), 720211 (HS100M12), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT), 720254 (4CH 1M16)
- Channels that can be used for power analysis are CH13 and CH14. Power analysis results are output to the subchannels of CH13 and CH14.
  The number of calculations performed in one analysis is equal to the total number of subchannels of CH13 and CH14.
- There can be up to 126 power analysis parameters that can be calculated. The number of parameters varies depending on the number of systems to be analyzed and wiring system. For details, see the appendix.
- Power analysis conditions can be changed even during waveform acquisition. However, if you change the conditions, the measurement count (waveform acquisition count) is reset.
  The measurement count is displayed in the lower left of the screen.
- The analysis result waveform can be used as a trigger source, but it cannot be used as a real time math source.
- Power analysis can be performed on two systems. This allows power efficiency and motor efficiency to be calculated.

Measurement Functions

The various physical quantities such as rms voltage, average current, power, and phase difference that the DL850E/DL850EV measures and displays are called measurement functions. Each physical quantity is displayed with a corresponding symbol.
For example, Urms represents the true rms voltage.

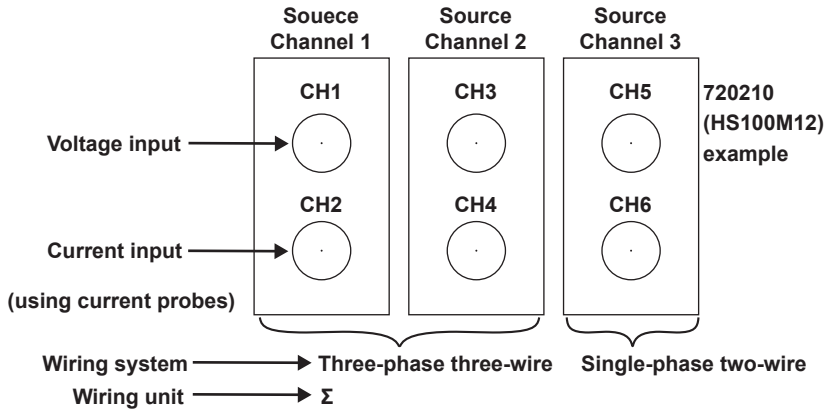
Source Channels

The channels that receive the pair of voltage and current signals to be measured are called source channels. There are three source channel numbers: 1, 2, and 3. The DL850E/DL850EV displays a source channel number after the measurement function symbol to indicate which source channel corresponds to the displayed numeric data.
For example, Urms1 represents the true rms voltage of source channel 1.
The channels that can be used as source channels are those of the modules that can perform power analysis (indicated above).

Wiring Unit

Wiring Unit refers to a group of two or three input source channels with the same wiring system used to measure three-phase power.
Wiring unit is represented with the symbol Σ. Measurement functions for wiring units are called Σ functions.
For example, UrmsΣ represents the true rms value of the average of the voltages measured on the input source channels assigned to wiring unit Σ.

- **Configuration Example of Wiring System and Wiring Unit**

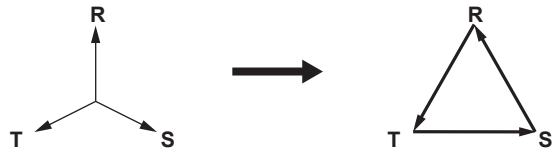


Delta Math

Measurement function ΔU and ΔI can be determined based on the sum and difference of the instantaneous voltage and current (sampling data) of the source channels assigned to the wiring unit set as the delta math source. This calculation is called *delta math*.

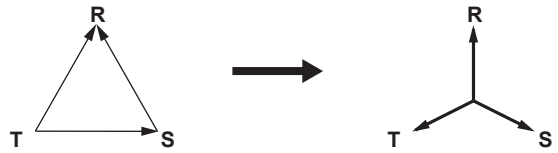
3P4W→3V3A

- Using the data of a three-phase four-wire system, delta connection data can be calculated from star connection data (star-delta transformation).



3V3A→3P4W

- Using the data of a three-phase three-wire system (three-voltage, three-current method), star connection data can be calculated from delta connection data (delta-star transformation). This is useful when you want to observe the phase voltage of a measurement source without a neutral line.



Measurement Function Types

- Source channel measurement functions
  The following 32 measurement functions are available.
  U (voltage): Urms (rms value),* Umn (rectified mean value calibrated to the rms value),* Udc (simple average), Uac (AC component)
  I (current): Irms (rms value),* Imn (rectified mean value calibrated to the rms value),* Idc (simple average), Iac (AC component)
  P (active power), S (apparent power), Q (reactive power), λ (power factor), φ (phase difference), fU (voltage frequency),
  fI (current frequency), U+pk (maximum voltage), U-pk (minimum voltage), I+pk (maximum current), I-pk (minimum current), P+pk (maximum power), P-pk (minimum power), WP (integrated power), WP+ (positive integrated power),
  WP- (negative integrated power)
  q (integrated ampere-hour), q+ (positive integrated ampere-hour), q- (negative integrated ampere-hour), WS (volt-ampere hours), WQ (var hours),
  Z (impedance), RS (series resistance), XS (series reactance), RP (parallel resistance), XP (parallel reactance)

* You can select either the rms value or the rectified mean value calibrated to the rms value (but not both). In either case, the value is displayed as rms.

- **Wiring unit Σ measurement functions**

  The following 24 measurement functions are available.
  UΣ (average voltage): UrmsΣ (rms value),* UmnΣ (rectified mean value calibrated to the rms value),* UdcΣ (simple average), UacΣ (AC component)
  IΣ (average current): IrmsΣ (rms value),* ImnΣ (rectified mean value calibrated to the rms value),* IdcΣ (simple average), IacΣ (AC component)
  PΣ (total active power), SΣ (total apparent power), QΣ (total reactive power), λΣ (average power factor), φΣ (average phase difference)
  WPΣ (total integrated power), WP+Σ (total positive integrated power), WP-Σ (total negative integrated power), qΣ (total integrated ampere-hour), q+Σ (positive total integrated ampere-hour), q-Σ (negative total integrated ampere-hour),
  WSΣ (total apparent energy), WQΣ (total reactive energy), ZΣ (average impedance), RSΣ (average series resistance), XSΣ (average series reactance), RPΣ (average parallel resistance), XPΣ (average parallel reactance)

  * You can select either the rms value or the rectified mean value calibrated to the rms value (but not both). In either case, the value is displayed as rms.

- **Delta math measurement functions**

  For details on line voltages and R, S, and T points, see the wiring system figure provided later.

  3P3W→3V3A
  The following 8 measurement functions are available.
  Urs (R-S line voltage): Urms3 (rms value),* Umn3 (rectified mean value calibrated to the rms value),* Udc3 (simple average), Uac3 (AC component)
  It (phase current): Irms3 (rms value),* Imn3 (rectified mean value calibrated to the rms value),* Idc3 (simple average), Iac3 (AC component)

  3V3A→3P4W
  The following 13 measurement functions are available.
  Ur (R-N voltage): Urms1 (rms value),* Umn1 (rectified mean value calibrated to the rms value),* Udc1 (simple average), Uac1 (AC component)
  Us (S-N voltage): Urms2 (rms value),* Umn2 (rectified mean value calibrated to the rms value),* Udc2 (simple average), Uac2 (AC component)
  Ut (T-N line voltage): Urms3 (rms value),* Umn3 (rectified mean value calibrated to the rms value),* Udc3 (simple average), Uac3 (AC component)
  In (neutral line current)

  3P4W→3V3A
  The following 13 measurement functions are available.
  Urs (R-S voltage): Urms1 (rms value),* Umn1 (rectified mean value calibrated to the rms value),* Udc1 (simple average), Uac1 (AC component)
  Ust (S-T voltage): Urms2 (rms value),* Umn2 (rectified mean value calibrated to the rms value),* Udc2 (simple average), Uac2 (AC component)
  Utr (T-R line voltage): Urms3 (rms value),* Umn3 (rectified mean value calibrated to the rms value),* Udc3 (simple average), Uac3 (AC component)
  In (neutral line current)

  * You can select either the rms value or the rectified mean value calibrated to the rms value (but not both). In either case, the value is displayed as rms.

- **Other measurement functions**

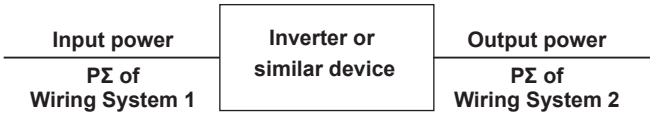
  The following 3 measurement functions are available.
  η (efficiency): Motor efficiency, power efficiency
  Uubf (three-phase voltage unbalance factor)
  Iubf (three-phase current unbalance factor)

Analysis Mode (Analysis Mode)

Select the system to be analyzed.

- 1 Wiring System: One system is analyzed.
- 2 Wiring Systems: Two systems are analyzed. The primary and secondary sides of the system to be analyzed can be measured to derive the efficiency.
- OFF: Power analysis is disabled.

- **Device's power factor example**



Setting Analysis Conditions (Wiring System)

Set the wiring system, math source waveforms, and analysis method (measurement period, analysis conditions, and efficiency).

Wiring System (Wiring)

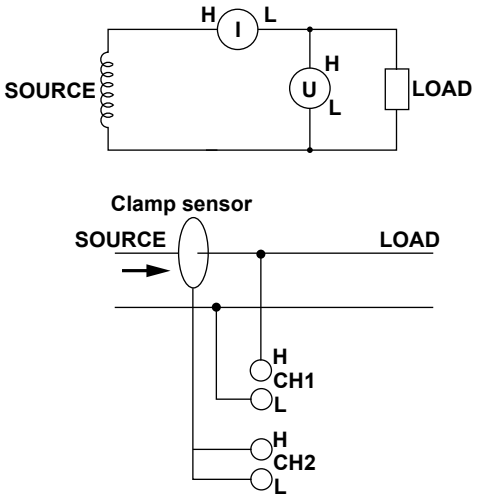
The following eight wiring systems are available on the DL850E/DL850EV.

1P2W: Single-phase two-wire
1P3W: Single-phase three-wire
3P3W: Three-phase three-wire
3V3A: Three-voltage three-current measurement method
3P4W: Three-phase four-wire
3P3W→3V3A: Conversion of three-phase three-wire system data to the three-voltage three-current measurement method
3V3A→3P4W: Delta-star transformation using three-phase three-wire system data
3P4W→3V3A: Star-delta transformation using three-phase four-wire system data

To apply voltage, use a passive probe.
For details on how to select the appropriate passive probes and how to connect them (high and low), see section 3.5 in the Getting Started Guide, IM DL850E-03EN.
To apply current, use a current probe.
For details on how to select the appropriate current probes and how to connect them (current direction), see section 3.5 in the Getting Started Guide, IM DL850E-03EN, and the user's manual that came with the current probe.

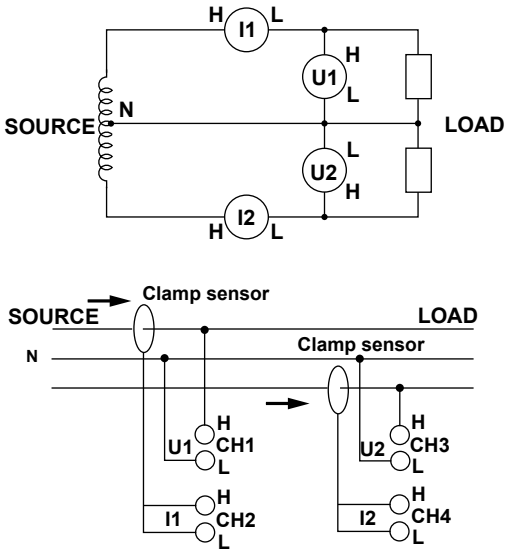
- **Single-Phase Two-wire (1P2W)**

  Two channels that receive one pair of voltage and current signals can be wired.



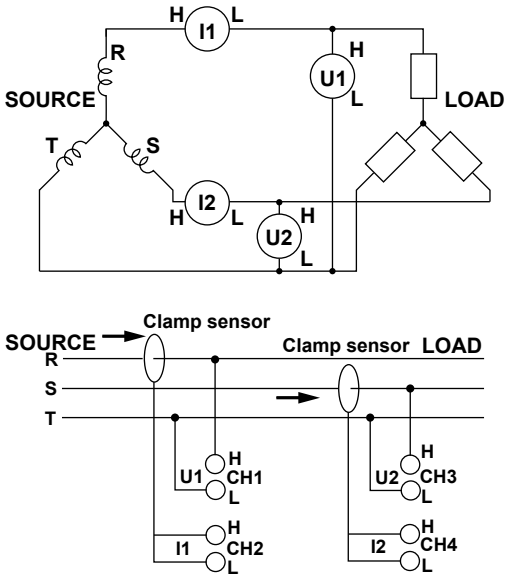
- **Single-Phase Three-Wire (1P3W)**

  Four channels that receive two pairs of voltage and current signals can be wired.



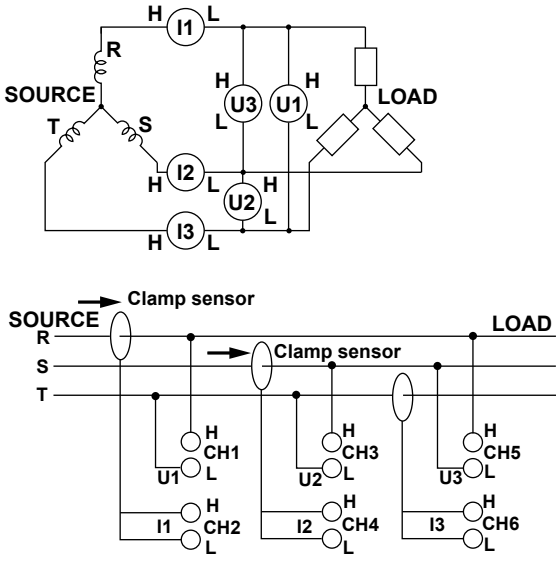
- **Three-Phase Three-Wire (3P3W)**

  Four channels that receive two pairs of voltage and current signals can be wired.



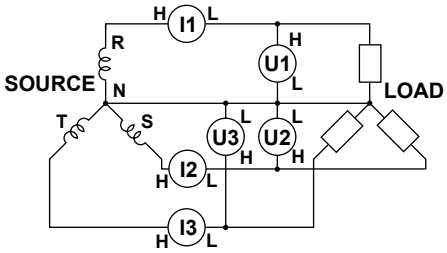
- **Three-Voltage Three-Current Method (3V3A)**

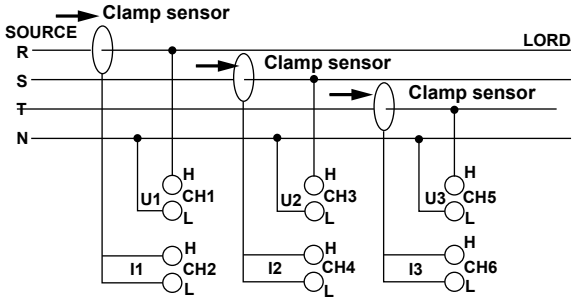
  Six channels that receive three pairs of voltage and current signals can be wired.



- **Three-Phase Four-Wire (3P4W)**

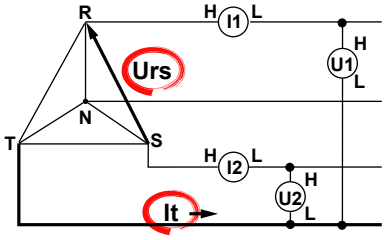
  Six channels that receive three pairs of voltage and current signals can be wired.





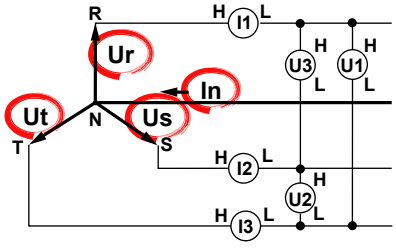
- **Conversion of Three-Phase Three-Wire System Data to the Three-Voltage Three-Current Measurement Method (3P3W→3V3A)**

  Four channels that receive two pairs of voltage and current signals can be wired. Urs and It can be determined using delta math.



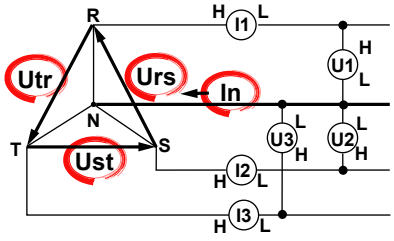
- **Delta-Star Transformation (3V3A→3P4W)**

  Six channels that receive three pairs of voltage and current signals can be wired. Ur, Us, Ut, and In can be determined using delta math.
  The center of the delta connection is assumed to be the center of the star connection. If the actual centers are not aligned, errors will result in the calculation.



- **Star-Delta Transformation (3P4W→3V3A)**

  Six channels that receive three pairs of voltage and current signals can be wired. Urs, Ust, Utr, and In can be determined using delta math.



Math Source Waveforms (U1 to U3, I1 to I3)

The modules described in "Power analysis can be performed only when one of the following modules is installed in a slot other than slot 7" under "Power Analysis (Power)" are applicable. CH13 or CH14 cannot be selected.

Calculation Period (Calc Period)

Select the method that is used to determine the calculation period of power math values.

- Edge: Zero crossing rising edge of the selected signal
- Auto Timer: Specified time
- AC: Zero crossing rising edge of the selected AC signal
  The DL850E/DL850EV determines the stopping of the signal selected for stop prediction and forces the power value to zero. This is valid for analysis where the drive source signal is AC.
- AC+DC: Zero crossing rising edge of the selected signal
  After the DL850E/DL850EV performs stop prediction, the method is automatically switched to Auto Timer. This is valid for analysis where the driver source supplies AC power while it is in operation and DC power while it is stopped.

If the Calculation Period Is Edge

- **Edge Detection Source (Edge Source)**
  Select the input channel of the signal that is used to determine the calculation period.

- **Hysteresis (Hysteresis)**
  The same as the standard feature. For details, see "Trigger Hysteresis" in chapter 4.

- **Edge Source Filter (Edge Source Filter)**
  Select from the following.
  OFF, 128 kHz, 64 kHz, 32 kHz, 16 kHz, 8 kHz, 4 kHz, 2 kHz, 1 kHz, 500 Hz, 250 Hz, 125 Hz, 62.5 Hz

  The DL850E/DL850EV reduces the effects of noise by using hysteresis when it detects zero crossings.
  If the synchronization source is distorted or harmonics and noise are superposed on the signal to a level exceeding this hysteresis, harmonic components will cause zero crossing detection to occur frequently, and the zero crossing of the fundamental frequency will not be detected stably.
  Consequently, the measured voltage and current may be unstable.
  To stably detect zero crossings, set the synchronization source filter.

If the Calculation Period Is Auto Timer

Set the calculation period update time.
Range: 100 ns to 500 ms. Resolution: 100 ns.

If the Calculation Period Is AC

- **Edge Detection Source (Edge Source)**
  The options are the same as Edge.

- **Hysteresis (Hysteresis) and Edge Source Filter (Edge Source Filter)**
  The options are the same as Edge.

- **Stop Prediction (Stop Prediction)**
  Set the time from the point when the pulse input stops to the point when the DL850E/DL850EV determines that the object has stopped.
  - 2, 4, 8, 16: Stop prediction is performed on the basis of the specified number of times the pulse period (four settings) of the pulse one period before the pulse input stopped.
    For details, see chapter 2.

If the Calculation Period Is AC+DC

- **Edge Detection Source (Edge Source)**
  The options are the same as Edge.
- **Hysteresis (Hysteresis) and Edge Source Filter (Edge Source Filter)**
  The options are the same as Edge.
- **Stop Prediction (Stop Prediction)**
  The options are the same as Edge.
- **Update Time (Auto Timer)**
  Range: 100 ns to 500 ms. Resolution: 100 ns.

Vertical Scale (Value/Div) Optimization (ALL Output Optimize Value/Div)

This is the same feature as Optimize Value/Div of real time math (RealTime Math).

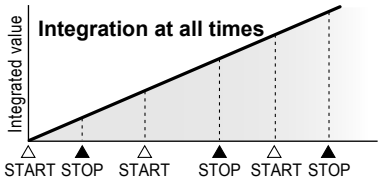
Analysis Setting (Analysis Setting)

Set how to calculate power math values.

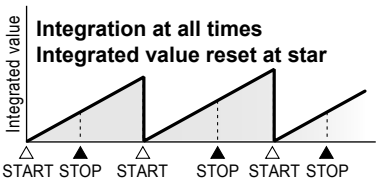
- **RMS Type (RMS Type)**
  Select the rms value from the following.
  True RMS (rms value), Rect. Mean (rectified mean value calibrated to the rms value)
- **φ Scaling (φ Scale)**
  Select how to display phase differences.
  Radian: Radian
  Degree: Degrees
- **Integration Condition (Condition)**
  All times: Integration is performed at all times.
  In Acquisition: Integration is performed only during measurement.
- **Reset on Start (Reset on Start)**
  OFF: Integration continues regardless of the START/STOP key state. To reset the value, reset manually.
  ON: The integrated value is reset to zero whenever waveform acquisition starts as a result of pressing the START/STOP key.

When Integration Condition is set to All times

- **When Reset on Start is OFF**

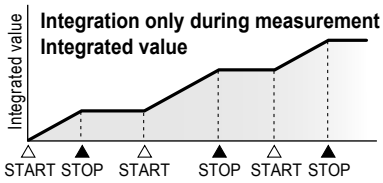


- **When Reset on Start is ON**

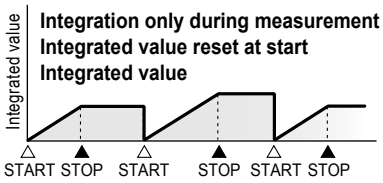


When Integration Condition is set to In Acquisition

- **When Reset on Start is OFF**



- **When Reset on Start is ON**



- **Scaling (Scaling)**
  Select the integral time unit.
  Second: Second
  Hour: Hour

Efficiency Setting (Efficiency Setting)

Select the measurement function efficiency η type from the following.

