User's Manual

DL9000 Series Digital Oscilloscope/ SB5000 Series Vehicle Serial Bus Analyzer Power Supply Analysis Function (/G4 Option)

YOKOGAWA
Yokogawa Electric Corporation

IM 701310-61E
4th Edition

Foreword

Thank you for purchasing this DL9000* series Digital Oscilloscope/ SB5000 Series Vehicle Serial Bus Analyzer with the Power Supply Analysis function. This user's manual describes only the Power Supply Analysis function. For information about other functions, operating procedures, and handling precautions of the DL9000, see the following manuals.

* The DL9000 series consist of the following two series.
- DL9040/DL9140/DL9240 series
  DL9040, DL9040L, DL9140, DL9140L, DL9240, and DL9240L
- DL9500/DL9700 series
  DL9505L, DL9510L, DL9705L, and DL9710L

Manual Title	Manual No.	Description
DL9040/DL9140/DL9240 Series Digital Oscilloscope User's Manual	IM 701310-01E	Explains all functions and procedures of the DL9040/DL9140/DL9240 series excluding the communication functions.
DL9500/DL9700 Series Digital Oscilloscope User's Manual	IM 701331-01E	Explains all functions and procedures of the DL9500/DL9700 series excluding the communication functions.
SB5000 Series Vehicle Serial Bus Analyzer User's Manual	IM 701361-01E	Explains all functions and procedures of the SB5000 series excluding the communication functions.
DL9040/DL9140/DL9240 Series Digital Oscilloscope Communication Interface User's Manual (in CD)	IM 701310-17E	Explains the communication interface functions of the DL9040/DL9140/DL9240 series.
DL9500/DL9700 Series Digital Oscilloscope Communication Interface User's Manual (in CD)	IM 701331-17E	Explains the communication interface functions of the DL9500/DL9700 series.
SB5000 Series Vehicle Serial Bus Analyzer Communication Interface User's Manual (in CD)	IM 701361-17E	Explains the communication interface functions of the SB5000 series.
DL9040/DL9140/DL9240 Series Digital Oscilloscope Serial Bus Signal Analysis Function User's Manual	IM 701310-51E	Explains the operating procedures of the optional I^2C bus signal/CAN bus signal/LIN bus signal/SPI bus signal analysis function of the DL9040/DL9140/DL9240 series.
DL9500/DL9700 Series Digital Oscilloscope Serial Bus Signal Analysis Function User's Manual	IM 701331-51E	Explains the operating procedures of the optional I^2C bus signal/CAN bus signal/LIN bus signal/SPI bus signal analysis function of the DL9500/DL9700 series.

Notes

- The contents of this manual are subject to change without prior notice as a result of improvements in the instrument's performance and functions. Display contents illustrated in this manual may differ slightly from what actually appears on your screen.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your nearest YOKOGAWA dealer.
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Revisions

- 1st Edition: December, 2006
- 2nd Edition: March, 2007
- 3rd Edition: August, 2007
- 4th Edition: December, 2007

4th Edition: December 2007 (YK)

Conventions Used in This Manual

Safety Markings

The following markings are used in this manual.

Note Calls attention to information that is important for proper operation of the instrument.

Notations Used in the Procedural Explanations

The following notations are used to distinguish procedures from their explanations.

Procedure This subsection contains the operating procedure used to carry out the function described in the current section. The procedures are written with inexperienced users in mind; experienced users may not need to carry out all the steps.

Explanation This subsection describes the setup parameters and the limitations on the procedures.

Terms Used in Explanations of Procedures

Panel Keys and Soft Keys

Bold characters used in the procedural explanations indicate characters that are marked on the panel keys or the characters of the soft keys displayed on the screen menu.

SHIFT+Panel Key

SHIFT+key means you will press the SHIFT key to turn it ON and then press the panel key. The setup menu marked in purple below the panel key that you pressed appears on screen.

Units

k	Denotes 1000. Example: 12 kg, 100 kHz
K	Denotes 1024. Example: 459 KB (file size)

Contents

1 Overview of the Power Supply Analysis Function

Correcting (Deskewing) the Difference in the Transfer Time of Analyzed Signals

To correctly measure the analysis parameters (power supply analysis parameters) such as power, impedance, power factor, watt hour, and ampere hour from the voltage and current under analysis, the voltage and current signals must be applied to the signal input terminals of the DL9000 with no difference in the transfer time. However, difference in the transfer time may occur between signals depending on the probe that is being used. When the probe* and deskew correction signal source are connected, the DL9000 can correct (deskew) the difference in the transfer time of the signals automatically or manually and measure the power supply analysis parameters.

* It is recommended that YOKOGAWA products listed below be used to execute deskew and measure the power supply analysis parameters.

Deskew correction signal source	Model 701935
Passive probe	Model 701943
Differential probe	Model 700924 or 701921
Current probe	Model 701932 or 701933

Note

A power supply is required for the accessory deskew adjustment signal source, current probe, and differential probe (differential probe can also be powered on batteries). If your instrument did not include the DL9000 Probe Power option (/P2, 2 terminals), the Probe Power Supply (model 701934, sold separately) is required.

Automated Measurement and Statistical Processing of Power Supply Analysis Parameters

As with the standard measurement parameters (waveform parameters), the following power supply analysis parameters (waveform parameters) can be measured automatically on the displayed waveform (within the display record length).

Voltage	Amplitude Up-p, maximum value U+pk, minimum value U-pk, DC component Udc, rms value Urms, AC component Uac, rectified mean value calibrated to the rms value Umn, rectified mean value Urmn
Current	Amplitude Ip-p, maximum value I+pk, minimum value I-pk, DC component Idc, rms value Irms, AC component Iac, rectified mean value calibrated to the rms value Imn, rectified mean value Irmn
Power	Apparent power S, active power P, and reactive power Q
Power factor	Power factor λ of the circuit under measurement
Impedance	Impedance Z of the circuit under measurement
Watt hour	Sum of positive and negative watt hours Wp, positive watt hours Wp+, negative watt hours Wp-, sum of absolute value of watt hours (Wp+ + Wp-) Abs.Wp
Ampere hour	Sum of positive and negative ampere hours q, positive ampere hours q+, negative ampere hours q-, sum of absolute value of ampere hours (q+ + q-) Abs.q
Heat energy	Joule integral I^2t

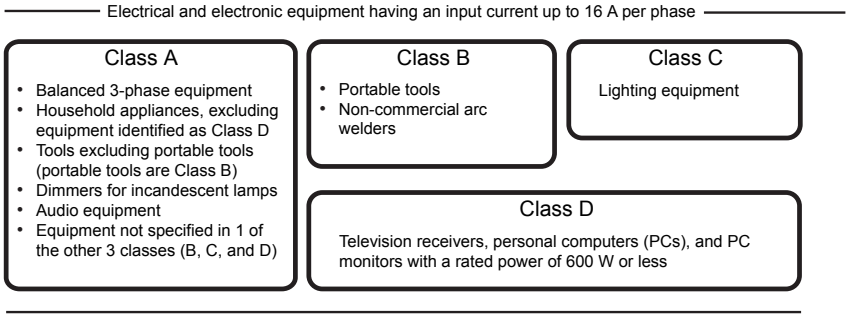
Statistical Processing

As with the standard measurement parameters, you can perform statistical processing on the measured values of power supply analysis parameters. Normal statistical processing, statistical processing per cycle, and statistical processing of history data are available. For details on the function and procedural explanations,
see sections 10.3 in IM701310-01E, or 11.3 in IM701331-01E of the DL9000 User's Manual.

Waveform Computation and Analysis on power supply analysis Parameters

As with the standard waveform computation, instantaneous power, impedance, and Joule integral can be computed on the displayed waveform (within the display record length), and the computed results can be displayed using waveforms (computed waveforms). You can also perform power spectrum (FFT) and harmonic analysis with the DL9000 analysis function. In harmonics computation, the harmonics generated by the unit under test2 as defined by the IEC Standard1 can be computed for each applicable class (A through D). Bar graphs and lists can be displayed for making comparisons between the limits of the harmonic current and the analyzed values. The analysis results obtained through this function do not accurately comply with the standard. To make accurate measurements complying with the standard, the WT3000 Series Digital Power Meter and Harmonic Analysis Software (Model 761922) are required.

1. • The harmonic current emissions "IEC 61000-3-2 (Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current [less than or equal to] 16 A per phase)) Edition 2:2.
   • EN6100-3-2 (2000)
   • IEC 61000-4-7 Edition 2
2. Electrical and electronic equipment having an input current of up to 16 A per phase and connected to public low-voltage distribution systems. The figure below shows the description of the applicable equipment. However, the DL9000 can only compute the harmonics of single-phase equipment. It cannot compute the harmonics of three-phase equipment.



Trend Display of Measured Values of Waveform Parameters

Using a procedure similar to measurement and statistical processing (see sections 10.3 in IM701310-01E, or 11.3 in IM701331-01E of the DL9000 User's Manual), the measured values of waveform parameters per cycle can be determined on the displayed waveform (within the display record length), and the change over time in the measured values can be shown on the trend display.

History Search Using Measured Values of Power Supply Analysis Parameters (Waveform Parameter Search)

As with the standard waveform parameters, you can perform history search using power supply analysis parameters. For functions and procedures, see sections 11.4 in IM701310-01E, or 12.4 in IM701331-01E of the DL9000 User's Manual.

GO/NO-GO Determination Using Measured Values of Power Supply Analysis Parameters

As with the standard waveform parameters, you can perform GO/NO-GO judgement using power supply analysis parameters. For details on the function and operating procedures, see sections 7.13 in IM701310-01E, or 8.13 in IM701331-01E of the DL9000 User's Manual.

Display of the Area of Voltage-Current Operation (X-Y Display)

By assigning the voltage input channel and current input channel to the X-axis and Y-axis, respectively, and displaying the X-Y waveform on the DL9000, the area of voltage-current operation of the unit under test can be displayed. You can check whether this area is within the area of safe operation (ASO). For instructions on displaying the X-Y waveform, see sections 10.8 in IM701310-01E, or 11.8 in IM701331-01E of the DL9000 User's Manual. This manual does not explain the procedure.

2 Connecting Probes/Performing Phase Correction, Degauss, and Zero Adjustment/ Deskewing

Connecting the Probes

To measure power supply analysis parameters, voltage and current signals must be applied to predefined signal input terminals (channels). The following figure shows the channels for applying the signals and the channel pairs when measuring power supply analysis parameters.

Signal Input Terminal (Channel)	Input Signal	Channel Pair When Measuring Power Supply Analysis Parameters
CH1	Voltage	Measures power supply analysis parameters on the voltage and current applied to CH1 and CH2.
CH2	Current	
CH3	Voltage	Measures power supply analysis parameters on the voltage and current applied to CH3 and CH4.
CH4	Current	

Connect the voltage probes (passive probes or differential probes) and current probes to the signal input terminals of the DL9000 and the probe power terminals (/P2 option) on the rear panel of the DL9000 as necessary. For the precautions to be taken when connecting probes, descriptions of the current capacity of the DL9000 probe power supply, and other information, see section 3.4 in IM701310-01E or IM701331-01E of the DL9000 user's manual.

Note

A power supply is required for the accessory deskew adjustment signal source, current probe, and differential probe (differential probe can also be powered on batteries). If your instrument did not include the DL9000 Probe Power option (/P2, 2 terminals), the Probe Power Supply (model 701934, sold separately) is required.

Compensating Voltage Probes (Phase Correction)

After connecting the voltage probes to the signal input terminals, perform phase correction on probes that can be phase corrected. For a description of the handling of voltage probes, see the manual that came with the product. For instructions on the phase correction of probes, see section 3.5 in the DL9000 User's Manual.

Degaussing Current Probes and Performing Zero Adjustment

After connecting the current probes to the signal input terminals, perform degaussing[1] and zero adjustment[2] of the current probes before making measurements if such functions are available.

For a description of degaussing and zero adjustment as well as the handling of current probes, see the manual that came with the product.

1 Degauss is a function used to demagnetize the magnetic cores of current probes caused by the ON/OFF of the power supplied to the current probes, excessive input signal, and other factors. Be sure to degauss the current probes before making measurements.

2 Zero adjustment is a function used to correct the characteristic drift of the current probes caused by temperature changes. Before making measurements, perform zero adjustment after degaussing.

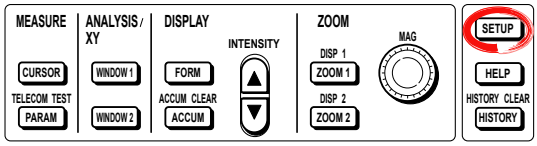
Deskewing

Depending on the probe that is being used, a difference in the transfer time may occur between voltage and input signals. You can deskew the difference in the transfer time between the signals automatically or manually on the DL9000. To correctly measure power supply analysis parameters, execute deskew between the signals after connecting the probes and the deskew correction signal source. It is recommended that the YOKOGAWA products listed below be used to execute deskew and measure the power supply analysis parameters on the DL9000.

Deskew correction signal source	Model 701935
Passive probe	Model 701943
Differential probe	Model 700924 or 701921
Current probe	Model 701932 or 701933

3 Turning ON the Power Supply Analysis Function/ Selecting the Attenuation or Current-to-Voltage Conversion Ratio of Probes/Enabling Waveform Computation Setup

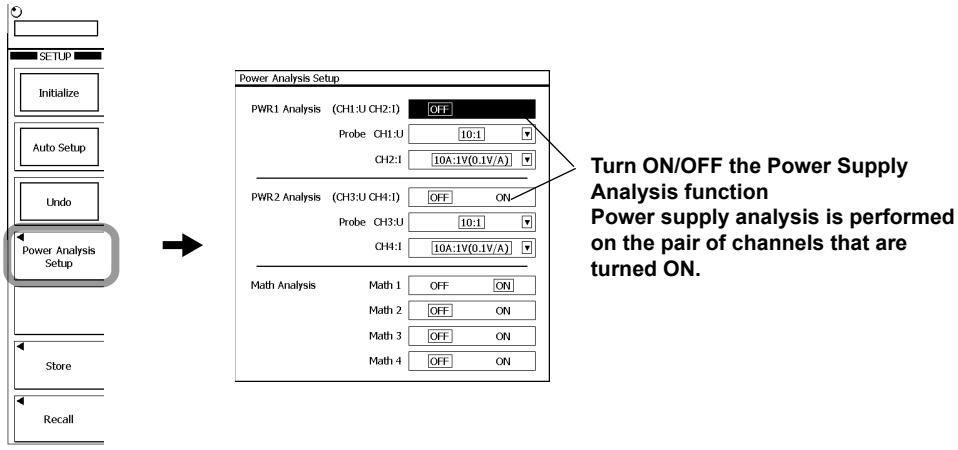
Procedure



1. Press **SETUP**. The SETUP menu appears.
2. Press the **Power Analyze Setup** soft key. The Power Analyze Setup screen is displayed.

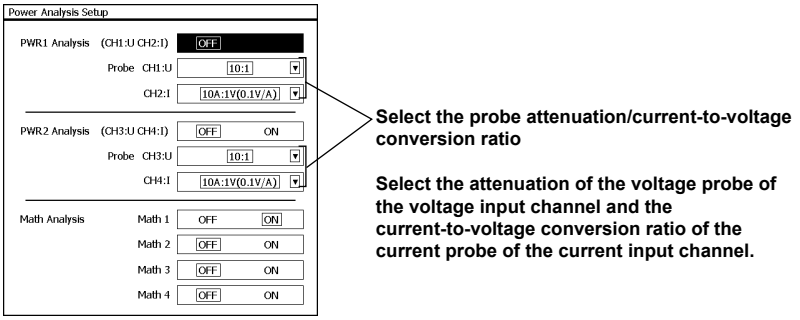
Turning ON the Power Supply Analysis Function

3. Use **rotary knob & SET** to select ON or OFF for each power supply analysis channel pair (PWR1 Analyze, PWR2 Analyze).
   - When OFF is selected, power supply analysis will not be performed on the channel pair.
   - When ON is selected, power supply analysis will be performed on the channel pair.



Selecting the Probe Attenuation or Current-to-Voltage Conversion Ratio

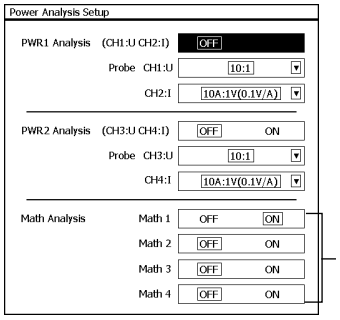
4. Use **rotary knob & SET** to select the attenuation of the voltage probes of the voltage input channels (CH1 and CH3).
5. Use **rotary knob & SET** to select the current-to-voltage conversion ratio of the current probes of the current input channels (CH2 and CH4).



Performing Waveform Computation (Enabling Power Supply Analysis Parameters to Be Assigned for Computed Waveforms)

6. Use **rotary knob & SET** to select ON or OFF for Math1 through Math4.

- When OFF is selected, standard waveform computation parameters can be assigned to the computed waveform.
- When ON is selected, power supply analysis parameters can be assigned to the computed waveform.

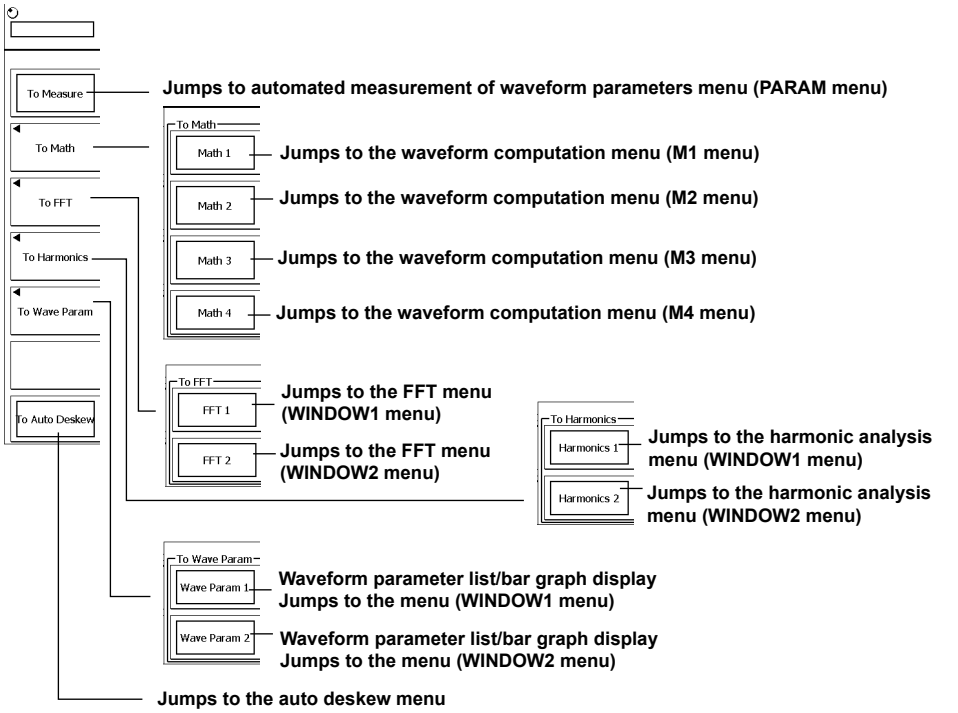


Turn ON/OFF the assignment of the power supply analysis parameters to the computed waveform
Power supply analysis parameters can be assigned to computed waveforms that are turned ON.

