User's Manual

DL6000/DLM6000 Series Digital Oscilloscope/ Mixed Signal Oscilloscope Power Supply Analysis Function (/G4 Option)

YOKOGAWA
Yokogawa Electric Corporation

IM DLM6054-61EN
1st Edition

Foreword

Thank you for purchasing a YOKOGAWA Digital Oscilloscope with the Power Supply Analysis Function (/G4 option). This user's manual describes the power supply analysis function.

Manual Title	Manual No.	Description
DL6000/DLM6000 Series Digital Oscilloscope/ Mixed Signal Oscilloscope User's Manual	IM DLM6054-01EN	Explains all functions and procedures of the DL6000/DLM6000 Series excluding the communication functions.
DL6000/DLM6000 Series Digital Oscilloscope/ Mixed Signal Oscilloscope Communication Interface User's Manual (in CD)	IM DLM6054-17EN	Explains the communication interface functions of the DL6000/DLM6000 Series.
DL6000/DLM6000 Series Digital Oscilloscope/ Mixed Signal Oscilloscope Serial Bus Signal Triggering and Analysis Function User's Manual	IM DLM6054-51EN	Explains the optional I2C bus signal, CAN bus signal, LIN bus signal, SPI bus signal, and UART bus signal triggering and analysis features and how to use them.

Notes

- You can check the firmware version of your DL6000/DLM6000 on the overview screen. For instructions on how to open the overview screen, see section 17.4 in the *User's Manual IMDLM6054-01EN* . For instructions on how to update the firmware and for information about firmware versions, see the following Webpages.
  http://www.yokogawa.com/tm/DLM6000/
- 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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1st Edition: October 2009 (YK)

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Revisions

- 1st Edition: October 2009

Symbols and Notations 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 Carry out the procedure according to the step numbers. All procedures are written with inexperienced users in mind; experienced users may not need to carry out all the steps.

Explanation This section describes the setup items and the limitations regarding the procedures.

Notation of User Controls

Panel/Soft Key Names and Menu Items Set in Boldface

Boldface type indicates the names of user-controlled panel keys, and soft key items and menu items displayed on screen.

SHIFT+Panel Key

The SHIFT+Panel key means you will press the SHIFT key to turn ON the indicator of SHIFT key and then press the panel key. The menu marked in purple above the pressed key appears on the screen.

Jog shuttle and SET

Jog shuttle and SET key indicates selecting or setting parameters and entering values using the jog shuttle, the SET key, and other keys. For details on the procedure, see section 4.1 and 4.2 in the *User's Manual IMDLM6054-01EN*.

Unit

k: Denotes "1000."	Example: 100 kS/s (sample rate)
K: Denotes "1024."	Example: 720 KB (file data size)

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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 DL6000/DLM6000 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 DL6000/DLM6000 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, 701921, or 701926
Current probe	Model 701928, 701929, 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 DL6000/DLM6000 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

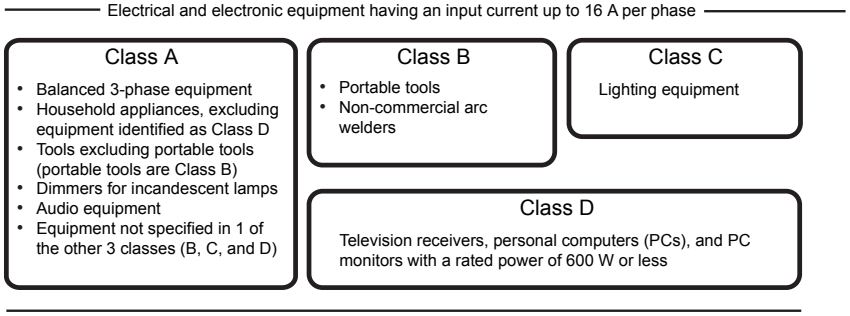
Statistical Processing

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 section 10.3 in the *User's Manual IM DLM6054-01EN*.

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 DL6000/DLM6000 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 DL6000/DLM6000 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 section 10.3 in the *User's Manual IM DLM6054-01EN*.) 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 section 11.3 in the *User's Manual IM DLM6054-01EN*.

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 section 6.16 in the *User's Manual IM DLM6054-01EN* .

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 DL6000/DLM6000, 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 section 10.6 in the *User's Manual IM DLM6054-01EN* .

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 DL6000/DLM6000 and the probe power terminals (/P2 or /P4 option) on the rear panel of the DL6000/DLM6000 as necessary. For the precautions to be taken when connecting probes, descriptions of the current capacity of the DL6000/DLM6000 probe power supply, and other information, See section 3.4 in the *User's Manual IM DLM6054-01EN*.

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). The DL6000/DLM6000 must have the Probe Power Option (/P2 or /P4) or the Probe Power Supply (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 *User's Manual IM DLM6054-01EN*.

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 DL6000/DLM6000. 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 DL6000/DLM6000.

Deskew correction signal source	Model 701935
Passive probe	Model 701943
Differential probe	Model 700924, 701921, or 701926
Current probe	Model 701928, 701929, 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

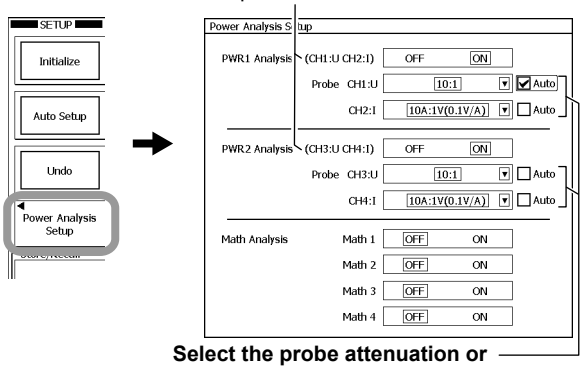
1. Press **SETUP MENU**. The SETUP menu appears.
2. Press the **Power Analyze Setup** soft key.
   The Power Analyze Setup screen is displayed.

Turning ON the Power Supply Analysis Function

3. Use **jog shuttle & 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 **jog shuttle & SET** to select the attenuation of the voltage probes of the voltage input channels (CH1 and CH3).
   If you select the Auto check box and a voltage probe that is compatible with the probe interface is connected, the DL6000/DLM6000 will automatically set the attenuation based on the probe.
5. Use **jog shuttle & SET** to select the current-to-voltage conversion ratio of the current probes of the current input channels (CH2 and CH4).
   If you select the Auto check box and a current probe that is compatible with the probe interface is connected, the DL6000/DLM6000 will automatically set the current-to-voltage conversion ratio based on the probe.

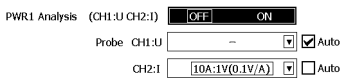


Turning the Power Supply Analysis Function ON/OFF
Power supply analysis is performed on the pair of channels that are turned ON.