- Power: The power efficiency is calculated. Available when the analysis mode is 2Wirig System.
- Motor: The motor drive efficiency is calculated.
- OFF: Efficiency is not calculated.

- **Torque (Torque)**
  Select the real time math channel set to math “Torque.”

- **Coefficient (K)**
  Set scaling coefficient K.
  Range: –9.9999E+30 to +9.9999E+30. The default value is 1.0000.

- **Pm Type (Pm Type)**
  Select the type of rotating speed.
  RotationAngle: Rotation angle (rad/s)
  Speed: Rotating speed

  When the Pm Type Is RotationAngle
  - **Rotation Angle (Rotation Angle**)
    Select the real time math channel set to math “Rotary Angle.”

  When the Pm Type Is Speed
  - **Speed**
    Select the input channel of the module measuring the number of rotations.
  - **Scaling (Scaling)**
    Select the unit that is used on the vertical scale.
    rps: The unit is set to revolutions per second.
    rpm: The unit is set to revolutions per minute.

Harmonic Analysis (Harmonics)

Harmonics refer to sine waves whose frequency is an integer multiple (2 and higher) of the fundamental wave except for the fundamental wave itself.
When the fundamental is mixed with harmonics, waveform distortion results.
The DL850E/DL850EV analyzes the harmonics of rms values (voltage and current) and active power.
The DL850E/DL850EV analyzes harmonic orders 1 to 40 for rms values and 1 to 35 for active power.
This is a feature available on the /G5 option.

- Harmonic analysis can be performed when any of the following modules is installed in a slot other than slot 8.
  701250 (HS10M12), 720250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 701267 (HV (with RMS)), 720268 (HV (AAF, RMS)), 720210 (HS100M12), 720211 (HS100M12), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT), 720254 (4CH 1M16)
- Channels that can be used for harmonic analysis are CH15 and CH16. Harmonic analysis results are output to the subchannels of CH15 and CH16.
  The number of calculations performed in one analysis is equal to the total number of subchannels of CH15 and CH16.
- The maximum number of harmonic analysis parameters that can be calculated is as follows.
  Harmonic analysis of rms values: 123 parameters
  Harmonic analysis of active power: 121 parameters
- The harmonic analysis result waveform can be used as a trigger source, but it cannot be used as a real time math source.

Measurement Functions and Source Channels

For the terminology definitions, see “Measurement Functions“ and “Source Channels” provided in the Power Analysis section.

Measurement Function Types

The following measurement functions are available.

- **Rms Value Measurement Functions**
  RMS (rms values of the 1st to the 40th harmonic), Rhdf (percentage contents of the 1st to the 40th harmonic), φ (phases of the 1st to the 40th harmonic), RMS (total rms value), THDIEC (distortion factor: IEC), THDCSA (distortion factor: CSA)

- **Active Power Measurement Functions**
  P (active powers of the 1st to the 35th harmonic), Phdf (active power percentage contents of the 1st to the 35th harmonic), φ (active power phases of the 1st to the 35th harmonic), P (all active powers), S (all apparent powers), Q (all reactive powers), λ (power factor),
  U1 (1st harmonic rms voltage), U2 (1st harmonic rms voltage), U3 (1st harmonic rms voltage), I1 (1st harmonic rms current),
  I2 (1st harmonic rms current), I3 (1st harmonic rms current), φU1-U1 (phase angle), φU1-I1 (phase angle), φU1-U2 (phase angle), φU1-I2 (phase angle), φU1-U3 (phase angle), φU1-I3 (phase angle)

Analysis Mode (Analysis Mode)

Select the harmonic analysis item.

- Line RMS: Harmonic analysis is performed on voltage and current.
- Power: Harmonic analysis is performed on active power.
- OFF: Harmonic analysis is disabled.

When the Analysis Mode Is Line RMS

- **Math Source Waveforms (Source)**

  The modules described in "Harmonic analysis can be performed only when one of the following modules is installed in a slot other than slot 8" under "Harmonic Analysis (Harmonic)" are applicable. CH15 or CH16 cannot be selected.

- **Edge Detection Source (Edge Source)**

  The same channel as the math source waveform (cannot be changed).

- **Hysteresis (Hysteresis)**

  The same as the standard feature. For details, see "Trigger Hysteresis" in chapter 4.

- **Edge Source Filter (Edge Source Filter)**

  Select from the following.
  OFF, 128 kHz, 64 kHz, 32 kHz, 16 kHz, 8 kHz, 4 kHz, 2 kHz, 1 kHz, 500 Hz, 250 Hz, 125 Hz, 62.5 Hz
  This is the same as "Edge Source Filter" described under "Power Analysis (Power)."

- **φ Scaling (φ Scale)**

  Select how to display phase differences.
  Radian: Radian
  Degree: Degrees

When the Analysis Mode is Power

- **Wiring System (Wiring)**

  The same as Wiring System under "Power Analysis (Power)."

- **Math Source Waveforms (U1 to U3, I1 to I3)**

  The options are the same as those for Line RMS analysis mode.

- **Edge Detection Source (Edge Source)**

  The same channel as the math source waveform. Select from U1 to U3 and I1 to I3.

- **Hysteresis (Hysteresis)**

  The same as the standard feature. For details, see "Trigger Hysteresis" in chapter 4.

- **Edge Source Filter (Edge Source Filter)**

  Select from the following.
  OFF, 128 kHz, 64 kHz, 32 kHz, 16 kHz, 8 kHz, 4 kHz, 2 kHz, 1 kHz, 500 Hz, 250 Hz, 125 Hz, 62.5 Hz
  This is the same as "Edge Source Filter" described under "Power Analysis (Power)."

- **φ Scaling (φ Scale)**

  Select how to display phase differences.
  Radian: Radian
  Degree: Degrees

All Item (Value/Div) Optimization (ALL Output Optimize Value/Div)

This is the same feature as Optimize Value/Div of real time math (RealTime Math).

Harmonic Analysis Window Setup (Harmonic Window Setup)

Graph Position (Graph Position)

Select the analysis position on the waveform display of the main screen. The analysis results for the cursor position are displayed in the graph window.

Main Screen Ratio (Main Ratio)

Set the percentage of the entire waveform display area that the main screen will occupy.

- 50%: The main screen is displayed in the top half of the entire area.
- 20%: The main screen is displayed in the top 20% of the entire area.
- 0%: The main screen is not displayed.

Window Layout (Window Layout)

Set the display layout of the two graph windows.

- Side: Side by side
- Vertical: Top and bottom

Graph Window (Graph Window)

Select from the following.

- Bar: A bar graph is displayed for the calculated harmonic value of each harmonic up to the 40th harmonic.
- Vector: The relationship of the phase difference and size (rms value) between the fundamental waves U(1) and I(1) of the source channel is displayed with vectors.
- List: A numerical list is displayed for the calculated harmonic value of each harmonic up to the 40th harmonic.

When the Graph Window is Bar

- **Display Item (Display Item)**

  The following parameters can be displayed.
  RMS (rms value), P (active power), hdf (percentage content), φ (phase)

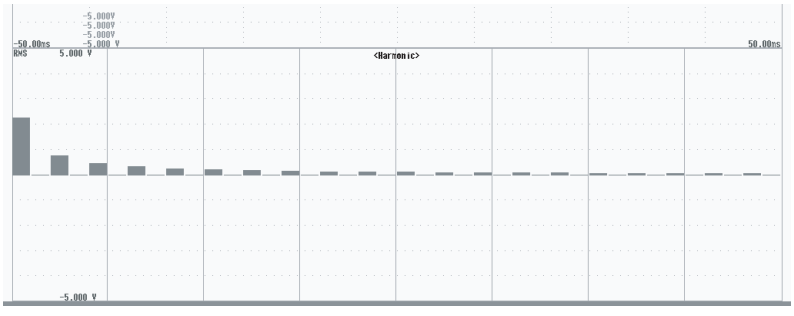
- **Maximum Order to Display (Display Max Order)**

  Set the harmonics to display in the graph window.
  The range is as follows.
  Line RMS mode: 1 to 40
  Power mode: 1 to 35

- **Vertical Scale (V Scale)**

  Set the vertical scale to Linear or Log (logarithmic).
  This setting applies to the scales for RMS (rms value) and P (active power).

Graph display example



1st harmonic ⟶ **Up to the 40th harmonic**

When the Graph Window is Vector

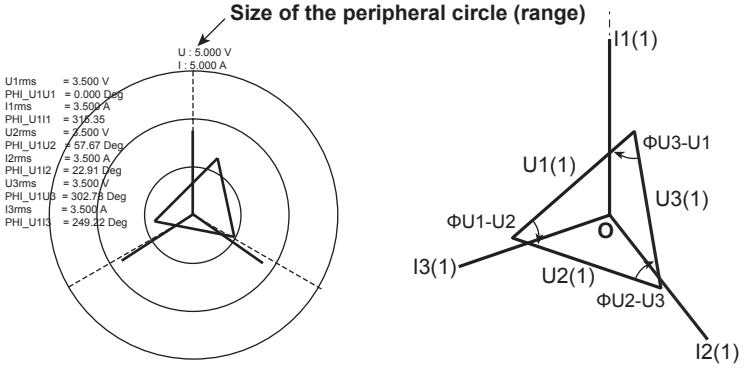
- **Numeric Display On/Off**

  Set whether to display the numeric measured results in the graph window.
  ON: The numeric measured results are displayed.
  OFF: The numeric measured results are not displayed.

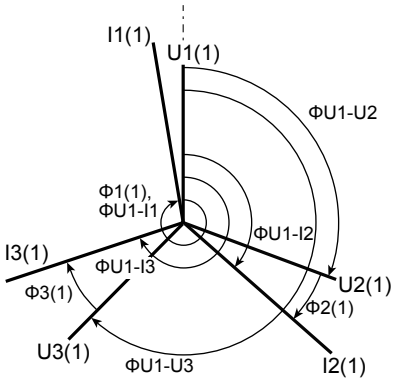
- **Zoom (U:Zoom, I:Zoom)**

  You can change the size of vectors. When you zoom the vectors, the value that indicates the size of the vector display's peripheral circle changes according to the zoom factor.
  Range: 0.1 to 100

When the wiring system is 3V3A (three-voltage three-current method), 3P3W→3V3A (conversion of three-phase three-wire system to the three-voltage three-current measurement method), or 3P4W→3V3A (star-delta transformation)
• U1(1), U2(1), and U3(1) are line voltages.
• I1(1), I2(1), and I3(1) are line currents.



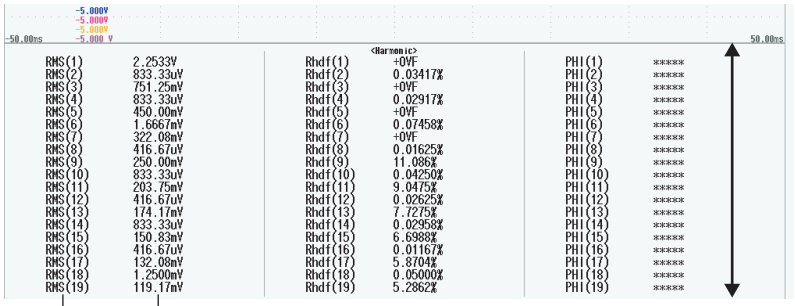
When the wiring system is 1P2W (single-phase two-wire), 1P3W (single-phase three-wire), 3P3W (three-phase four-wire), 3P4W (three-phase four-wire), or 3V3A→3P4W (delta-star transformation)
• U1(1), U2(1), and U3(1) are phase voltages.
• I1(1), I2(1), and I3(1) are line currents.



When the Graph Window is List

- **Display Item (Display Item)**
  The same as with Bar.
- **Maximum Order to Display (Display Max Order)**
  The same as with Bar.
- **List Start Order (List Start Order)**
  Set the harmonic to display at the top of the list.
  Harmonics less than the specified harmonic are not shown in the list.
  This is used to scroll the list.
  The range is as follows.
  Line RMS mode: 1 to 40
  Power mode: 1 to 35

List display example (rms and percentage content)



Harmonics **Harmonic analysis values**

Press the List Start Order soft key and turn the jog shuttle to scroll.

18 Printing and Saving Screen Captures

You can print screen captures from a built-in printer (option) or a network printer, save images to files, and so on.

Destination Type (Print To)

You can save screen captures and print them on the following types of printers.

- Built-in printer (BuiltIn): You can select this option when the optional built-in printer is installed.
- Network printer (Network): You can select a network printer that the DL850E/DL850EV is connected to. You must configure the network printer in advance.
- USB printer (USB): The printer connected to the DL850E/DL850EV through USB.
- File (File): You can save screen captures to files in PNG, BMP, and JPEG formats.

Printing from the Built-In Printer (BuiltIn; option)

Models that have the optional built-in printer installed can print from it. Images printed from the built-in printer are printed just as they are displayed on the DL850E/DL850EV.

Comment (Comment)

You can enter a comment of up to 26 characters in length. The comment that you create is displayed in the bottom of the screen.
Changing this comment also changes the network printer and file comments.

Printing from a Network Printer (Network)

You can select a network printer that the DL850E/DL850EV is connected to. You must configure the network printer in advance.

▶ See here.

Images printed from the network printer are printed just as they are displayed on the DL850E/DL850EV.
On EPSON inkjet printers, the vertical lines of the grid and frame are not printed because the screen image is compressed.

Printer Type (Format)

The printers that the DL850E/DL850EV can use are listed below.

- HP Inkjet: HP inkjet printers
- PCL Laser: PCL laser printers
- EPSON Inkjet: EPSON inkjet printers

Color (Color)

You can select the color format to print in from the options below.

- ON: The DL850E/DL850EV prints using the same colors as the screen, excluding the background color. The grid and some other items are printed in black.
- OFF: The DL850E/DL850EV prints in the same way that it prints from the built-in printer.

Comment (Comment)

You can enter a comment of up to 26 characters in length. The comment that you create is displayed in the bottom of the screen.
Changing this comment also changes the built-in printer and file comments.

Printing on a USB Printer (USB)

Printing is possible on a printer connected through USB. When printing on a USB printer, the screen displayed on the DL850E/DL850EV is printed exactly as it appears.
On a Brother PocketJet printer, you can expand and print a specific area of the screen.

USB Ports

There are two standard type A ports and one standard type B port on the left side panel of the DL850E/DL850EV. Connect the printer to one of the standard type A ports.

Left side panel

Type A

Type B

Pin No.	Signal name
1	VBUS : +5V
2	D − : − Data
3	D+ : +Data
4	GND : Grand

Printer Type (Format)

The following USB Printer Class Ver.1.0 printers can be used.

- HP Inkjet: HP inkjet printers, single function models
- Brother : Brother PocketJet or RJ-4030 printer

- Do not connect an incompatible USB printer.
- For USB printers that have been tested for compatibility, contact your nearest YOKOGAWA dealer.

Connection Procedure

Connect a USB printer directly to the DL850E/DL850EV using a USB cable.
You can connect or remove the USB cable regardless of whether the DL850E/DL850EV is on or off (hot-plugging is supported).
If you connect a USB printer when the DL850E/DL850EV is on, the DL850E/DL850EV will detect the printer and enable it for use.

- Connect the USB printer directly, not through a hub.
- Do not connect multiple printers to the USB ports.
- While the printer is printing, do not turn off the printer or remove the USB cable.
- Do not connect or remove USB cables from the time when the DL850E/DL850EV is turned on until key operation becomes available (approximately 20 to 30 seconds).

Color (Color)

When the printer type is HP Inkjet, select the color mode from the following options.

- ON: Printing is performed using the same colors as the screen (however with no background and grid printed in black).
- OFF: Printing is performed using colors that are similar to those used when printing from the built-in printer.

Comment (Comment)

You can specify a comment using up to 26 characters. The comment appears at the bottom of the screen.
The comment is used when printing on the built-in printer, printing on a network printer, and saving files.

Mode (Mode)

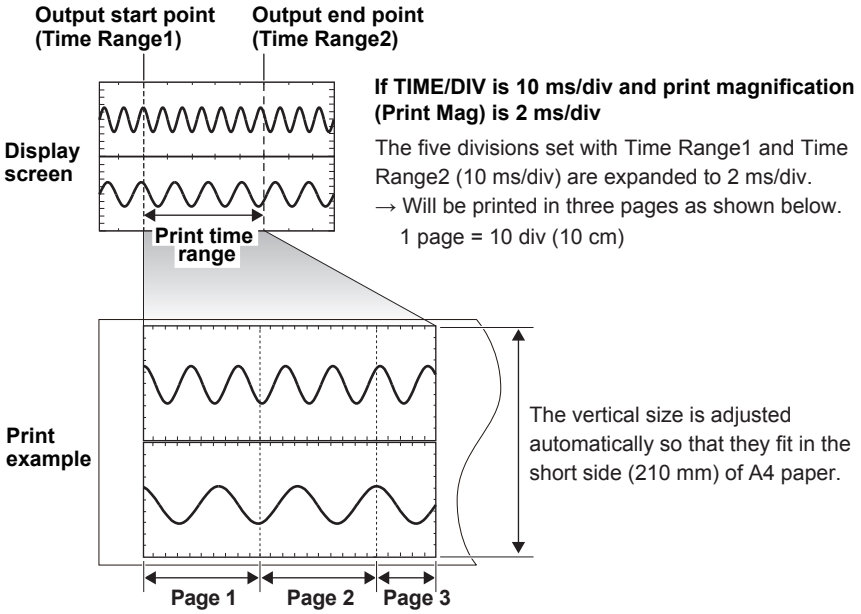
When the printer type is Brother, select the print mode from the following options.

- Hard Copy (Hard Copy): The waveforms displayed on the screen are printed as they appear on the screen.
- Long Print (Long Print): The specified print time range of the waveforms displayed on the screen are printed with the time axis expanded. The vertical size is adjusted automatically so that they fit in the short side (210 mm) of A4 paper. Brother RJ-4030 does not support Long Print.

Print Time Range of Long Print (Time Range1/Time Range2)

If the mode is set to Long Print, set the print time range to print. Move and set the cursors for the output start point (Time Range1) and output end point (Time Range2) using the jog shuttle.

Selectable range: ±5 div of the time axis



Print Magnification (Print Mag) of Long Print

If the mode is set to Long Print, set the print time magnification using the jog shuttle. The number of print pages* is displayed on the soft key menu according to the specified print time range and print magnification.

* 1 page = 10 div (10 cm)

The method to set the magnification varies depending on whether the waveforms to be printed are sampled using the internal clock or sampled using an external clock.

- **For waveforms sampled with the internal clock**

  Set using the time per division (T/div). If it is set to the same value as the sampling T/div, 10 divisions of waveforms are printed on a page (= 10 cm).

  The selectable range varies depending on the T/div value and record length (in 1-2-5 steps).

- **For waveforms sampled with an external clock**

  Set using the magnification. If the magnification is set to 1, 10 divisions of waveforms are printed on a page (= 10 cm).

  Varies depending on the record length.

The maximum number of pages that can be printed at once is 25. If the maximum number of print pages is exceeded, an error message will appear when printing is executed.

Detail Settings of Long Print (Print Setup)

If the mode is set to Long Print, set the print details.

Comment (Comment)

▶ See here.

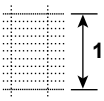
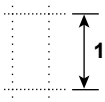
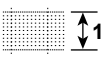
Width of the Vertical Scale (Graticule Type)

Select DIV or 10mm.

- DIV: Grid that divides the print zone into 10 sections
- 10mm: Grid of a millimeter graph paper type

Graticule lines that are printed

The format of the printed scale varies depending on the selected scale width and the grid type selected on the DISPLAY menu as shown below.

Width of the vertical scale (Graticule Type)	Grid (Graticule)		
			
DIV	 1div	No graticule lines	 1div
10mm	 10mm	No graticule lines	 10mm

Display Information (Display Information)

Select whether to print the following display information.

- **Time (Time)**

  The recording start time and recording end time from the time reference mark are printed at the bottom of the print area.
- **Gauge (Gauge)**

  A gauge, arrow indicating the ground position, and trace number are printed to the left of the print area.
- **Header (Header)**

  The time of the waveform time reference, time reference mark, and Time/div are printed in the top section of the print area.

  For details on the time of the waveform time reference, see section 1.3 in the Getting Stared Guide, IM DL850-E-03EN.
- **Annotation (Annotation)**

  Trace information or messages assigned to each channel are printed at the bottom of the waveform print area.

Annotation Type (Annotation Type)

If you select the annotation print check box, select the annotation type from the following options.

- Trace information (Trace Info): V/div, filter, module settings, and the like are printed.
- Message (Message): Character strings assigned to each channel are printed.

▶ See here.

Annotation Message (Annotation Message)

If you set the annotation type to message, set the following items.

- Trace (Trace): Select the target waveform to assign the annotation message.
- Message (Message): Set the message for the wavefomr selected with Trace (Trace) using up to 50 characters.

Notes on printing with a USB printer

- The comment may not be printed properly on some printers. Use a USB printer that has been tested for compatibility.
- The DL850E/DL850EV may not be able to detect out-of-paper or other errors on the USB printer. If an error occurs, press PRINT again to stop the printout.

Notes on Long Print

- Long Print is not possible while waveform acquisition is in progress.
- The items that can be printed using Long Print are T-Y waveform data stored in the acquisition memory, math waveforms, and hard disk recording waveforms.
- If history waveforms are displayed, only the waveform selected with Select Record No. is applicable for Long Print.
- Snapshots, accumulated waveforms, and waveforms captured using the dual capture feature cannot be printed using Long Print.
- If the number of print pages exceeds 25, Long Print is not possible.