Jumping to Related Menus
(Perform the following operations as necessary. You can also display the same menus using panel keys and soft keys.)

7. Press the soft key for **To Measure**, **To Math**, **To FFT**, **To Harmonic**, **To Wave Param** or **To Auto Deskew** to jump to the corresponding menu.

- To Measure: Displays a menu used to set up automated measurement of waveform parameters.
- To Math: Displays a menu used to set up waveform computation.
- To FFT: Displays a menu used to set up FFT.
- To Harmonics: The menu for setting up harmonic analysis appears.
- To Wave Param: Displays a menu used to set up lists/bar graph displays of waveform parameters.
- To Auto Deskew: Displays a menu used to correct the difference in the transfer time of probe signals.



Explanation

To compute power supply analysis parameters using the Power Supply Analysis function (/G4 option), you must turn ON the Power Supply Analysis function, select the voltage probe attenuation, and select the current-to-voltage conversion ratio of current probes. In addition, the waveform computation setting must be turned ON (enabled) when performing waveform computation.

Turning ON/OFF the Power Supply Analysis Function

Channels for applying voltage and current signals are predefined. The pairing of channels is also predefined as shown below.

Signal Input Terminal (Channel)	Input Signal	Channel Pair When Measuring Power Supply Analysis Parameters
CH1	Voltage	Measures power supply analysis parameters on the voltage and current applied to CH1 and CH2.
CH2	Current	
CH3	Voltage	Measures power supply analysis parameters on the voltage and current applied to CH3 and CH4.
CH4	Current	

You can select whether to perform power supply analysis (ON/OFF) for each channel pair.

OFF: Power supply analysis is not performed on the channel pair.

ON: Power supply analysis is performed on the channel pair.

Selecting the Probe Attenuation or Current-to-Voltage Conversion Ratio

You can select the probe attenuation or current-to-voltage conversion ratio for each voltage/current input channel.

- You can select the attenuation of the voltage probes of the voltage input channels (CH1 and CH3).
  1:1, 2:1, 5:1, 10:1, 20:1, 50:1, 100:1, 200:1, 500:1, 1000:1
- You can select the current-to-voltage conversion ratio of the current probes of the current input channels (CH2 and CH4).
  1 A:1 V (1 V/A), 10 A:1 V (0.1 V/A), 100 A:1 V (0.01 V/A)
  * The conversion display of the model 701932 and 701933 current probes by Yokogawa reads “0.1 V/A.” This display indicates that the output voltage of the current probe is 1 V when the current probe measures 10 A.
    When the model 701932 or 701933 current probe is connected to the instrument’s measurement input terminals and 10 A:1 V is selected as the current-to-voltage conversion ratio for the above current probe, the instrument displays 10 A as the current value measured by the current probe when the output voltage from the current probe is 1 V.

Note

The probe’s attenuation ratio or current-to-voltage conversion ratio can also be set in the CH menu. The power analysis setup screen settings are linked with the CH menu settings. If the probe’s attenuation ratio or current-to-voltage conversion ratio is changed using one of the settings, the other settings change as well.

Waveform Computation (Enabling Power Supply Analysis Parameters to Be Assigned for Computed Waveforms)

You can turn power supply analysis parameters (effective power, impedance, and Joule-integral) ON or OFF for computed waveforms Math1 through Math4.

OFF: Standard waveform computation parameters can be assigned to the computed waveform.

ON: Power supply analysis parameters can be assigned to the computed waveform.

4 Correcting (Deskewing) the Difference in the Transfer Time of Analyzed Signals

Procedure

Connecting the Deskew Correction Signal Source

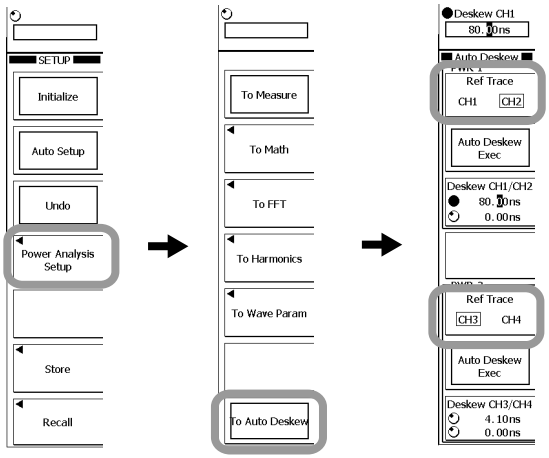
Connect the deskew correction signal source, voltage probe (passive probe or differential probe) and current probe to the DL9000.

1. Connect the voltage probe (passive probe or differential probe) and current probe to the deskew correction signal source.
   For the connection procedure, see the manual for the deskew correction signal source.
   For information on the handling when the YOKOGAWA 701935 Deskew Correction Signal Source is used, see the Deskew Correction Signal Source User's Manual IM701935-01E.
2. Connect the voltage probe to CH1 or CH3 on the instrument, and the current probe to CH2 or CH4.
   For a description of the pair of channels on which to apply the voltage and current signals when measuring power supply analysis parameters, see page 6 in this manual.
3. Set the attenuation for the voltage probe and current-to-voltage conversion ratio for the current probe.
   - Turn ON the Power Supply Analysis function and set the attenuation and current-to-voltage conversion ratio according to the procedures given in chapter 3 in this manual or set the attenuation and current-to-voltage conversion ratio according to the procedures given section 5.6 of the DL9000 User's Manual.
   - For a current probe, perform degauss and zero adjustment. In the case of the current signal that the YOKOGAWA 701935 Deskew Correction Signal Source outputs, perform zero adjustment with the vertical sensitivity (V/div, see section 5.7 in the DL9000 User's Manual) set to 20.0 mA/div. If zero adjustment is not performed correctly, auto deskew may not be possible.

Executing the Deskew

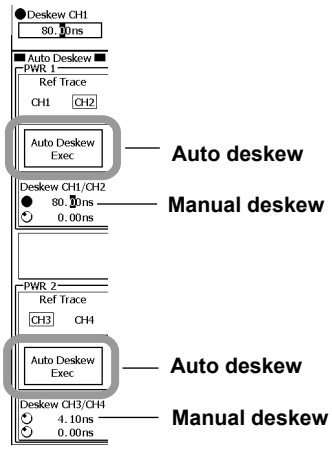
Execute deskew after the warm-up time of the DL9000 and other equipment (as necessary) has elapsed.

4. Press **SETUP**. The SETUP menu appears.
5. Press the **Power Analysis Setup** soft key. The power supply analysis setup screen is displayed.
6. Press the **To Auto Deskew** soft key. The Auto Deskew menu is displayed.
7. Press the **Ref Trace** soft key for PWR1 or PWR2 to select the reference channel.



Executing Auto Deskew

8. Press the PWR1 or PWR2 **Auto Deskew Exec** soft key. Deskew is automatically executed.



Executing Manual Deskew

- You can also manually execute deskew. You can use manual skew to correct the difference further after executing auto deskew.
- For a description of the settings related to the vertical axis or horizontal axis (time axis) used when displaying the signals applied to each channel, see the procedural explanations in the respective sections in the DL9000 User's Manual and set the display for easy viewing of the correction condition.

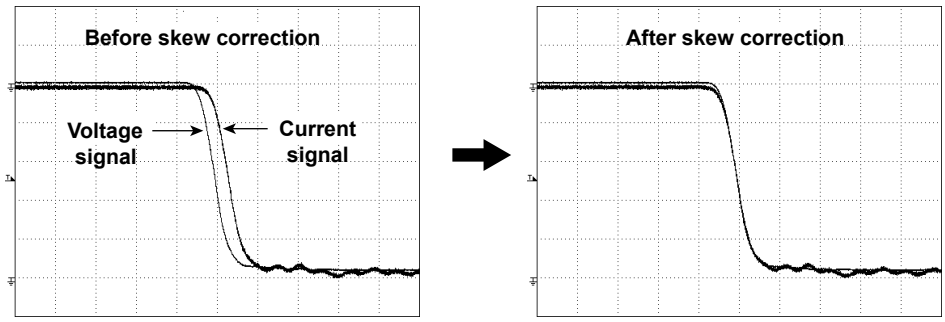
8. Press the **Deskew CH1/CH2** or **Deskew CH3/CH4** soft key to assign the rotary knob.

9. Turn the **rotary knob** and set Deskew Time so that the offset in the displayed voltage and current waveforms is as small as possible.

Note

- To improve the deskew accuracy, it is recommended that the bandwidth limit of the two channels be set the same (as close to Full as possible) when executing deskew.
- Execute deskew each time you change the bandwidth setting.
- Auto deskew may not work properly due to noise effects.
- If the input signal cannot be detected, a timeout of approximately ten seconds occurs, and deskew is not executed.
- Deskew cannot be executed if the probe on the current channel (CH2 or CH4) is 100A:1V.
- If auto deskew is successful, the deskew of the reference channel becomes 0 seconds.
- When settings are initialized, all deskew settings are set to 0 seconds.

Deskew Execution Example



* The example above is of a waveform when auto deskew was performed. The waveform is displayed smoothly because the acquisition mode (waveform acquisition condition) is set to averaging. After auto deskew is executed, the waveform is not smooth because the acquisition mode is set to normal.

Explanation

To correctly measure the power supply analysis parameters such as power, impedance, power factor, watt hour, and ampere hour from the voltage and current under analysis, the difference in the transfer time of the voltage and current signals must be corrected (deskewed).

Connecting the Deskew Correction Signal Source

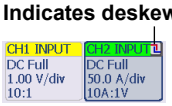
Apply the voltage and current signals from the deskew correction signal source to the pair of channels on the DL9000 that you wish to deskew using a voltage probe (passive probe or differential probe) and a current probe. For a description of the pair of channels for applying the voltage and current signals when measuring power supply analysis parameters, see page 6 in this manual.

Note

For information on the handling of the deskew correction signal source, passive probe, differential probe, and current probe, see the respective manuals.

Executing the Deskew

- Deskew is a function used to bring the signal of the channel that is paired with the reference channel close to that reference channel on the time axis and correct the difference in the transfer time.
- Execute deskew with CH1 & CH2 and CH3 & CH4 as pairs.
- Execute auto deskew after the warm-up time of the DL9000 and other equipment (as necessary) has elapsed.
- The deskew icon is displayed in the information area of the deskewed channel.



Auto Deskew

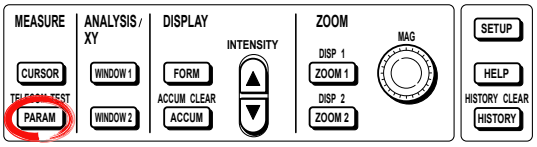
- When auto deskew is executed, only the reference channel and the channel paired with the reference channel are displayed.
- If you execute auto deskew, settings such as ACQ, trigger, CH, and Display are changed to match the signal received from the 701935 Deskew Correction Signal Source. For details, see appendix 1.
- During auto deskew, the deskew icon blinks in the bottom left of the screen.

Manual Deskew

- You can deskew signals further after performing auto deskew described above.
- For a description of the settings related to the vertical axis or horizontal axis (time axis) used when displaying the signals applied to each channel, see the procedural explanations in the respective sections in the DL9000 User's Manual shown below and set the display for easy viewing of the corrections.
  - Auto setup: Section 4.5
  - Vertical position setting: Section 5.3
  - Voltage sensitivity (Scale) setting: Section 5.7
  - Channel ON/OFF: Section 5.1
  - Bandwidth limit selection: Section 5.5
  - T/div setting: Section 5.8

5 Performing Automated Measurement of Power Supply Analysis Parameters

Procedure

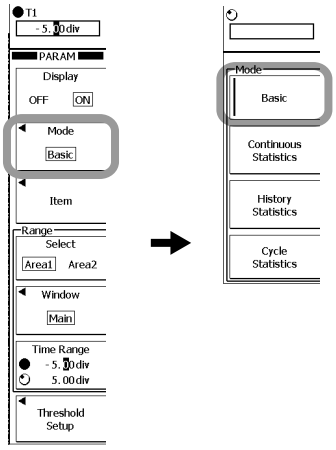


To perform automated measurement of power supply analysis parameters, you must turn ON the Power Supply Analysis function on the applicable channels. For the setup procedure, see section 3 in this manual.

Note

To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

1. Press **PARAM**. The PARAM menu is displayed.
   You can also display the PARAM menu by selecting To Measure in the power supply analysis Setup menu described in section 3 of this manual and pressing SET.
2. Press the **Mode** soft key. The Mode menu appears.
3. Press the **Basic** soft key.



Selecting the Measurement Parameters

4. Press the **Item** soft key. The Item Setup menu and Item Setup dialog box appear.
5. Press the soft key corresponding to the waveform to be measured to select it.

Note

If you select a trace for which the Power Supply Analysis function is ON, the power supply analysis parameter Item Setup dialog box is displayed.
If you select a trace for which the Power Supply Analysis function is OFF, the normal waveform parameter Item Setup dialog box is displayed.

6. Select a parameter to measure using the **rotary knob**.

7. Press **SET** to turn it ON or OFF.
You can turn all parameters OFF at once by selecting ALL OFF and pressing **SET**.
You can copy the current settings to all traces in the same area by selecting Copy to All Trace and pressing **SET**.

Selecting the Cycle Mode (applicable to products with firmware version 3.2 or higher)

You can change the measurement range of a portion of the power supply analysis parameters (Wp, Wp+, Wp-, Abs.Wp, q, q+, q-, and Abs.q) by turning the cycle mode ON/OFF.

For CH1 and CH3

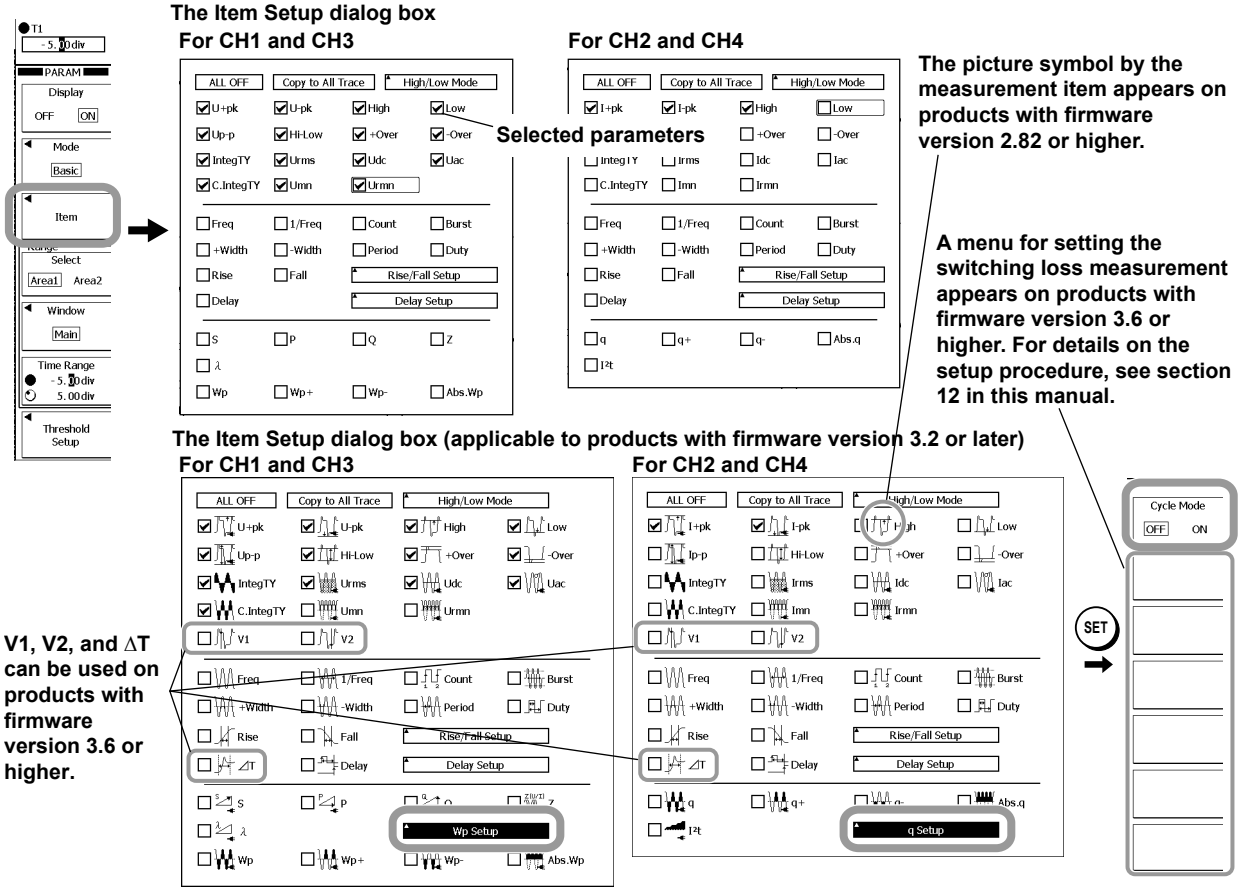
8. Turn the rotary knob to select Wp Setup, and press SET.

9. Press the Cycle Mode soft key to select OFF or ON.
- If you select OFF, Wp, Wp+, Wp-, and Abs.Wp are measured over the range specified by Time Range.
- If you select ON, Wp, Wp+, Wp-, and Abs.Wp are measured over a section of the waveform that can be extracted as cycles (see page 15) within the range specified by Time Range.

For CH2 and CH4

8. Turn the rotary knob to select q Setup, and press SET.

9. Press the Cycle Mode soft key to select OFF or ON.
- If you select OFF, q, q+, q-, and Abs.q are measured over the range specified by Time Range.
- If you select ON, q, q+, q-, and Abs.q are measured over a section of the waveform that can be extracted as cycles (see page 15) within the range specified by Time Range.



10. Press **ESC**. The Item Setup dialog box closes.

The rest of the procedure is the same as the steps in sections 10.2 or 10.3 in IM701310-01E, or 11.2 or 11.3 in IM701331-01E of the DL9000 User's Manual.

Explanation

To perform automated measurement of power supply analysis parameters, you must turn ON the Power Supply Analysis function on the applicable channels. For the setup procedure, see section 3 in this manual.