Select the probe attenuation or current-to-voltage conversion ratio
Select the voltage probe attenuation for voltage input channels and the current-to-voltage conversion ratio for current input channels.

If you turn the power supply analysis function OFF, the probe attenuation or current-to-voltage conversion ratio will not be set automatically even when Auto is selected.

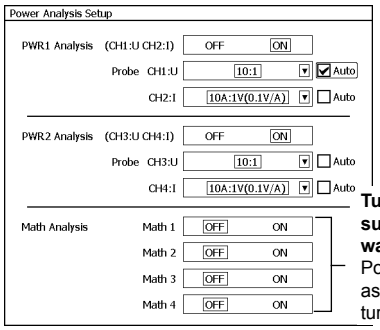
In the figure below, the probe attenuation is not displayed, because the power supply analysis function is OFF.



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

6. Use **jog shuttle & 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.



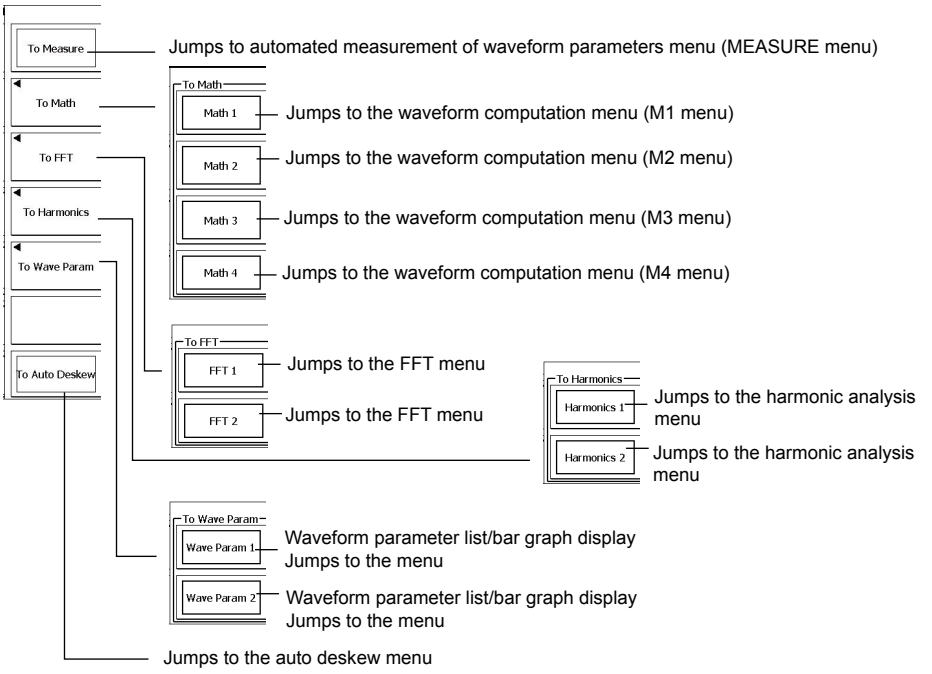
Turn ON/OFF the assignment of the power supply analysis parameters to the computed waveform
Power supply analysis parameters can be assigned to computed waveforms that are turned ON.

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.

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. If the power supply analysis function is turned on, the power analysis setup screen settings will be 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.
- If you connect any of the following probes when Auto is selected, the attenuation ratio of the voltage input channel is set to 1:1, and the current-to-voltage ratio of the current input channel is set to 1A:1V.
  - When a probe that is not compatible with the probe interface is connected.
  - When a current probe that is compatible with the probe interface is connected to a voltage input channel.
  - When a voltage probe that is compatible with the probe interface is connected to a current input channel.

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

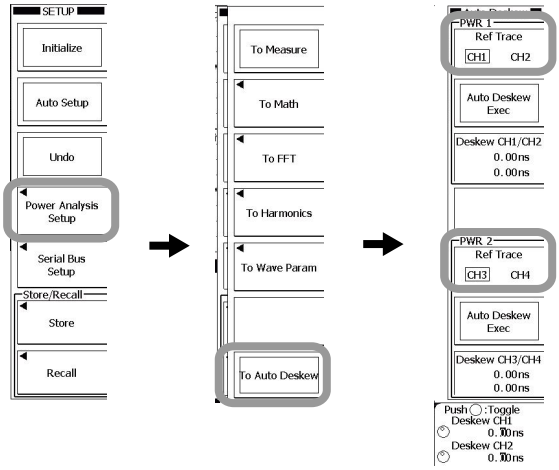
Connect the deskew correction signal source, voltage probe (passive probe or differential probe) and current probe to the DL6000/DLM6000.

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 IM701935-01*E.
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 7 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 or current-to-voltage conversion ratio according to the procedures given in section 5.1 in the *User's Manual IMDLM6054-01EN* .
   - 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 5.1 in the *User's Manual IM DLM6054-01EN*) set to 20.0 mA/div. If zero adjustment is not performed correctly, auto deskew may not be possible.

Executing the Deskew

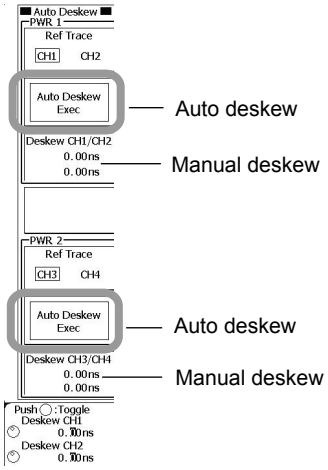
Execute deskew after the warm-up time of the DL6000/DLM6000 and other equipment (as necessary) has elapsed.

4. Press **SETUP MEMU**.
   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, configure the DL6000/DLM6000 so that you can easily view the skew condition by referring to chapter 5 in the *User's Manual IM DLM6054-01EN*.

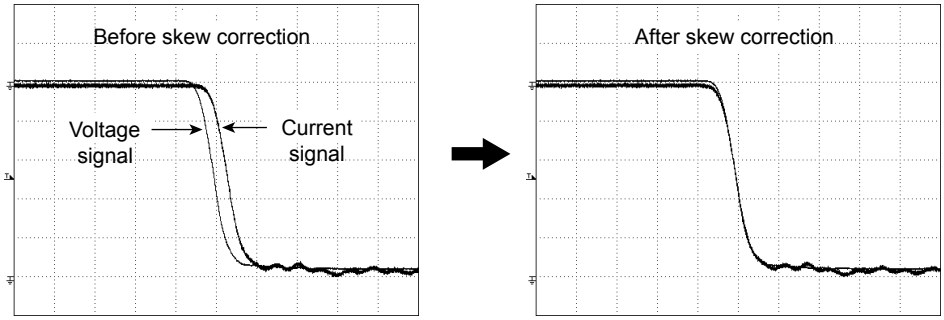
8. Press the **Deskew CH1/CH2** or **Deskew CH3/CH4** soft key to assign the jog shuttle.