Saving Screen Captures to Files (File)

You can save screen captures to files in PNG, BMP, and JPEG formats.

Data Format (Format)

You can select the format to save to from the options listed below.

- PNG: The extension is .PNG. The file size is approximately 50 KB for black and white mode and approximately 100 KB for color mode.
- BMP: The extension is .BMP. The file size is approximately 150 KB for black and white mode and approximately 2 MB for color mode.
- JPEG: The extension is .JPG. The file size is approximately 250 KB for color mode.

The file sizes listed here are for reference. Actual file sizes will vary depending on the image that is saved.

Color (Color)

You can select the color format to save to from the options below.

- ON: Saves data using 65536 colors.
- ON (Gray): Saves data using 16 grayscale levels.
- ON (Reverse): Saves data using 65536 colors. The image background is set to white.
- OFF: Saves data in black and white.

Background Transparent or Opaque (Background)

For PNG format, you can save the waveform display area with a transparent background. This feature is convenient when you want to compare waveforms by overlaying screen captures on the PC.

- Normal (Normal): Saves data without changing the background (not made transparent).
- Transparent (Transparent): Saves data by making the background transparent.

Frame On or Off (Frame)

For JPEG format, you can add a white frame to the image to prevent the surrounding area from dropping out when the capture is printed.

- ON: The capture is saved with a frame.
- OFF: The capture is saved without a frame.

File Name Setting (File Setup)

You can set file names, comments, and so on. This is the same as the file feature.
Changing the comment also changes the built-in printer and network printer comments.

▶ See here.

Printing or Saving a Screen Capture (PRINT)

The screen capture is printed from the specified printer or saved to the specified file.

19 Saving and Loading Data

You can save the following kinds of data to an SD memory card, USB storage device, internal or external hard disk, or network drive.

Waveform data, setup data, screen capture data, snapshot waveform data, automated measurement data, FFT analysis results of waveform parameters

You can load the following types of data from a storage medium into the DL850E/DL850EV.

Waveform data, setup data, snapshot waveform data

You can also rename and copy files and set or clear protection on files.

Storage Media You Can Save and Load From

The DL850E/DL850EV can access the following five types of storage media for saving and loading data.

SD Memory Card (SD-1)

The SD memory card inserted into the SD memory card slot of the DL850E/DL850EV.

USB Storage Medium (USB-0 or USB-1)

A USB storage device that is connected to the DL850E/DL850EV USB port. USB2.0 mass storage devices compatible with USB Mass Storage Class Ver. 1.1 can be connected to the DL850E/DL850EV.

Internal Hard Disk (HD-0)

The internal hard disk installed on models with the /HD1 option.

External Hard Disk (HD-0)

An external hard disk connected to the EXT HDD connector on models with the /HD0 option. You can connect an external hard disk that supports eSATA.

Network Drive (Network)

A storage device on the network. You can use a network storage device by connecting the DL850E/DL850EV to an Ethernet network.

Notes about Using the USB Memory

- Connect USB storage media directly, not through a USB hub.
- Only connect a compatible USB keyboard, mouse, or storage device to the USB connector for peripherals.
- Do not connect and disconnect multiple USB devices repetitively. Provide a 10-second interval between removal and connection.
- Do not connect or remove USB cables from the time when the DL850E/DL850EV is turned on until key operation becomes available (approximately 20 to 30 seconds).
- You can use USB storage media that are compatible with USB Mass Storage Class Ver. 1.1.
- The DL850E/DL850EV can handle up to four storage media. If the connected medium is partitioned, the DL850E/DL850EV treats each partition as a separate storage medium. As such, the DL850E/DL850EV can handle up to four partitions.
- Do not connect USB storage media to the DL850E/DL850EV during hard disk recording or when you will start hard disk recording.

Saving Data (Save)

The DL850E/DL850EV saves data to the specified storage medium.

Press SHIFT and then SAVE to display the SAVE menu. On this menu, you can configure the waveform-data and screen-capture-data save operations. Press SAVE (without SHIFT) to execute the save operation. On the menu for configuring the save operation (the SAVE menu), you cannot turn off both the waveform-data and screen-capture-data save operations.

Saving Waveform Data (Waveform)

You can save the waveform data that the DL850E/DL850EV has measured to a file in binary, ASCII, floating-point, or MATLAB format.

Save Destination (File List)

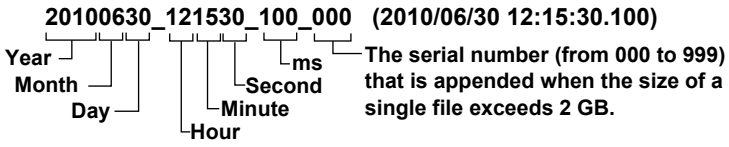
Specify the file to save to.

File Name (File Name)

Set the file name.

- You can use the auto naming feature to automatically assign file names.
- Whether Auto Naming is set to Numbering, Date, or OFF, when the size of a single file exceeds 2 GB, an underscore and a three-digit serial number (000 to 999) are appended to the file names.

File Name Example for When Auto Naming Is Set to Date



- The underscore and three-digit serial number are not appended to the file name when the file size is 2 GB or less. However, when a file is saved through the hard disk recording feature, an underscore and the three-digit serial number 000 are appended to the file name even if the file size does not exceed 2 GB.

- **Auto Naming (Auto Naming)**
  - Numbering (Numbering)
    The DL850E/DL850EV automatically adds a four-digit number from 0000 to 9999 after the common name specified using the File Name setting (up to 32 characters) and saves files.
  - Date (Date)
    The file name is the date and time (down to ms) when the file is saved. The file name specified using the File Name setting is not used.
  - OFF
    Disables the auto naming feature. The name that you specify using the File Name setting is used. If there is a file with the same name in the save destination folder, you cannot save the data.
  - Save Destination during Hard Disk Recording and Action Execution
    In the specified drive, a folder is automatically created with the date (year, month, and day) as its name, and data is saved to that folder using file names specified by the auto naming feature. If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.
    You can configure the DL850E/DL850EV so that data is saved to the specified folder when an action is executed, not to the folder that is automatically created with the date. ▶ See here.

- **File Name (File Name)**

  You can set the common file name that is used when the auto naming feature is turned off or when the auto naming feature is set to Numbering. The maximum number of characters that you can use for file names and folder names is 32 characters. The following restrictions apply.
  - The following types of characters can be used: 0 to 9, A to Z, a to z, _, −, =, (,), {, }, [,], #, $, %, &, ~, !, `,and @. @ cannot be entered consecutively.
  - The following character strings cannot be used due to MS-DOS limitations.
    AUX, CON, PRN, NUL, CLOCK, LPT1, LPT2, LPT3, LPT4, LPT5, LPT6, LPT7, LPT8, LPT9, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, or COM9
  - Make sure that the full file path (absolute path from the root directory) is less than or equal to 255 characters in length. If it exceeds 255 characters, an error occurs when you perform a file operation (such as save, copy, rename, or create folder). When an operation is being performed on a folder, the full path is up to the name of the folder. When an operation is being performed on a file, the full path is up to the name of the file.

  The following additional restrictions apply when you use the file name auto naming feature.
  - If you set auto naming to Numbering, the file name will be the common name that you specify as the file name with a four-character sequence number.
  - If you set auto naming to Date (date and time), the characters that you entered for the file name will not be used. File names will consist of only the date information.

- **Comment (Comment)**

  You can add a comment that consists of up to 120 characters when saving files. You do not have to enter a comment. All characters, including spaces, can be used in a comment.

Data Type (Data Type)

Set the data type to binary, ASCII, floating point, or MATLAB.

- **Binary (Binary)**
  - The sampled data stored to the acquisition memory is saved to a file in binary format. The extension is .WDF. A thumbnail file is also saved at the same time. The thumbnail file can be viewed in the File Property screen.
  - You can load the saved binary format data into the DL850E/DL850EV, display the waveform of the data, and view the values that it contains. Accumulate is always set to OFF for loaded data.
  - If you save a waveform measured using the dual capture feature in binary format, the main waveform data and captured waveform data are saved to the same file.
  - The instrument numbers of the DL850E/DL850EV and each module are saved in the file properties. However, the instrument numbers of the following modules are not saved.
    701250, 701251, 701255, 701260, 701267, 701261, 701262, 701265, 701270, 701271, 701275, 701280, 720210, 720220, 720230, 720240

- **ASCII (ASCII)**
  - The sampled data stored in the acquisition memory is converted using the specified range and saved to a file in ASCII format. The extension is .CSV. You can use the file to analyze waveforms on your PC.
  - You cannot load the file into the DL850E/DL850EV.
  - Waveforms measured using the dual capture feature are saved simultaneously to separate main-waveform-data and captured-waveform-data files. The captured-waveform-data file is automatically saved to the same name as the main-waveform-data file with DC added to the end of the file name.
    If you configure the record length and the number of channels so that the size of a file would exceed 2 GB, the file cannot be created.
  - If the main channel sample rate and the rate at which data is written to the sub channel acquisition memory are different, “NAN” may be present in the start section of the sub channel data. The minimum number of NAN points is zero. The maximum is according to the following equation.

$$\frac{\text{Main Channel Sample Rate}}{\text{Rate at which data is written to the sub channel acquisition memory}}$$

- **Floating Point (Float)**
  - The sampled data stored in the acquisition memory is converted using the specified range and saved to a file in 32-bit IEEE floating format. The extension is .FLD. You can use the file to analyze waveforms on your PC. The data notation is little-endian (Intel format).
  - You cannot load the file into the DL850E/DL850EV.
  - Waveforms measured using the dual capture feature are saved simultaneously to separate main-waveform-data and captured-waveform-data files. The captured-waveform-data file is automatically saved to the same name as the main-waveform-data file with DC added to the end of the file name.
    If you configure the record length and the number of channels so that the size of a file would exceed 2 GB, the file cannot be created.

- **MATLAB**
  - The sampled data stored in the acquisition memory is saved to a file in MATLAB format. You can select whether to include text format information (ON) or not (OFF).
    The extension is .MAT. You can use the file to analyze waveforms on your PC.
  - You cannot load the file into the DL850E/DL850EV.
  - Waveforms measured using the dual capture feature cannot be saved.
  - If you configure the record length and the number of channels so that the size of a file would exceed 2 GB, the file cannot be created.
  - Waveform data files conform to Level-5 MAT format. Files are not compressed.

Data Size

The data sizes indicated below are for when the record length is 100 kpoint and you save the measured data from CH1 to CH4 with all computed waveforms turned off and one history waveform.

Data Type	Extension	Size (In bytes)
Binary	.WDF	Approx. 1.45 M: (100 kpoint) × 4 channels × 2 + the DL850E/DL850EV setup data (700 k to 2 M depending on the installation state)
ASCII	.CSV	4 to 5 Mpoint
Float	.FLD	Approx. 1.6 M: (100 kpoint) × 4 × 4
MATLAB	.MAT	Approx. 1.6 M: (100 kpoint) × 4 × 4, 1 byte per bit for logic signals

Save Range (Range)

You can select the waveform save range (area) from one of the choices below.
- Main window (Main): Saves the data displayed in the main window
- Zoom 1 or Zoom2 (Zoom1 or Zoom2): Saves the data displayed in the specified zoom window
- Cursor range (Cursor Range): Saves the data in the area between the cursors

Save Conditions (Waveform Save Setup)

- **Waveform to Save (Select Save Trace)**
  - You can select All ON, CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT,[3] and Math. The waveforms you select that are displayed are saved. Even if you select All ON, only the waveforms that are displayed are saved.
    1 You can select the channel of an installed module. A sub channel of a 4-CH module cannot be selected.
    2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. You cannot select sub channels.
    3 On a DL850EV when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. You cannot select sub channels.
  - The vertical-axis, horizontal-axis, and trigger settings are also saved along with the waveforms.

- **Saving History Waveforms (History)**

  You can set the source waveform to one of the waveforms below.
  - One waveform (One): Only the waveform with the record number specified in the history menu is saved.
  - All waveforms (All): All history waveforms between the start and end numbers specified in the history menu are saved.

  * If the data type is set to MATLAB, the number of history waveforms that can be saved is fixed to one (One), and options are not displayed.

  Average waveforms of history waveforms cannot be saved. Save the necessary range of history waveforms using All, load the saved history waveforms, and then set the display mode of the history function to Average Record to display the average waveform.

- **P-P Compression (P-P Comp)**

  When you save waveform data in binary format, you can choose whether to use P-P compression on it.
  - ON: P-P compression is used on the data before it is saved.
  - OFF: The data is saved without being P-P compressed.

- **Location Information (Location Info, /C30 option)**

  When saving data in binary format, you can select whether to save location information to the file. This is available only when the time synchronization feature based on GPS signals (Time Syncro, /C30 option) is in use.

  ▶ See here.

- **Selecting the Power Math Data to Save (G5 Save Item, /G5 option)**

  When saving data in binary format, select the power math data to save from the following:
  - All: All power math waveform data will be saved.
  - Display: Only the power math waveform shown on the display will be saved.

- **Data Removal Interval (Interval)**

  When you save data in ASCII format, you can thin out the data before you convert it to ASCII format. Set the data removal interval.

  OFF (no data is removed), 5 points (Per 5), 10 points (Per 10), 20 points (Per 20), 50 points (Per 50), 100 points (Per 100), 200 points (Per 200), 500 points (Per 500), 1000 points (Per 1000), 2000 points (Per 2000), 5000 points (Per 5000)

  For example, if you select Per 5, the data will be removed as indicated below.

  First data point, +5, +10, +15...

- **Time Information (Time Info.)**

  When you save data in ASCII format, you can choose whether to save time information.
  - ON: Time information is saved.
  - OFF: Time information is not saved.

- **Extension (Extension)**

  When you save data in ASCII format, you can set the extension of the files that you save to csv (.CSV) or MATLAB (.TXT).

- **Decimal Point (Decimal Point)**

  When you save data in ASCII format, you can choose how to separate the data.
  - Point (Point): The decimal point is a period, and the separator is a comma.
  - Comma (Comma): The decimal point is a comma, and the separator is a period.

- **Saving Sub Channel Data (Sub Channel)**

  When you save data in ASCII format, you can choose how to interpolate the data of 16-CH voltage input module or 16-CH temperature/voltage input module sub channels.
  - Supplement (Supplement): Blank spaces are filled with repetitions of the same data so that the sub channels have the same amount of data as an ordinary channel.
  - Space (Space): Spaces are left where there is no data.

Notes about Using the 16-CH Voltage Input Module (720220),

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

Notes on resaving data

If captured data saved using dual capture is loaded into the DL850E/DL820EV, the data can be resaved. However, captured data obtained in auto (Auto) mode with data existing in an area in which 10 divisions of main waveform data cannot be retained cannot be resaved if it is loaded.

- If you change the extension of the saved data file, by using a PC or some other device, the DL850E/DL850EV will no longer be able to load it.
- Up to 1000 files and folders can be displayed in the file list. If there are more than a total of 1000 files and folders in a given folder, the file list for that folder will display only 1000 files and folders. There is no way to set which files and folders are displayed.

Data Format for Saving Multiple Records

The DL850E/DL850EV saves data that contains multiple records, such as history waveforms, in the following data format.

ASCII format: CR+LF is inserted between records.

<Header>
CH1 data 1-1, CH2 data 1-1, ..., [CR+LF]
CH1 data 1-2, CH2 data 1-2, ..., [CR+LF]
⋮
CH1 data 1-m, CH2 data 1-m, ..., [CR+LF]
[CR+LF]
CH1 data 2-1, CH2 data 2-1, ..., [CR+LF]
CH1 data 2-2, CH2 data 2-2, ..., [CR+LF]
⋮
CH1 data 2-n, CH2 data 2-n, ..., [CR+LF]
[CR+LF]
⋮

One history record

Float format: Data is saved separately by channel.

Measured data for CH1 on record 1
Measured data for CH1 on record 2
⋮
Measured data for CH1 on record N
Measured data for CH2 on record 1
Measured data for CH2 on record 2
⋮
Measured data for CH2 on record N
⋮

Saving Setup Data (Setup)

You can save the DL850E/DL850EV setup information to the specified storage medium. The extension is .SET.

Save Destination (File List), File Name (File Name), Comment (Comment)

▶ See here.

Saving to Internal Memory

You can save setup data to internal memory from the Store/Recall menu.

▶ See here.

Saving Other Types of Data (Others)

You can save the following types of data.

Save Destination (File List), File Name (File Name), Comment (Comment)

▶ See here.

Data Type (Data Type)

- Screen capture (Screen Image): You can save the displayed screen image to a file in PNG, BMP, or JPEG format. You can also save the screen image from the menu that appears when you press the PRINT MENU key.
- Snapshot waveforms (Snap): You can save the waveform data captured in a snapshot. The extension is .SNP.
- Measure (Measure): You can save the results of the automated measurement of waveform parameters to a file in CSV format.
- FFT analysis results (FFT): You can save FFT analysis results to a file in CSV format.

Automated Measurement Values of Waveform Parameters (Measure)

Save the results of automatic waveform parameter measurement to a file in CSV format. The extension is .CSV. CSV files are text files that contain data separated by commas. They are used to convert data between spreadsheet and database applications.
The maximum number of previous values that you can save is equal to 100000 ÷ number of items that are turned on.
Data size in bytes = Number of measured items × 15 × number of history waveforms

Save Conditions (Measure Save Setup)

- **Unit (Unit)**

  You can select whether to save the units of measure along with the measured results.
  - ON: Units are saved.
  - OFF: Units are not saved.

- **Time information (Time Info.)**

  ▶ See here.

FFT Analysis Results (FFT)

You can save the analysis results of FFT1 or FFT2 to a file in CSV format. The extension is .CSV.

Save Conditions (FFT Save Setup)

- **Frequency Information (Frequency Info.)**

  You can select whether to save frequency information along with computed results.
  - ON: Frequency information is saved.
  - OFF: Frequency information is not saved.

- **Decimal Point (Decimal Point)**

  ▶ See here.

Saving (Execute Save)

Saves the data to the specified save destination with the specified file name.

Loading Data (Load)

You can load waveform data, setup data, and snapshot waveforms that have been saved by the DL850E/DL850EV.

Loading Waveform Data (Waveform)

Waveform data in binary format (files with .WDF extensions) can be loaded.
You can load a specified waveform data file with the setup data. You can load the entirety of the specified waveform data file. Waveforms of computed data appear when computation is turned on. Because setup data is also loaded, the DL850E/DL850EV settings change when you load waveform data. If you start waveform acquisition by pressing the START/STOP key, the loaded data is cleared.

Loading Waveform Data from Models with Different Options

In the following cases, waveform data saved on models with different options can be loaded.

Memory Option

Option of the DL850E/DL850EV that waveform data was saved on	Option of the DL850E/DL850EV that waveform data will be loaded into (Yes: Loadable)		
	No options (250 Mpoint)	/M1 Option (1 Gpoint)	/M2 Option (2 Gpoint)
No options (250 Mpoint)	Yes	Yes	Yes
/M1 Option (1 Gpoint)	Yes[1, 2]	Yes	Yes
/M2 Option (2 Gpoint)	Yes[1, 2]	Yes[1, 3]	Yes

1 Waveform data can be loaded if all the following settings were used to save the data.
- History waveform save: 1 waveform (One)
- Dual capture: OFF

2 Waveform data with record length exceeding 10 Mpoint (500 Mpoint for hard disk recording) cannot be loaded.

3 Waveform data with record length exceeding 50 Mpoint (2 Gpoint for hard disk recording) cannot be loaded.

Computation Option

Option of the DL850E/DL850EV that waveform data was saved on	Option of the DL850E/DL850EV that waveform data will be loaded into (Yes: Loadable)		
	Without the /G3 or /G5 option	/G3 Option (Real Time Math)	/G5 Option (Power Math)
Without the /G3 or /G5 option	Yes	Yes	Yes
/G3 Option (Real Time Math)	Yes[1]	Yes	Yes
/G5 Option (Power Math)	Yes[1]	Yes[2]	Yes

1 Waveform data of real time math and power math channels cannot be loaded.

2 Waveform data of power math channels cannot be loaded.

- If the module configuration when the waveform data is saved and that when the data is loaded are different, only the waveform data of modules that match is loaded. When loading is complete, a message indicating the channel numbers that were not loaded is displayed.
- You can load only waveform data that you saved with the save range set to the main window.

Loading Setup Data (Setup)

The setup data of the specified file is loaded. The extension is .SET.

* The following settings are not loaded.
Date and time, Time synchronization feature (option), Storage media format, USB keyboard language, USB communication feature, Menu font size, Menu background color, Click sound on/off, Key lock, Network

Recalling Data from the Internal Memory

You can recall setup data from the internal memory from the save/load menu.

▶ See here.

If the module configuration when the setup data is saved and that when the data is loaded are different, only the setup data of modules that match is loaded. When loading is complete, a message indicating the channel numbers that were not loaded is displayed.

Loading Other Types of Data (Others)

The snapshot waveforms of the specified file or the contents of a symbol definition file are loaded.

Snapshot Waveforms (Snap)

The extension is .SNP. The snapshot waveforms that you load are displayed in white on the screen.

Symbol Definition Files (Symbol)

The extension is .SBL. These are CAN data ▶ See here. or LIN data ▶ See here. definition files.

Loading (Execute Load)

Loads the data of the specified file.

File Operations (Utility)

You can perform file operations such as creating folders on the storage medium, deleting and copying files, and changing file names.

Sorting the List (Sort To)

You can sort the file list by file name, data size, date, etc.

Display Format

Select whether to display a list of files or to display thumbnails.

Selecting the Type of File to List (File Filter)

You can limit the type of files that appear in the list by selecting an extension.