Note

To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

The addition of the Power Supply Analysis function (/G4 option) allows automated measurement of power supply analysis parameters as with standard waveform parameters. As with the results of automated measurement of standard waveform parameters, you can perform history searches, GO/NO-GO determination, and trend display using the results of automated measurement of power supply analysis parameters. The sections that differ from the standard function are described below.

Measured Waveforms and Measurement Parameters

The selectable parameters vary depending on whether power supply analysis is specified on the selected measured waveform as indicated below.

When Measured Waveforms are CH1/CH3 (Set for Power Supply Analysis)

- **Power supply analysis parameters**

  Up-p, U+pk, U-pk, Udc, Urms, Uac, Umn, Urmn, S, P, Q, Z, λ, Wp, Wp+, Wp-, Abs.Wp

  For details on how to determine each parameter, see “Determining Power Supply analysis Parameters” on the next page.

- **Ref. waveform parameters**

  High, Low, Hi-Low, +Over, -Over, IntegTY, C.IntegTY, Freq, 1/Freq, Count, Burst, +Width, -Width, Period, Duty, Rise, Fall, Delay, V1, V2, ΔT

  For details on how to determine each parameter, see sections 10.2 or 10.3 in IM701310-01E, or 11.2 or 11.3 in IM701331-01E of the DL9000 User’s Manual.

When Measured Waveforms are CH2/CH4 (Set for Power Supply Analysis)

- **Power supply analysis parameters**

  Ip-p, I+pk, I-pk, Idc, Irms, Iac, Imn, Irmn, q, q+, q-, Abs.q, I^2t

  For details on how to determine each parameter, see “Determining power supply analysis Parameters” on the next page.

- **Ref. waveform parameters**

  See “• Ref. waveform parameters” on above

When Measured Waveforms Are Not Targeted for Power Supply Analysis

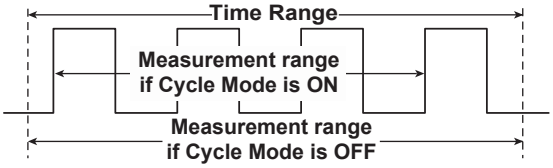
The standard measurement parameters. See sections 10.2 or 10.3 in IM701310-01E, or 11.2 or 11.3 in IM701331-01E of the DL9000 User’s Manual.

Cycle Mode

You can change the measurement range of a portion of the power supply analysis parameters (Wp, Wp+, Wp-, Abs.Wp, q, q+, q-, and Abs.q) by turning the cycle mode ON/OFF.

OFF	Measures within the range specified by Time Range.
ON	Measures over a section of the waveform that can be extracted as cycles* within the range specified by Time Range.

* The range from the rising (or falling) edge of the waveform to the next rising (or falling) edge is detected as a cycle. If multiple cycles are present within the range specified by Time Range, the measurement range is over those cycles.
Measurement is not possible if the waveform contains less than a cycle in the range specified by Time Range. In this case, the measured value is displayed as “*****.”



Determining the Power Supply Analysis Parameters

Power Analysis Parameter	Method of Determination, Equation				
Voltage U [V] DC component Udc True rms value Urms AC component Uac Rectified mean value calibrated to the rms value Umn Rectified mean value Urmn Amplitude Up-p Maximum value U+pk Minimum value U-pk	**Udc**	**Urms**	**Uac**	**Umn**	**Urmn**
	$\frac{1}{T}\int_0^T u(t)\,dt$	$\sqrt{\frac{1}{T}\int_0^T u(t)^2\,dt}$	$\sqrt{Urms^2 - Udc^2}$	$\frac{\pi}{2\sqrt{2}}\frac{1}{T}\int_0^T \lvert u(t)\rvert\,dt$	$\frac{1}{T}\int_0^T \lvert u(t)\rvert\,dt$
	Up-p		**U+pk**		**U-pk**
	Amplitude (equivalent to the standard measurement parameter P-P)		**Maximum value (equivalent to the standard measurement parameter Max)**		**Minimum value (equivalent to the standard measurement parameter Min)**
Current I [A] DC component Idc True rms value Irms AC component Iac Rectified mean value calibrated to the rms value Imn Rectified mean value Irmn Amplitude Ip-p Maximum value I+pk Minimum value I-pk	**Idc**	**Irms**	**Iac**	**Imn**	**Irmn**
	$\frac{1}{T}\int_0^T i(t)\,dt$	$\sqrt{\frac{1}{T}\int_0^T i(t)^2\,dt}$	$\sqrt{Irms^2 - Idc^2}$	$\frac{\pi}{2\sqrt{2}}\frac{1}{T}\int_0^T \lvert i(t)\rvert\,dt$	$\frac{1}{T}\int_0^T \lvert i(t)\rvert\,dt$
	IP-P		**I+pk**		**I-pk**
	Amplitude (equivalent to the standard measurement parameter P-P)		**Maximum value (equivalent to the standard measurement parameter Max)**		**Minimum value (equivalent to the standard measurement parameter Min)**
Active power P [W]	$\frac{1}{T}\int_0^T u(t)\cdot i(t)dt$ **u(t) · i(t) : Instantaneous power**				
Apparent power S [VA]	**Urms · Irms**				
Reactive power Q [var]	$\sqrt{S^2 - P^2}$				
Power factor λ	$\frac{P}{S}$				
Impedance of the load circuit Z [Ω]	$\frac{Urms}{Irms}$				
Watt hour [Wh] **Wp** **Wp+** **Wp-** **Abs.Wp**	$\int_0^T u(t)\cdot i(t)dt$ **Wp is the sum of positive and negative watt hours.** **Wp+ is the sum of positive P (consumed watt hours).** **Wp– is the sum of negative P (watt hours returned to the power supply).** **Abs.Wp is the sum of Wp+ and Wp- (sum of the absolute value of the watt hour) .**				
Ampere hour [Ah] **q** **q+** **q-** **Abs.q**	$\int_0^T i(t)dt$ **q is the sum of positive and negative Idc (ampere hours).** **q+ is the sum of positive Idc (ampere hours).** **q– is the sum of negative Idc (ampere hours).** **Abs.q is the sum of q+ and q- (sum of the absolute value of the ampere hour) .**				
Joule integral I^2t [A^2s]	$\int_0^T i^2(t)\,dt$				

Note

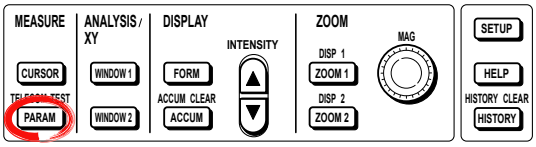
- T in the table above is the measurement range (Time Range) specified when performing automated measurement. For a description of the measurement range, see sections 10.2 or 10.3 in IM701310-01E, or 11.2 or 11.3 in IM701331-01E of the DL9000 User's Manual.
- u(t) and i(t) denote the sampled data of the voltage signal and the current signal, respectively.
- The measurement range of the power supply analysis parameters varies as follows:

Parameters measured over the entire measurement range	U+pk, U-pk, Up-p, I+pk, I-pk, Ip-p, and I2t
Parameters measured over a section a section of the waveform that can be extracted as cycles within the measurement range	Udc, Urms, Uac, Umn, Urmn, Idc, Irms, Iac, Imn, Irmn, P, S, Q, Z, and I
Parameters whose measurement range* changes depending on whether the cycle mode is ON or OFF	Wp, Wp+, Wp-, Abs.Wp, q, +q, -q, and Abs.q

* Over the entire measurement range if the cycle mode is OFF. A section of the waveform that can be extracted as cycles within the measurement range if the cycle mode is ON.

6 Performing Statistical Processing on the Measured Values of Power Supply Analysis Parameters

Procedure

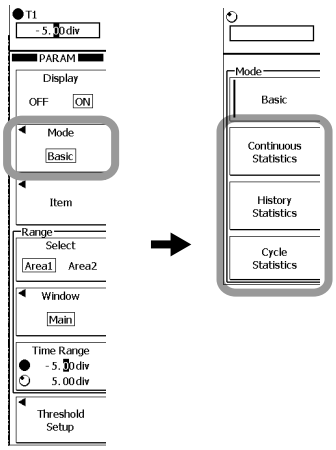


To perform automated measurement of power supply analysis parameters and statistical processing, you must turn ON the Power Supply Analysis function on the applicable channels. For the setup procedure, see section 3 in this manual.

Note

To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

1. Press **PARAM**. The PARAM menu is displayed.
   You can also display the PARAM menu by selecting To Measure in the power supply analysis Setup menu described in section 3 of this manual and pressing SET.
2. Press the **Mode** soft key. The Mode menu appears.
3. Press the soft key for **Continuous Statistic**, **History Statistic**, or **Cycle Statistic**.



The procedures thereafter are the same as those in section 5 of this manual.

Explanation

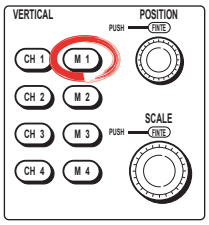
As with the standard measurement parameters (waveform parameters), you can perform statistical processing on the measured values of power supply analysis parameters. The following five statistics can be displayed for the measured values of two measurement parameters.

Max	Maximum
Min	Minimum value
Mean	Mean value
σ	Standard deviation
Cnt	Number of measured values used in the statistical processing

For example, if you selected power supply analysis parameter Up-p of CH1 as a measurement parameter, the maximum, minimum, average, standard deviation, and the number of measured values used in the statistical processing of the Up-p of CH1 are displayed. For a detailed description of statistical processing, see “Explanation” in sections 10.3 in IM701310-01E, or 11.3 in IM701331-01E of the DL9000 User’s Manual.

7 Performing Waveform Computation on Power Supply Analysis Parameters

Procedure



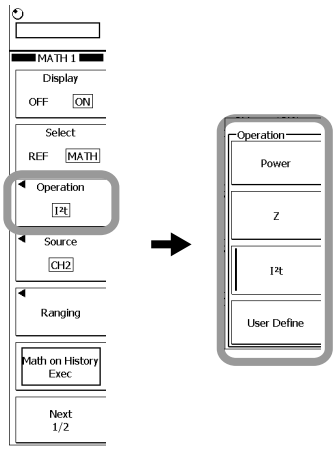
The following setup is required to perform waveform computation on power supply analysis parameters.

- Turn ON the assignment of the power supply analysis parameters for the computed waveform. For the setup procedure, see section 3 in this manual.
- Turn ON display of the computed waveform. For the setup procedures, see chapters 9 in IM701310-01E, or 10 in IM701331-01E of the DL9000 User's Manual.

Note

- The setup procedures for computed waveform M1 are described below.
- Computations using CH1 through CH4 are normal computations.
- For how to turn computed waveform display ON/OFF and how to label computed waveforms, see sections 8.5 and chapter 9 in IM701310-01E, or sections 9.5 and chapter 10 in IM701331-01E of the DL9000 User's Manual.
- To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

1. Press **M1**. The MATH1 menu is displayed.
   You can also display the MATH1 menu by selecting To Math and pressing Math1 in the power supply analysis Setup menu described in section 3 of this manual.
2. Press the **Select** soft key to select Math. The Math menu is displayed.
3. Press the **Operation** soft key. The operator selection menu is displayed.
4. Press the **Power**, **Z**, **I^2t**, or **User Define** soft key to set an operator.
   For the setup procedure of the three operators of power supply analysis parameters, see the pages indicated below. For details on User Define, see the DL9000 User's Manual.
   - Power (instantaneous power) -> Page 19
   - Z (impedance) -> Page 19
   - I^2t (Joule integral) -> Page 20

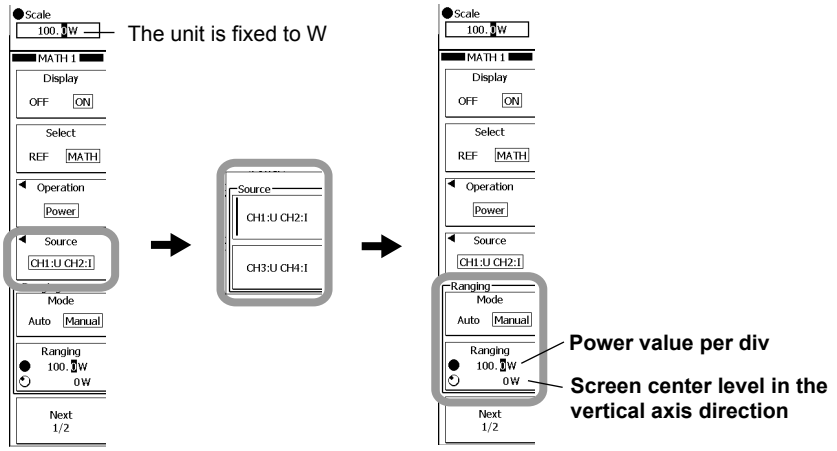


Setting the Computed Waveform of Instantaneous Power (When Power Was Selected in Step 4 on Page 18)

5. Press the **Source** soft key. The menu for selecting the computation source waveform is displayed.
6. Press the **CH1:U CH2:I** or **CH3:U CH4:I** soft key to select the source waveform.

Ranging (Setting the Display Range)

7. Press the **Mode** soft key to select Auto or Manual.
8. If you select Manual, use the **Ranging** soft key and the **rotary knob** to set the power and center level per div, thereby adjusting the display range.
   For the other setting procedures, see the DL9000 User's Manual.

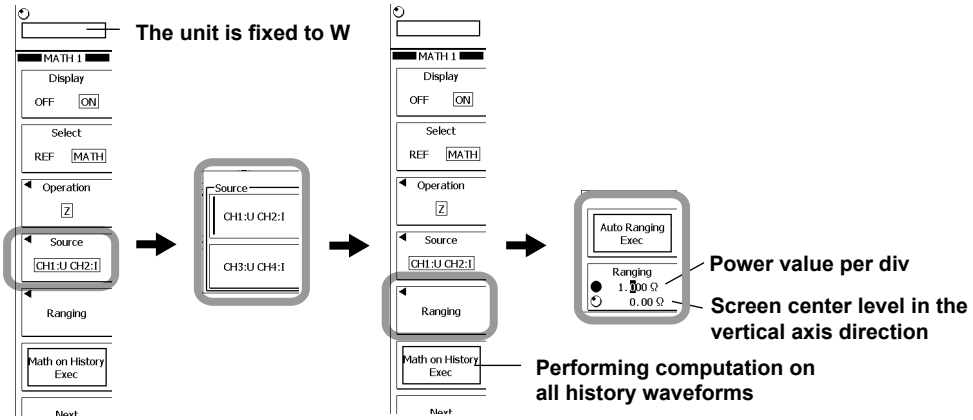


Setting the Computed Waveform of Impedance (When Z Was Selected in Step 4 on Page 18)

5. Press the **Source** soft key. The menu for selecting the computation source waveform is displayed.
6. Press the **CH1:U CH2:I** or **CH3:U CH4:I** soft key to select the source waveform.

Ranging (Setting the Display Range)

7. Press the **Ranging** soft key. The ranging setting menu is displayed.
8. If you wish to set the display range automatically, press the **Auto Ranging Exec** soft key to execute ranging. To set the range manually, use the **Ranging** soft key and the **rotary knob** to set the value per div and center position.
   For the other setting procedures, see the DL9000 User's Manual.



9. Press **ESC** to return to the previous screen.

Performing Computation on All History Waveforms

10. To perform specified computations on all history waveforms, press the Math on History Exec soft key. The computation is executed, and the Math on History Exec display changes to Abort.
To cancel computation, press the Abort soft key. The computation is Aborted, and the Abort display changes to Math on History Exec.

Setting the Computed Waveform of Joule Integral (When I²t Was Selected in Step 4 on Page 18)

5. Press the **Source** soft key. The menu for selecting the computation source waveform is displayed.

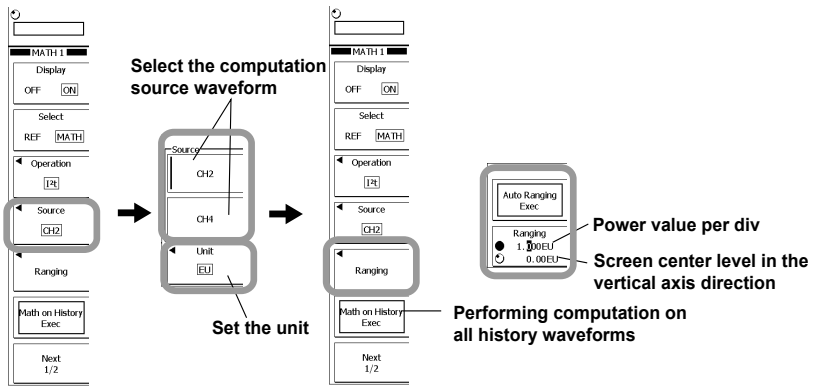
6. Press the **CH2** or **CH4** soft key to select the source waveform.

7. Press the **Unit** soft key. A keyboard for entering the unit is displayed. Enter the unit using the keyboard.

Ranging (Setting the Display Range)

8. Press the **Ranging** soft key. The ranging setting menu is displayed.

9. If you wish to set the display range automatically, press the **Auto Ranging Exec** soft key to execute ranging. To set the range manually, use the Ranging soft key and the **rotary knob** to set the value per div and center position.
For the other setting procedures, see the DL9000 User's Manual.



10. Press **ESC** to return to the previous screen.

Executing the Computation on All History Waveforms

11. To perform specified computations on all history waveforms, press the Math on History **Exec** soft key. The computation is executed, and the Math on History Exec display changes to Abort.
To cancel computation, press the **Abort** soft key. The computation is Aborted, and the Abort display changes to Math on History Exec.

Explanation

The following setup is required to perform waveform computation on power supply analysis parameters. Turn ON the assignment of the power supply analysis parameters to the computed waveform. For the setup procedure, see section 3 in this manual.

Note

To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

Operators

You can select three operators for Math1 through Math4.

Power (instantaneous power) Z (impedance) I^2t (Joule integral)

Waveform to Be Computed

The waveforms (sources) on which computation can be performed are as follows:

Operator	Source
Power	(CH1: U CH2: I), (CH3: U CH4: I)
Z	(CH1: U CH2: I), (CH3: U CH4: I)
I^2t	CH2, CH4

Displaying the Units of the Computed Waveforms (for I2t)

When the operator is I^2t, you can specify a unit using four characters or fewer.
The type of characters that can be used are those displayed on the keyboard.
The specified unit is displayed when scaled values are displayed.

Executing the Computation on All History Waveforms (for Z and I2t)

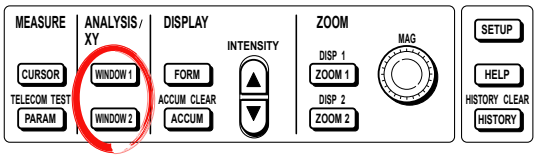
With waveform acquisition stopped, press the Math on History Exec soft key, and perform math on all history waveforms.