9. Turn the **jog shuttle** 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 DL6000/DLM6000 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 7 in this manual.

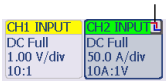
Note

For information on the handling of the deskew correction signal source, passive probe, differential probe, and current probe, see the User's manual IM DLM6054-01E.

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 DL6000/DLM6000 and other equipment (as necessary) has elapsed.
- The deskew icon is displayed in the information area of the deskewed channel.

Indicates 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 ACQUIRE, 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 user's manual IM DLM6054-01EN and set the display for easy viewing of the corrections.

Setting	Reference section
Auto setup	Section 4.5
Channel ON/OFF	Section 5.1
Vertical position	Section 5.1
Bandwidth limit	Section 5.1
Voltage scale	Section 5.1
TIME/DIV	Section 5.3

5 Performing Automated Measurement of Power Supply Analysis Parameters

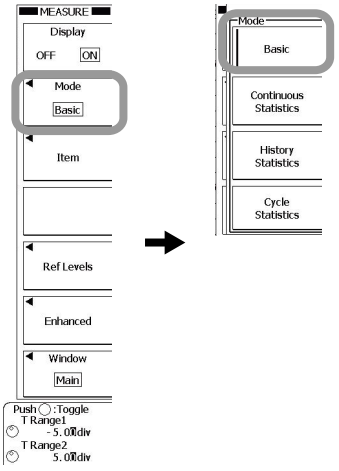
Procedure

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 **MEASURE**.
   The MEASURE menu is displayed.
   You can also display the MEASURE 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.

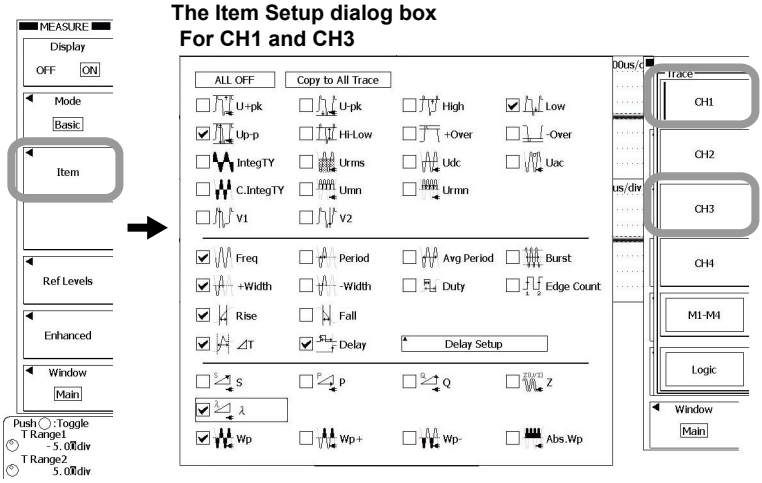
Note

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.

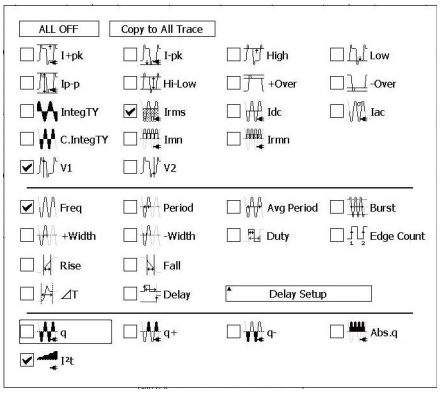
6. Select a parameter to measure using the **jog shuttle**.

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**.

The Item Setup dialog box
For CH1 and CH3



For CH2 and CH4



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

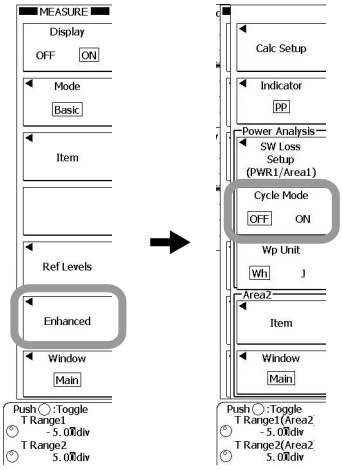
Selecting the Cycle Mode

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

9. Press the **Enhanced** soft key.

10. Press the Cycle Mode soft key to select OFF or ON.

- If you select OFF, S, P, Q, Z, λ, Wp, Wp+, Wp-, Abs.Wp, q, q+, q-, and Abs.q are measured over the range specified by Time Range.
- If you select ON, S, P, Q, Z, λ, Wp, Wp+, Wp-, Abs.Wpq, q+, q-, and Abs.q are measured over a section of the waveform that can be extracted as cycles (see page 16) within the range specified by Time Range.



For the subsequent steps, see section 10.2 in the *User's Manual IM DLM6054-01EN*.

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, Edge Count, Burst, +Width, -Width, Period, Avg Period, Duty, Rise, Fall, Delay, V1, V2, ΔT

  For details on how to determine each parameter, see section 10.2 in the *User’s Manual IM DLM6054-01EN* .

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, I²t

  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

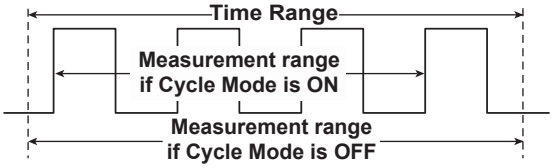
For the standard measurement parameters. see section 10.2 in the *User’s Manual IM DLM6054-01EN* .

Cycle Mode

You can change the measurement range of a portion of the power supply analysis parameters (S, P, Q, Z, λ, 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