Changing the Storage Medium (Change Drive)

You can select the storage medium that you want to access. The DL850E/DL850EV displays various storage media as follows:

- SD-1: The SD memory card inserted into the SD memory card slot of the DL850E/DL850EV
- USB-0: The USB storage device that is connected to a DL850E/DL850EV's USB port (type A) for connecting peripheral devices (the first connected device)
- USB-1: The USB storage device that is connected to a DL850E/DL850EV's USB port (type A) for connecting peripheral devices (the second connected device).
- HD-0: On models with the /HD0 option: an external hard disk that supports eSATA connected to the EXT HDD connector. On models with the /HD1 option: the internal hard disk.
- Network: A storage device on the network

Making Folders (Make Dir)

Make a folder.

You can use the same characters in folder names that you can in file names.

▶ See here.

Copying and Moving Files (Copy and Move)

You can copy or move the selected files and folders to other storage media or folders. You can copy or move multiple files at the same time.

Deleting Files and Folders (Delete)

You can delete the selected files and folders.

Renaming Files and Folders (Rename)

You can rename a selected file or folder.

Turning File Protection On and Off (Protect ON and OFF)

You can turn protection on and off for the selected file. The change is reflected in the file attributes, displayed under the Attr column in the file list.

Protection	File Attribute	Description
ON	r	File protection is on for the selected file. The file can only be read. The file cannot be written to or deleted.
OFF	r/w	File protection is off for the selected file. The file can be read and written to.

File Property (File Property)

You can view information about the selected file, such as its name (File Name), file size (File Size), the date and time when it was saved (Date/Time), its attributes (Attribute), and the GPS position information at trigger points. For binary waveform data (the extension is .WDF), you can view the instrument numbers of the DL850E/DL850EV and each module as file properties. However, the instrument numbers of the following modules are not viewed.

701250, 701251, 701255, 701260, 701267, 701261, 701262, 701265, 701270, 701271, 701275, 701280, 720210, 720220, 720230, 720240

Selecting Files (ALL SET, ALL RESET, and SET/RESET)

Selects or deselects all the files in the list.
You can also select or deselect only the highlighted files.

- To format the storage medium, press the UTILITY key to display the System Config menu, and then select Storage Manager.
  ▶ See here.
- You can abort the file copy and delete operations, except for the file that is being processed at the time.

20 Ethernet Communication (Network)

You can configure TCP/IP parameters and use the optional Ethernet interface to perform the following tasks.

To use this feature, set the communication interface to Network (from the UTILITY menu, select Remote Ctrl > Device > Network).

TCP/IP

TCP/IP settings for connecting to an Ethernet network.
Set the IP address, subnet mask, and default gateway.

▶ See here.

FTP Server (FTP/Web Server)

You can connect the DL850E/DL850EV as an FTP server to a network.
You can connect to the DL850E/DL850EV from a PC on the same network and retrieve waveform data.

▶ See here.

Web Server (FTP/Web Server)

You can connect the DL850E/DL850EV as a Web server to a network.
You can connect to the DL850E/DL850EV from a PC on the same network and monitor the DL850E/DL850EV display from the PC.

▶ See here.

Mail (Mail)

The action can be set to mail transmission.

▶ See here.

Network Printer (Net Print)

You can specify a network printer for printing screen captures.

▶ See here.

Network Drive (Net Drive)

You can save waveform data and setup data to a network drive.

▶ See here.

SNTP

The DL850E/DL850EV clock can be set using SNTP. The DL850E/DL850EV can be configured to automatically adjust its clock when it is turned on.

▶ See here.

To connect a PC to the DL850E/DL850EV, use a hub or router, and connect to a network. Do not connect a PC directly to the DL850E/DL850EV.

TCP/IP (TCP/IP)

Configure the settings that the DL850E/DL850EV needs to connect to a network.

DHCP

DHCP is a protocol that temporarily allocates settings that a PC needs to connect to the Internet.
To connect to a network that has a DHCP server, turn the DHCP setting on. When DHCP is turned on, the IP address can be automatically obtained when the DL850E/DL850EV is connected to a network. (You do not have to set it manually.)
When DHCP is turned off, you must set the appropriate IP address, subnet mask, and default gateway for the network.

DNS

DNS is a system used to associate Internet host names and domain names with IP addresses. Given AAA.BBBBB.com, AAA is the host name and BBBBB.com is the domain name. You can use host names and domain names to access the network instead of using IP addresses, which are just numbers. The DL850E/DL850EV allows you to specify the host by name, instead of by IP address. Set the domain name and the DNS server address (0.0.0.0 by default). For details, consult your network administrator.

DNS Servers (DNS Server1/DNS Server2)

You can specify up to two DNS server addresses: primary and secondary. If querying fails with the primary DNS server, the secondary DNS server is automatically used to find the mapping of the host name and domain name to the IP address.

Domain Suffixes (Domain Suffix1/Domain Suffix2)

The domain suffix is a piece of information that is automatically added when a query is made to a DNS server using only a portion of the domain name. For example, if BBBBB.co.jp is registered as a domain suffix and a query is made using “AAA,” the name “AAA.BBBBB.co.jp” is searched.
You can specify up to two domain suffixes: Domain Suffix1 and Domain Suffix 2.
You can use up to 127 characters. The characters that you can use are 0 to 9, A−Z, a−z, and dashes.

TCP/IP settings are applied when you press Bind and then SET or when you turn on the DL850E/DL850EV the next time.

FTP Server (FTP/Web Server)

You can connect the DL850E/DL850EV as an FTP server to a network.
Set the user name and password that will be used by devices on the network to access the DL850E/DL850EV.
Also, set the access timeout value.

User Name (User Name)

Set the user name that will be used to access the DL850E/DL850EV from a PC. The characters that you can use for the password are all the ASCII characters on the keyboard. If you set the user name to “anonymous,” you can connect to the DL850E/DL850EV without entering a password.

Password (Password)

Set the password that will be used to access the DL850E/DL850EV from a PC. The characters that you can use for the password are all the ASCII characters on the keyboard.

Timeout (Timeout)

If an ftp connection cannot be established between the DL850E/DL850EV and the PC within the amount of time specified here, the DL850E/DL850EV aborts the connection process.

To apply the settings that you specified, press Entry.

FTP Server Overview

When the DL850E/DL850EV is connected to the network as an FTP server, the following features become available.

FTP Server

You can view a list of files that are stored in a storage device that is connected to the DL850E/DL850EV and transfer the files to the PC.

PC System Requirements

PC

A computer running Microsoft Windows XP Professional, Microsoft Windows 7, or Mac OS X recommended.

OS

Microsoft Windows XP Professional, Microsoft Windows 7, or Mac OS X (10.4.8) recommended.

Internal memory

512 MB or more recommended.

Communication ports

100BASE-TX or 1000BASE-T Ethernet port. Use this port to connect the PC to the network.

Display

A display compatible with any of the above operating systems and with a resolution of 1024×768 or higher.

Mouse or pointing device

Mouse or pointing device compatible with any of the above operating systems

Web browser

Internet Explorer 6.0, Firefox 3.0, or Safari (3.2.1)

Web Server (FTP/Web Server)

You can connect the DL850E/DL850EV as a Web server to a network.
Set the user name and password that will be used by devices on the network to access the DL850E/DL850EV.
Also, set the access timeout value.

User Name (User Name)

Set the user name that will be used to access the DL850E/DL850EV from a PC. The characters that you can use for the password are all the ASCII characters on the keyboard. If you set the user name to “anonymous,” you can connect to the DL850E/DL850EV without entering a password.

Password (Password)

Set the password that will be used to access the DL850E/DL850EV from a PC. The characters that you can use for the password are all the ASCII characters on the keyboard.

To apply the settings that you specified, press Entry.

Web Server Overview

When the DL850E/DL850EV is connected to the network as an Web server, the following features become available.

Web Server

You can display the DL850E/DL850EV screen on the PC and start and stop measurement through the Ethernet network. You can refresh the DL850E/DL850EV screen that is displayed on the PC and take screen captures.

PC Operations

Setting the Screen Update Rate: You can set the update rate to 5 s, 10 s, 30 s, or 60 s.
Screen Update Start: The display starts updating automatically at the rate that you specify.
Screen Update Stop: You can stop the updating of the display.
Manually Update the Screen: You can update the display manually.
START/STOP: You can start and stop measurement on the DL850E/DL850EV.
Full Screen Capture: You can take full-screen screen captures.

PC System Requirements

▶ See here.

- You need Adobe Flash Player (version 8 and later) to use the Web server function. When visiting this Web site, the most recent Flash Player is automatically downloaded. If the download does not begin, please obtain the latest Flash Player from the Adobe Web site.
- When using the full screen capture function, be sure to disable pop-up blockers on your browser.
- The Web server function is unavailable when printing on the instrument or manipulating files.
- The Web server function can also not be used if the instrument is connected to a PC while the Mass Storage setting is enabled on the PC. After disconnecting the PC or enabling the USBTMC setting, restart the DL850E/DL850EV.

Mail (Mail)

You can send trigger times and other information in emails to a specific email address as an action in the action feature.

Mail Server (Mail Server)

Specify the IP address of the mail server on the network that the DL850E/DL850EV will use. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

Mail Address (Mail Address)

You can specify multiple email recipient addresses. Separate each address with a comma.

Comment (Comment)

If necessary, you can enter a comment in the first line of emails.

Attaching Image Files (Attached Image File)

You can attach a capture of the screen that is displayed at the time the email is sent.

File format: The format that you set in the FILE menu for saving screen captures.
File name: DL_image[time].extension
(Example: DL Image1006171158.extension is a screen capture taken at 11:58 on June 17, 2010.)
Resolution: XGA (1024 × 768 dots)
Approximate File Size
Normal screen: Approx. 50 KB
Maximum: Approx. 1.6 MB (when the screen contains many colors)

Timeout (Timeout)

If the DL850E/DL850EV cannot send an email for the amount of time specified here, it disconnects from the mail server.

Sending a Test Mail (Send Test Mail)

You can send a test mail to check whether emails can be sent properly.

Network Printer (Net Print)

You can print screen captures on a network printer.
The DL850E/DL850EV can print to the following printers.

- EPSON Inkjet printers (EPSON Inkjet)
- HP inkjet printers (HP Inkjet)
- PCL laser printers (PCL Laser)

LPR servers (LPR Server)

Specify the IP address of the printer server that the DL850E/DL850EV will connect to. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

LPR is a protocol used to print over a TCP/IP network.

LPR Name (LPR Name)

The name of the shared printer that the DL850E/DL850EV will connect to.

Timeout (Timeout)

If the DL850E/DL850EV cannot print for a certain amount of time, it disconnects from the network printer.

Network Drive (Net Drive)

You can save waveform data and setup data to a network drive.

FTP Server (FTP Server)

Specify the IP address of the FTP server on the network that you want to save waveform or setup data to. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

Login Name (Login Name)

Specify the login name. The characters that you can use for the password are all the ASCII characters on the keyboard.

Password (Password)

Specify the password that corresponds to the login name. The characters that you can use for the password are all the ASCII characters on the keyboard.

Passive Mode (Passive)

Turn passive FTP on or off.
In passive mode, the FTP client sets the port number for data transfer. Enable passive mode when you have set an external FTP server as a network drive or when you are accessing an FTP server through a firewall.

Timeout (Time Out)

If the DL850E/DL850EV cannot transfer files for a certain amount of time, it disconnects from the FTP server.

Connecting to the Network Drive(Connect/Disconnect)

When you press the Connect button, the DL850E/DL850EV connects to the specified network drive, and the drive appears in the file list (File List). When you press the disconnect button, the network drive is disconnected and removed from the file list (File List).

If the network drive or fixed IP address is not set correctly, you may not be able to operate the DL850E/DL850EV for the specified timeout period.

SNTP (SNTP)

The DL850E/DL850EV clock can be set using Simple Network Time Protocol (SNTP). The DL850E/DL850EV can be configured to automatically adjust its clock when it is turned on.

SNTP Server (SNTP Server)

Specify the IP address of the SNTP server that the DL850E/DL850EV will use. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

Timeout (Timeout)

If the DL850E/DL850EV cannot connect to the SNTP server for a certain amount of time, it aborts the operation.

Executing Time Adjustment (Adjust)

The DL850E/DL850EV clock is synchronized to the SNTP server clock.

Automatic Adjustment (Adjust at Power On)

You can configure the DL850E/DL850EV so that its clock is automatically synchronized to the SNTP server clock when the DL850E/DL850EV is turned on when it is connected to the network.

- If the time difference from GMT (Greenwich Mean Time) is set in the date/time setting, the DL850E/DL850EV will make appropriate adjustments to the time information received from the SNTP server.
  ▶ See here.
- If you do not want the DL850E/DL850EV to synchronize with an SNTP server, do not set the SNTP server IP address.

21 Other Features

Auto Setup (Auto Setup)

The auto setup feature automatically sets the SCALE (vertical axis), TIME/DIV (horizontal axis), trigger level, and other settings to values that are most suitable for the input signals. This feature is useful when you are not sure what type of signal will be applied to the DL850E/DL850EV. The auto setup feature will not work properly on some input signals. There are some modules with which the auto setup feature cannot be used.

Center Position after the Execution of Auto Setup

The center position after you execute auto setup will be 0 V.

Modules That Support Auto Setup

701250 (HS10M12), 720250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 701267 (HV (with RMS)), 720268 (HV (AAF, RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701275 (ACCL/VOLT), 720210 (HS100M12), 720211 (HS100M12), 720220 (16CH VOLT)*, 720254 (4CH 1M16)

* When you execute auto setup on the 720220, sub channel on/off settings and settings that relate to the horizontal axis (TIME/DIV) are not changed.

Source Channels

The DL850E/DL850EV executes auto setup based on the signals of all channels excluding logic channels.

Waveforms Displayed before the Execution of Auto Setup

Waveforms that were displayed before you execute auto setup will be cleared.

Signals That Auto Setup Can Be Applied To

You can use auto setup for the following types of input signals.

- When a 720210 or 720211 module is installed: Simple, repeating signals with frequencies between 50 Hz and 10 MHz

  When a 720210 or 720211 module is not installed: Simple, repeating signals with frequencies between 50 Hz and 1 MHz
- Signals whose maximum absolute input voltage is 20 mV at 1:1 probe attenuation to the maximum range × 10

The auto setup feature may not work properly for signals that include a DC component or high-frequency components.

Undoing Auto Setup (Undo)

You can revert to the settings that were used immediately before you executed auto setup.

Initializing Settings (Initialize)

You can reset the DL850E/DL850EV settings to their factory default values. This feature is useful when you want to cancel all the settings that you have entered or when you want to redo measurement from scratch.

Items That Cannot Be Reset

The following settings cannot be reset.

Date and time settings, communication settings, the language setting (Japanese or English), and environment settings

Undoing Default Reset (Undo)

If you perform default reset by mistake, you can undo it by pressing the Undo soft key.

To Reset All Settings to Their Default Values

While holding down the RESET key, turn the power switch on. All settings except the date and time settings (display on/off setting will be reset) and the setup data stored in internal memory will be reset to their factory default values. If you reset the settings using this method, the changes cannot be undone.

Storing and Recalling Setup Data (Setup Data Store and Recall)

You can save up to 17 sets of setup data to specific internal memory areas. It is convenient to save setup data that you use frequently. You can save a set of setup data to one of the following numbers.

1 to 16, Product Setting

By specifying these numbers, you can store and recall setup data easily.

Product Setting allows you to also store and recall instrument-specific information such as Ethernet communication and environmental settings.

You can attach comments in the same way that you can when you save waveform data.

▶ See here.

Calibration (CAL)

Executing Calibration (Execute Calibration)

Calibrates following items. Execute calibration when you want to make accurate measurements.

- Vertical-axis ground level

Calibration is performed automatically when the power switch is turned on.

Notes about Calibration

- Allow the DL850E/DL850EV to warm up for at least 30 minutes before you execute calibration. If you execute calibration immediately after power-on, the calibrated values may drift due to temperature changes or other environmental changes.
- Execute calibration in a stable temperature environment ranging from 5 to 40°C (23 ± 5°C recommended).
- Do not apply signals when calibrating. Calibration may not be executed properly when input signals are being applied to the DL850E/DL850EV.

Auto Calibration (Auto Calibration)

Auto calibration is executed when you start signal acquisition if any of the time periods listed below has elapsed since the power was turned on.

- Approx. 3 minutes
- Approx. 10 minutes
- Approx. 30 minutes and every 30 minutes thereafter

Power Integration Calibration (On Models with the /G5 Option)

Executing Calibration (Execute Calibration)

Calibrates the following items. Execute calibration when you want to make accurate measurements.

- Ground Level of Power Analysis Items
  This calibration is not performed automatically.
  To make accurate power measurements, perform this calibration manually.

Notes about Calibration

- Allow the DL850E/DL850EV to warm up for at least 30 minutes before you execute calibration.
  If you execute calibration immediately after power-on, the calibrated values may drift due to temperature changes or other environmental changes.
- Execute calibration in a stable temperature environment ranging from 5 to 40°C (23 ± 5°C recommended).
- Do not apply signals when calibrating.
  Calibration may not be executed properly when input signals are being applied to the DL850E/DL850EV.

Snapshot (SNAPSHOT)

Retains the currently displayed waveforms on the screen. This feature allows you to update the display without having to stop waveform acquisition. It is a useful feature when you want to compare waveforms.

Snapshot waveforms are displayed in white.

You cannot perform the following operations on snapshot waveforms.

Cursor measurement, automated measurement of waveform parameters, zoom, or computation

You can save and load snapshot waveforms.

Clear Trace (CLEAR TRACE)

Clears all the waveforms that are displayed on the screen.

If you change the display format or perform other similar operations, the DL850E/DL850EV redisplays the channel waveforms, computed waveforms, and loaded waveforms that were displayed before you executed the clear trace operation.

Snapshot and clear trace features are disabled:

- When the DL850E/DL850EV is in remote mode.
- When the DL850E/DL850EV is printing, when it is executing auto setup, or when it is accessing a storage medium.
- When go/no-go determination is in progress, when action is in progress, or when searching is in progress.

Remote Control (Remote Ctrl)

Communication interface for controlling the DL850E/DL850EV from a PC or communication interface for connecting the acquisition software to the DL850E/DL850EV . For details, see the *communication interface user's manual*, IM DL850E-17EN and the *cacquisition software user's manual*, IM DL850E-61EN.

Types of Communication Interfaces (Device)

USB, GP-IB, and Network are the available communication interfaces.

- Only use the selected communication interface. If you send commands simultaneously from another communication interface that has not been selected, the DL850E/DL850EV will not execute the commands properly.
- When the DL850E/DL850EV is in remote mode and is communicating with a PC, "Remote" appears in the lower right of the DL850E/DL850EV screen. All keys except SHIFT + CLEAR TRACE are disabled in Remote mode.

USB

Connects the DL850E/DL850EV to a PC using USB.

To remotely control the DL850E/DL850EV using communication commands through the USB port, select USBTMC and then carry out the following procedure.

- Install YOKOGAWA USB TMC (Test and Measurement Class) driver on your PC. For information about how to obtain the YOKOGAWA USB TMC driver, contact your nearest YOKOGAWA dealer. You can also access the YOKOGAWA USB driver download website and download the driver (http://www.yokogawa.com/ymi/).
- Do not use USB TMC drivers (or software) supplied by other companies.

GP-IB

Connects the DL850E/DL850EV to a PC using GP-IB.

Address (Address)

- You can set the address to a value from 0 to 30.
- Each device that is connected by GP-IB has its own unique address in the GP-IB system. This address is used to distinguish one device from other devices. Therefore, you must assign a unique address to the DL850E/DL850EV when connecting it to a PC or other device.

- Several cables can be used to connect multiple devices. However, no more than 15 devices, including the controller, can be connected on a single bus.
- When connecting multiple devices, you must assign a unique address to each device.
- When the controller is communicating with the DL850E/DL850EV or with other devices through GP-IB, do not change the address.
- Use cables that are 2 m or shorter in length to connect devices.
- Keep the total length of the cables under 20 m.
- When devices are communicating, have at least two-thirds of the devices on the bus turned on.
- To connect multiple devices, use a star or daisy-chain configuration. Loop and parallel configurations are not allowed.

Network

Connects the DL850E/DL850EV to a PC using Ethernet.

- You must set TCP/IP parameters to connect the DL850E/DL850EV to an Ethernet network.
  ▶ See here.
- To connect the DL850E/DL850EV to a PC, be sure to use straight cables through a hub. Correct operation is not guaranteed for a one-to-one connection using a cross cable.
- Use one of the following types of network cable that conforms to the transfer speed of your network.
  A UTP (Unshielded Twisted-Pair) cable
  An STP (Shielded Twisted-Pair) cable

Acquisition Software Connection (ACQ Software Connect)

You can select whether to permit (Permit) or forbid (Forbid) a connection request from the PC's Acquisition Software when the DL850E/DL850EV is connected to a PC through the USB or Ethernet interface.

The DL850E/DL850EV keys are disabled while the PC's Acquisition Software is connected to the DL850E/DL850EV. If you want to control the DL850E/DL850EV using its keys, on the PC, disconnect the Acquisition Software from the DL850E/DL850EV.

System Configuration (System Configuration)

You can specify the following settings.

- DL850E/DL850EV date and time
- Language
- Click sound on/off
- LCD adjustment
- Format Storage Media
- USB Keyboard Language
- USB Communication

Date and Time Settings (Date/Time)

The DL850E/DL850EV date and time.

Turning the Display On and Off (Display)

Set whether to display the date and time on the DL850E/DL850EV screen.

Display Format (Format)

You can display the date in one of the following formats.

2010/06/30 (year/numeric month/day)
30/06/2010 (day/numeric month/year)
30-JUN-10 (day-English abbreviation of the month-last two digits of the year)
30 JUN 2010 (day month (English abbreviation) year)

Date and Time Settings (Date/Time)

Sets the date and time.