Note

- The computation cannot be performed on all history waveforms while waveforms are being acquired.
- The computation-in-progress icon appears at the lower left of the screen, and a progress bar is displayed in the center of the screen while the computation on all history waveforms is in progress. All operations other than the Abort soft key are disabled.
- If you set the trigger mode to N Single and start the waveform acquisition, the computation is performed only on the latest waveform after the acquisition is stopped. To perform the computation on all history waveforms, carry out the procedure given in “Executing the Computation on All History Waveforms.”
- If you change a setting that affects the computation result, recomputation is performed only on the selected history waveform.
- The Average display of HISTORY or PARAM of History Statistics appears only if all history waveforms exist. If the Average display of History or PARAM of History Statistics is not performed, carry out the procedure given in “Executing the Computation on All History Waveforms.”

8 Measuring the Power Spectrum

Procedure

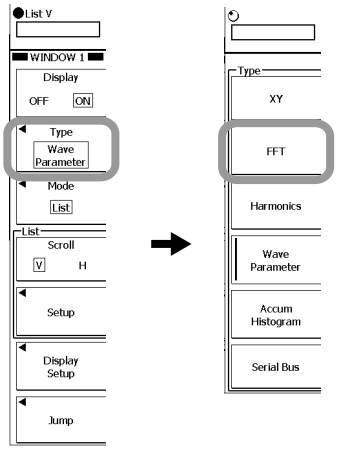


The following setup is required to measure the power spectrum.

Note

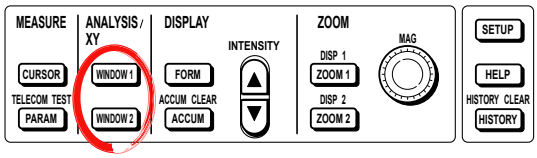
To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

1. Press the **WINDOW1** or **WINDOW2** soft key. The WINDOW menu is displayed.
   You can also display the WINDOW menu by selecting To FFT in the power supply analysis Setup menu described in section 3 of this manual and pressing FFT1 (WINDOW1) or FFT2 (WINDOW2).
2. Press the **Type** soft key. The FFT setting menu is displayed.
   For subsequent procedures, see sections 10.9 in IM701310-01E, or 11.9 in IM701331-01E of the DL9000 User's Manual.



9 Analyzing Harmonics

Procedure



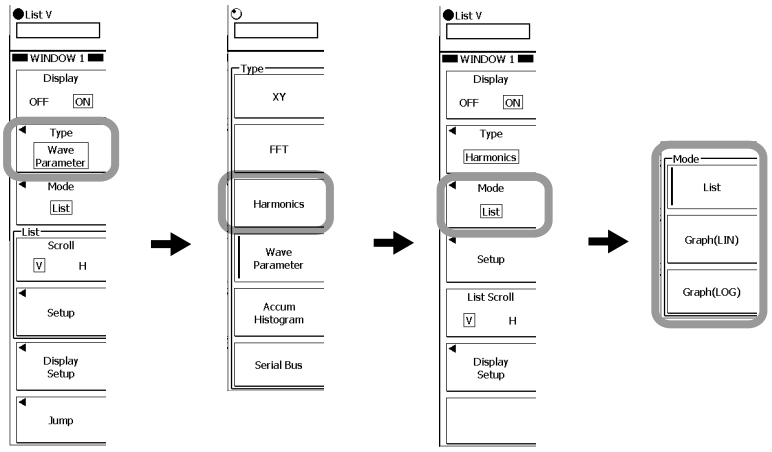
The following setup is required to analyze harmonics.

Turn ON the Power Supply Analysis function on the applicable channels, and turn ON the assignment of waveform analysis parameters for computed waveforms. For the setup procedure, see section 3 in this manual.

Note

To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

1. Press the **WINDOW1** or **WINDOW2** soft key. The WINDOW menu is displayed. You can also display the WINDOW menu by selecting To Harmonics in the power supply analysis Setup menu described in section 3 of this manual and pressing Harmonics 1 (WINDOW1) or Harmonics 2 (WINDOW2).
2. Press the **Type** soft key, and then press the **Harmonics** soft key in the menu that is displayed. The harmonic analysis setting menu is displayed.
3. Press the **Mode** soft key. The menu for selecting the display method for harmonic analysis results is displayed.
4. Press the **List**, **Graph(LIN)**, or **Graph(LOG)** soft key to set the display mode.

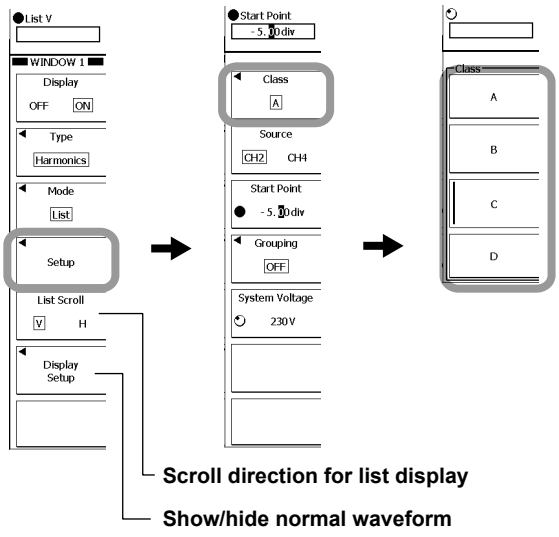


Selecting the Applicable Class

5. Press the **Setup** soft key. The harmonic analysis setting menu is displayed.

6. Press the **Class** soft key. The applicable class setting menu is displayed.

7. Press the soft key corresponding to the applicable class. The contents of the menu varies depending on the specified applicable class.



When Applicable Class A or B Is Selected

8. Press the **Source** soft key to set the source waveform to CH2 or CH4.

9. Press the **Start Point** soft key.

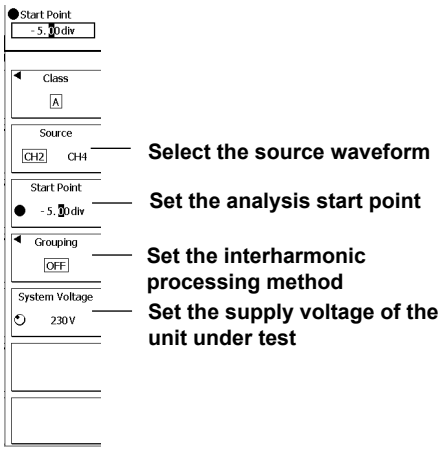
10. Set the analysis start point using the **rotary knob**.

11. Press the **Grouping** soft key. A menu for selecting the interharmonic processing method is displayed.

12. Press the **OFF** (do not include interharmonics), ***Type1*** (include adjacent interharmonics), or ***Type2*** (include all interharmonics) soft key to set the interharmonic processing method.

13. Press the **System Voltage** soft key.

14. Set the power supply voltage of the unit under test using the **rotary knob**.



When Applicable Class C Is Selected

8. Press the **Source** soft key to set the source waveform to CH2 or CH4.

9. Press the **Start Point** soft key.

10. Set the analysis start point using the **rotary knob**.

11. Press the **Grouping** soft key. A menu for selecting the interharmonic processing method is displayed.

12. Press the **OFF** (do not include interharmonics), **Type1** (include adjacent interharmonics), or **Type2** (include all interharmonics) soft key to set the interharmonic processing method.

13. Press the **System Voltage** soft key.

14. Set the power supply voltage of the unit under test using the **rotary knob**.

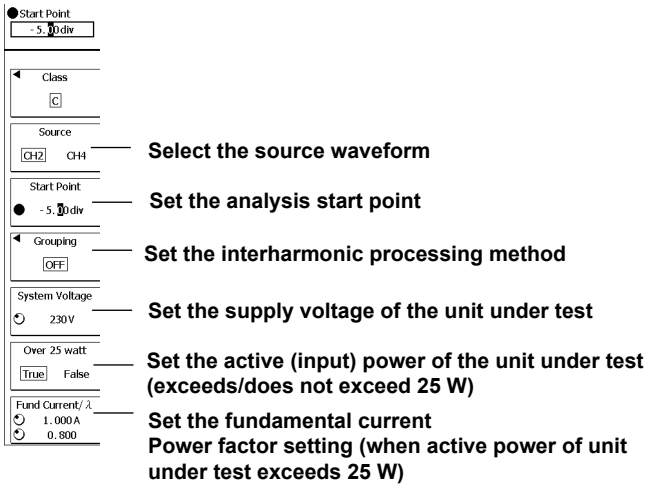
15 Press the **Over 25 watt** soft key to specify whether the active (input) power of the unit under test exceeds 25 W (True) or does not exceed 25 W (False).

16. Press the **Max Fund Current** soft key.

17. Using the **rotary knob**, set the fundamental current when the load on the unit under test is set to maximum.

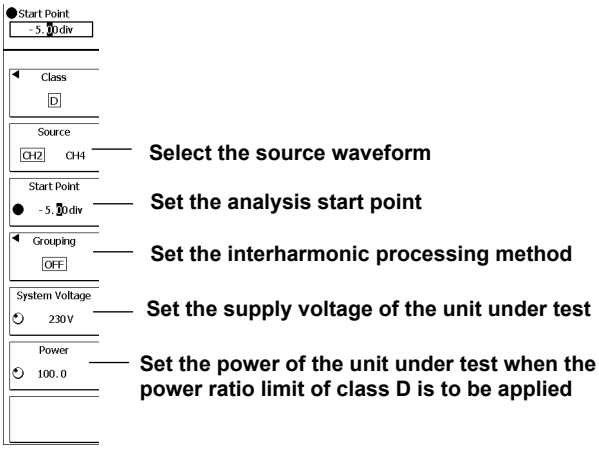
18. If Over 24 watt is set to True, press the λ soft key.

19. Using the **rotary knob**, set the power factor when the load on the unit under test is set to maximum.



When Applicable Class D Is Selected

8. Press the **Source** soft key to set the source waveform to CH2 or CH4.
9. Press the **Start Point** soft key.
10. Set the analysis start point using the **rotary knob**.
11. Press the **Grouping** soft key. A menu for selecting the interharmonic processing method is displayed.
12. Press the **OFF** (do not include interharmonics), **Type1** (include adjacent interharmonics), or **Type2** (include all interharmonics) soft key to set the interharmonic processing method.
13. Press the **System Voltage** soft key.
14. Set the power supply voltage of the unit under test using the **rotary knob**.
15. Press the **Power** soft key.
16. Using the **rotary knob**, set the power of the unit under test when the power ratio limit of class D is to be applied.



Explanation

Harmonics

Harmonics refer to sine waves whose frequencies are integer multiples of the fundamental wave (normally sine waves of commercial frequency 50 Hz or 60 Hz). The lowest harmonic frequency is twice the fundamental frequency. The input current that flows through the power rectification circuit, phase control circuit, and other circuits used in various electric and electronic equipment generates harmonic current or voltage on the power line. When the fundamental and harmonic waves are combined, distortion occurs in the waveform, and interference sometimes occurs in equipment connected to the power line.

Fundamental Wave

The sine wave with the longest period among the different sine waves derived from the periodic complex wave, or the sine wave among the components of a complex wave having the fundamental frequency.

Fundamental Frequency

Refers to the frequency corresponding to the longest period in the period complex wave.

Harmonic Order

Integer ratio of the harmonic frequency with respect to the fundamental frequency.

Harmonic Component

Waveform component with a frequency that is an integer multiple (twice or greater) of the fundamental frequency.

Interharmonics

With IEC harmonic measurement, if the input signal is 50 Hz, ten periods of the input signal undergo Fourier transform, and are analyzed at 5–Hz resolution. Thus, ten frequency components between each harmonic order are analyzed. In this case, the components between each harmonic order are called *interharmonics*.
If the input signal is 60 Hz, 5-Hz sections of the twelve periods of the input signal are analyzed. Thus, the waveform is divided into twelve sections of interharmonics. For details, see appendix 3.

Measurement/Analysis Conditions

The following special measurement and analysis conditions and parameters are required for harmonic analysis.

Trigger Mode

To perform harmonics analysis continuously when waveform acquisition is started, set the trigger mode to Normal.

Time Window

Rect (Rectangular).

Number of Waveforms and Number of Waveform Data Points

For analysis that meets harmonic current emissions standards, the following conditions for the number of data points and periods must be met.

Data points

200 ms worth of data with 9000 points or more

Periods

50 Hz power supply (45 Hz–55 Hz): 10 periods of data
60 Hz power supply (45 Hz–65 Hz): 12 periods of data

Harmonic Orders

Harmonic components of up to the 40th order are computed.

Supply Voltage of the Unit under Test (System Voltage)

Set the supply voltage of the instrument on which to perform harmonic analysis. The harmonic limit defined by the harmonic current emissions standard (see page 5) is converted using the supply voltage and used as the criteria. The default value is 230 V.

Setting range 90–440 V
Setting resolution 1 V

The harmonic current emissions standard defines limits of harmonics for each order by assuming 220 V, 230 V, and 240 V for the supply voltages of the unit under test (single phase). For other supply voltages, the limits need to be converted. The Power Supply Analysis function of the DL9000 uses the following equation to convert the limits of all classes excluding the range of 220 V to 240 V.

Converted limit = Limit of each class x 230/Supply voltage of equipment

Applicable Class

Select the applicable class for the unit under test. The harmonic current emissions standard classifies the unit under test into classes A through D, and criteria are specified for each class.

Required Items for Class C

Active Power of the Unit under Test (Over 25 Watts)

Select whether or not the active power of the unit under test exceeds 25 W (True/False). With class C, the judgement criteria varies with the active power of the instrument.

Fundamental Current of the Unit under Test (Fund Current)

Set the fundamental current when the load on the unit under test is set to maximum. To set the maximum current measured on the DL9000, perform harmonic analysis with the maximum load, and then set the Max value that is displayed as the 1st order in the list. For information on the list display, see the operating procedure on page 22. For class C, evaluation is made on the percentage of the harmonic component with respect to the maximum fundamental current of the unit under test.

Power Factor (λ)

If the active (input) power of the unit under test exceeds 25 W (True), set the power factor when the load on the unit under test is set to maximum. On the DL9000, set the power factor that is measured according to the procedure given in section 5. For Class C, if the active (input) power of the unit under test exceeds 25 W, the circuit power factor when the equipment load is set to maximum is used when evaluating the percentage of the 3rd order harmonic component with respect to the fundamental current.

Default:	0.800
Setting range:	0.01–1.000
Setting resolution:	0.001

Required Items for Class D

Active Power of the Unit under Test

Set the active power of the unit under test. For Class D, the harmonic current per watt (power ratio limit) is also evaluated.

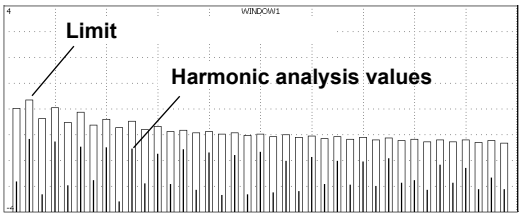
Analysis Results Display

Bar Graph Display

The harmonic measurement data and the standard limits for each order up to the 40th order can be displayed on a bar graph. You can set the scale to LIN (linear) or LOG (logarithmic).

Graph (LIN)

Graph (LOG)



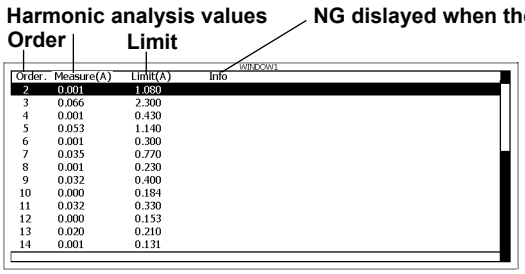
List Display

The harmonic measurement data and the standard limits for each order up to the 40th order can be listed.

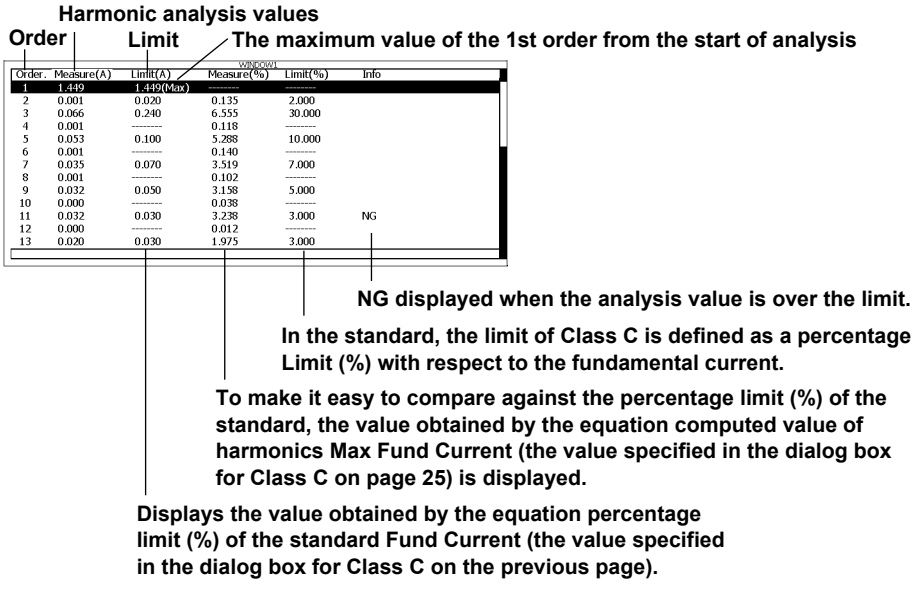
Note

- The DL9000 can only analyze the harmonics of single-phase equipment, and cannot analyze the harmonics of three-phase equipment.
- IEC6000-4-7 stipulates smoothing of measured data with a 1.5-second primary filter, but because the DL9000's harmonic analysis results are instantaneous, they do not comply exactly with the standard. To make accurate measurements complying with the standard, the WT3000 Series Digital Power Meter and Harmonic Analysis Software (Model 761922) are required.
- Of the harmonic analysis results, the analysis results of each harmonic component and the limits defined by the standard can be saved to a file in CSV format (see section 11 in this manual). The waveform data of harmonics cannot be saved.
- The original waveform data used to analyze the harmonics can be saved. If the original waveform data is saved in the ACQ Memory data type, harmonic analysis described in this section can be performed by loading the data into the DL9000 with the Power Supply Analysis function (/G4 option). For instructions on saving the data in binary format, see sections 13.5 in IM701310-01E, or 14.5 in IM701331-01E of the DL9000 User's Manual.
- If harmonic analysis cannot be performed for reasons such as 200 ms of waveform not being contained in ten (45 Hz–55 Hz) or twelve (55 Hz–60 Hz) periods within the measuring range, or the number of data points being less than 9000, "---------" is displayed in the Measure(A) or Measure(%) column of the list. Also, "--------" is displayed for the orders of an unspecified limit (Limit(A)) in each class.