<table>
<tr><th>Power Analysis Parameter</th><th colspan="5">Method of Determination, Equation</th></tr>
<tr><td rowspan="4">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</td><td>Udc</td><td>Urms</td><td>Uac</td><td>Umn</td><td>Urmn</td></tr>
<tr><td>$\frac{1}{T}\int_0^T u(t)\,dt$</td><td>$\sqrt{\frac{1}{T}\int_0^T u(t)^2\,dt}$</td><td>$\sqrt{Urms^2 - Udc^2}$</td><td>$\frac{\pi}{2\sqrt{2}}\frac{1}{T}\int_0^T \lvert u(t)\rvert\,dt$</td><td>$\frac{1}{T}\int_0^T \lvert u(t)\rvert\,dt$</td></tr>
<tr><td colspan="2">Up-p</td><td colspan="2">U+pk</td><td>U-pk</td></tr>
<tr><td colspan="2">Amplitude (equivalent to the standard measurement parameter P-P)</td><td colspan="2">Maximum value (equivalent to the standard measurement parameter Max)</td><td>Minimum value (equivalent to the standard measurement parameter Min)</td></tr>
<tr><td rowspan="4">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</td><td>Idc</td><td>Irms</td><td>Iac</td><td>Imn</td><td>Irmn</td></tr>
<tr><td>$\frac{1}{T}\int_0^T i(t)\,dt$</td><td>$\sqrt{\frac{1}{T}\int_0^T i(t)^2\,dt}$</td><td>$\sqrt{Irms^2 - Idc^2}$</td><td>$\frac{\pi}{2\sqrt{2}}\frac{1}{T}\int_0^T \lvert i(t)\rvert\,dt$</td><td>$\frac{1}{T}\int_0^T \lvert i(t)\rvert\,dt$</td></tr>
<tr><td colspan="2">Ip-p</td><td colspan="2">I+pk</td><td>I-pk</td></tr>
<tr><td colspan="2">Amplitude (equivalent to the standard measurement parameter P-P)</td><td colspan="2">Maximum value (equivalent to the standard measurement parameter Max)</td><td>Minimum value (equivalent to the standard measurement parameter Min)</td></tr>
<tr><td>Active power P [W]</td><td colspan="5">$\frac{1}{T}\int_0^T u(t)\cdot i(t)dt$ u(t) · i(t) : Instantaneous power</td></tr>
<tr><td>Apparent power S [VA]</td><td colspan="5">Urms · Irms</td></tr>
<tr><td>Reactive power Q [var]</td><td colspan="5">$\sqrt{S^2 - P^2}$</td></tr>
<tr><td>Power factor λ</td><td colspan="5">$\frac{P}{S}$</td></tr>
<tr><td>Impedance of the load circuit Z [Ω]</td><td colspan="5">$\frac{Urms}{Irms}$</td></tr>
<tr><td>Watt hour [Wh]
Wp
Wp+
Wp-
Abs.Wp</td><td colspan="5">$\int_0^T u(t)\cdot i(t)dt$
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) .</td></tr>
<tr><td>Ampere hour [Ah]
q
q+
q-
Abs.q</td><td colspan="5">$\int_0^T i(t)dt$
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) .</td></tr>
<tr><td>Joule integral I²t [A²s]</td><td colspan="5">$\int_0^T i^2(t)\,dt$</td></tr>
</table>

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 section 10.2 in the *User's Manual IMDLM6054-01EN*.
- 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, and Irmn
Parameters whose measurement range* changes depending on whether the cycle mode is ON or OFF	S, P, Q, Z, λ, 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

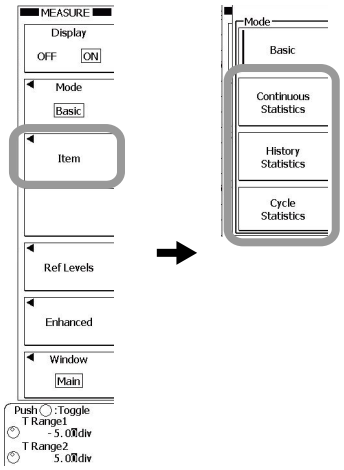
Procedure

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 **MEASURE**.
   The MEASURE menu is displayed.
   You can also display the MEASURE 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 the explanation in section 10.3 in the *User's Manual IM DLM6054-01EN* .

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 chapter 9 in the *User's Manual IM DLM6054-01EN*.

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 chapter 9 in the *User's Manual IM DLM6054-01EN*.
- 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 **MATH/REF**.

The MATH/REF menu is displayed.

You can also display the MATH/REF menu by selecting To Math and pressing Math1 to Math4 in the power supply analysis Setup menu described in section 3 of this manual.

2 Press the **Mode** soft key to select Math.

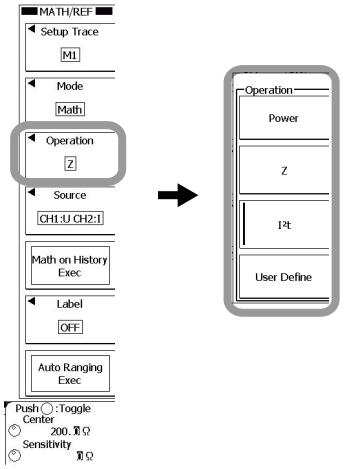
3. Press the **Operation** soft key.

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 section 9.10 in the *User's Manual IM DLM6054-01EN* .

- Power (instantaneous power) -> Page 20
- Z (impedance) -> Page 20
- I^2t (Joule integral) -> Page 21



Setting the Computed Waveform of Instantaneous Power (When Power Was Selected in Step 4 on Page 19)

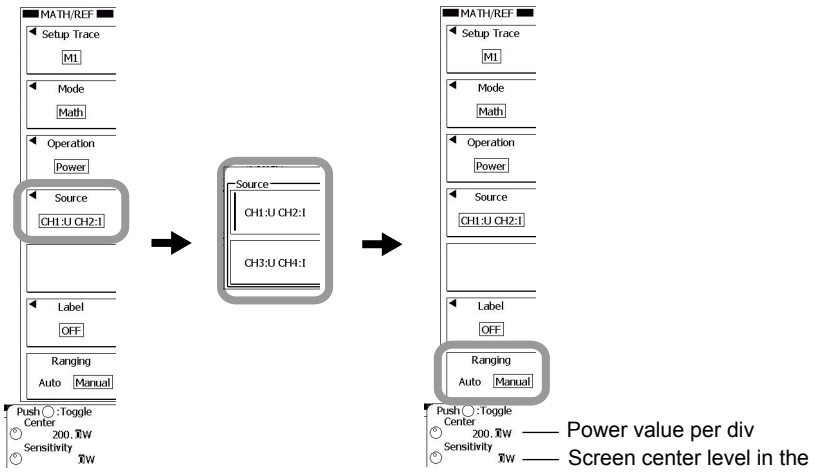
5. Press the **Source** soft key. The menu for selecting the computation source waveform is displayed.

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 to select Auto or Manual.

8. If you select Manual, use the **jog shuttle** to set the power per div (Sensitivity) and center level (Center), thereby adjusting the display range.