Time Difference from Greenwich Mean Time (Time Diff. GMT)

Set the time difference between the region where you are using the DL850E/DL850EV and Greenwich Mean Time.

Selectable range: Set the time difference in the range of −12 hours 00 minutes to 13 hours 00 minutes.

For example, Japan standard time is ahead of GMT by 9 hours. In this case, set Time Hour to 9 and Minute to 00.

Checking the Standard Time

Using one of the methods below, check the standard time of the region where you are using the DL850E/DL850EV.

- Check the Date, Time, Language, Regional Options on your PC.
- Check the standard time at the URL on the right. http://www.worldtimeserver.com/

- The DL850E/DL850EV does not support Daylight Savings Time. To set the Daylight Savings Time, reset the time difference from Greenwich Mean Time.
- Date and time settings are backed up using the internal lithium battery. They are retained even if the power is turned off.
- The DL850E/DL850EV has leap-year information.

Time Synchronization Feature (Time Synchro; /C20 option)

You can use this feature to use an IRIG (Inter Range Instrumentation Group) signal to synchronize the time on the DL850E/DL850EV with the GPS (Global Positioning System). This feature has three conditions: Unlock, Lock, and Stable. When an IRIG signal is properly received, the DL850E/DL850EV enters into the Lock condition and acquires time information.

IRIG/OFF of the Time Synchronization Feature (Time Synchro)

Set whether to use time synchronization based on the IRIG (Inter Range Instrumentation Group) signal (IRIG) or not (OFF).

If the time synchronization feature is set to OFF, you can set the IRIG code format, IRIG code modulation type, and impedance, explained in the next section.

IRIG Code Format (IRIG Format)

You can set the IRIG code format to A or B.

IRIG Code Modulation Type (Modulation)

You can set the IRIG code modulation type to AM or Pulse-width Code (PWCode).

Input Impedance (Impedance)

You can set the input impedance to 50 Ω or 5 kΩ.

The time synchronization feature has three conditions: Unlock, Lock, and Stable. When an IRIG signal is properly received, the DL850E/DL850EV enters into the Lock condition. Time acquisition and synchronization are possible after 1 s. A few minutes after the DL850E/DL850EV enters the Lock condition, it enters into the Stable condition. In the Stable condition, the internal clock of the DL850E/DL850EV is synchronized to within 10 ppm of the GPS.

Time Synchronization Feature (Time Synchro; /C30 option)

You can use this feature to synchronize the time on the DL850E/DL850EV with the GPS (Global Positioning System) on the basis of a GPS signal received through the GPS antenna.
This feature has two conditions: Unlock and Lock.
When a GPS signal is properly received, the DL850E/DL850EV enters into the Lock condition and acquires time information.

GPS/OFF of the Time Synchronization Feature (Time Synchro)

You can select whether to use a GPS signal for time synchronization (GPS) or not (OFF).

If the time synchronization feature is set to OFF, you can set the time difference from Greenwich Mean Time, leap second correction, and reception status display.

Time Difference from Greenwich Mean Time and Leap Second Correction (Time Diff.)

- **Time Difference from Greenwich Mean Time (Time Diff. GMT)**

  This is the same feature as the time difference of the date and time settings. However, the time is set in 15 minute intervals.

- **Leap Second Correction (GPS-UTC)**

  Set the leap second for synchronizing the clock synchronized to the GPS signal to Coordinated Universal Time (UTC).
  Selectable range: 0 to 99 (seconds)

  The universal time UTC is an approximation of UT1 obtained by adjusting the offset between the International Atomic Time (TAI) and Universal Time (UT1; one of the Universal Times based on the earth rotation). The leap second information to synchronize to UTC is transmitted regularly from GPS satellites at approximately 12.5 minute intervals. The time specified here is used until that time.

Receiving Status Indication (Receiving Status)

The receiving status of the GPS signal is indicated. The information can be updated.

- GPSFix
  Displays a summary of the GPS receiving status.
  OK: The receiving status meets the reference value.
  No: The receiving status does not meet the reference value. The DL850E/DL850EV will not enter into the Lock condition.
- 3D Position Accuracy Estimate
  Indicates the accuracy of the position information. The accuracy must be 100 m or less to achieve GPS Lock.
- Position DOP
  Indicates the accuracy of the position information. The accuracy must be 25 or less to achieve GPS Lock.
- Number of Satelites
  Indicates the number of GPS satellites that are being used to calculate the position information.
- Leap Second
  Indicates the leap seconds used to calculate the UTC time. The default condition is 17 seconds.

GPSFix indicates Yes and the time synchronization is locked when the 3D Position Accuracy Estimate value is 100 m or less and the Position DOP value is 25 or less.

Language (Language)

Sets the language that is used in the setup menu and messages.
The available languages vary depending on the DL850E/DL850EV model that you are using.

Adjusting the LCD (LCD)

You can turn off the LCD and adjust its brightness.

Adjusting the Brightness (Brightness)

You can adjust the brightness in the range of 1 (darkest) to 9 (brightest). You can prolong the LCD service life by decreasing the LCD brightness or by turning off the LCD when you do not need to view it.

Turning Off the LCD (LCD Turn OFF)

You can turn off the LCD. When the LCD is off, you can turn it back on by pressing a key.

Automatically Turning Off the LCD (Auto OFF)

The LCD turns off automatically when there are no key operations for a given time period. The LCD turns back on when you press a key.

Formatting Storage Media (Storage Manager)

You can select the storage medium to be formatted from the following options and format it.

- External hard disk (option)
- Iternal hard disk (option)
- SD memory card
- The USB storage device that is connected to the DL850E/DL850EV's USB port (type A, top port) for connecting peripheral devices.
- The USB storage device that is connected to the DL850E/DL850EV's USB port (type A, bottom port) for connecting peripheral devices.

When you format a storage medium, all the data on it is deleted.

USB Keyboard Language (USB Keyboard)

Sets the USB keyboard language to English or Japanese. The USB keyboard can be used to enter file names, comments, etc.

USB Communication (USB Function)

You can specify the communication features that are used when you connect the DL850E/DL850EV to a PC through USB.

- TMC: You can use USB TMC (Test and Measurement Class) to control the DL850E/DL850EV from a PC. To remotely control the DL850E/DL850EV using communication commands through the USB port, carry out the following procedure.
  Install YOKOGAWA USB TMC driver on your PC.
  (Do not use USB TMC drivers (or software) supplied by other companies.)
- Storage: The connected PC can use the DL850E/DL850EV as a USB storage device.
  There is no need to install the USB TMC driver into your PC.

- For information about how to obtain the YOKOGAWA USB TMC driver, contact your nearest YOKOGAWA dealer. You can also access the YOKOGAWA USB driver download website and download the driver (http://www.yokogawa.com/ymi/).
- When USB Function is set to Storage, only the internal hard disk of the DL850E/DL850EV can be used as a storage device. You cannot access the storage media connected to the USB ports of the DL850E/DL850EV.
- When you access the internal hard disk of the DL850E/DL850EV from a PC, only perform read operations. Otherwise, the DL850E/DL850EV may be damaged.
- When USB Function is set to Storage and files are being accessed, do not remove the USB cable or turn off the DL850E/DL850EV. Doing so may damage the DL850E/DL850EV.

Environment Settings (Preference)

Action Performed at Power On (Power On Action)

Setting Whether to Start Waveform Acquisition (Start)

Select whether to start waveform acquisition at power on (ON) or not (OFF).

Setting Whether to Turn the Action Function On or Off (Action)

Select whether to enable the action function at power on (ON) or not (OFF).

- ON: When the power is turned on, the action mode setting is the same as it was when the power was turned off.
- OFF: When the power is turned on, the action mode is off.

Logic Settings (Logic Setup)

Logic Channel Display Format (Numerical Format)

Choose whether to display the logic waveform values in the numeric monitor as binary (Bit) or hexadecimal (Hex) values.

Cursor Read Order (Cursor Order)

Choose the order that you want to read the bit data from logic input signals in.

- 1->8: Bit 1 to bit 8
- 8->1: Bit 8 to bit 1

Bit Data Display Order (Bit Order)

Choose the order that you want to display the bit data from logic input signals in.

- 1->8: Bit 1 to bit 8
- 8->1: Bit 8 to bit 1

Terminal Setup (Terminal Setup)

Enabling or Disabling the Remote High Edge (STOP) Signal (Remote Stop)

Select whether to enable (ON) the high edge (STOP) in the external start/stop remote signal or disable (OFF).

Trigger Output Signal (Trigger Out)

Select the type of signal to transmit from the trigger output terminal from the following options.

- Normal (Normal)
  A falling signal is transmitted when a trigger occurs.
- Pulse (Pulse)
  A pulse signal is transmitted when a trigger occurs. You can set the pulse width.
- Sample Pulse (Sample Pulse)
  A pulse signal is transmitted at regular intervals when waveform acquisition is started. You can set the pulse rate.
- Start/Stop (Start/Stop)
  A high level signal is transmitted during waveform acquisition, and a low level signal is transmitted otherwise.

Pulse Width (Pulse Width)

When you set the trigger output signal type to Pulse, you can set the pulse width to 1 ms, 50 ms, 100 ms, or 500 ms.

Pulse Rate (Pulse Rate)

If you set the type of trigger output signal to sample pulse, set the pulse rate in the range of 5 Hz to 200 kHz (in 1-2-5 steps).

Configuring the Display (Display Setup)

Menu Font Size (Menu Font Size)

You can set the font size of the menu to Small or Large.

Menu Background Color (Base Color)

You can set the background color of the menu to Blue or Gray.

Scale Value Display Font Size (Scale Font Size)

You can set the font size of the scale value display to small or large.

Items Whose Scale Values Are Displayed (Scale On Item)

Set the items that you want to display when Scale Value is set to ON.

- ALL: The vertical axis (V Scale) and horizontal axis (Time Scale) are displayed.
- Time Scale: Only the horizontal axis (Time Scale) is displayed.

Turning the Level Indicator Display On and Off (Level Indicator)

You can choose whether to display the level indicator (ON), which shows the waveform levels, or not (OFF). The level indicator appears on the right side of the waveform display window.

Horizontal Axis Display Mode (Horizontal Axis Display Mode)

Set the type of time to display on the horizontal scale to relative time (Relative), absolute time (Absolute), or auto (Auto).

- Relative: Relative time from the start of measurement
- Absolute: Absolute time of measurement (not selectable when the measurement time is 1 second or less)
- Auto: If the horizontal scale (TIME DIV) during measurement is greater than 6 min/div, absolute time is used. Otherwise, relative time is used.

Intensity (Intensity)

You can set the intensities of the grid (Grid), cursor (Cursor), and marker (Marker) to values within the range of 1 to 8.

Key and Knob Setup (Key/Knob Setup)

Turning On or Off the Click Sound (Click Sound)

You can turn on or off the click sound that is generated when you operate the jog shuttle.

START/STOP Key Response Time (START/STOP Response Time)

You can set the response time of the START/STOP key to instant (Quick) or 1 s or more (> 1sec).

Key Lock (Key Protect)

You can lock the operation keys to prevent unintentional changes to the current state of the DL850E/DL850EV.

- Type (Type)
  Select whether to lock all the keys (ALL) or to lock all keys except the START/STOP key (Except START/STOP).
- Release Method (Release Type)
  Select whether to release the key lock by pressing the KEY PROTECT key (Key) or by entering a password (Password).
- Password (Password)
  Specify the password to use to release the key lock. Specify the password using up to eight alphanumeric characters. If you forget the password, you can release the key lock by turning the DL850E/DL850EV on while holding down the RESET key. Note that all settings will be initialized when you do this.
  ▶ See here.

Setting the Cursor Read Mode and Data Save Destination (Analysis Setup)

Cursor Read Mode (Cursor Read Mode)

You can select whether to perform cursor measurements on P-P compressed display data or the data that has been acquired in the acquisition memory.

- Display data (Display)
  Cursor measurements are performed on the display data.
- Acquisition (ACQ)
  Cursor measurements are performed on sampled data in acquisition memory.
  ▶ See here.

Setting the Destination That Data Is Saved to upon Action Execution (Action Folder Mode)

You can select the destination that data is saved to when actions are executed.

- ON: Data is saved to the folder that is automatically created with the date.
  If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.
- OFF: Data is saved in the folder that you have specified.
  - The maximum number of files that can be saved to a single folder is 1000. Make sure that there are no files in the destination folder before you execute an action.
    ▶ See here.
  - If the measurement count (Acquisition Count) is set to a number greater than 1000, the measurement cannot be started.
    ▶ See here.

Setting the DC Offset and Gain Adjustment (Input Setup)

Turning DC Offset and Gain Adjustment On and Off (DC Offset & Gain Adjust)

Select whether to use offset adjustment or gain adjustment (ON/OFF).

Self-Test (Selftest)

You can test the keyboard and memory operations. In addition , if necessary for information security control or other purpose, all deletable information in the DL850E/DL850EV can be cleared.

Test Type (Type)

You can perform the following tests.

Key Test (Key Board)
Tests whether the front-panel keys are operating properly. If the name of the key that you press is highlighted, the key is operating properly.

Memory Test (Memory)
You can test the internal memory to determine whether it is functioning normally. If it is functioning normally, “Pass” appears. If an error occurs, “Error” appears.

SD Memory Card Test (SD CARD)
You can test an SD memory card to determine whether it is functioning normally. If an error occurs, “Error” appears.

Hard Disk Test (HDD)
You can test an internal or external hard drive to determine whether it is functioning normally. If an error occurs, “Error” appears.

Printer Test (Printer)
Tests whether the optional built-in printer is operating properly. If the print density is correct, the built-in printer is operating properly. If an error occurs, the built-in printer does not print properly.

Sure Delete (Sure Delete)
This is not a self-test. Executing this item will delete information. You cannot undo this operation. See “Clearing all Deletable Information (Sure Delete)“ later in this section.

Version Update (Version Up)
This is not a self-test. If you execute this item, the firmware of installed modules that can be updated will be updated. You cannot undo this operation. This is a maintenance feature. Use it only when you receive instruction to do so from YOKOGAWA.

Execution (Test Exec)

Executes the selected item.

If an Error Occurs during a Self-Test

If an error occurs even after you carry out the following procedure, contact your nearest YOKOGAWA dealer.

- Execute the self-test again several times.
- Check whether the media being tested is properly inserted.
- Check that the paper is set properly in the built-in printer and that paper is not jammed.

Clearing all Deletable Information (Sure Delete)

If you set the test type (Type) to Sure Delete, information in all deletable areas of the DL850E/DL850EV, such as the internal hard disk, is cleared or overwritten. Use this function only when you need to delete all the data for security reasons, such as when disposing of the DL850E/DL850EV. Do not use it on a regular basis.

Executing Sure Delete (Test Exec)
Two confirmation dialog boxes that ask whether you want to execute the deletion are displayed. Then the deletion executed.

- Executing Sure Delete will clear information in all deletable areas of the DL850E/DL850EV.
- While Sure Delete is in progress, you cannot cancel it or perform any other operation. Never turn off the power while Sure Delete is in progress. Doing so may permanently damage the hard disk.
- Executing Sure Delete does not clear setup data. To initialize the settings to their factory default values, perform initialization.

Overview (Overview)

You can display the following information about the DL850E/DL850EV. The instrument numbers of the DL850E/DL850EV and each module are also displayed. However, the instrument numbers of the following modules are not displayed.

701250, 701251, 701255, 701260, 701267, 701261, 701262, 701265, 701270, 701271, 701275, 701280, 720210, 720220, 720230, 720240

- Model
- Record Length
- Serial No: Instrument number
- Product ID: Unique number and MAC address assigned to each instrument (This information is necessary to add paid options.)
- Slot: Models and Instrument numbers of the inserted modules
- Options
- Default Language
- Firm Version: Firmware version number
- FPGA1/2 Version: FPGA1/2 version number

- The 701265, 720266, 720221, 720240, and 720241 modules have internal CPUs and firmware. For slots that have these modules installed in them, the version number of the firmware installed on the module is also displayed.
  For the 701265 and 720266
  Example: 701265 A.AA
  A.AA is the version of the firmware installed on the module.
  For the 720221, 720240, and 720241
  Example: 720240 B.BB/C.CC
  B.BB is the version of the firmware installed on the module. C.CC is the version of the firmware installed in the DL850E/DL850EV and that can be installed on the 701281 (FREQ) and 720281 (FREQ). If the two above versions are the same, only one version number will be displayed.
- For the 701281, 720281, 720242, and 720243, the module version is displayed.
  Example: 701281 0xAA
- For slots that have the 701260 or 701267 module installed, the module model 701260/701267 is displayed.

Key Lock (KEY PROTECT)

You can lock the operation keys to prevent unintentional changes to the current state of the DL850E/DL850EV. When the keys are locked, pressing any keys other than KEY PROTECT has no effect, and the USB mouse and keyboard cannot be used.

▶ See here.

NUM LOCK

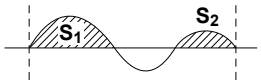
Press this key to use the CH1 to CH16 keys to enter numbers. After you press NUM LOCK, you can press a channel key to enter the number, sign, unit prefix, or exponent displayed to the upper right of the key in white, or to confirm an entry or selection (ENTER).

Appendix

Appendix 1 How to Calculate the Area of a Waveform

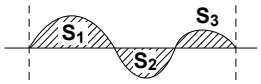
Integ1TY

Sum of only the positive curve areas : $S_1 + S_2$



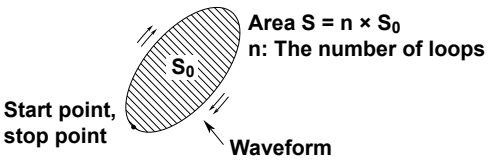
Integ2TY

Sum of the positive and negative curve areas: $S_1 + S_3 - S_2$

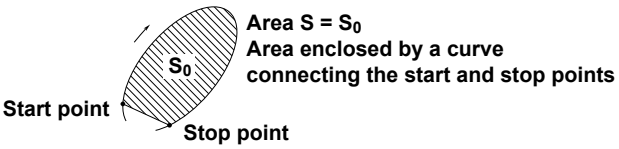


Integ1XY

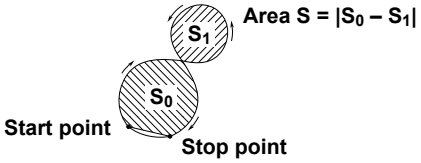
(1) Multiple Loops



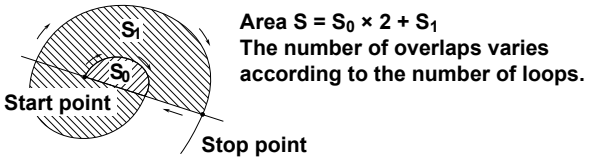
(2) Non-Closed Curve



(3) Loop Tracing a Figure-Eight



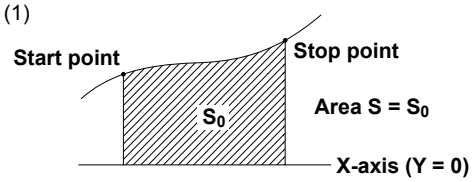
(4) Loop Tracing a Spiral



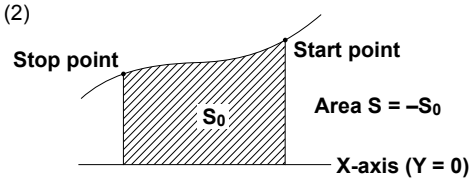
Integ2XY

(1) When Each Y Data Point Corresponds to a Single X Data Point

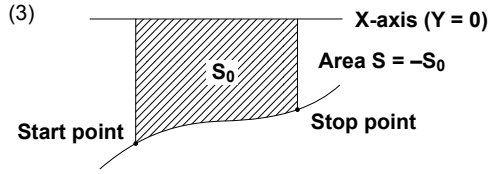
(1)



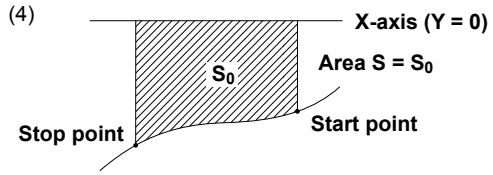
(2)



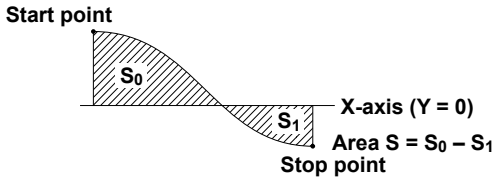
(3)



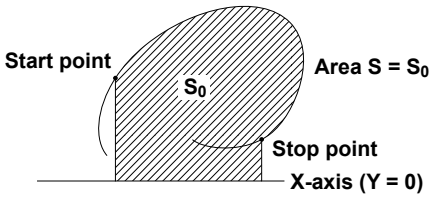
(4)

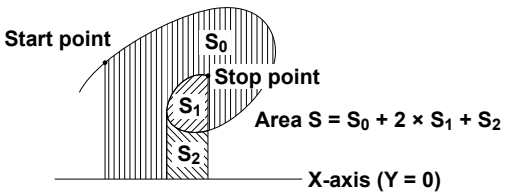


(2) When the Waveform Extends into the Negative Side



(3) When Multiple Y Data Corresponds to One Point of X Data





Appendix 2 User-Defined Computation (Optional)

Digital Filter

Type

Type	Bandwidth
Gauss (Gaussian)	LowPass
Sharp	LowPass/HighPass/BandPass
IIR (Butterworth)	LowPass/HighPass/BandPass

Filter Order

See the following table for the filter orders.