Display example for applicable classes A, B, and D

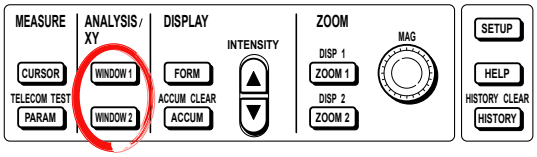


Display example for applicable class C



10 Displaying Power Supply Analysis Parameters in a Graph, Trend, or List

Procedure



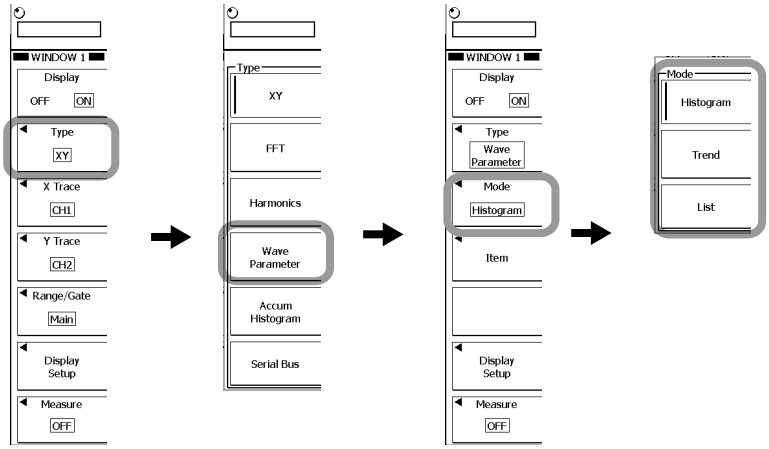
The following setup is required to analyze harmonics.

- Turn ON the Power Supply Analysis function on the applicable channels, and turn ON the assignment of waveform analysis parameters for computed waveforms. For the setup procedure, see section 3 in this manual.

Note

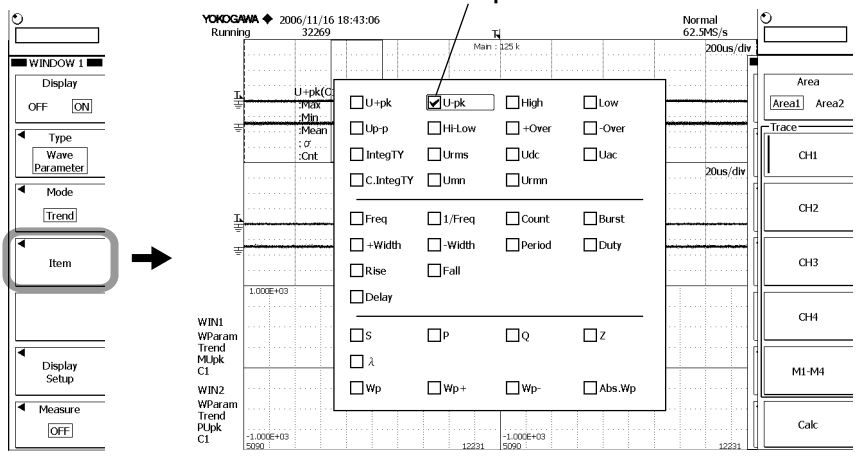
To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

1. Press the **WINDOW1** or **WINDOW2** soft key. The WINDOW menu is displayed. You can also display the WINDOW menu by selecting To Wave Param in the power supply analysis Setup menu described in section 3 of this manual and pressing Wave Param 1 (WINDOW1) or Wave Param 2 (WINDOW2).
2. Press the **Type** soft key, and then press the **Wave Parameter** soft key in the menu that is displayed.
3. Press the **Mode** soft key. The menu for selecting the display method for harmonic analysis parameters is displayed.
4. Press the **Histogram**, **Trend**, or **List** soft key to set the display mode.



5. If Histogram or Trend is selected in step 4, select the parameters to display.
Press the **Item** soft key. The Item Setup menu and Item Setup dialog box appear.

6. Press the soft key corresponding to the waveform to be measured to select it.



Note

If you select a waveform for which the Power Supply Analysis function is ON, the power supply analysis parameter Item Setup dialog box is displayed.
If you select a waveform for which the Power Supply Analysis function is OFF, the normal waveform parameter Item Setup dialog box is displayed.

7. Select a parameter to measure using the **rotary knob**.

8. Press **SET** to turn it ON or OFF.

9. Press **ESC**. The Item Setup dialog box closes.

The rest of the procedure is the same as the steps in sections 10.10 in IM701310-01E, or 11.10 in IM701331-01E of the DL9000 User's Manual.

Explanation

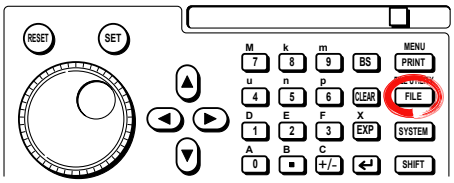
The results of automated measurement of power supply analysis parameters are displayed in a diagram, trend, or list. For diagram or trend display, select one of the measured power supply analysis parameters (parameters set in section 5 and 6 of this manual) to display.
For list display, all selected power supply analysis parameters are displayed.

Note

To display power supply analysis parameters per cycle in a trend, set Cycle Statistics as explained in section 6 of this manual.

11 Saving the Computed Results of Harmonics

Procedure



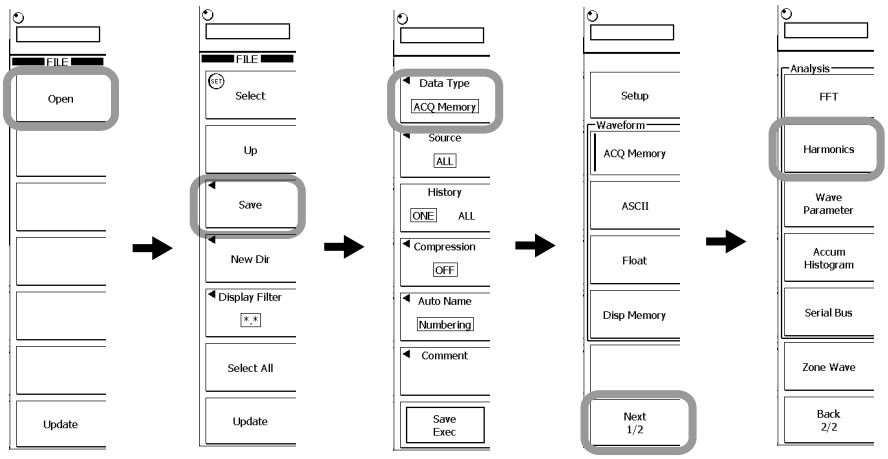
1. Press **FILE**.

Selecting the Save Destination Medium and/or Directory

2. Select the save destination medium using the **rotary knob**.
3. Press the **Open** soft key to confirm the medium.
   To save to a directory within the medium, select a directory in the same manner as in the procedure above, and then press the **Open** soft key to confirm the directory. The selected medium and/or directory is displayed under Path=..... in the upper left of the File List window.
   If you press the UP soft key, the instrument moves to the parent directory.

Setting the Data Type

4. Press the **Save** soft key. The file name setting menu is displayed.
5. Press the **Data Type** soft key. A menu for selecting the data type appears.
6. Press the **Next 1/2** soft key.
7. Press the **Harmonics** soft key.



The rest of the procedure is the same as steps 7 to 19 in section 13.9 in the DL9000 User's Manual.

Explanation

In the same manner as with the standard analysis results, you can save harmonic analysis results in CSV format (files with the CSV extension). For details, see sections 13.9 in IM701310-01E, or 14.9 in IM701331-01E of the DL9000 User's Manual.

Note

- The power spectrum is saved as FFT analysis data. Select FFT in step 7.
- Parameters that were automatically saved as power supply analysis parameters are saved as waveform parameters. Select Wave Parameter in step 7.
- Active power, impedance, and Joule-integral values are saved as computed data. For details, see section 13.5 in the DL9000 User's Manual.

Example for classes A, B, and D

Analysis Type	Harmonics		
Model Name	DL9000		
Model Version	X.XX		
Order.	Measure(A)	Limit(A)	Info
2	0.001	1.08	
3	0.222	2.3	
4	0.001	0.43	
⋮	⋮	⋮	
39	0.017	0.058	
40	0	0.046	

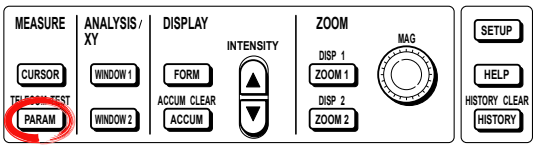
Example for class C

Analysis Type	Harmonics				
Model Name	DL9000				
Model Version	X.XX				
Order.	Measure(A)	Limit(A)	Measure(%)	Limit(%)	Info
1	0.67	0.904(Max)	--------	--------	
2	0.001	1.08	0.096	2	
3	0.222	2.3	15.892	30	
4	0.001	0.43	0.086	--------	
5	--------	0.1	--------	10	
6	0	--------	0.032	--------	
7	0.096	0.098	6.824	7	
8	0.001	--------	0.055	--------	
9	0.073	0.07	5.242	5	NG
⋮	⋮	⋮	⋮	⋮	
39	0.017	0.058	1.182	--------	
40	0	0.046	0.033	7	

12 Measuring the Switching Loss

This function can be used on products with firmware version 3.6 or later.

Procedure



To measure the switching loss, the power supply analysis function of the corresponding channel must be turned ON. For the setup procedure, see section 3 in this manual.

Note

To make correct measurements and computation, we recommend that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

1. Press **PARAM** to display the PARAM menu.

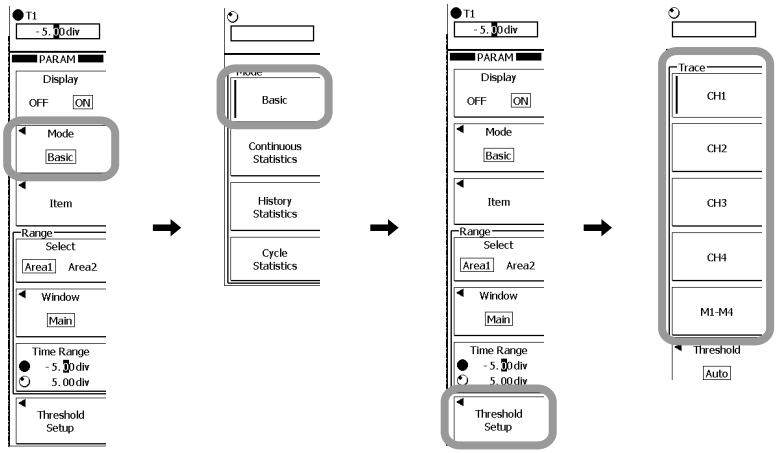
   You can also display the PARAM menu by selecting To Measure on the Power Analysis Setup menu described in section 3 of this manual and pressing SET.
2. Press the **Mode** soft key to display the Mode menu.
3. Press the **Basic** soft key.

Preparation

Setting Threshold Values

Set threshold values so that both the rising and falling edges of the voltage signals of CH1 or CH3 can be searched as switching points.

4. Press the **Threshold Setup** soft key to display a menu.
5. Press the soft key corresponding to the waveform to be measured to set the source waveform.



- **Selecting the Method of Setting the Threshold Values**

  6. Press the **Threshold** soft key.

  7. Press the soft key corresponding to the desired method.
  If you select Auto, proceed to step 8.
  If you select Level/Hys, proceed to step 9.
  If you select Upper/Lower, proceed to step 12.

- **Auto**

  8. Press the **Center of** soft key to select P-P or High-Low.

  Proceed to step 15.

- **Level/Hys**

  9. Press the **Level/Hys** soft key so that the rotary knob is controlling the threshold level.

  10. Turn the **rotary knob** to set the threshold level.

  11. Likewise, set the hysteresis of the threshold.

  Proceed to step 15.

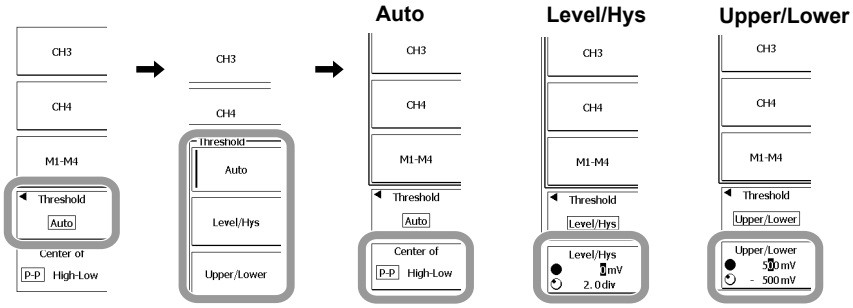
- **Upper/Lower**

  12. Press the **Upper/Lower** soft key so that the rotary knob is controlling the upper limit of threshold value.

  13. Turn the **rotary knob** to set the upper limit of the threshold value.

  14. Likewise, set the lower limit of the threshold value.

  15. Press **ESC** to return to the waveform parameter setup menu.



Selecting the Measurement Parameters

16. Press the **Item** soft key. The Item Setup menu and Item Setup dialog box appear.

17. Press the **CH1** or **CH3** soft key to select the pair of channels on which to measure the switching loss.
If you select CH1, CH1 and CH2 are selected as voltage and current pairs. If you select CH3, CH3 and CH4 are selected as voltage and current pairs.

Note

If you select a trace for which the Power Supply Analysis function is ON, the power supply analysis parameter Item Setup dialog box is displayed.
If you select a trace for which the Power Supply Analysis function is OFF, the normal waveform parameter Item Setup dialog box is displayed.

18. Use **rotary knob & SET** to select the measurement parameter.
The switching loss can be measured and displayed if you select a measurement parameter related to power (Wp, Wp+, Wp-, Abs.Wp, etc.).

19. Use **rotary knob & SET** to select Wp Setup. The switching loss measurement menu appears

Searching the Switching Points and Selecting the Measurement Location

Search the waveform using the threshold values that were specified up to this point and select the location where you want to measure the switching loss.

- **Executing the Search**

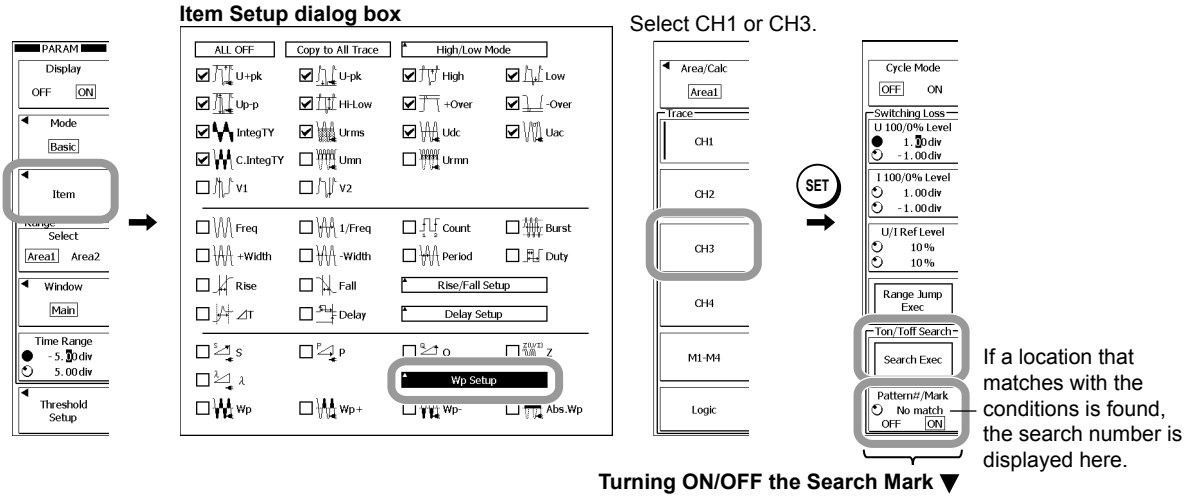
20. Press the **Search Exec** soft key to execute the search.
The Search Exec soft key changes to Search Abort. To stop the search, press the **Search Abort** soft key.

- **Selecting the Measurement Point**

21. Turn the **rotary knob** to select the search location where you want to measure the switching loss.
The waveform at the location of the search number is displayed in the zoom waveform area.

- **Turning ON/OFF the Search Mark**

22. Press **Pattern#/Mark** soft key to select ON or OFF.



Turning ON/OFF the Search Mark ▼

Search marks can be displayed on the main window and zoom window to indicate the locations on the waveform that have been found. The search mark corresponding to the search number is highlighted.

Setting the Reference Level

- **Setting the 100% and 0% Voltage Levels**

  23. Press the **U 100/0% Level** soft key so that the rotary knob is controlling U 100%.

  24. Turn the **rotary knob** to set the 100% voltage level.

  25. Likewise set the 0% voltage level.

- **Setting the 100% and 0% Current Levels**

  26. Press the **I 100/0% Level** soft key so that the rotary knob is controlling I 100%.

  27. Turn the **rotary knob** to set the 100% current level.

  28. Likewise set the 0% current level.

- **Setting the Measurement Level**

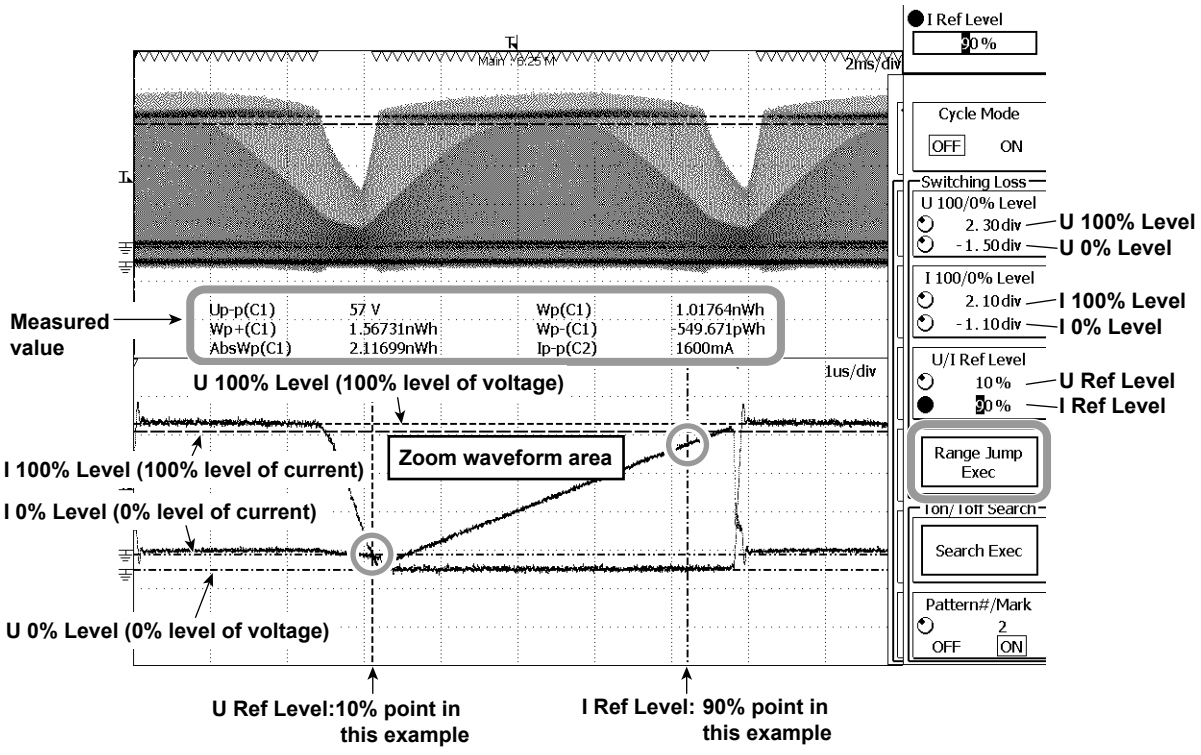
  29. Press the **U/I Ref Level** soft key so that the rotary knob is controlling U Ref Level.