Setting the Computed Waveform of Impedance (When Z Was Selected in Step 4 on Page 19)

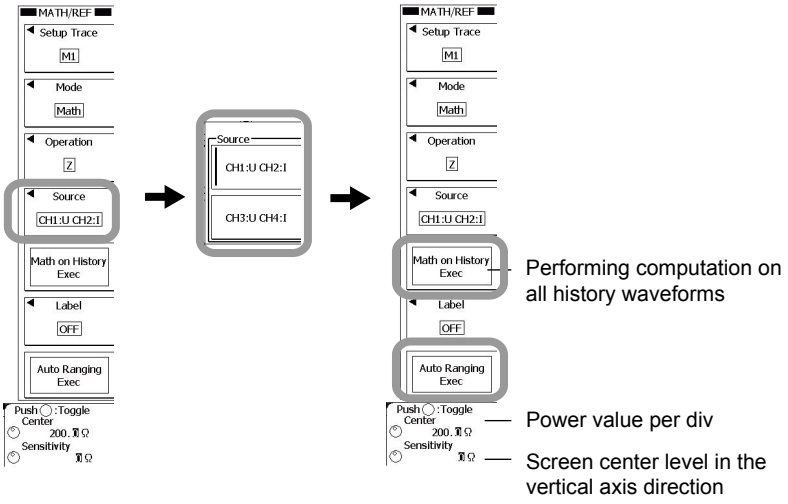
5. Press the **Source** soft key. The menu for selecting the computation source waveform is displayed.

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. If you wish to set the display range automatically, press the **Auto Ranging Exec** soft key to execute ranging.

8. To set the range manually, use the **Ranging** soft key and the **jog shuttle** to set the value per div and center position.



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 19)

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

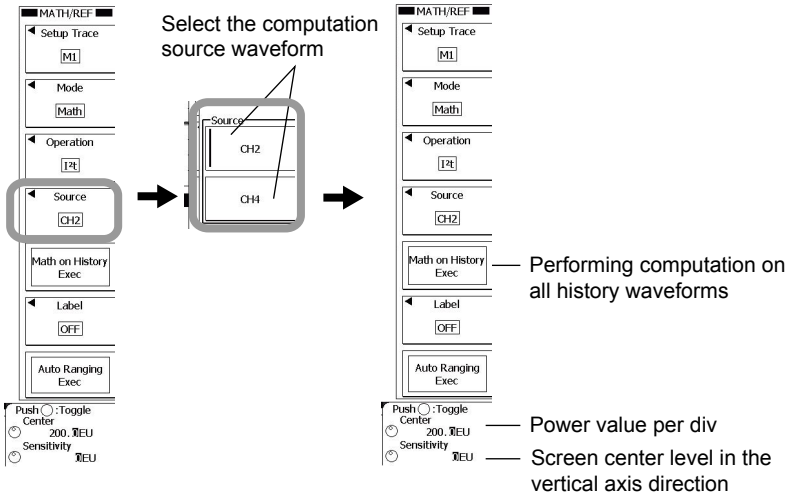
6. Press the **CH2** or **CH4** soft key to select the source waveform.

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. If you wish to set the display range automatically, press the **Auto Ranging Exec** soft key to execute ranging.

9. To set the range manually, use the **Ranging** soft key and the **jog shuttle** to set the value per div and center position.



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 four operators for Math1 through Math4.

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

For details on User Define, see section 9.10 in the *User's Manual IM DLM6054-01EN*.

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 I^2t)

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 start the waveform acquisition with SINGLE key, 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 MEASURE of History Statistics appears only if all history waveforms exist. If the Average display of History or MEASURE of History Statistics is not performed, carry out the procedure given in "Executing the Computation on All History Waveforms."

8 Measuring the Power Spectrum

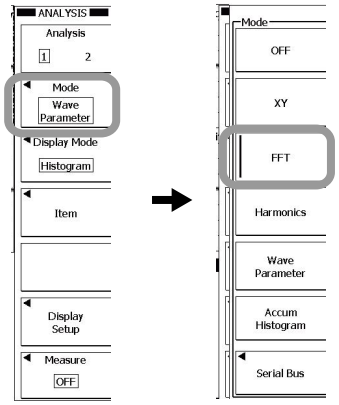
Procedure

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 **ANALYSIS**.
   The ANALYSIS menu is displayed.
   You can also display the ANALYSIS menu by selecting To FFT in the power supply analysis Setup menu described in section 3 of this manual and pressing FFT1 or FFT2.
2. Press the **Analysis** soft key to select 1 or 2.
3. Press the **Mode** soft key, and then press the **FFT** soft key in the menu that is displayed..
   The FFT setting menu is displayed.
   For subsequent procedures, see section 10.7 in the *User's Manual IM DLM6054-01EN* .



Note

9 Analyzing Harmonics

Procedure

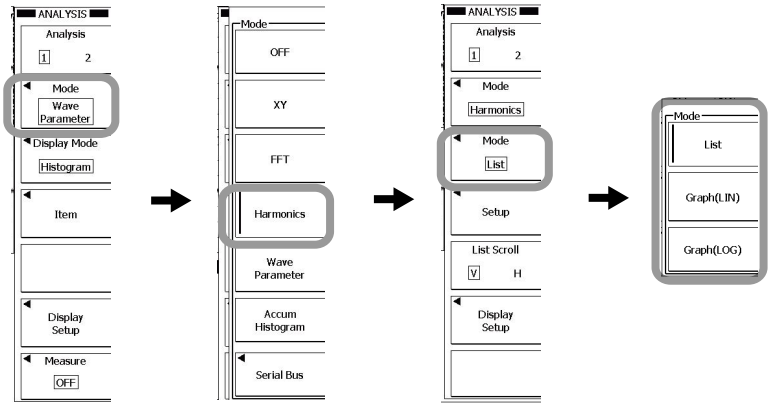
The following setup is required to analyze harmonics.

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

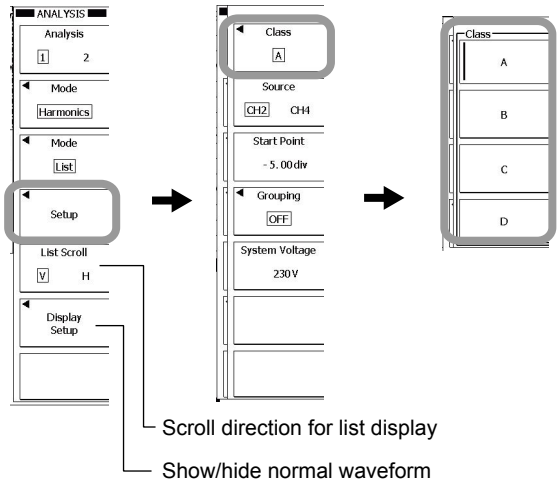


Selecting the Applicable Class

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

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

8. 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

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

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

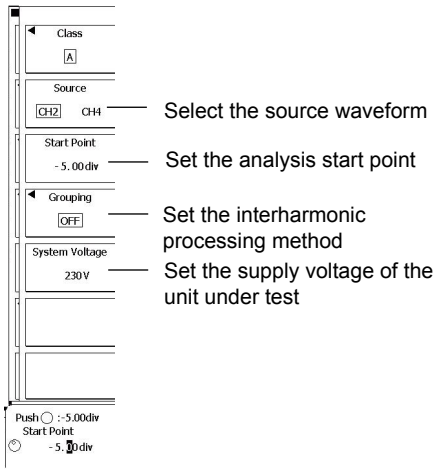
11. Set the analysis start point using the **jog shuttle**.