		2%	5%	10%	20%	30% (Cutoff)
Gauss	LowPass	49	21	9	5	5
Sharp	LowPass	88	36	18	9	8
	HighPass	159	65	33	17	13
IIR	LowPass	4	4	4	3	2
	HighPass	4	4	4	4	3

Filter Characteristics

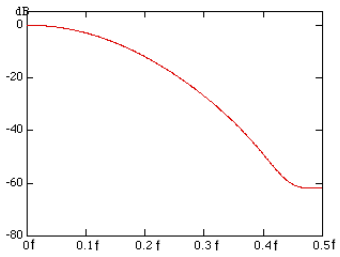
Filter	Pass-band Ripple	Attenuation Slope	Attenuation at the Stop-band	Phase
Gauss	0 dB	*	–	Linear phase
Sharp	±0.3 dB	−40 dB at 1 oct (Lowpass),	−40 dB	Linear phase
		−40 dB at −1 oct (Highpass)	–	Linear phase
IIR	0 dB	−5 dB at 1/6 oct (Lowpass),	–	Non-linear
		−20 dB at −1 oct (Highpass)	–	phase

* For Gaussian filter: $-3.0 \times (f/fc)^2$ dB (f: frequency, fc: cutoff frequency)

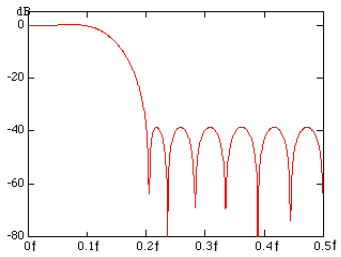
Frequency Characteristics of Filters

f: Sampling frequency (Hz)

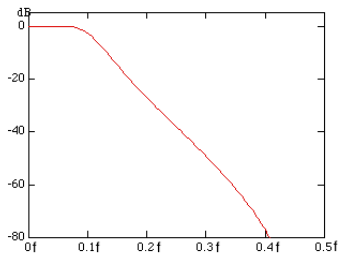
Gauss (10% cutoff)



Sharp (Low pass; 10% cutoff)



IIR (Low pass; 10% cutoff)



The higher the filter order the longer it takes for computation.

Hilbert Function (HLBT)

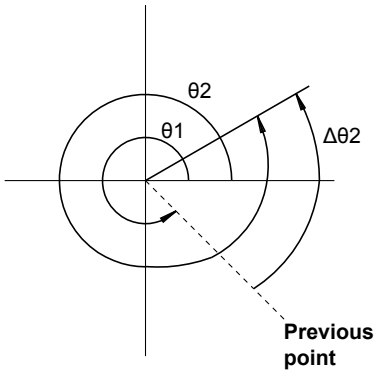
Normally, when we analyze real-time signals, it is useful to think of these signals as the real part of functions of complex variables, and to carry out the actual signal analysis using such functions.
If the real-time signal is considered to be the real part of the function, the imaginary part can be determined with the Hilbert transform of the real part.
The Hilbert transform does not change the order of the individual variables. The Hilbert transform of a time signal results in another time signal.
The Hilbert transform procedure is as follows.
When a time-domain signal is transformed, the signal is first transformed into the frequency domain through Fourier transform. Next, the phase of each frequency component is shifted by −90 degrees if the frequency is positive and +90 degrees if the frequency is negative. Lastly, taking the inverse Fourier transform completes the Hilbert transform.

Example

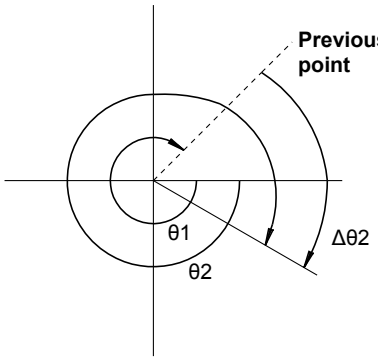
- The Hilbert transform can be used to analyze an envelope waveform.
  AM (amplitude modulation): SQRT(C1 × C1 + HLBT(C1) × HLBT(C1))
  Demodulation of an FM Signal: DIF(PH(C1, HLBT(C1)))

Phase Function (PH)

Phase function PH(X1, Y1) computes $\tan^{-1}$(X1/Y1).
The phase function takes the phase of the previous point into consideration and continues to sum even when the value exceeds ±π (the ATAN function reflects at ±π).
The unit is radians.



θ2 = θ1 + Δθ2

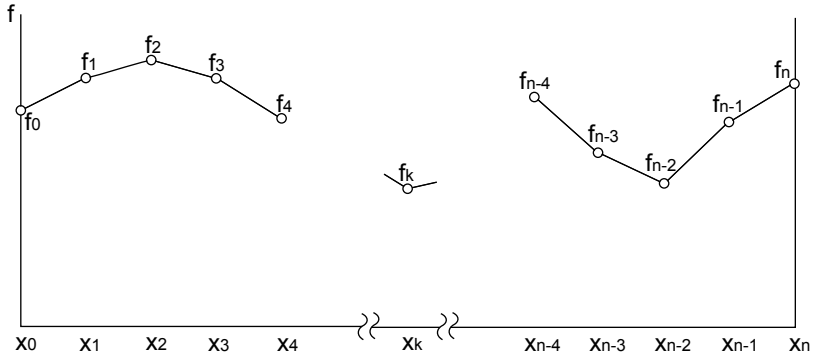


θ2 = θ1 – Δθ2

Differentiation and Integration (DIF, DDIF, INTG, and IINTG)

Differentiation (DIF, DDIF)

The computation of the first-order and second-order differentiated values uses the 5th order Lagrange interpolation formula to derive a point of data from the five points of data before and after the target.
The figure below shows data f0 to fn with respect to sampling times x0 to xn. The derivative and integrated values corresponding to these data points are computed as shown below.



- Equations for First Order Derivatives

Point x_0 f_0' = $\frac{1}{12h}[-25f_0 + 48f_1 - 36f_2 + 16f_3 - 3f_4]$

Point x_1 f_1' = $\frac{1}{12h}[-3f_0 - 10f_1 + 18f_2 - 6f_3 + f_4]$

Point x_2 f_2' = $\frac{1}{12h}[f_0 - 8f_1 + 8f_3 - f_4]$

Point x_k f_k' = $\frac{1}{12h}[f_{k-2} - 8f_{k-1} + 8f_{k+1} - f_{k+2}]$

Point x_{n-2} f_{n-2}' = $\frac{1}{12h}[f_{n-4} - 8f_{n-3} + 8f_{n-1} - f_n]$

Point x_{n-1} f_{n-1}' = $\frac{1}{12h}[-f_{n-4} + 6f_{n-3} - 18f_{n-2} + 10f_{n-1} + 3f_n]$

Point x_n f_n' = $\frac{1}{12h}[3f_{n-4} - 16f_{n-3} + 36f_{n-2} - 48f_{n-1} + 25f_n]$

h = Δx is the sampling interval (s) (example: h = 200 × 10^{-6} at 5 kHz)

- Equations for Second Order Derivatives (DDIF)

Point x_0 f_0'' = $\frac{1}{12h^2}[35f_0 - 104f_1 + 114f_2 - 56f_3 + 11f_4]$

Point x_1 f_1'' = $\frac{1}{12h^2}[11f_0 - 20f_1 + 6f_2 + 4f_3 - f_4]$

Point x_2 f_2'' = $\frac{1}{12h^2}[-f_0 + 16f_1 - 30f_2 + 16f_3 - f_4]$

Point x_k f_k'' = $\frac{1}{12h^2}[-f_{k-2} + 16f_{k-1} - 30f_k + 16f_{k+1} - f_{k+2}]$

Point x_{n-2} f_{n-2}'' = $\frac{1}{12h^2}[-f_{n-4} + 16f_{n-3} - 30f_{n-2} + 16f_{n-1} - f_n]$

Point x_{n-1} f_{n-1}'' = $\frac{1}{12h^2}[-f_{n-4} + 4f_{n-3} + 6f_{n-2} - 20f_{n-1} + 11f_n]$

Point x_n f_n'' = $\frac{1}{12h^2}[11f_{n-4} - 56f_{n-3} + 114_{n-2} - 104f_{n-1} + 35f_n]$

Integration (INTG, IINTG)

The first and second order integrated values are derived using the trapezoidal rule.

- Equations for First Order Integration (INTG)

  Point x_0 $I_0 = 0$

  Point x_1 $I_1 = \frac{1}{2}(f_0 + f_1)h$

  Point x_2 $I_2 = \frac{1}{2}(f_0 + f_1)h + \frac{1}{2}(f_1 + f_2)h = I_1 + \frac{1}{2}(f_I + I_2)h$

  Point x_n $I_n = I_{n-1} + \frac{1}{2}(f_{n-1} + f_n)h$

- Equations for Second Order Integration (IINTG)

  Point x_0 $II_0 = 0$

  Point x_1 $II_1 = \frac{1}{2}(I_0 + I_1)h$

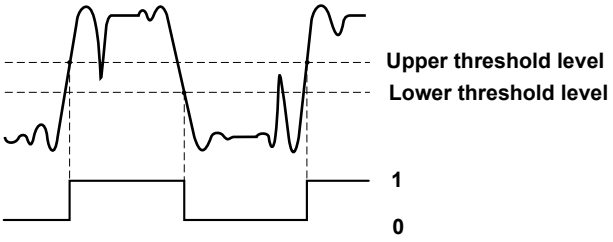
  Point x_2 $II_2 = \frac{1}{2}(I_0 + I_1)h + \frac{1}{2}(I_1 + I_2)h = II_1 + \frac{1}{2}(I_I + I_2)h$

  Point x_n $II_n = II_{n-1} + \frac{1}{2}(I_{n-1} + I_n)h$

Binary Conversion (BIN)

Binary conversion is performed through the use of the specified threshold levels.

BIN(C1)



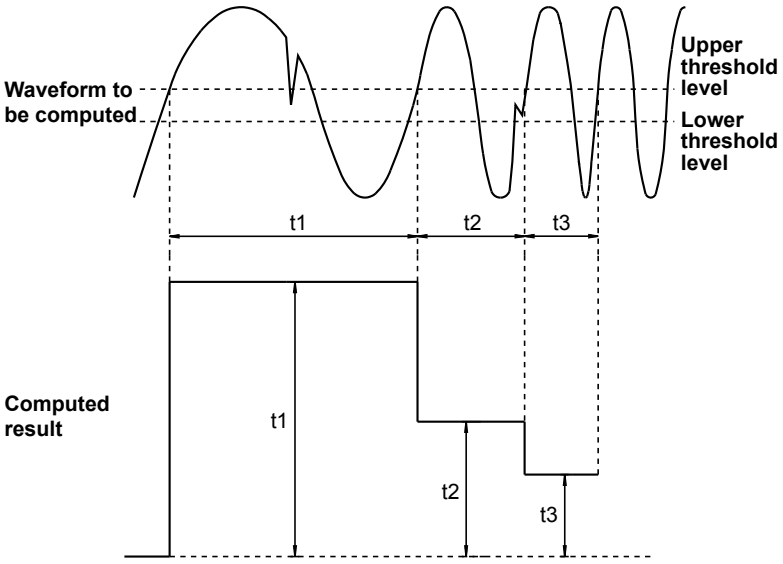
Pulse Width Computation

The signal is converted to binary values according to the preset threshold levels, and the time of the pulse width is plotted as the Y-axis value for that interval.

You can select one of the following interval.

PWHH From a rising edge to the next rising edge.
PWHL From a rising edge to the next falling edge.
PWLH From a falling edge to the next rising edge.
PWLL From a falling edge to the next falling edge.
PWXX From a rising or falling edge to the next rising or falling edge.
FV Inverse of PWHH

Example for PWHH



FFT Function - user-defined

Each frequency component G of a linear spectrum is represented by G = R + jI, where R is the real part and I is the imaginary part.

Linear Spectrum

The linear spectrum can be directly determined with the FFT. Through this spectrum, the magnitude and phase of each frequency component included in the measured waveform can be found. The power spectrum and cross spectrum can also be determined from the linear spectrums of one or two signals.

Because the FFT is a complex function, the linear spectrum produces the real part and imaginary part of the frequency components. The magnitude and phase of the linear spectrum can also be determined from this result.

The DL850E/DL850EV can determine the following spectrums.

Item	Expression	Computation
Real part	LS-REAL	R
Imaginary part	LS-IMAG	I
Magnitude	LS-MAG	$\sqrt{(R^2+I^2)}$
Log magnitude	LS-LOGMAG	$20 \times \log \sqrt{(R^2+I^2)}$
Phase	LS-PHASE	$\tan^{-1}(I/R)$

Log magnitude reference (0 dB): 1 Vpeak

RMS Spectrum

The RMS spectrum expresses the amplitudes of the linear spectrum with RMS values. It dose not contain phase information.
The DL850E/DL850EV can determine the following spectra.

Item	Expression	Computation
Magnitude	RS-MAG	$\sqrt{(R^2+I^2)/2}$
Log magnitude	RS-LOGMAG	$20 \times \log \sqrt{(R^2+I^2)/2}$

Log magnitude reference (0 dB): 1 Vrms

Power Spectrum

The power spectrum expresses the power (squared value) of each frequency component included in the measured signal. It is determined by taking the product of the linear spectrum and its complex conjugate. It does not contain phase information.
The DL850E/DL850EV can determine the following spectrums.

Item	Expression	Computation
Magnitude	PS-MAG	DC component $R^2 + I^2$
		AC component $(R^2 + I^2)/2$
Log magnitude	PS-LOGMAG	DC component $10 \times \log(R^2 + I^2)$
		AC component $10 \times \log\{(R^2 + I^2)/2\}$

Log magnitude reference (0 dB): 1 $Vrms^2$

Power Spectrum Density

The power spectrum density expresses the power spectrum per unit frequency. It is determined by dividing the power spectrum by the frequency resolution Δf found during the analysis of the power spectrum. The computation varies depending on the window function.
Power spectrum density is used to compare power spectrums analyzed at different frequency bands. However, it is not necessary for signals having a line spectrum such as sine waves.
The DL850E/DL850EV can determine the following spectrums.

Item	Expression	Computation
Magnitude	PSD-MAG	PS-MAG/(Δf × k)
Log magnitude	PSD-LOGMAG	10 × log PS-MAG/(Δf × k)

Log magnitude reference (0 dB): 1 $Vrms^2$

Overall Value

The overall value is the total RMS value determined from the frequency spectrum included in the signal. The overall value is the square root of the summation of the power spectrums of all frequencies.

$$\text{Overall value} = \sqrt{\frac{2 \times PS_0 + \Sigma PS_i}{k}} \ \text{(Vrms)}$$

“Rms = overall value” appears on the screen when automated measurement of waveform parameters is being performed (MEASURE is set to ON) on the channel that has been selected for power spectrum computation (PS or PSD) and Rms is set to ON.
However, when Window is set to Exponential, overall values are not displayed.

k

k varies as indicated below depending on the selected time window.

Time Window Type	k
Rect (rectangular window)	1
Hanning (hanning window)	1.5
FlatTop (flattop window)	3.19693
Hamming (hamming window)	1.3628

Cross Spectrum

The cross spectrum is determined from two signals. It is the product of the linear spectrum of one signal (Gy) and the complex conjugate (Gx^*) of the linear spectrum of the other signal (Gx).
If the linear spectrums of the two signals are represented by

$Gx = Rx + jIx$

$Gy = Ry + jIy$

then the cross spectrum Gyx is

$Gyx = Gy \times Gx^*$

$= (Ry + jIy)(Rx - jIx) = Ryx + jIyx$

where $Ryx = RyRx + IyIx$

$Iyx = RxIy - RyIx$

The DL850E/DL850EV can determine the following spectrums.

Item	Expression	Computation
Real part	CS-REAL	Ryx/2
Imaginary part	CS-IMAG	Iyx/2
Magnitude	CS-MAG	[redacted]
Log magnitude	CS-LOGMAG	10 × log ([redacted])
Phase	CS-PHASE	$\tan^{-1}$(Iyx/Ryx)

Transfer Function

The transfer function expresses the frequency responses of the input to and the output from the transfer system. The transfer function is determined by the ratio of the output linear spectrum (Gy) and the input spectrum (Gx) at each frequency. Also, as can be seen from the following equation, the transfer function can be defined as the ratio of the cross spectrum of the input and output (Gyx) and the input power spectrum (Gxx).

Transfer function = $Gy/Gx = (Gy \times Gx^*)/(Gx \times Gx^*) = Gyx/Gxx$

$= (Ryx + jIyx)/(Rx2 + Ix2)$

The DL850E/DL850EV can determine the following items.

Item	Expression	Computation
Real part	TF-REAL	$Ryx/(Rx^2 + Ix^2)$
Imaginary part	TF-IMAG	$Iyx/(Rx^2 + Ix^2)$
Magnitude	TF-MAG	[redacted]$/(Rx^2 + Ix^2)$
Log magnitude	TF-LOGMAG	20 × log [redacted]$/(Rx^2 + Ix^2)$
Phase	TF-PHASE	$\tan^{-1}$(Iyx/Ryx)

The magnitude of the transfer function shows the ratio of the magnitudes of the output linear spectrum and the input linear spectrum while the phase shows the phase difference of the two.

Coherence Function

The coherence function expresses the ratio of the output power generated by the input signal to the transfer system and the total output power.

Coherence function = $Gyx \times Gyx^*/(Gxx \times Gyy)$

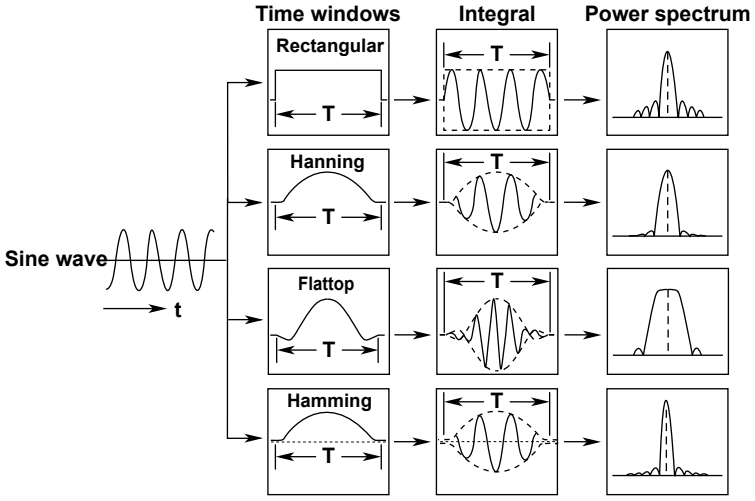
Item	Expression	Computation
Phase	CH-MAG	$(Ryx^2 + Iyx^2)/(Gxx \times Gyy)$

If the output signal is due entirely to the input signal, the coherence function becomes 1. As the ratio decreases, it falls below 1. Thus, the coherence function always takes on a value between 0 and 1.

On one data acquisition, the coherence function becomes 1 across all frequencies. Make sure to take the frequency average of the computation.

Time Windows

You can use a rectangular, Hanning, flattop, Hamming, or exponential time window (you can use an exponential time window on models only with the user-defined computation option).
The rectangular window is suited to transient signals, such as impulse waves, which attenuate completely within the time window. The Hanning, flattop, and Hamming windows allow continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, they are suited to continuous signals. The Hanning window provides a higher frequency resolution compared to the flattop window. However, the flattop window has a higher level of accuracy. The Hamming window is a corrected Hanning window. The frequency resolution of its main beam is greater than that of the Hanning window. The Hamming window is best suited for dividing close signals. When the waveform being analyzed is a continuous signal, consider the above characteristics in selecting the proper window to be applied. When the waveform being analyzed is a continuous signal, consider the above characteristics in selecting the proper window to be applied.



Rectangular : $W(t) = u(t) - u(t - T)$ u(t): **Step function**

Hanning : $W(t) = 0.5 - 0.5 \cos(2\pi \frac{t}{T})$

Flattop : $W(t) = \{0.54 - 0.46 \cos(2\pi \frac{t}{T})\} \frac{\sin\{2\pi(1 - 2t/T)\}}{2\pi(1 - 2t/T)}$

Hamming : $W(t) = 0.54 - 0.46 \cos(2\pi \frac{t}{T})$

The exponential window is used to eliminate noise components from the signal. It is suited for the signals of impulse-excitation frequency-response tests and other similar signals. On the DL850E/DL850EV, the exponential window and force window are activated simultaneously.

Exponential Window

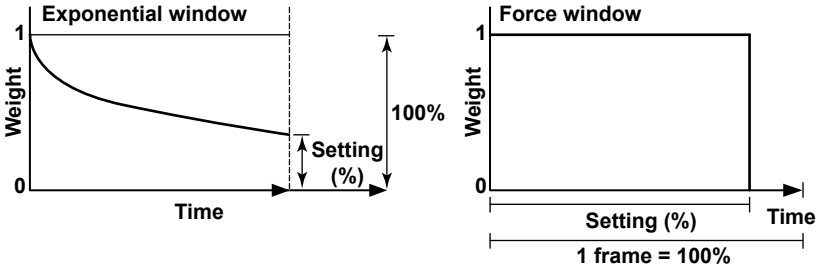
The damping rate is set in terms of the weight of the last data point, with the weight of the first data point in the specified number of FFT points taken to be 100% (= 1). You can set the damping rate in the range of 1 to 100% (1% resolution). The exponential window damps the signal exponentially along the time axis. It is effective when the signal does not attenuate fully within the record length. When the damping rate is set to 100%, the window functions like a rectangular window.

Force Window

Set the area over which computation is performed in terms of a percentage from the first FFT point, taking the set number of FFT points to be 100%. The areas (force 1 and force 2) can be set in the range of 1 to 100% (1% resolution) of the input/output signal. When an area is set to 100%, the window functions like a rectangular window. On the DL850E/DL850EV, the outer area is the average of the results of the window function for the data outside the area.

Force1: This setting applies to the input signals of one-waveform and two-waveform FFTs.