  30. Turn the **rotary knob** to set the voltage measurement level.

  31. Likewise set the current measurement level.

Executing the Switching Loss Measurement

32. Press the **Range Jump Exec** soft key. The two vertical cursors are displayed at their measurement level positions, and the switching loss between the two vertical cursors is measured.



Explanation

The measurement functions of the power supply analysis parameters can be used to measure the switching loss (power loss during switching). This function can be used on products with firmware version 3.6 or later.

Setting Threshold Values

Auto	Determines the threshold values from P-P or High-Low and automatically sets the values.
Level/Hys	Set using the rotary knob.
Upper/Lower	Set using the rotary knob.

Selecting the Measurement Parameters

Set measurement parameters related to power (such as Wp, Wp+, Wp-, and Abs.Wp).

Searching Switching Points and Measurement Locations

Search the waveform using the specified threshold values and select the location where you want to measure the switching loss.

Reference Level

Set the range in the selected search location to be measured.

- **100% and 0% Voltage Levels**
  Set the 100% and 0% voltage levels.
  Selectable range: –4.00 to 4.00 divisions, resolution: 0.01 divisions

- **100% and 0% Current Levels**
  Set the 100% and 0% current levels.
  Selectable range: –4.00 to 4.00 divisions, resolution: 0.01 divisions

- **Setting the Measurement Level**
  Set the range of voltage and current levels to be measured with respect to the 100% voltage and current levels above.
  Selectable range: 0 to 100%, resolution: 1%

Executing the Switching Loss Measurement

When executed, a search is performed from the left edge to the right edge of the zoom waveform area. The DL9500/DL9700 measures the power between the first measurement level of the voltage or current and the next measurement level of the voltage or current. (If the first measurement level that is found is of voltage, the next measurement level will be of current or vice versa.)

13 Communication Commands

This section contains only the communication commands that have been added for the Power Supply Analysis function (/G4 Option). For a description of the standard communication commands and other communication interfaces, see the DL9000 Communication Interface User's Manual IM701310-17E or IM701331-17E (in CD).

Command	Function	Page
HISTory Group		
:HISTory[:CURRent][:SEARch]:SELect<x>:PARameter:MEASure:TRACe<x>:AREA<x>:TYPE:<parameter>	Sets the upper and lower limits of the power supply analysis parameters for measurement search or or queries the current setting	46
MATH Group		
:MATH<x>:I2T:ARANging	Executes auto ranging of the Joule-integral computation	47
:MATH<x>:I2T:HISTory:ABORt	Cancels history computation for Joule integral computation.	47
:MATH<x>:I2T:HISTory:EXECute	Executes history computation for Joule integral computation.	47
:MATH<x>:I2T:UNIT?	Queries all settings related to the units of Joule integral computation or queries the current setting.	47
:MATH<x>:I2T:UNIT[:DEFine]	Sets the units of Joule integral computation or queries the current setting.	
:MATH<x>:OPERation	Sets operators for power supply analysis or queries the current setting	47
:MATH<x>:Z:ARANging	Executes auto ranging of the impedance computation	47
:MATH<x>:Z:HISTory:ABORt	Cancels history computation for impedance computation.	47
:MATH<x>:Z:HISTory:EXECute	Executes history computation for impedance computation.	47
MEASure Group		
:MEASure:TRACe<x>:AREA<x>:CMODe	Turns ON/OFF the cycle mode or queries the current setting.	48
:MEASure:TRACe<x>:AREA<x>:<parameter>:COUNt?	Queries the count for continuous statistical processing of power supply analysis parameter.	48
:MEASure:TRACe<x>:AREA<x>:<parameter>:{MAXimum|MEAN|MINimum|SDEViation}?	Queries each statistical value of the power supply analysis parameter.	48
:MEASure:TRACe<x>:AREA<x>:<parameter>:STATe	Turns ON/OFF the power supply analysis parameter or queries the current setting.	48
:MEASure:TRACe<x>:AREA<x>:SWLoss?	Queries all settings related to the switching loss.	49
:MEASure:TRACe<x>:AREA<x>:SWLoss:ILEVel	Sets the current level of the switching loss or queries the current setting.	49
:MEASure:TRACe<x>:AREA<x>:SWLoss:RJUMp:ABORt	Aborts the range jumping of the switching loss.	49
:MEASure:TRACe<x>:AREA<x>:SWLoss:RJUMp:EXECute	Executes the range jumping of the switching loss.	49
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch?	Queries all settings related to the switching loss search function.	49
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:ABORt	Aborts the switching loss search.	49
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:EXECute	Executes the switching loss search.	49
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:MARK	Turns ON/OFF the switching loss search marks or queries the current setting.	50
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:SELect	Sets the search number of the switching loss search function or queries the current setting.	50
:MEASure:TRACe<x>:AREA<x>:SWLoss:UIRLevel	Sets the range level percentage of the switching loss or queries the current setting.	50
:MEASure:TRACe<x>:AREA<x>:SWLoss:ULEVel	Sets the voltage level of the switching loss or queries the current setting.	50
:MEASure:TRACe<x>:AREA<x>:<parameter>:VALue?	Queries automatically measured values of the power supply analysis parameter.	51

Command	Function	Page
PANalyze Group		
:PANalyze?	Enters all settings related to power supply analysis or queries the current settings.	51
:PANalyze:MATH<x>?	Enters all settings related to each computed waveform for power supply analysis or queries the current settings.	51
:PANalyze:MATH<x>:Mode	Sets active/reactive power of ecah computed waveform for power supply analysis or queries the current setting.	51
:PANalyze:PWR<x>?	Enters all settings related to power supply analysis input or queries the current settings.	51
:PANalyze:PWR<x>:DESKew?	Enters all settings related to power supply analysis skew correction or queries the current settings.	51
:PANalyze:PWR<x>:DESKew:AEXeute	Executes power supply analysis auto skew correction.	52
:PANalyze:PWR<x>:DESKew:RTRace	Sets the target trace for power supply analysis skew correction or queries the current setting.	52
:PANalyze:PWR<x>:DESKew:TIME<x>	Sets the power supply analysis skew correction or queries the current setting.	52
:PANalyze:PWR<x>:I?	Queries all settings related to power supply analysis current input channels.	52
:PANalyze:PWR<x>:I:PROBe	Sets the current-to-voltage conversion ratio of the probe on the current. input channel for power supply analysis or queries the current setting.	52
:PANalyze:PWR<x>:Mode	Sets active/reactive power supply analysis or queries the current setting.	52
:PANalyze:PWR<x>:U?	Queries all settings related to the power supply analysis voltage input channel.	52
:PANalyze:PWR<x>:U:PROBe	Sets the attenuation of the probe on the voltage input channel for Power Supply Analysis or queries the current setting.	52

ANALysis Group

:ANALysis:HARMonics<x>?

Function Queries all settings related to the harmonic computation function or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1? -> :ANALYSIS:
Harmonics 1:CCLASS:LAMBDA 800.0E-03;
MAXCURRENT 1.0000000E+00;
OPOWER TRUE;:ANALYSIS:Harmonics 1:
CLASS A;DCLASS:POWER 100.00000E+00;:
ANALYSIS:Harmonics 1:GROUPING OFF;
LIST:SCROLL VERTICAL;:ANALYSIS:
Harmonics 1:Mode LIST;SOURCE 2;
SPOINT -5.00E+00;
SVOLTAGE 230.00000E+00
```

:ANALysis:HARMonics<x>:CCLass?

Function Queries all settings related to harmonic computation class C.

Syntax
```
:ANALysis:HARMonics<x>:CCLass?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:CCLASS? ->
:ANALYSIS:Harmonics 1:CCLASS:
LAMBDA 800.0E-03;
MAXCURRENT 1.0000000E+00;OPOWER TRUE
```

:ANALysis:HARMonics<x>:CCLass:LAMBda

Function Sets the power factor for harmonic computation class C or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:CCLass:
LAMBda {<NRf>}
:ANALysis:HARMonics<x>:CCLass:LAMBda?
```
<x> = 1, 2
<NRf> = 0.001 to 1.0

Example
```
:ANALYSIS:Harmonics 1:CCLASS:
LAMBDA 0.10
:ANALYSIS:Harmonics 1:CCLASS:LAMBDA?
-> :ANALYSIS:Harmonics 1:CCLASS:
LAMBDA 100.0E-03
```

:ANALysis:HARMonics<x>:CCLass:MAXCurrent

Function Sets the fundamental current for harmonic computation class C or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:CCLass:
MAXCurrent {<NRf>|<current>}
:ANALysis:HARMonics<x>:CCLass:
MAXCurrent?
```
<x> = 1, 2
<NRf>, <current> = 0.001–100.000(A)

Example
```
:ANALYSIS:Harmonics 1:CCLASS:
MAXCURRENT 50A
:ANALYSIS:Harmonics 1:CCLASS:
MAXCURRENT? ->
:ANALYSIS:Harmonics 1:CCLASS:
MAXCURRENT 50.000E+00
```

:ANALysis:HARMonics<x>:CCLass:OPOWer

Function Sets whether or not active power of harmonic computation class C exceedes 25 W or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:CCLass:
OPOWer {FALSe|TRUE}
:ANALysis:HARMonics<x>:CCLass:OPOWer?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:CCLASS:
OPOWER FALSE
:ANALYSIS:Harmonics 1:CCLASS:OPOWER?
-> :ANALYSIS:Harmonics 1:CCLASS:
OPOWER FALSE
```

:ANALysis:HARMonics<x>:CLASs

Function Sets the applicable class of the harmonic computation target instrument or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:
CLASs {A|B|C|D}
:ANALysis:HARMonics<x>:CLASs?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:CLASS A
:ANALYSIS:Harmonics 1:CLASS? ->
:ANALYSIS:Harmonics 1:CLASS A
```

:ANALysis:HARMonics<x>:DCLass?

Function Queries all settings related to harmonic computation class D.

Syntax
```
:ANALysis:HARMonics<x>:DCLass?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:DCLASS?
-> :ANALYSIS:Harmonics 1:DCLASS:
POWER 100.00000E+00
```

:ANALysis:HARMonics<x>:DCLass:POWer

Function Sets the power value for harmonic computation class D or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:DCLass:
POWer {<NRf>}
:ANALysis:HARMonics<x>:DCLass:POWer?
```
<x> = 1, 2
<NRf> = –1.0000E+31 to 1.0000E+31

Example
```
:ANALYSIS:Harmonics 1:DCLASS:POWER 1
:ANALYSIS:Harmonics 1:DCLASS:POWER?
-> :ANALYSIS:Harmonics 1:DCLASS:
POWER 1.000E+00
```

:ANALysis:HARMonics<x>:GROuping

Function Sets the harmonic comptuation grouping or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:
GROuping {OFF|TYPE1|TYPE2}
:ANALysis:HARMonics<x>:GROuping?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:GROUPING OFF
:ANALYSIS:Harmonics 1:GROUPING?
-> :ANALYSIS:Harmonics 1:GROUPING OFF
```

:ANALysis:HARMonics<x>:LIST?

Function Queries all settings related to harmonic computation list display.

Syntax
```
:ANALysis:HARMonics<x>:LIST?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:LIST?
-> :ANALYSIS:Harmonics 1:LIST:
SCROLL VERTICAL
```

:ANALysis:HARMonics<x>:LIST:ITEM?

Function Queries the harmonic computation list display items.

Syntax
```
:ANALysis:HARMonics<x>:LIST:ITEM?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:LIST:ITEM?
-> :ANALYSIS:Harmonics 1:LIST:
ITEM "Order.,Measure(A),Limit(A),
Measure(%),Limit(%),Info,"
```

:ANALysis:HARMonics<x>:LIST:SCRoll

Function Sets the scroll direction for the harmonic computation list display or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:LIST:
SCRoll {HORizontal|VERTical}
:ANALysis:HARMonics<x>:LIST:SCRoll?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:LIST:
SCROLL HORIZONTAL
:ANALYSIS:Harmonics 1:LIST:SCROLL? ->
:ANALYSIS:Harmonics 1:LIST:
SCROLL HORIZONTAL
```

:ANALysis:HARMonics<x>:LIST:VALue?

Function Queries the computed values of harmonics and limits defined by the standard for each order.

Syntax
```
:ANALysis:HARMonics<x>:LIST:
VALue? {<NRf>}
```
<x> = 1, 2
<NRf> = 1 to 40 (harmonic order)

Example
```
:ANALYSIS:Harmonics 1:LIST:VALUE? 2
-> :ANALYSIS:Harmonics 1:LIST:
VALUE "  2, 0.031, 0.020, 3.149,
2.000,NG,"
```

:ANALysis:HARMonics<x>:Mode

Function Sets the harmonic comptuation display mode or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:
Mode {LINear|LIST|LOG}
:ANALysis:HARMonics<x>:Mode?
```
<x> = 1, 2

Example
```
:ANALYSIS:Harmonics 1:Mode LINEAR
:ANALYSIS:Harmonics 1:Mode?
-> :ANALYSIS:Harmonics 1:Mode LINEAR
```

:ANALysis:HARMonics<x>:SOURce

Function Sets the harmonic comptuation source or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:SOURce {<NRf>}
:ANALysis:HARMonics<x>:SOURce?
```
<x> = 1, 2
<NRf> = 2, 4

Example
```
:ANALYSIS:Harmonics 1:SOURCE 2
:ANALYSIS:Harmonics 1:SOURCE?
-> :ANALYSIS:Harmonics 1:SOURCE 2
```

:ANALysis:HARMonics<x>:SPOint

Function Sets the harmonic comptuation start point or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:SPOint {<NRf>}
:ANALysis:HARMonics<x>:SPOint?
```
<x> = 1, 2
<NRf> = –5 to 5(div)

Example
```
:ANALYSIS:Harmonics 1:SPOINT 1
:ANALYSIS:Harmonics 1:SPOINT?
-> :ANALYSIS:Harmonics 1:
SPOINT 1.000E+00
```

:ANALysis:HARMonics<x>:SVOLtage

Function Sets the harmonic comptuation supply voltage or queries the current setting.

Syntax
```
:ANALysis:HARMonics<x>:
SVOLtage {<NRf>|<voltage>}
:ANALysis:HARMonics<x>:SVOLtage?
```
<x> = 1, 2
<NRf>, <voltage> = 90–440(V)

Example
```
:ANALYSIS:Harmonics 1:SVOLTAGE 230
:ANALYSIS:Harmonics 1:SVOLTAGE? -> :
ANALYSIS:Harmonics 1:
SVOLTAGE 220.00000E+00
```

:ANALysis:TYPE<x>

Function Sets the analysis function type or queries the current setting.

Syntax
```
:ANALysis:TYPE<x> {AHIStogram|FFT|
HARMonics|SBUS|WPARameter|XY}
:ANALysis:TYPE<x>?
```
<x> = 1, 2

Example
```
:ANALYSIS:TYPE1 AHISTOGRAM
:ANALYSIS:TYPE1? -> :ANALYSIS:
TYPE1 AHISTOGRAM
```

:ANALysis:WPARameter<x>:TRACe<x>:AREA<x>:TYPE

Function Sets the waveform parameters to be measured or queries the current setting.

Syntax
```
:ANALysis:WPARameter<x>:TRACe<x>:
AREA<x>:TYPE {<parameter>}
:ANALysis:WPARameter<x>:TRACe<x>:
AREA<x>:TYPE?
```
WPARameter<x>: <x> = 1, 2
TRACe<x>: <x> = 1 to 4
AREA<x>: <x> = 1, 2
<parameter> = {AH|AHABs|AHN|AHP|I2T|IAC|IDC|IMN|INPeak|IPPeak|IPTopeak|IRMN|IRMS|LAMBda|P|Q|S|UAC|UDC|UMN|UNPeak|UPPeak|UPTopeak|URMN|URMS|WH|WHABs|WHN|WHP|Z}

Example
```
:ANALYSIS:WPARAMETER1:TRACE1:AREA1:
TYPE UDC
:ANALYSIS:WPARAMETER1:TRACE1:AREA1:
TYPE? -> :ANALYSIS:WPARAMETER1:
TRACE1:AREA1:TYPE UDC
```

Explanation
- For the correspondence between communication commands and the unit used, see appendix 4.
- The power supply analysis parameters vary depending on the trace. See appendix 4.

FILE Group

:FILE:SAVE:HARMonics:ABORt

Function Aborts the saving of the computed results of harmonics.

Syntax
```
:FILE:SAVE:HARMonics:ABORt
```

Example
```
:FILE:SAVE:HARMonics:ABORT
```

:FILE:SAVE:HARMonics[:EXECute]

Function Executes saving of results of harmonic computation. This is an overlapable command.

Syntax
```
:FILE:SAVE:HARMonics
[:EXECute] {<string>}
```
<string> = 259 chars or less

Example
```
:FILE:SAVE:HARMonics:EXECUTE
:FILE:SAVE:HARMonics:
EXECUTE "\Flash Mem\DIR\DATA"
(absolute path specification)
:FILE:SAVE:HARMonics:EXECUTE "DATA"
(relative path specification)
```

Explanation
- If a path is not specified, it is saved under the file name specified using `:FILE:SAVE:NAME`.
- If a path is specified the automatic file name creation function does not execute.
- For details about the <string>, see the explanation for `FILE[:DIRectory]:CDIRectory`.

:FILE:SAVE:HARMonics:ANALysis

Function Sets the analysis trace to which to save the harmonic computation results or queries the current setting.

Syntax
```
FILE:SAVE:HARMonics:ANALysis {<NRf>}
FILE:SAVE:HARMonics:ANALysis?
```
<NRf> = 1, 2

Example
```
:FILE:SAVE:HARMonics:ANALYSIS 1
:FILE:SAVE:HARMonics:ANALYSIS?
-> :FILE:SAVE:HARMonics:ANALYSIS 1
```

GONogo Group

:GONogo:ZPARameter:SELect<x>:PARameter:MEASure:TRACe<x>:AREA<x>:TYPE:<parameter>

Function Sets the upper and lower limits of the power supply analysis parameter of measure judgement or queries the current setting.

Syntax
```
:GONogo:ZPARameter:SELect<x>:
PARameter:MEASure:TRACe<x>:
AREA<x>:TYPE:<parameter>
{<NRf>,<NRf>|<voltage>,
<voltage>|<current>,<current>}
:GONogo:ZPARameter:SELect<x>:
PARameter:MEASure:TRACe<x>:AREA<x>:
TYPE:<parameter>?
```
SELect<x>: <x> = 1 to 4
TRACe<x>: <x> = 1 to 4
AREA<x>: <x> = 1, 2
<parameter> = {AH|AHABs|AHN|AHP|I2T|IAC|IDC|IMN|INPeak|IPPeak|IPTopeak|IRMN|IRMS|LAMBda|P|Q|S|UAC|UDC|UMN|UNPeak|UPPeak|UPTopeak|URMN|URMS|WH|WHABs|WHN|WHP|Z}

Example
```
:GONOGO:ZPARAMETER:SELECT1:PARAMETER:
MEASURE:TRACE1:AREA1:TYPE:UDC 1,2
:GONOGO:ZPARAMETER:SELECT1:PARAMETER:
MEASURE:TRACE1:AREA1:TYPE:UDC?
-> :GONOGO:ZPARAMETER:SELECT1:
PARAMETER:MEASURE:TRACE1:AREA1:TYPE:
UDC 2.000E+00,1.000E+00
```

Explanation
- For the correspondence between communication commands and the unit used, see appendix 4.
- The power supply analysis parameters vary depending on the trace. See appendix 4.
- The power supply analysis parameters below can be substituted using standard waveform parameters.