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

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

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

15. Set the power supply voltage of the unit under test using the **jog shuttle**.



When Applicable Class C Is Selected

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

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

11. Set the analysis start point using the **jog shuttle**.

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

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

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

15. Set the power supply voltage of the unit under test using the **jog shuttle**.

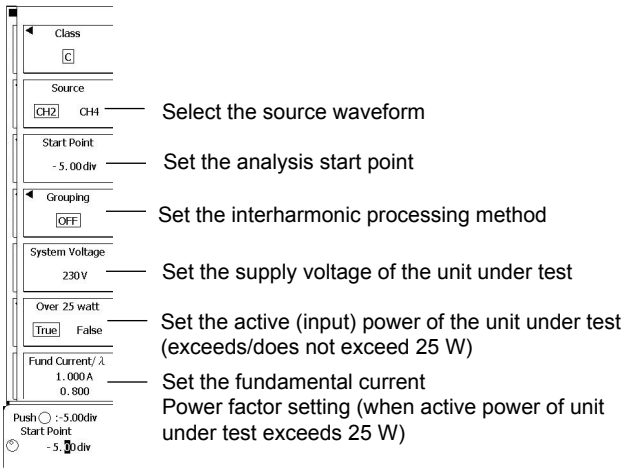
16 Press the **Over 25 watt** soft key to specify whether the active (input) power of the unit under test exceeds 25 W (True) or does not exceed 25 W (False).

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

18. Using the **jog shuttle**, set the fundamental current when the load on the unit under test is set to maximum.

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

20. Using the **jog shuttle**, set the power factor when the load on the unit under test is set to maximum.



When Applicable Class D Is Selected

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

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

11. Set the analysis start point using the **jog shuttle**.

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

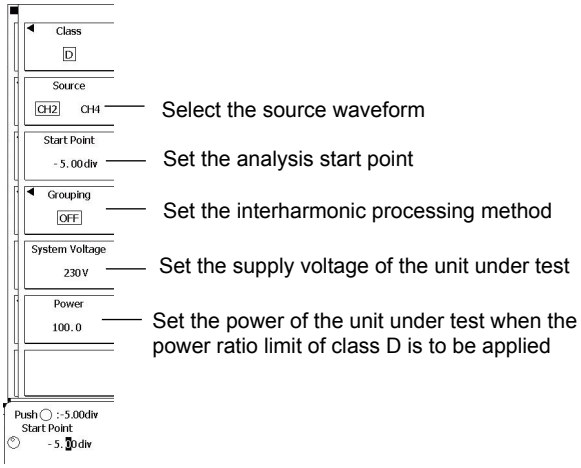
13. Press the **OFF** (do not include interharmonics), **Type1** (include adjacent interharmonics), or **Type2** (include all interharmonics) soft key to set the interharmonic processing method.

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

15. Set the power supply voltage of the unit under test using the **jog shuttle**.

16. Press the **Power** soft key.

17. Using the **jog shuttle**, 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 6) 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 DL6000/DLM6000 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 DL6000/DLM6000, 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 24. 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 DL6000/DLM6000, 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

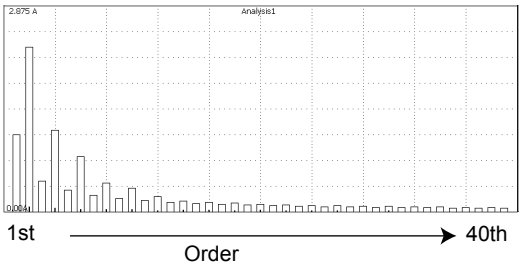
Set the active power of the unit under test. For Class D, the harmonic current per watt (power ratio limit) is also evaluated.

Analysis Results Display

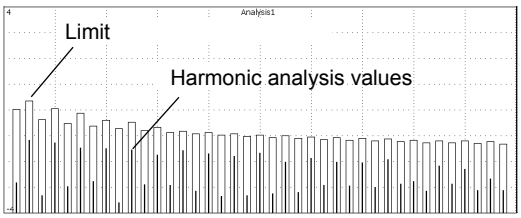
Bar Graph Display

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)



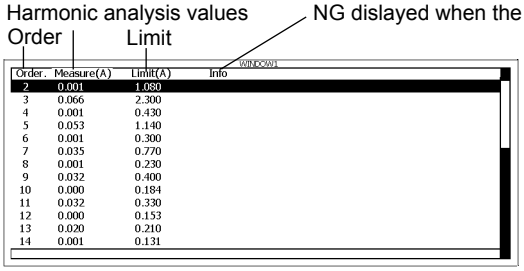
List Display

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

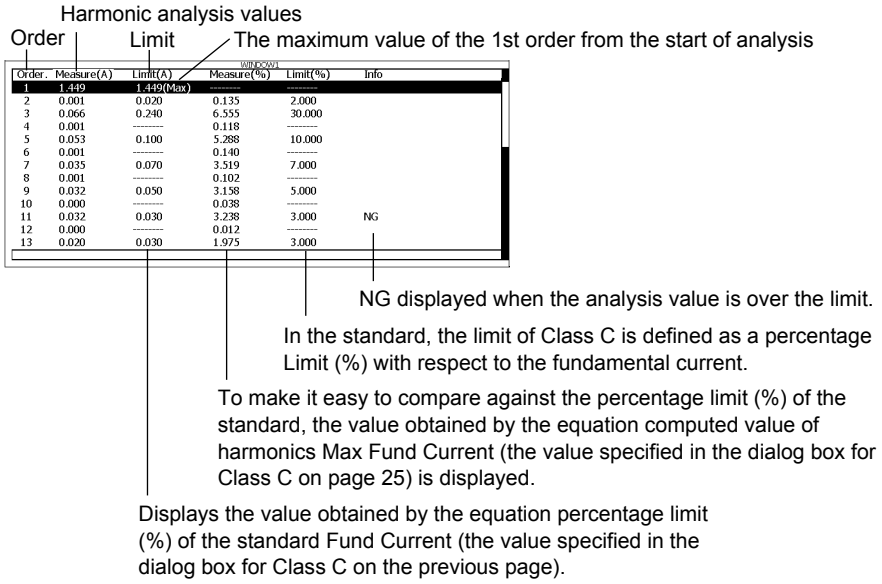
Note

- The DL6000/DLM6000 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 DL6000/DLM6000'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 DL6000/DLM6000 with the Power Supply Analysis function (/G4 option). For instructions on saving the data in binary format, see section 13.4 in the *User's Manual IM DLM6054-01EN* .
- 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

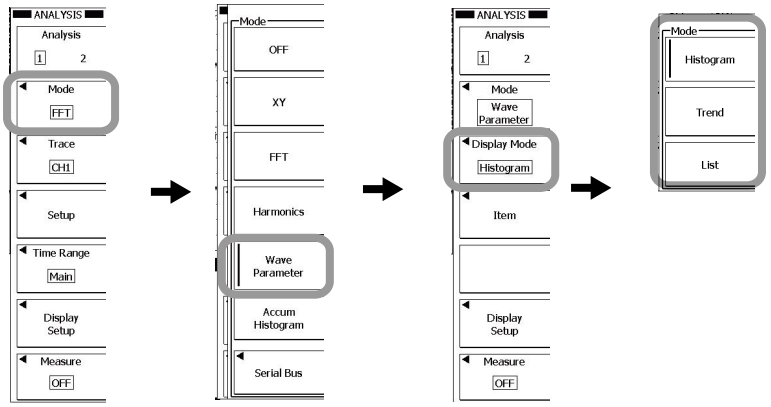
The following setup is required to analyze harmonics.