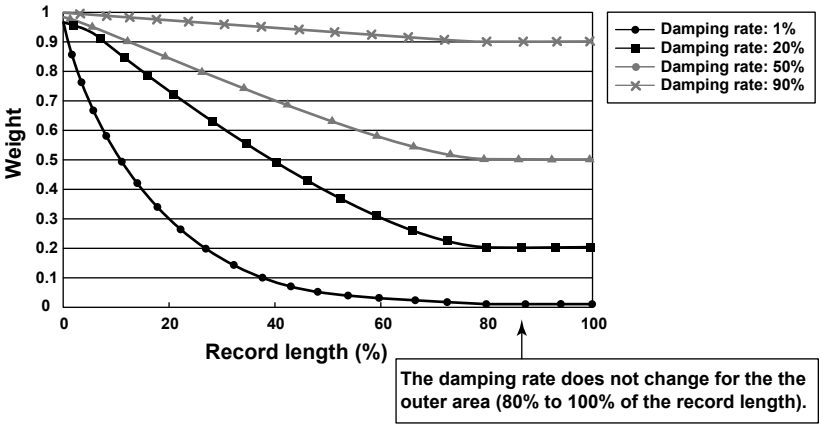
Force2: This setting applies to the output (response) signal (second parameter) of a two-waveform FFT.



Combined Form of the Exponential and Force Windows

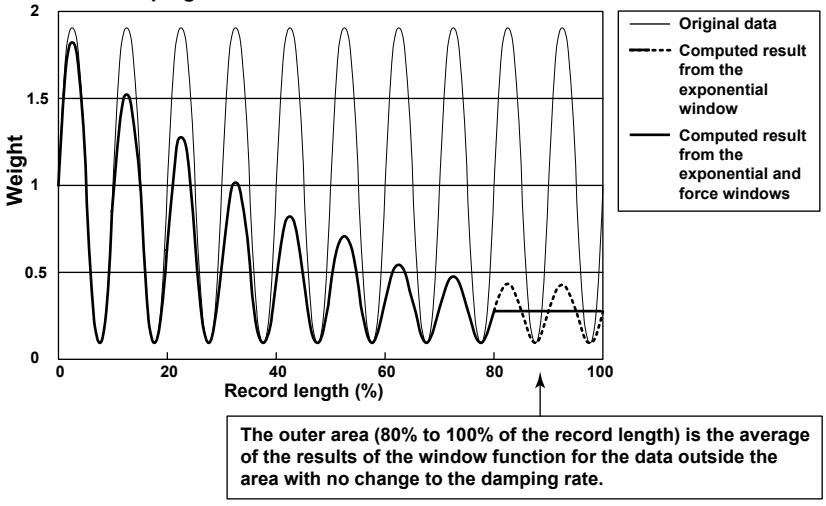
The DL850E/DL850EV uses a window function that combines the exponential window and force window to perform computations. The outer area of the force window is the average of the results of the window function for the data outside the area.

When the Force Window Area Is Set to 80% and the Data Outside the Area Is Taken into Account



- Application Example on the DL850E/DL850EV

When the Damping Rate Is Set to 20% and Force 1 Is Set to 80%



Notes about Executing FFT Computation

Computation is normally performed on the sampled data in the acquisition memory. However, for waveforms that have been acquired in envelope mode, computation is performed on the maximum and minimum values per acquisition interval.

Appendix 3 Fundamental Equations for Defining Strain

Definition of Strain

ΔL/L = ε .....(1)

ε: Strain
L: Initial length of the material
ΔL: Amount of change due to external strain

Definition of the Gauge Factor

Gauge factor (K) refers to the ratio between the mechanical strain and the change in the resistance of the strain gauge resistor.

$$\varepsilon = \frac{\Delta L}{L} = \frac{\Delta R/R}{K} \quad \text{.....(2)}$$

$$(\Delta R/R) = K \times \varepsilon \quad \text{.....(3)}$$

R: Gauge resistance
ΔR: Amount of change in resistance when strain is applied

Normally, K = 2.0. However, the value varies depending on the strain gauge material.

General Equation for the Measured Voltage (V) and Strain (ε) of a Wheatstone Bridge (1 Gauge Method)

If we assume V to be the voltage measured on the bridge and E to be the voltage applied to the bridge,
V = (1/4) × E × (ΔR/R) .....(4)

From equation (3),
(ΔR/R) = K × ε

Thus, V = (1/4) × E × K × ε .....(5)

When Determining the Strain (e) from the Measured Voltage (V) (Using a Strain Gauge and the 1 Gauge Method)

If we derive e from equation (5)
ε = (4/K) × (V/E) .....(6)

When Determining the Measured Value of the Strain Gauge Sensor (e) from the Voltage Measured on the Bridge (V) (Strain Gauge Sensor)

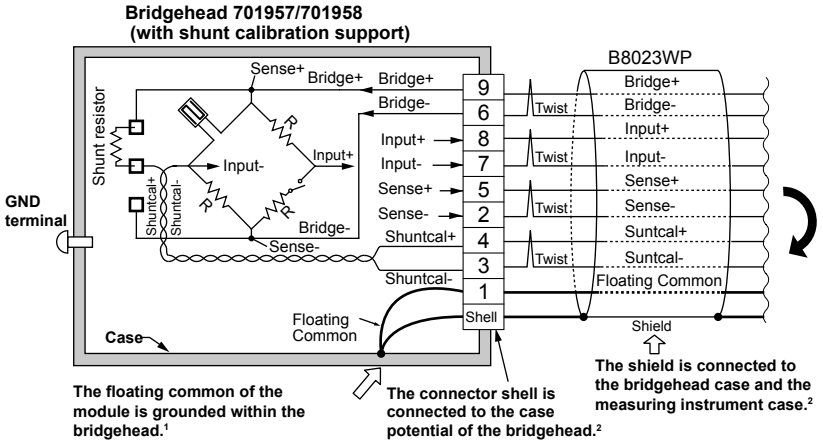
Assuming e to be the measured value (measured value of the strain gauge sensor: mV/V unit) and substituting ε = e in equation (6),
e = (4/K) × (V/E) .....(7)

In the case of a strain gauge sensor, set the gauge factor (K) to 2 on the DL850E/DL850EV. If you change the value of K, the values are converted through the use of the above equation.

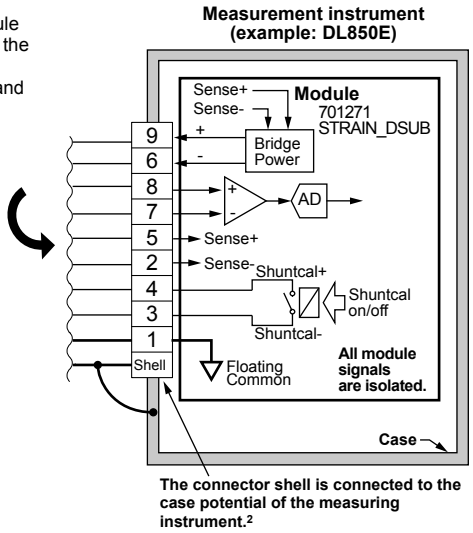
Appendix 4 Shunt Calibration of the Strain Module

In shunt calibration, the strain measurement gain is adjusted through the connection of a known resistance (the resistance for shunt calibration, hereinafter referred to as the shunt resistance) in parallel to the strain gauge. The strain module (701271 (STRAIN_DSUB)) supports shunt calibration with a built-in shunt-calibration relay circuit.

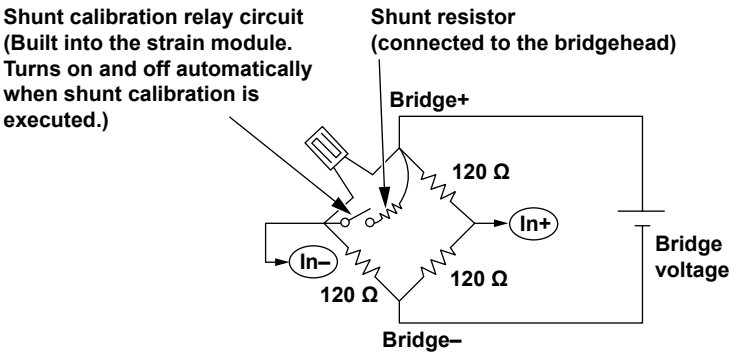
To perform shunt calibration, you need a bridgehead that supports shunt calibration (701957 or 701958).



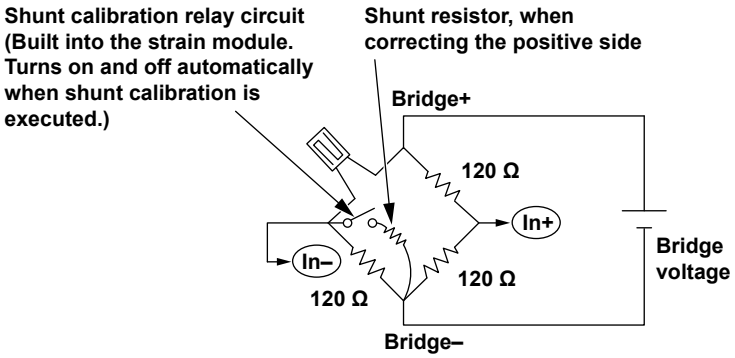
1 The GND (floating common) of the module is connected to the case potential inside the bridge box.
2 The bridgehead case, the cable shield, and the measuring instrument case are connected as measures against noise.



- **When correcting the gain on the negative side (normal)**



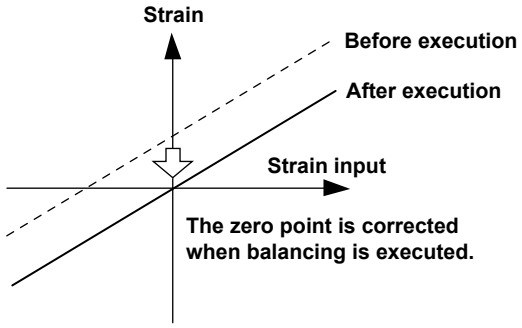
• When correcting the gain on the positive side



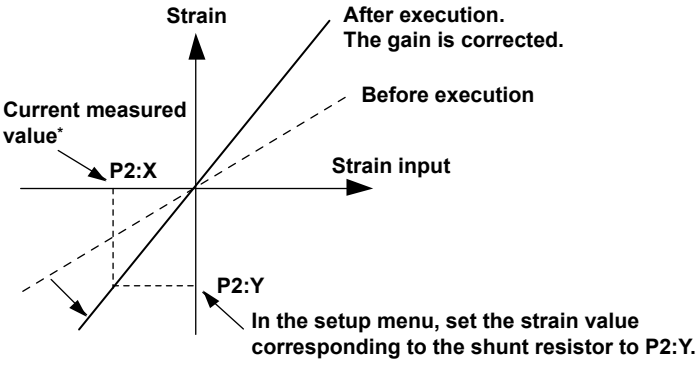
Shunt Calibration Procedure

1. Calculate the strain value (μSTR) that corresponds to the shunt resistor you will use. For the calculation procedure, see “Calculating the Shunt Resistance” in the next section.
2. Execute balancing without applying a load to the strain gauge, and correct the zero point.
3. Execute shunt calibration, and correct the gain.
   To execute shunt calibration, in the CH menu, select Linear Scale, Mode, and then Shunt. Usually, the negative gain is corrected. However, if you are correcting the positive gain, change the position of the shunt resistor as shown in the above figure.

• Balance



• Shunt calibration



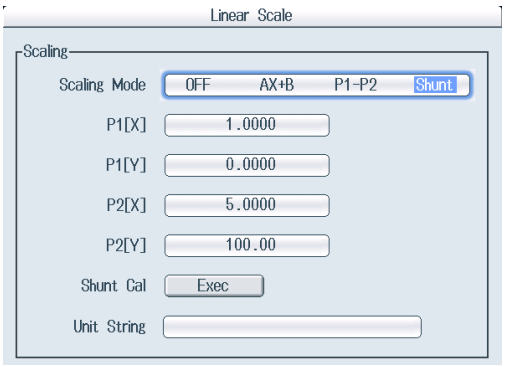
* Obtained automatically when shunt calibration is performed

Shunt Calibration Execution Menu

The shunt calibration execution menu appears when you select Linear Scale, Mode, and then Shunt in the CH menu. In normal shunt calibration, only P2:Y is set. On the DL850E/DL850EV, in addition to performing normal shunt calibration (when the shunt-calibration relay circuit is on), you can also set the zero-point value when the relay circuit is off. The zero-point value is valid when the strain value after balancing is performed is not 0.

Items in the Execution Menu

(1) P1[X]: When shunt calibration is executed, the input value when the relay circuit is off is applied.
(2) P1[Y]: Set the value for when the relay circuit is off (normally 0).
(3) P2[X]: When shunt calibration is executed, the input value when the relay circuit is on is applied.
(4) P2[Y]: Set the strain value that corresponds to the shunt resistance when the relay circuit is on.



- When you execute shunt calibration, select an appropriate range so that the measured values will stay within the range when the shunt-calibration relay circuit is on. The DL850E/DL850EV attempts to perform shunt calibration within the current range.
- An error message will appear if shunt calibration fails (because of out-of-range values or some other reason). When this happens, change the range, and perform shunt calibration again.
- Do not connect and disconnect multiple USB devices repetitively. Provide a 10-second interval between removal and connection.

Reducing Noise

Because measurements are made at the mV level, the strain gauge is extremely susceptible to noise. If the execution of balancing or shunt calibration fails, it may be due to noise. Please take the following points into consideration.

- Because the strain gauge is attached away from the bridgehead, we recommend that you use twisted wire for extensions.
- Use a bridgehead with high noise resistance. We recommended that you use a YOKOGAWA bridgehead (701957 or 701958); they are highly resistant to noise.

Calculation of the Shunt Resistance

To execute shunt calibration, you need to calculate the shunt resistance (Rs) and the expected strain (ε) in advance. For "P2-Y," use ε as given in the equation below (normally a negative value).
In the general method given for shunt calibration (the easy method), an error of 1 to 2% is introduced as the strain value (ε) increases. Therefore, use the detailed method whenever possible.

Equation for Rs and ε When Shunt Calibration Is Executed

General Equation (Easy method)

$\Delta R/R = K \times \varepsilon$ ..... (1): Fundamental strain equation

$\Delta R = R - R//Rs^{*}$ ..... (2): Equation for the change in resistance when the shunt resistance is on

* In this manual, the equation for parallel resistances is expressed as follows:

$$R//Rs = \frac{1}{\frac{1}{R} + \frac{1}{Rs}} = \frac{R \times Rs}{R + Rs}$$

If ΔR from (1) and (2) is cancelled out,

$Rs = R \times (1 - K \times \varepsilon)/(K \times \varepsilon)$
Equation A: General equation for calculating the shunt resistance (includes error)

- **ε: Strain (strain value that you want to be generated when the shunt resistance is turned on)**
- **K: Gauge factor**
- **R: Bridge resistance**
- **ΔR: Resistance change**
- **Rs: Shunt resistance (shunt resistance you want to derive)**

Detailed Equation

$V_0 = E \times (R_1 \times R_3 - R_2 \times R_4)/\{(R_1 + R_2) \times (R_3 + R_4)\}$
.....(1): Basic equation for a Wheatstone bridge

When shunt calibration is on,

$V_0 = E \times (R_1 \times R_3 - R' \times R_4)/\{(R_1 + R') \times (R_3 + R_4)\}$
.....(2): Equation when shunt calibration is on

$R' = R_2//Rs$.....(3): Equation for combined resistance R'

$R_1 = R_2 = R_3 = R_4 = R$ .....(4): Since R_1 to R_4 are equal, they are represented as R.

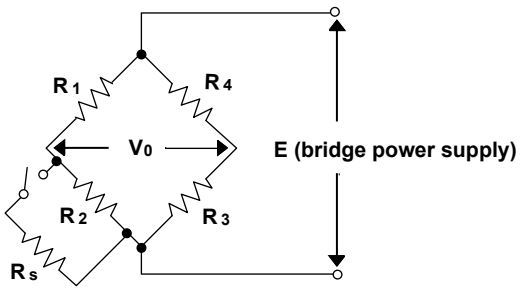
Also, from the basic equation of strain,

$V_0/E = K \times \varepsilon/4$ .....(5): Basic equation of strain

If V_0/E and R_1 to R_4 from (2), (3), (4), and (5) are cancelled out,

$Rs = R \times (1 - K \times \varepsilon/2)/(K \times \varepsilon)$
Equation B: Detailed equation for calculating the shunt resistance (no error)

- **E: Bridge voltage**
- **V_0: Bridge output voltage**
- **R_1 to R_4: Bridge resistance ($R_1 = R_2 = R_3 = R_4$)**
- **Rs: Shunt resistance (shunt resistance you want to derive)**
- **R': Combined resistance when the relay is turned on (R' = R//Rs)**



Calculation Example

When Determining the Shunt Resistance (Rs) from the Strain (ε)

Given a gauge factor (K) of 2,

Detailed equation (equation B) Rs = R × (1 − ε)/(2 × ε) .....(6)

General equation (equation A) Rs = R × (1 − 2 × ε)/(2 × ε) .....(7) Degree of error of 1 to 2%

Desired Strain ε (μSTR)	Rs Value (Ω) Derived from the Detailed Equation (6)		Rs Value (Ω) Derived from the General Equation (7)	
	R = 120 Ω	R = 350 Ω	R = 120 Ω	R = 350 Ω
1 000	59 940	174 825	59 880	174 650
2 000	29 940	87 325	29 880	87 150
5 000	11 940	34 825	11 880	34 650
10 000	5 940	17 325	5 880	17 150

When Determining the Strain (ε) from the Shunt Resistance (Rs)

If we derive ε from equations (6) and (7),

Detailed equation (equation B) ε = 1/(1 + 2 × Rs/R) .....(8)

General equation (equation A) ε = 1/{2 × (1 + Rs/R)} .....(9) Degree of error of 1 to 2%

• When the Bridge Resistance R is 120 Ω

RS Value (Ω)	Strain ε (μSTR) Derived from the Detailed Equation (8)	Strain ε (μSTR) Derived from the General Equation (9)
60 000	999	998
30 000	1 996	1 992
12 000	4 975	4 950
6 000	9 901	9 804

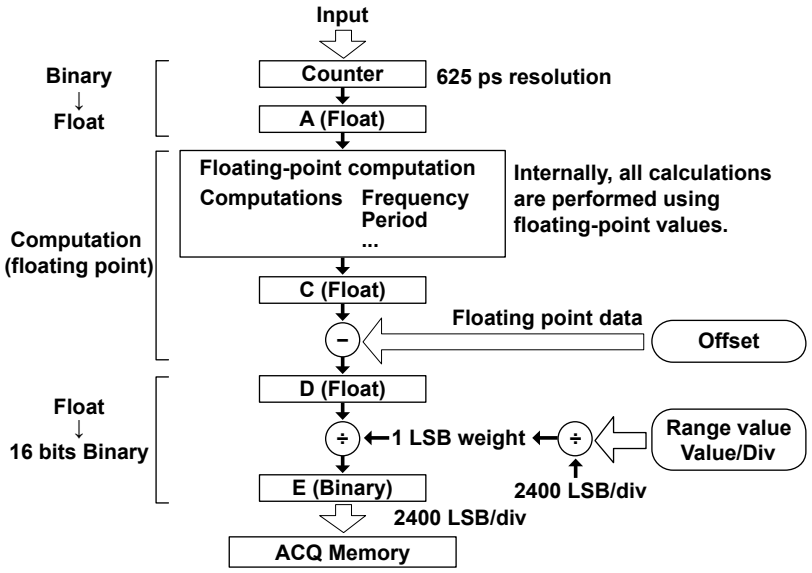
• When the Bridge Resistance R is 350 Ω

RS Value (Ω)	Strain ε (μSTR) Derived from the Detailed Equation (8)	Strain ε (μSTR) Derived from the General Equation (9)
180 000	971	970
90 000	1 941	1 937
36 000	4 838	4 814
18 000	9 629	9 537

Appendix 5 Frequency Module's Math Expression and Smoothing Filter's Filter Response

Computation Format (Resolution) of the Frequency Module

The computation flow on the frequency module is indicated below.



The frequency module measures the period of the input signal at a resolution of 625 ps. Therefore, the minimum resolution is 625 ps.

Computations are performed in floating point format. The data that is output from the frequency module and written to the acquisition memory (ACQ Memory) is 16-bit binary data. The frequency module converts the data using a weight of 1 LSB that is determined by Value/div. The data is normalized to 2400 LSB/div when displayed on the screen.

Input: Conversion from Counter Values to Floating Point Values

The frequency module converts the count value that it obtains at 625 ps resolution to floating point format, and determines period A using the following equation.

Period: A (Float) = (Count value) × 625 ps

Computation

Various computations are performed in floating point format based on the settings.

Example Frequency: C (float) = 1/A (float)

Calculation of the 1 LSB Weight of the Output

The 1 LSB weight of the output is determined from the range (value/div).

Because 1 div = 2400 LSB,

1 LSB weight of the output = (Value/div)/2400

Computation Output: Conversion from Floating Point Values to 16-bit Binary Values (When the Offset Is 0)

When the offset value is 0, offset calculation is not performed, and C (float) = D (float).

The data is converted into 16-bit binary data and written to the acquisition memory (ACQ Memory).

16-bit binary data: E (binary) = D (float) ÷ (1 LSB weight of the output)

Offset Computation

When the offset value is not 0, the frequency module computes the offset value in floating point format using the following equation and then converts the value to 16-bit binary data.

D (float) = C (float) − offset value (float)

In offset computation, if the computed result C (float) is equal to the offset value, the output is 0. If the computed result C (float) is less than the offset value, E (binary) is negative.