```
UPTopeak, IPTopeak = PTOPeak
UPPeak, IPPeak = MAXimum
UNPeak, INPeak = MINimum
UDC, IDC = CMEan
URMS, IRMS = CRMS
UAC, IAC = CSDeviation
```

HISTory Group

:HISTory[:CURRent][:SEARch]:SELect<x>:PARameter:MEASure:TRACe<x>:AREA<x>:TYPE:<parameter>

Function Sets the upper and lower limits of the power supply analysis parameter of measure search or queries the current setting.

Syntax
```
:HISTory[:CURRent][:SEARch]:
SELect<x>:PARameter:MEASure:TRACe<x>:
AREA<x>:TYPE:
<parameter> {(<NRf>,<NRf>)|
(<voltage>,<voltage>)|
(<current>,<current>)}
:HISTory[:CURRent][:SEARch]:
SELect<x>:PARameter:MEASure:TRACe<x>:
AREA<x>:TYPE:<parameter>?
```
SELect<x>: <x> = 1 to 4
TRACe<x>: <x> = 1 to 4
AREA<x>: <x> = 1, 2
<parameter> = {AH|AHABs|AHN|AHP|I2T|IAC|IDC|IMN|INPeak|IPPeak|IPTopeak|IRMN|IRMS|LAMBda|P|Q|S|UAC|UDC|UMN|UNPeak|UPPeak|UPTopeak|URMN|URMS|WH|WHABs|WHN|WHP|Z}

Example
```
:HISTORY:CURRENT:SEARCH:SELECT1:
PARAMETER:MEASURE:TRACE1:AREA1:TYPE:
UDC 0,1
:HISTORY:CURRENT:SEARCH:SELECT1:
PARAMETER:MEASURE:TRACE1:AREA1:TYPE:
UDC? -> :HISTORY:CURRENT:SEARCH:
SELECT1:PARAMETER:MEASURE:TRACE1:
AREA1:TYPE:UDC 1.000E+00,0.000E+00
```

Explanation
- For the correspondence between communication commands and the parameters used, see appendix 4.
- The power supply analysis parameters vary depending on the trace. See appendix 4.
- The power supply analysis parameters below can be substituted using standard waveform parameters.

```
UPTopeak, IPTopeak = PTOPeak
UPPeak, IPPeak = MAXimum
UNPeak, INPeak = MINimum
UDC, IDC = CMEan
URMS, IRMS = CRMS
UAC, IAC = CSDeviation
```

MATH Group

:MATH<x>:I2T:ARANging

Function Executes auto ranging of the Joule-integral computation.

Syntax `:MATH<x>:I2T:ARANging`
<x> = 1 to 4

Example `:MATH1:I2T:ARANGING`

:MATH<x>:I2T:HISTory:ABORt

Function Cancels history computation for Joule integral computation.

Syntax `:MATH<x>:I2T:HISTory:ABORt`
<x> = 1 to 4

Example `:MATH1:I2T:HISTORY:ABORT`

:MATH<x>:I2T:HISTory:EXECute

Function Executes history computation for Joule integral computation.

Syntax `:MATH<x>:I2T:HISTory:EXECute`
<x> = 1 to 4

Example `:MATH1:I2T:HISTORY:EXECUTE`

:MATH<x>:I2T:UNIT?

Function Queries all settings related to the units of Joule integral computation or queries the current setting.

Syntax `:MATH<x>:I2T:UNIT?`
<x> = 1 to 4

Example
```
:MATH1:I2T:UNIT? ->
:MATH1:I2T:UNIT:DEFINE "EU"
```

:MATH<x>:I2T:UNIT[:DEFine]

Function Sets the units of Joule integral computation or queries the current setting.

Syntax
```
:MATH<x>:I2T:UNIT[:DEFine] {<string>}
:MATH<x>:I2T:UNIT[:DEFine]?
```
<x> = 1 to 4
<string>= 4 characters or fewer

Example
```
:MATH1:I2T:UNIT:DEFINE "EU"
:MATH1:I2T:UNIT:DEFINE? ->
:MATH1:I2T:UNIT:DEFINE "EU"
```

:MATH<x>:OPERation

Function Sets the power supply analysis operator or queries the current setting.

Syntax
```
:MATH<x>:OPERation {(I2T|POWer|USERdefine|Z),<NRf>,<NRf>}
:MATH<x>:OPERation?
```
<x> = 1 to 4
<NRf> = 1 to 4

Example
```
:MATH1:OPERATION FILTER,1
:MATH1:OPERATION?
-> :MATH1:OPERATION FILTER,1
```

Explanation
- For unary operators(I^2T), select the target wvaeform using the first <NRf>.
- For binary operators (`POWer|Z`), select the target waveform of the first term using the first <NRf> and the target waveform of the second term using the second <NRf>.
- For the USERdefine operator, <NRf> is not requred.

:MATH<x>:Z:ARANging

Function Executes auto ranging of the impedance computation.

Syntax `:MATH<x>:Z:ARANging`
<x> = 1 to 4

Example `:MATH1:Z:ARANGING`

:MATH<x>:Z:HISTory:ABORt

Function Cancels history computation for impedance computation.

Syntax `:MATH<x>:Z:HISTory:ABORt`
<x> = 1 to 4

Example `:MATH1:Z:HISTORY:ABORT`

:MATH<x>:Z:HISTory:EXECute

Function Executes history computation for impedance computation.

Syntax `:MATH<x>:Z:HISTory:EXECute`
<x> = 1 to 4

Example `:MATH1:Z:HISTORY:EXECUTE`

MEASure Group

:MEASure:TRACe<x>:AREA<x>:CMODe

Function Turns ON/OFF the cycle mode or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:CMODe {<Boolean>}
:MEASure:TRACe<x>:AREA<x>:CMODe?
```
<x> of TRACe<x> = 1 to 4
<x> of AREA<x> = 1, 2

Example
```
:MEASURE:TRACE1:AREA1:CMODE ON
:MEASURE:TRACE1:AREA1:CMODE? -> :MEASURE:TRACE1:AREA1:CMODE 1
```

Explanation The measurement ranges of some power supply analysis parameters change depending on whether the cycle mode is ON/OFF. The applicable parameters vary depending on the trace. For trace 1 or 3, the measurement ranges of parameters Wp, Wp+, Wp-, and Abs.Wp change. For trace 2 or 4, the measurement ranges of parameters q, q+, q-, and Abs.q change.

:MEASure:TRACe<x>:AREA<x>:<parameter>:COUNt?

Function Queries the count for continuous statistical processing of power supply analysis parameters.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:<parameter>:COUNt?
```
TRACe<x>: <x> = 1 to 4
AREA<x>: <x> = 1, 2
<parameter>={AH|AHABs|AHN|AHP|I2T|IAC|IDC|IMN|INPeak|IPPeak|IPTopeak|IRMN|IRMS|LAMBda|P|Q|S|UAC|UDC|UMN|UNPeak|UPPeak|UPTopeak|URMN|URMS|WH|WHABs|WHN|WHP|Z}

Example
```
:MEASURE:TRACE1:AREA1:UDC:COUNT? -> :MEASURE:TRACE1:AREA1:UDC:COUNT 0
```

Explanation
- For the correspondence between communication commands and the unit used, see appendix 4.
- The power supply analysis parameters vary depending on the trace. See appendix 4.
- The power supply analysis parameters below can be substituted using standard waveform parameters.

```
UPTopeak, IPTopeak = PTOPeak
UPPeak, IPPeak = MAXimum
UNPeak, INPeak = MINimum
UDC, IDC = CMEan
URMS, IRMS = CRMS
UAC, IAC = CSDeviation
```

:MEASure:TRACe<x>:AREA<x>:<parameter>:{MAXimum|MEAN|MINimum|SDEViation}?

Function Queries the statistical value of the power supply analysis parameter.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:<parameter>:{MAXimum|MEAN|MINimum|SDEViation}?
```
TRACe<x>: <x> = 1 to 4
AREA<x>: <x> = 1, 2
<parameter> = {AH|AHABs|AHN|AHP|I2T|IAC|IDC|IMN|INPeak|IPPeak|IPTopeak|IRMN|IRMS|LAMBda|P|Q|S|UAC|UDC|UMN|UNPeak|UPPeak|UPTopeak|URMN|URMS|WH|WHABs|WHN|WHP|Z}

Example
```
:MEASURE:TRACE1:AREA1:UDC:MAXIMUM? -> :MEASURE:TRACE1:AREA1:UDC:MAXIMUM 1.000E+00
```

Explanation
- For the correspondence between communication commands and the unit used, see appendix 4.
- The power supply analysis parameters vary depending on the trace. See appendix 4.
- The power supply analysis parameters below can be substituted using standard waveform parameters.

```
UPTopeak, IPTopeak = PTOPeak
UPPeak, IPPeak = MAXimum
UNPeak, INPeak = MINimum
UDC, IDC = CMEan
URMS, IRMS = CRMS
UAC, IAC = CSDeviation
```

:MEASure:TRACe<x>:AREA<x>:<parameter>:STATe

Function Turns ON/OFF the power supply analysis parameter or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:<parameter>:STATe {<Boolean>}
:MEASure:TRACe<x>:AREA<x>:<parameter>:STATe?
```
TRACe<x>: <x> = 1 to 4
AREA<x>: <x> = 1, 2
<parameter> = {AH|AHABs|AHN|AHP|I2T|IAC|IDC|IMN|INPeak|IPPeak|IPTopeak|IRMN|IRMS|LAMBda|P|Q|S|UAC|UDC|UMN|UNPeak|UPPeak|UPTopeak|URMN|URMS|WH|WHABs|WHN|WHP|Z}

Example
```
:MEASURE:TRACE1:AREA1:UDC:STATE ON
:MEASURE:TRACE1:AREA1:UDC:STATE? -> :MEASURE:TRACE1:AREA1:UDC:STATE 1
```

Explanation
- For the correspondence between communication commands and the unit used, see appendix 4.
- The power supply analysis parameters vary depending on the trace. See appendix 4.
- The power supply analysis parameters below can be substituted using standard waveform parameters.

```
UPTopeak, IPTopeak = PTOPeak
UPPeak, IPPeak = MAXimum
UNPeak, INPeak = MINimum
UDC, IDC = CMEan
URMS, IRMS = CRMS
UAC, IAC = CSDeviation
```

:MEASure:TRACe<x>:AREA<x>:SWLoss?

Function Queries all settings related to the switching loss.

Syntax `:MEASure:TRACe<x>:AREA<x>:SWLoss?`
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS?
-> :MEASURE:TRACE1:AREA1:SWLOSS:
ILEVEL 2.000E+00,1.000E+00;SEARCH:
SELECT NAN;:MEASURE:TRACE1:AREA1:
SWLOSS:UIRLEVEL 10,90;
ULEVEL 2.000E+00,1.000E+00
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:ILEVel

Function Sets the current level of the switching loss or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:
ILEVel {<NRf>,<NRf>}
:MEASure:TRACe<x>:AREA<x>:SWLoss:
ILEVel?
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2
<NRf> = −4 to 4 (div)

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:
ILEVEL 1, 2
:MEASURE:TRACE1:AREA1:SWLOSS:ILEVEL?
-> :MEASURE:TRACE1:AREA1:SWLOSS:
ILEVEL 2.000E+00,1.000E+00
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:RJUMp:ABORt

Function Aborts the range jumping of the switching loss.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:
RJUMp:ABORt
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:RJUMP:
ABORT
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:RJUMp:EXECute

Function Executes the range jumping of the switching loss. This is an overlap command.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:
RJUMp:EXECute
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:RJUMP:
EXECUTE
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch?

Function Queries all settings related to the switching loss search function.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:
SEARch?
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:SEARCH?
-> :MEASURE:TRACE1:AREA1:SWLOSS:
SEARCH:SELECT NAN
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:ABORt

Function Aborts the switching loss search.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:
SEARch:ABORt
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:SEARCH:
ABORT
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:EXECute

Function Executes the switching loss search. This is an overlap command.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:
SEARch:EXECute
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:SEARCH:
EXECUTE
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:MARK

Function Turns ON/OFF the switching loss search marks or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:MARK {<Boolean>}
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:MARK?
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:SEARCH:MARK ON
:MEASURE:TRACE1:AREA1:SWLOSS:SEARCH:MARK?
-> :MEASURE:TRACE1:AREA1:SWLOSS:SEARCH:MARK 1
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:SELect

Function Sets the search number of the switching loss search function and queries the position corresponding to the search number.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:SELect {<NRf>|MAXimum}
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:SELect?
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2
<NRf> = 0 to 4999

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:SEARCH:SELECT 1
:MEASURE:TRACE1:AREA1:SWLOSS:SEARCH:SELECT?
-> :MEASURE:TRACE1:AREA1:SWLOSS:SEARCH:SELECT 1.500E+00
```

Description If there is no searched position, “NAN” is returned for the query.

:MEASure:TRACe<x>:AREA<x>:SWLoss:UIRLevel

Function Sets the range level of the switching loss in percentage or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:UIRLevel {<NRf>,<NRf>}
:MEASure:TRACe<x>:AREA<x>:SWLoss:UIRLevel?
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2
<NRf> = 0 to 100(%)

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:UIRLEVEL 10,90
:MEASURE:TRACE1:AREA1:SWLOSS:UIRLEVEL?
-> :MEASURE:TRACE1:AREA1:SWLOSS:UIRLEVEL 10,90
```

:MEASure:TRACe<x>:AREA<x>:SWLoss:ULEVel

Function Sets the voltage level of the switching loss or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:SWLoss:ULEVel {<NRf>,<NRf>}
:MEASure:TRACe<x>:AREA<x>:SWLoss:ULEVel?
```
<x> of TRACe<x> = 1, 3
<x> of AREA<x> = 1, 2
<NRf> = −4 to 4 (div)

Example
```
:MEASURE:TRACE1:AREA1:SWLOSS:ULEVEL 1, 2
:MEASURE:TRACE1:AREA1:SWLOSS:ULEVEL?
-> :MEASURE:TRACE1:AREA1:SWLOSS:ULEVEL 2.000E+00,1.000E+00
```

:MEASure:TRACe<x>:AREA<x>:<parameter>:VALue?