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

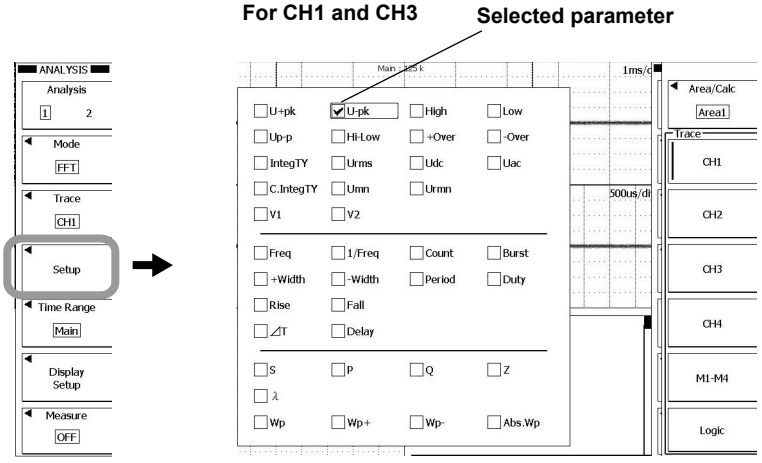
To make correct measurements and computation, it is recommended that the difference in the transfer time of the analyzed signals be corrected (deskewed). For the setup procedure, see section 4 in this manual.

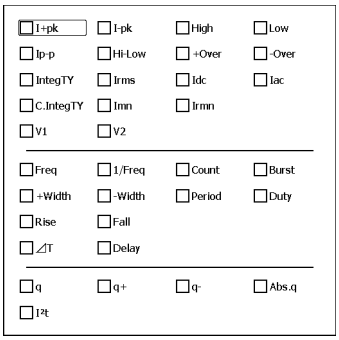
1. Press the **ANALYSIS**.
   The ANALYSIS menu is displayed.
   You can also display the ANALYSIS menu by selecting To Wave Param in the power supply analysis Setup menu described in section 3 of this manual and pressing Wave Param 1 or Wave Param 2.
2. Press the **Mode** soft key, and then press the **Wave Parameter** soft key in the menu that is displayed.
3. Press the **Display 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 **jog shuttle**.

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

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

For other operations, see the procedures given in section 10.8 in the *User's Manual IM DLM6054-01EN*.

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

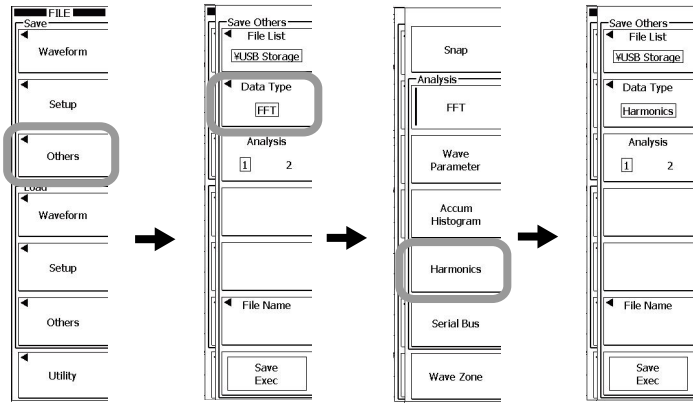
1. Press **FILE**.

Setting the Data Type

2. Press the **Others**(Save) soft key.
3. Press the **Data Type** soft key.
4. Press the **Harmonics** soft key.

Selecting the Save Destination Medium and/or Directory

5. Press the **File List** soft key.
   The file list appears.
6. Select the save destination medium or directory using the **jog shuttle & SET**.



For the subsequent steps, see section 13.6 in the *User's Manual IM DLM6054-01EN*.

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).

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.

Example for classes A, B, and D

Analysis Type	Harmonics		
Model Name	DL6000		
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	DL6000				
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 Total Loss

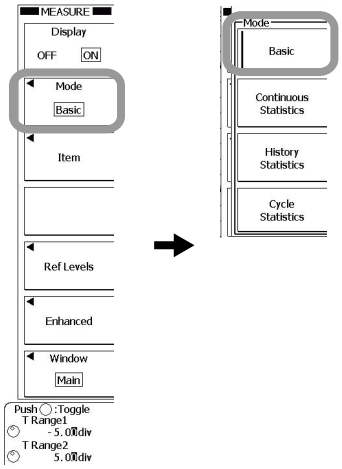
Procedure

To measure the total loss, you must turn the target channel's power supply analysis function ON. For the setup procedure, see section 3 in this manual.

Note

To measure or compute the total loss accurately, we recommend that you correct (deskew) the difference in the transfer time of analyzed signals. For the setup procedure, see section 4 in this manual.

1. Press **MEASURE**.
   The MEASURE menu appears.
   You can also display the MEASURE menu by selecting To Measure and pressing SET in the Power Analysis Setup menu described in chapter 3 of this manual.
2. Press the **Mode** soft key.
   The Mode menu appears.
3. Press the **Basic** soft key.



Selecting the Measurement Items

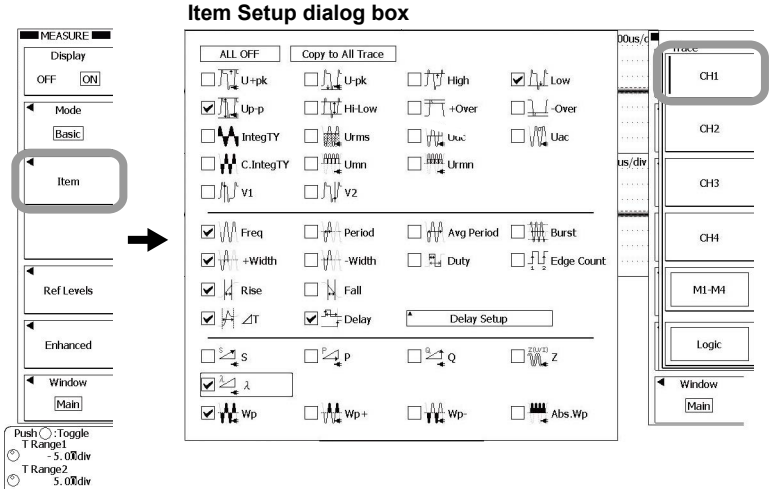
4. Press the **Item** soft key.
   The Item Setup menu and the Item Setup dialog box appear.
5. Press the **CH1** soft key .
   If you select CH1, CH1 and CH2 are selected for the voltage and current pair.