Filter Characteristics (Time Delay) of the Smoothing Filter

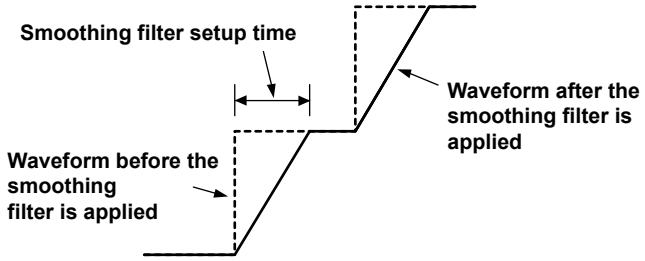
The smoothing filter is a moving average filter in which computation is performed in real time. The smoothing filter takes the simple average of the data whose data update rate is 1 µs (1 MHz) over 40 µs and performs moving average at 40 µs intervals. The computation interval of moving average is constant, independent of the DL850E/DL850EV sample rate. The data computed at 40 µs intervals is linearly interpolated to 1 µs data and transmitted.

The moving average order (the number of averaged points) is specified in terms of time. The maximum value is 25000 points (when the time is set to 1000 ms).

The characteristics of the smoothing filter are as follows:

- The filter is a low-pass filter.
- The pass band is flat.
- The filter has linear phase characteristics. The group delay is constant for a given filter order.
  The group delay can be derived through the following equation.
  Group delay = (the number of averaged points − 1) × 40 µs/2
- The filter has comb-shaped bandwidth characteristics.

The figure below shows the result of applying the smoothing filter to a waveform that changes in steps. The smoothing filter setup time follows the step change.



Appendix 6 List of Preset Settings of the Frequency Module

Logic 5V

Setup Item	Setting
V Range	±10 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	2.5 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

Logic 3V

Setup Item	Setting
V Range	±5 V (Probe = 1:1) ±10 V (Probe = 10:1)
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	1.5 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

Logic 12V

Setup Item	Setting
V Range	±20 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	6 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

Logic 24V

Setup Item	Setting
V Range	±50 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	12 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

Pull-up 5V

Setup Item	Setting
V Range	±10 V
Coupling	DC
Probe	1:1
Bandwidth	Yes[2]
Threshold	2.5 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	Yes[6]

ZeroCross

Setup Item	Setting
V Range	Yes[7]
Coupling	AC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	0 V
Hys	Yes[3]
Slope	Rising
Chattering Suppression	Yes[5]
Pull Up	No

AC100V

Setup Item	Setting
V Range	±200 V
Coupling	AC
Probe	10:1
Bandwidth	Yes[2] (Full cannot be selected)
Threshold	0 V
Hys	Yes[3]
Slope	Rising
Chattering Suppression	Yes[5]
Pull Up	No

AC200V

Setup Item	Setting
V Range	±500 V
Coupling	AC
Probe	10:1
Bandwidth	Yes[2] (Full cannot be selected)
Threshold	0 V
Hys	Yes[3]
Slope	Rising
Chattering Suppression	Yes[5]
Pull Up	No

EM Pickup

Setup Item	Setting
V Range	±1 V
Coupling	DC
Probe	1:1
Bandwidth	Yes[2]
Threshold	0 V
Hys	Yes[3]
Slope	Rising
Chattering Suppression	Yes[5]
Pull Up	No

User

Setup Item	Setting
V Range	Yes[7]
Coupling	Yes[8]
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	Yes[9]
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

When you select a preset, the setup items are automatically set to the values in the table. The meaning of Yes and No in the table is as follows:
Yes: The setting can be configured.
No: The setting cannot be configured (it does not appear on the menu).

1 Set the probe type to 1:1 or 10:1.
2 Set the bandwidth limit to 100 Hz, 1 kHz, 10 kHz, 100 kHz, or Full. You cannot select full for AC100V or AC200V.
3 Set the hysteresis to ±1%, ±2.5%, or ±5%.
4 Set the slope to rising or falling.
5 Set the chattering elimination value to a value from 0 ms to 1000 ms.
6 Enable or disable the pull-up. This setting is available only for Pull-up 5V.
7 Voltage ranges:
When probe = 1:1, select ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, or ±50 V.
When probe = 10:1, select ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, or ±500 V.
8 Set the coupling to DC or AC.
9 Set the threshold level to a value within the specified voltage range.

Appendix 7 TCP and UDP Port Numbers

The TCP and UDP port numbers that are used on the Ethernet interface of the DL850E/DL850EV are listed below.

TCP Port Numbers

Port Number	Description	Used For
20	File Transfer [Default Data]	FTP server, FTP client,* and a portion of the Web server
21	File Transfer [Control]	FTP server, FTP client, and a portion of the Web server
25	Simple Mail Transfer Protocol	SMTP client
80	World Wide Web HTT	Web server and WebDAV server
515	–	LPR client
111 1024 1025 10002 (send)	–	Instrument control through the Ethernet interface

UDP Port Numbers

Port Number	Description	Used For
67	Bootstrap Protocol Server	DHCP client
68	Bootstrap Protocol Client	(listen port)
123	Network Time Protocol	SNTP client

* The port number when FTP passive mode is disabled. When FTP passive mode is enabled, you can set any port number. When FTP passive mode is disabled, connections are established from the server. If you are connecting the DL850E/DL850EV from behind a firewall, enable FTP passive mode.

Appendix 8 Firmware Version and New Features

This manual covers firmware versions 4.30 and later of the DL850E/DL850EV. The following table contains new features that are available for each firmware version. If you are using an older version, you will not be able to use all the features described in this manual. To view the firmware version, press UTILITY and then the Overview soft key and check Firm Version on the Overview screen that is displayed

Version	Suffix Code	New Features
3.10 and later	Normal	Frequency module (701281) was added. (frequency measurement range up to 500 kHz, vertical scale can be set up to 100 kHz/div)
		Start/stop level signal output was added to trigger output.
	/G3	Angle difference math function was added to real time math.
	/G5	Integration operation options for when measurement is stopped was added. (All times (integrate at all times), In Acquisition (integrate only during measurement)
3.20 and later	Normal	Five division display was added to the display format.
		Long print is possible on USB printers.
		MATLAB format was added to the waveform data save formats.
		The Sure Delete feature was added.
		Infinite was added to the number of action mail transmissions.
		Support for 1A:1V current probes was added.
		The vertical zoom range of the frequency module (701281) was changed. (The selectable range for 100kHz/div was changed to ×0.625 (5/8) to ×100.)
	/C30	An option to save GPS position information was added to the save conditions.
4.00 and later	Normal	High-Speed 100 MS/s, 12-Bit Isolation Module (720211) was added.
		SENT Monitor Module (720243) was added.
		4-CH, 1 MS/s, 16-Bit Isolation Module (720254) was added.
		Module firmware update feature was added.
		An option to include text format information when saving to MATLAB format was added.
		GPS leap second correction feature was added.
		A parameter for outputting the data of history average results was added to communication commands.
	/G3 or /G5	Real time math features • 3 phase resolver function was added. • Z phase inversion function was added to the angle-of-rotation, cosine, sine, and electrical angle functions. • The selectable pulse count range for the angle-of-rotation function was change to up to 500000. • An offset setting was added to the frequency and resolver functions.
4.10 and later	Normal	High-Speed 10 MS/s, 12-Bit Isolation Module (720250) was added.
		Temperature, High-Precision Voltage Isolation Module (Low noise) (720266) was added.
		High-Voltage 1 MS/s, 16-Bit Isolation Module (with AAF, RMS) (720268) was added.
		Frequency Module (720281) was added.
4.20 and later	Normal	A timeout function was added to the duty cycle measurement of the FV setting on the frequency module (701281, 720281).
		A fast channel multiplexing function was added to the SENT monitor module (720243).
		Measurement items were added to the XY cursor.
		Loading waveform data from models with different options is now partially supported.
		The maximum number of characters of the common name when the auto naming function is set to sequence number was changed to 32.
		Math waveforms that are less than 10 div. can now be saved.
		Brother RJ-4030 was added as a supported printer.
	/G5	A function for selecting the power math data to be saved was added.
4.30 and later	Normal	CAN/CAN FD Monitor Module (720242) was added.

Appendix 9 Using Data Files (WDF Files)

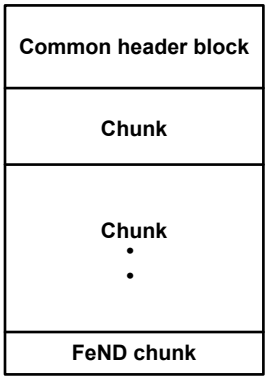
- To use the data in binary data files generated by the DL850E/DL850EV on a PC, use the “DL850E/DL850EV WDF File Access Library” provided by YOKOGAWA.
- To convert data into YOKOGAWA’s legacy file format (*.WVF + *.HDR), use the “Binary Data File Converter” provided by YOKOGAWA.
- To view the data in WDF files without using the “DL850E/DL850EV WDF File Access Library,” refer to the following information.

This information does not apply to files created using hard disk recording of the DL850E/DL850EV or free-run recording of the acquisition software. To use the data in these types of files, use the “DL850E/DL850EV WDF File Access Library” provided by YOKOGAWA.

Information for Viewing Data in WDF Files

WDF File Structure

A WDF file is made up of a common header block and blocks of data organized by type, which are referred to as *chunks*. Chunks are analogous to boxes that data is placed in. Multiple chunks are strung together to form a single WDF file. A special chunk called “FeND chunk” that contains no data always appears at the end of a file (except for waveform files divided into multiple files).



Multiple chunk

Common Header Block

The main role of the common header block is to indicate that the file is a WDF waveform file. An identifier is contained in the first four bytes. The next four bytes indicate the size of the common header. The rest of the common header block is undisclosed.

Offset	Type	Identifier	byte	Description
0x0000	CHR	FileID	4	“%WDF”
0x0004	UINT	Length	4	Common header size
0x000C	-	Data	-	Undisclosed

Chunk

Chunks are structured like boxes that hold data. A chunk consists of a unique name (four characters long), data size, data, and end marker.
The data size indicates the size of the stored raw data; it does not include the size of the chunk name, the value field (which indicates the data size) or the end marker. The total chunk size is raw data + 16 bytes. To use the information in a WDF file, there is no need to read the raw data in every chunk; the chunks in the file can be scanned or skipped until the appropriate one is found.

Offset	Type	Identifier	byte	Description
0x0000	CHR	ChunkType	4	Chunk name string
0x0004	UINT64	Length	8	Data size in chunk
0x000C	-	Data	-	Raw data (data size in length)
	UINT	EndMark	4	0xffffffff or the data's CRC32 value

Waveform Analysis Information Chunk

Analysis information are stored in XHDR chunks. Analysis information of dual capture waveforms during dual capturing is stored in DHDR chunks.
An analysis information chunk starts with a 4-byte "XHDR" identifier and ends with a 4-byte 0xFFFFFFFF end mark. The eight bytes immediately after the "XHDR" identifier contains the data size (in bytes) of the analysis information chunk. The content of the data is text information (described later), which closely resembles the information in YOKOGAWA's legacy WVF and HDR files.

Offset	Type	Identifier	byte	Description
0x0000	CHR	ChunkType	4	Chunk type "XHDR" or "DHDR"
0x0004	UINT64	Length	8	Data size
0x000C	-	Data	-	Analysis information (text information)
	UINT	EndMark	4	0xffffffff or the data's CRC32 value

Analysis Information Overview

Analysis information data is big endian. The data in analysis information chunks is text. The line feed code is "0x0A."

Analysis Information Example

The following example shows the waveform file analysis information containing four channels and five history entries.

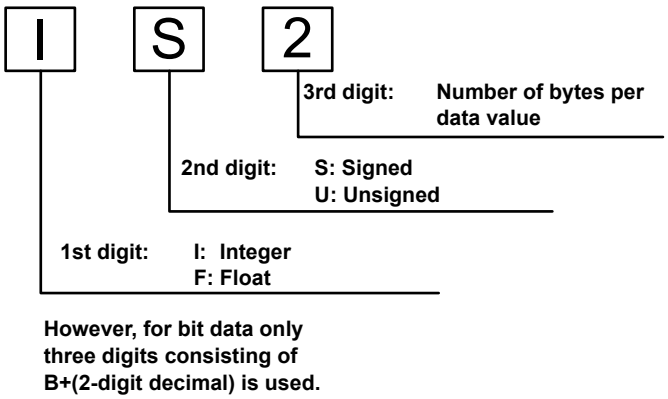
```
//YOKOGAWA ASCII FILE FORMAT

$PublicInfo
FormatVersion       1.00
Model               DL850V
Endian              Big
DataFormat          Trace
GroupNumber         1
TraceTotalNumber    4
DataOffset          687898

$Group1
TraceNumber         4
BlockNumber         5
TraceName           CH7                 CH8                 CH13_1              CH13_2
BlockSize           10010               10010               5005                5005
VResolution         2.0833333E-02       2.0833333E-02       8.3333333E-04       8.3333333E-04
VOffset             0.0000000E+00       0.0000000E+00       0.0000000E+00       0.0000000E+00
VDataType           IS2                 IS2                 IS2                 IS2
VUnit               V                   V                   V                   V
VPlusOverData       ?                   ?                   ?                   ?
VMinusOverData      ?                   ?                   ?                   ?
VIllegalData        -32768              -32768              -32768              -32768
VMaxData            32767               32767               32767               32767
VMinData            -32767              -32767              -32767              -32767
HResolution         1.0000000E-06       1.0000000E-06       2.0000000E-06       2.0000000E-06
HOffset             -5.0000000E-03      -5.0000000E-03      -5.0000000E-03      -5.0000000E-03
HUnit               s                   s                   s                   s
Date                2015/03/03          2015/03/03          2015/03/03          2015/03/03
Time                11:36:12.67389414   11:36:12.67389414   11:36:12.67389414   11:36:12.67389414

$PrivateInfo
DisplayPointNo.     0
ModelVersion        3.20
StartOffset1        0 0 1 1
StartOffset2        0 0 0 0
StartOffset3        0 0 0 0
StartOffset4        0 0 1 1
StartOffset5        0 0 0 0
TrigTime1           2015/03/03 11:36:12.67389414
TrigTime2           2015/03/03 11:36:12.80217914
TrigTime3           2015/03/03 11:36:12.93678314
TrigTime4           2015/03/03 11:36:13.03031214
TrigTime5           2015/03/03 11:36:13.12382914
DataEnd
```

Description of Parameters in Analysis Information

//YOKOGAWA ASCII FILE FORMAT		A line that starts with "//" is a comment line.
$PublicInfo		A label that indicates common information. A label always starts with a dollar ($) mark. The character code of the dollar mark is 0x24.
	FormatVersion	Version number of this piece of analysis information
	Model	Model of the measuring instrument that generated the file
	Endian	Big or Little. All files generated by the DL850E/DL850EV are big endian.
	Trace	Internal structure of the waveform data Trace or Block. All files generated by the DL850E/DL850EV are Trace.
	GroupNumber	Total number of groups in the analysis information
	TraceTotalNumber	Number of traces that this data file contains
	DataOffset	How many bytes into the file where binary data begins
$Group		A label indicating the beginning of group information
	TraceNumber	Number of traces in the relevant group
	BlockNumber	Number of history entries
	TraceName	Trace label of each trace
	BlockSize	Number of data points in the block corresponding to the trace name
	VResolution	Y-axis conversion coefficient of each trace
	VOffset	Y-axis conversion offset of each trace The Y-axis value (vertical value) can be determined using the following conversion formula. Y-axis value = VResolution × binary data + VOffset
	VDataType	Data type of each trace (details provided separately)
	VUnit	Y-axis unit
	VPlusOverData, VMinusOverData	(Reserved)
	VIllegalData	Indicates illegal data when an illegal calculation is performed (such as dividing by 0) or hidden code for preventing the data from being displayed on the screen
	VMaxData, VMinData	Maximum and minimum values that data may take on in this block of each trace
	HResolution, HOffset	Coefficient and offset of time-axis conversion of each trace Time-axis value = HResolution × (data number – 1) + HOffset
	HUnit	Time-axis unit
	Date	Date of the first (oldest) history number
	Time	Time of the first (oldest) history number
$PublicInfo		
	DisplayPointNo.	How many points into the waveform data where measurement start point begins
	ModelVersion	Firmware version number
	StartOffset1	Number of phase difference points per trace (history number at the end)
	DateTime1	Time reference time for each history entry (trigger time) (history number at the end)
	DataEnd	End of information

Data Type Expression (VDataType)

Type of waveform data stored in a file is indicated by the VDataType field
VDataType is a 3-character text string. The definition of each character is provided below.



The data types are shown below.

Module/Data Type	Bit Count	Value Type	VDataType
2-CH and 4-CH modules, SCAN, temperature SCAN, Math, RMath	–		IS2
LOGIC	–		B16
CAN, CAN/CAN FD, CAN/LIN	2 to16	Unsign	IU2
	2 to16	Sign	IS2
	17 to 32	Unsign	IU4
	17 to 32	Sign	IS4
	–	Float	IS2
	1 to 8	Logic	B16
SENT	1 to16	Unsign	IU2
	1 to16	Sign	IS2

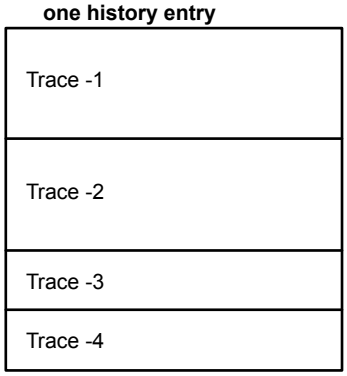
Bit data is stored in 16 bits. The bits are arranged in order from the least significant bit (bit 1 to bit 8), and the highest 8 bits are not used.

Waveform Data

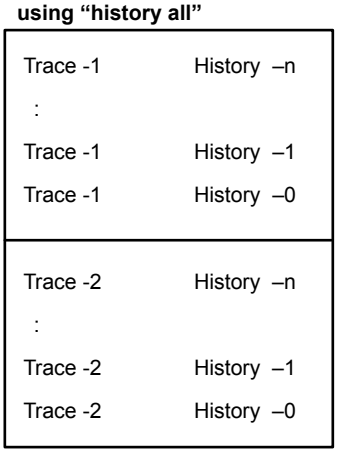
Waveform data begins DataOffset bytes into the file[1].
Data is arranged in order by trace. The number of data points is indicated by BlockSize of each trace in the waveform analysis information. The data size of each point is indicated by VDataType.
Due to different sampling rates on the measurement module, the number of data points may vary for each trace.

For waveform data saved using the “history all” feature, the data of all history entries is stored for each trace. The history entries are arranged in order from the oldest to the most recent. The number of stored history entries can be verified by BlockNumber in the waveform analysis information.

Data example saved for one history entry



Data example saved using “history all”



1 “DrAW” chunks hold waveform data (“dsRW” chunks hold dual capture waveforms).
A “DrAW” chunk contains “the data size in chunk” followed by the file data size (4 bytes) and file number (4 bytes). DataOffset points to the head of the raw data, which comes after these pieces of data.
In the case of a “dsRW” chunk (used in dual capturing), the head of the raw data comes immediately after “the data size in chunk,” and thus DataOffset (DHDR) also points to this position.

StartOffset

Sub channel data may not begin from the first point of the main channel data.
In such a case, it begins after the “start offset” of the main channel data.
Normally, this information does not need to be considered.

Label		Item	Description	Number of Parameters	Notes	Data Example
$Private Info			A label indicating the beginning of common information	0		
		Format Version	File format version number	1		1.00
		Model	Measuring instrument model			DL850E
		Endian	Waveform data endianness			Big
		Data Format	Waveform data save format (Trace or Block)		Fixed to Trace	Trace
		Group Number	Number of trace groups			2
		TraceTotal Number	Number of traces			8
		Data Offset	Offset in waveform data file			682874
	$Group 1		Label indicating the beginning of a group (a number from 1 to GroupNumber is attached to the end)	0		
		Trace Number	Number of traces in the group	1		4
		Block Number	Number of history entries			5
		Trace Name	Trace name (label)	Trace Number (1 to 4)	Spaces are converted to underscores.	CH1
		Block Size	Number of data points			10010
		V Resolution	Y-axis conversion coefficient (VResolution × raw data value + VOffset)			8.3333333E-04
		VOffset	Y-axis offset			0.0000000E+00
		VData Type	Binary data type (integer or real number, signed or unsigned, number of bytes per data)			IS2
		VUnit	Y-axis unit			V
		VPlus OverData	Upper limit of normal data		Fixed to “?” for reserve	?
		VMinus OverData	Lower limit of normal data		Fixed to “?” for reserve	?
		VIllegal Data	Hidden code value		“?” for modules that do not have a hidden code	-32768
		VMax Data	Maximum data value		Maximum value that the data type can take on	32767
		VMin Data	Minimum data value		Minimum value that the data type can take on	-32767
		H Resolution	X-axis conversion coefficient (X-axis value = HResolution × (data number – 1) + HOffset)			1.0000000E-06
		HOffset	X-axis offset			-5.0000000E03
		HUnit	X-axis unit			s
		Date	Time reference date		Only the first history entry when there are multiple entries. 8 decimal places for seconds for Time (nsec)	2013/08/18
		Time	Time reference time			14:23:30. 01234567

Label	Item	Description	Number of Parameters	Notes	Data Example
$PublicInfo		Label indicating the beginning of model-specific information	0		
	Display PointNo.	How many points into the waveform data where measurement start point begins	TraceTotal Number	For WVF compatibility	1
	Model Version	Firmware version number	1		3.01
	Start Offset1	Number of phase difference points per trace (history number at the end)	TraceTotal Number	Output as many times as there are history entries	0 0 13
	Date Time1	Time reference time for each history entry (trigger time) (history number at the end)	1	Output as many times as there are history entries	2013/08/18 14:23:30. 01234567
	DataEnd	End of information	0		

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