Function Queries the automatically measured value of the power supply analysis parameter.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:
<parameter>:VALue? {<NRf>}
```
TRACe<x>: <x> = 1 to 4
AREA<x>: <x> = 1, 2
<parameter> = {AH|AHABs|AHN|AHP|I2T|IAC|IDC|IMN|INPeak|IPPeak|IPTopeak|IRMN|IRMS|LAMBda|P|Q|S|UAC|UDC|UMN|UNPeak|UPPeak|UPTopeak|URMN|URMS|WH|WHABs|WHN|WHP|Z}
<NRf>=1 to 100000

Example
```
:MEASURE:TRACE1:AREA1:UDC:VALUE?
-> :MEASURE:TRACE1:AREA1:UDC:
VALUE 1.000E+00
```

Explanation
- For the correspondence between communication commands and the unit used, see appendix 4.
- The power supply analysis parameters vary depending on the trace. See appendix 4.
- If measurement cannot be performed, NAN (Not A Number) is returned.
- For <NRf>, specify the <NRf>'th past automatically measured value.
  For cycle statistics, specify the <NRf>'th cycle from the left of the screen.
  To specify the oldest automatically measured value, set 1.
  If <NRf> is ommitted, the most recent measured value is specified. If the value corresponding to the relevant count is not present, NAN (Not A Number) is returned.
- The power supply analysis parameters below can be substituted using standard waveform parameters.
  ```
  UPTopeak, IPTopeak = PTOPeak
  UPPeak, IPPeak = MAXimum
  UNPeak, INPeak = MINimum
  UDC, IDC = CMEan
  URMS, IRMS = CRMS
  UAC, IAC = CSDeviation
  ```

PANalyze Group

:PANalyze?

Function Queries all settings related to the harmonic analysis or queries the current setting.

Syntax
```
:PANalyze?
```

Example
```
:PANALYZE? -> :PANALYZE:MATH1:
Mode 0;:PANALYZE:MATH2:Mode 0;:
PANALYZE:MATH3:Mode 0;:PANALYZE:
MATH4:Mode 0;:PANALYZE:PWR1:DESKEW:
RTRACE 1;TIME1 0.000E+00;
TIME2 0.000E+00;:PANALYZE:PWR1:I:
PROBE C1;:PANALYZE:PWR1:Mode 0;U:
PROBE 1;:PANALYZE:PWR2:DESKEW:
RTRACE 3;TIME1 0.000E+00;
TIME2 0.000E+00;:PANALYZE:PWR2:I:
PROBE C1;:PANALYZE:PWR2:Mode 0;U:
PROBE 1
```

:PANalyze:MATH<x>?

Function Queries all settings related to each computed waveform of harmonic analysis or queries the current setting.

Syntax
```
:PANalyze:MATH<x>?
```
<x> = 1 to 4

Example
```
:PANALYZE:MATH1? -> :PANALYZE:MATH1:
Mode 1
```

:PANalyze:MATH<x>:Mode

Function Sets active/reactive for each computed waveform of harmonic analysis or queries the current setting.

Syntax
```
:PANalyze:MATH<x>:Mode {<Boolean>}
:PANalyze:MATH<x>:Mode?
```
<x> = 1 to 4

Example
```
:PANALYZE:MATH1:Mode ON
:PANALYZE:MATH1:Mode? -> :PANALYZE:
MATH1:Mode 1
```

:PANalyze:PWR<x>?

Function Queries all settings related to the input of harmonic analysis or queries the current setting.

Syntax
```
:PANalyze:PWR<x>?
```
<x> = 1, 2

Example
```
:PANALYZE:PWR1? -> :PANALYZE:PWR1:
DESKEW:RTRACE 1;TIME1 1.000E-09;
TIME2 1.000E-09;:PANALYZE:PWR1:I:
PROBE C1;:PANALYZE:PWR1:Mode 1;U:
PROBE 1
```

:PANalyze:PWR<x>:DESKew?

Function Queries all settings related to the skew of harmonic analysis or queries the current setting.

Syntax
```
:PANalyze:PWR<x>:DESKew?
```
<x> = 1, 2

Example
```
:PANALYZE:PWR1:DESKEW?
-> :PANALYZE:PWR1:DESKEW:RTRACE 1;
TIME1 0.000E+00;TIME2 0.000E+00
```

:PANalyze:PWR<x>:DESKew:AEXeute

Function Executes power supply analysis auto skew correction.

Syntax `:PANalyze:PWR<x>:DESKew:AEXeute`
<x> = 1, 2

Example `:PANALYZE:PWR1:DESKEW:AEXEUTE`

:PANalyze:PWR<x>:DESKew:RTRace

Function Sets the target trace for power supply analysis skew correction or queries the current setting.

Syntax `:PANalyze:PWR<x>:DESKew:RTRace {<NRf>}`
`:PANalyze:PWR<x>:DESKew:RTRace?`
<x> = 1, 2
<NRf> = 1 to 4

Example `:PANALYZE:PWR1:DESKEW:RTRACE 1`
`:PANALYZE:PWR1:DESKEW:RTRACE?`
`-> :PANALYZE:PWR1:DESKEW:RTRACE 1`

:PANalyze:PWR<x>:DESKew:TIME<x>

Function Sets the power supply analysis skew correction or queries the current setting.

Syntax `:PANalyze:PWR<x>:DESKew:TIME<x> {<time>}`
`:PANalyze:PWR<x>:DESKew:TIME<x>?`
PWR<x>: <x> = 1, 2
TIME<x>: <x> = 1, 2
<time> = –80ns to 80ns (10ps steps)

Example `:PANALYZE:PWR1:DESKEW:TIME1 1NS`
`:PANALYZE:PWR1:DESKEW:TIME1? ->`
`:PANALYZE:PWR1:DESKEW:TIME1 1.000E-09`

:PANalyze:PWR<x>:I?

Function Queries all settings related to the current input channel of harmonic analysis or queries the current setting.

Syntax `:PANalyze:PWR<x>:I?`
<x> = 1, 2

Example `:PANALYZE:PWR1:I? ->`
`:PANALYZE:PWR1:I:PROBE C1`

:PANalyze:PWR<x>:I:PROBe

Function Sets the current-to-voltage conversion ratio of the current input channel of the power supply analysis or queries the current setting.

Syntax `:PANalyze:PWR<x>:I:PROBe {C1|C10|C100}`
`:PANalyze:PWR<x>:I:PROBe?`
<x> = 1, 2

Example `:PANALYZE:PWR1:I:PROBE C1`
`:PANALYZE:PWR1:I:PROBE? ->`
`:PANALYZE:PWR1:I:PROBE C1`

:PANalyze:PWR<x>:Mode

Function Sets the power supply analysis active/reactive or queries the current setting.

Syntax `:PANalyze:PWR<x>:Mode {<Boolean>}`
`:PANalyze:PWR<x>:Mode?`
<x> = 1, 2

Example `:PANALYZE:PWR1:Mode ON`
`:PANALYZE:PWR1:Mode? ->`
`:PANALYZE:PWR1:Mode 1`

:PANalyze:PWR<x>:U?

Function Queries all settings related to the voltage input channel of harmonic analysis or queries the current setting.

Syntax `:PANalyze:PWR<x>:U?`
<x> = 1, 2

Example `:PANALYZE:PWR1:U? ->`
`:PANALYZE:PWR1:U:PROBE 1`

:PANalyze:PWR<x>:U:PROBe

Function Sets the probe attenuation of the voltage input channel of the power supply analysis or queries the current setting.

Syntax `:PANalyze:PWR<x>:U:PROBe {<NRf>}`
`:PANalyze:PWR<x>:U:PROBe?`
<x> = 1, 2
<NRf> = 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000

Example `:PANALYZE:PWR1:U:PROBE 1`
`:PANALYZE:PWR1:U:PROBE? ->`
`:PANALYZE:PWR1:U:PROBE 1`

14 Specifications

Function	Specifications
Correction of the difference in the transfer time (Deskew)	Corrects (deskews) the difference in the transfer time of voltage and current signals automatically or manually The correction range is ±80 ns (0.01 ns resolution)
Automated measurement of power supply analysis parameters	As with the standard measurement parameters (waveform parameters), performs automated measurement of power supply analysis parameters (see page 4)/Switching loss
Statistical processing on the measured values	As with the standard measurement parameters, performs statistical processing on the measured values of power supply analysis parameters.
Waveform computation on power supply analysis	As with the standard waveform computation, performs waveform computation of such items as instantaneous power, impedance, Joule parameters, integral, power spectrum, and harmonics. Harmonic analysis allows for easy comparisons with the following limit values: • The harmonic current emissions "IEC 61000-3-2 (Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current [less than or equal to] 16 A per phase)) Edition 2:2. • EN6100-3-2 (2000) • IEC 61000-4-7 Edition 2.
Trend display	Displays the trend of the change in the measured values of waveform parameters per cycle over time
History search	As with the standard measurement parameters, performs history search using power supply analysis parameters
GO/NO-GO determination	As with the standard measurement parameters, performs GO/NO-GO determination using power supply analysis parameters
Saving of the computed	Saves the computed result of harmonics to a file in CSV formatresults of harmonics

Appendix 1 Setup Parameters That Are Changed during the Execution of Auto Deskew

The settings of the following parameters are changed when auto deskew is executed.

Panel Key and Knob	Soft Key	Setting
CH1–CH4		
	Display	ON
	Select	INPUT
	Coupling	DC
	Offset	0 V
SCALE: Vertical axis		
	Voltage CH	1 V/ div (or 2 V/div for probe 1000:1)
	Current CH	20 mA/div (or execution error for probe 100 A:1 V)
POSITION		
	Voltage CH	–3 div
	Current CH	2 div
M1–M4		
	Display	OFF
ACQ		
	Mode	Normal
	Record Len	12.5 k
	Interpolation	OFF
	Repetitive	ON
	Interleave	OFF
T/DIV: Horizontal axis		
	20 ns/div	
Trigger related		
	Mode	Normal
	Type	Edge
	Position	50%
	Delay	OFF
	Hold off	20 ns
	Source	Ref Trace
	The following are settings for trigger source CH	
	Level	3 V (when the voltage CH is the trigger source)
		–40 mA (when the current CH is the trigger source)
	Polarity	Fall
	Coupling	DC
	HF Rej	OFF
	Hys	Small
	Window	OFF
FORM: Display		
	VT Form	Single

Appendix 2 Record Length and T/div Settings That Allow Waveform Computation of Harmonics

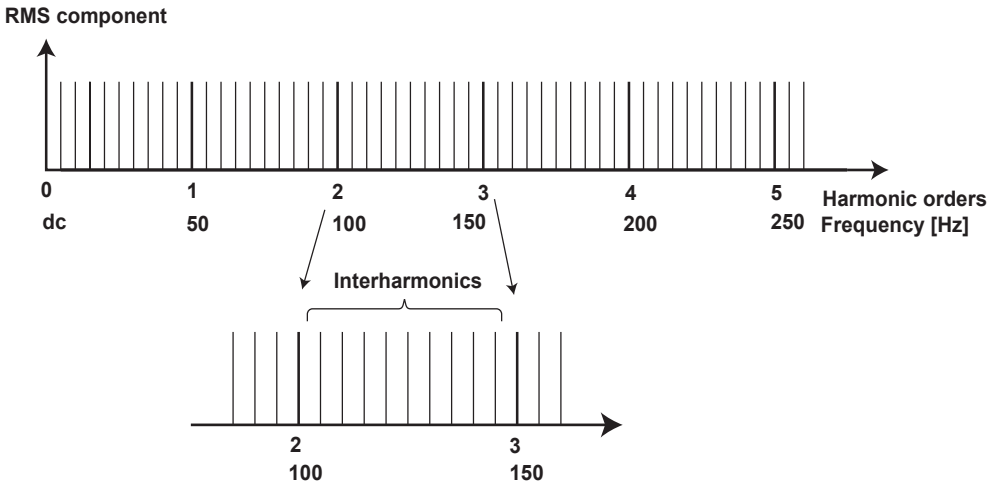
The record lengths and T/div settings that allow waveform computation of harmonics are as follows.

	12.5 k	25 k	62.5 k	125 k	250 k	625 k	1.25 M	2.5 M	6.25 M
20 ms/div	Y	Y	Y	Y	Y	Y	Y	Y	Y
50 ms/div	N	Y	Y	Y	Y	Y	Y	Y	Y
100 ms/div	N	N	Y	Y	Y	Y	Y	Y	Y
200 ms/div	N	N	N	Y	Y	Y	Y	Y	Y
500 ms/div	N	N	N	N	Y	Y	Y	Y	Y
1 s/div	N	N	N	N	N	Y	Y	Y	Y
2 s/div	N	N	N	N	N	N	Y	Y	Y
5 s/div	N	N	N	N	N	N	N	Y	Y
10 s/div	N	N	N	N	N	N	N	N	Y

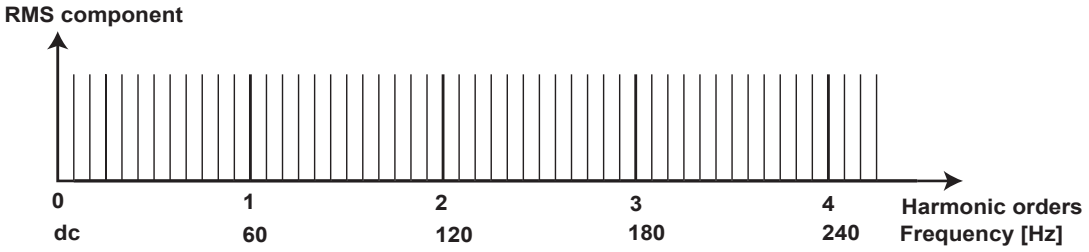
Appendix 3 Interharmonics and Groups

Interharmonics

If the input signal is 50 Hz, ten periods of the waveform are divided in 5-Hz resolution. Thus, the section between each harmonic order is divided into ten sections. The components between each harmonic order are called interharmonics.

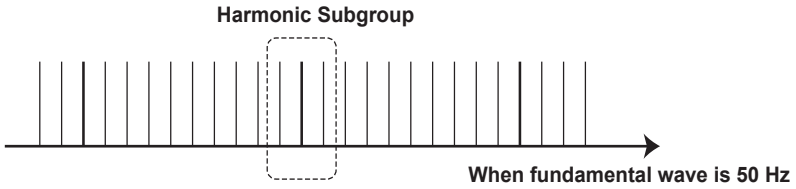


If the input signal is 60 Hz, twelve periods of the waveform are divided in 5-Hz resolution. Thus, the section between each harmonic order is divided into twelve sections.



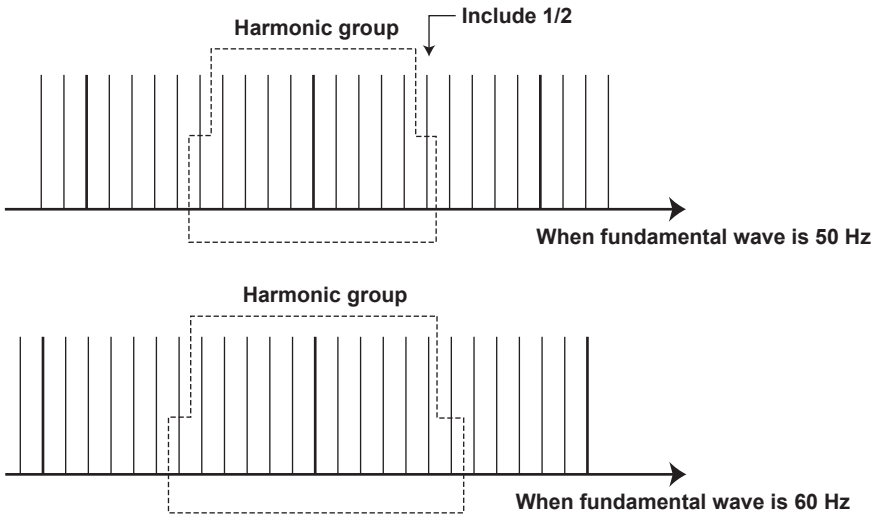
Harmonic Subgroup

A harmonic and its two directly adjacent interharmonics are collectively called a *harmonic subgroup*. The computing method to combine the harmonic and its two adjacent interharmonics is not simple addition, but the square root of the sum of the square of each component.



Harmonic Groups

A harmonic and its two directly adjacent interharmonics are collectively called a *harmonic subgroup*. The computing method to combine the components is the average of the sum of the squares as with the harmonic subgroup. A half of the amplitude is included for the interharmonic that is in the middle of two orders.



Grouping of Harmonics in IEC Harmonic Measurement

There are three types of grouping of harmonics in IEC harmonic measurement. The method to calculate the amplitude of the rms value of the harmonics varies depending on the grouping method.

No Grouping (OFF)

Only the components of the integer multiples of the fundamental wave are considered harmonics. Therefore, interharmonic components are not included.

Grouping Type 1

The harmonic subgroup is considered a component of the corresponding order. Therefore, harmonics take on a larger value when harmonic subgroups are included in the input signal as compared to when grouping is turned OFF.

$$\sqrt{\sum_{i=-1}^{1} I(k+i)^2}$$

Grouping Type 2

The harmonic group is considered a component of the corresponding order. Therefore, harmonics take on a larger value when harmonic groups are included in the input signal as compared to when grouping is turned OFF.

When frequency of item under test is 50 Hz

$$\sqrt{\frac{I(k-5)^2}{2} + \sum_{i=-4}^{4} I(k+i)^2 + \frac{I(k+5)^2}{2}}$$

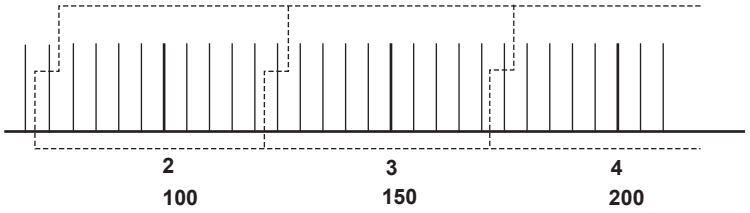
When frequency of item under test is 60 Hz

$$\sqrt{\frac{I(k-6)^2}{2} + \sum_{i=-5}^{5} I(k+i)^2 + \frac{I(k+6)^2}{2}}$$

Example of Grouping Type 2

For example, the 3rd order (150-Hz) harmonic component of the 50-Hz input signal is determined by averaging the sum of the squares of the following frequency components.

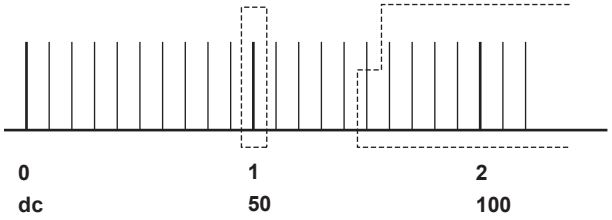
- 1/2 of the 125-Hz component — The other 1/2 is included in the 2nd order (100-Hz) component.
- 130-Hz component
- 135-Hz component
- 140-Hz component
- 145-Hz component
- 150-Hz component — 3rd order harmonic
- 155-Hz component
- 160-Hz component
- 165-Hz component
- 170-Hz component
- 1/2 of the 175-Hz component — The other 1/2 is included in the 4th order (200-Hz) component.



The component of each order between the 2nd and 40th order is determined as shown above. The computation of the 1st order (fundamental) component differs from the method shown above.

1st Order (Fundamental) Component

When measuring and computing the 1st order (fundamental) component, interharmonics are not included regardless of the grouping setting.



In other words, components such as 40 Hz, 45 Hz, 55 Hz, and 60 Hz are not included in the 1st order (fundamental) component. However, the interharmonic components are included in the 1st order (fundamental) component according to the grouping setting when computing the harmonic distortion.

Appendix 4 Table of Power Supply Analysis Parameter Names

When the Waveform under Test is CH1 or CH3

Name displayed in setting menus on the main unit screen	Name used in communication commands	Name when displaying measured results on the main unit screen
U+pk	UPPeak	U+pk
U-pk	UNPeak	U-pk
Up-p	UPPeak	Up-p
Urms	URMS	Urms
Udc	UDC	Udc
Uac	UAC	Uac
Umn	UMN	Umn
Urmn	URMN	Urmn
S	S	S
P	P	P
Q	Q	Q
Z	Z	Z
λ	LAMBda	λ
Wp	WH	Wp
Wp+	WHP	Wp+
Wp-	WHN	Wp-
Abs.Wp	WHABs	Abs.Wp

When the Waveform under Test is CH2 or CH4

Name displayed in setting menus on the main unit screen	Name used in communication commands	Name when displaying measured results on the main unit screen
I+pk	IPPeak	I+pk
I-pk	INPeak	I-pk
Ip-p	IPPeak	Ip-p
Irms	IRMS	Irms
Idc	IDC	Idc
Iac	IAC	Iac
Imn	IMN	Imn
Irmn	IRMN	Irmn
q	AH	q
q+	AHP	q+
q-	AHN	q-
Abs.q	AHABs	Abs.q
I^2t	I2T	I^2t

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