Note

- If you select a trace whose power supply analysis function is ON, the Item Setup dialog box for power supply analysis appears.
- If you select a trace whose power supply analysis function is OFF, the Item Setup dialog box for normal waveform parameters appears.
- You can measure the total loss for CH1 and CH2 as a voltage and current pair.

6. Use the **jog shuttle & SET** to select measurement items.
You can measure and display the total loss by selecting a measurement item related to power (such as P, Wp, Wp+, Wp-, and Abs.Wp).

Item Setup dialog box



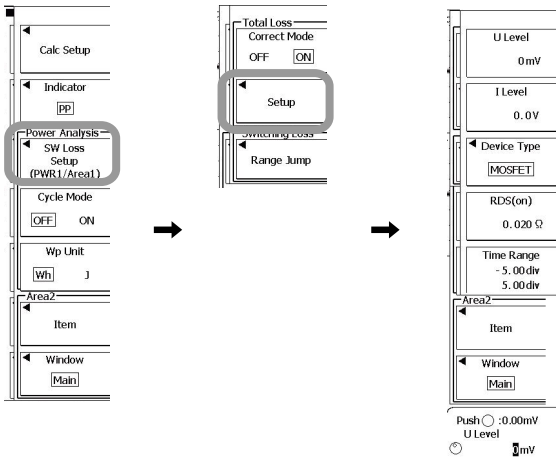
To Measure the Corrected Total Loss

Correction Mode ON

7. Press the **Enhanced** soft key > **SW Loss Setup(PWR1/Aea1**) soft key.

8. Press the **Correct Mode** soft key to select ON.
If you select OFF, the subsequent setup menus will not appear.

9. Press the **Setup** soft key.
The total loss correction menu appears.



Note

- **Indicator feature**
  You can press the Indicator soft key to indicate the location of a specified measurement item with cursors. Measured locations can be displayed for the following items.
  PwP (P), PwZ (Z), WH (Wp), WHP (Wp+), WHM (Wp-), and Abs.WH (Abs.Wp)
- **Total loss unit**
  Set the unit to use when displaying the measured values for Wp, Wp+, Wp-, and Abs.Wp to Wh (watt hours) or J (Joules).

Setting the Voltage the Current Levels

- **Setting the Voltage Level**

  Set the voltage level used to calculate the loss in correction mode. When the sampled voltage is less than this voltage level, the DL6000/DLM6000 calculates the loss using the equation based on the device type described later.

  10. Press the **U Level** soft key.

  11. Use the **jog shuttle** to set the voltage level.

- **Setting the Current Level**

  Set the current level at which the DL6000/DLM6000 will assume the loss to be zero in correction mode. When the sampled current is less than this current level, the DL6000/DLM6000 assumes the current to be zero. Consequently, the loss will be zero.

  12. Press the **I Level** soft key.

  13. Use the **jog shuttle** to set the current level.

Selecting the Device Type

14. Press the **Device Type** soft key.

15. Press the **BJT/IGBT** or **MOSFET** soft key to select the device type.
If you select BJT/IGBT, proceed to step 16. If you select MOSFET, proceed to step 18.

- **Setting the Device's Collector-Emitter Saturation Voltage**

  16. Press the **Vce (SAT)** soft key.

  17. Use the **jog shuttle** to set the device's saturation voltage.
  Proceed to step 20.

- **Setting the Device's On-Resistance**

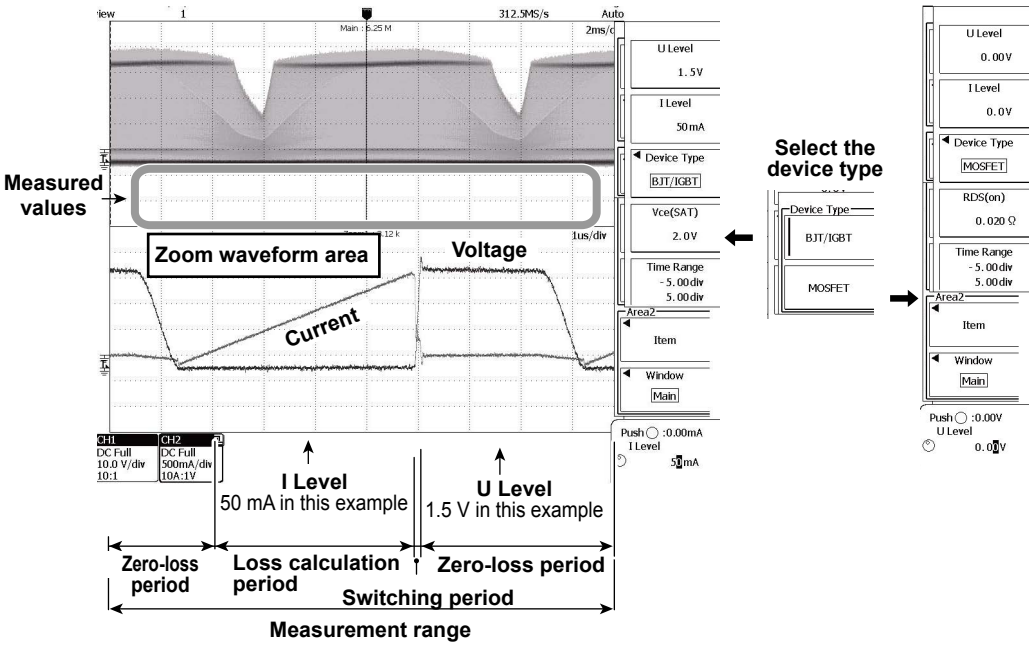
  18. Press the **RDS(on)** soft key.

  19. Use the **jog shuttle** to set the device's on-resistance.
  Proceed to step 20.

Setting the Measurement Range

20. Press the **Time Range** soft key.

21. Use the **jog shuttle** to set the time range start point (T1) and end point (T2).
Press the soft key to select the point that you want to set using the jog shuttle.



Explanation

You can use the power supply analysis parameter measurement function to measure a device's total loss (power loss).

Total Loss

You can determine the total loss that is obtained through normal power supply parameter measurement and the corrected total loss.

Correction Mode

OFF	Measures the total loss that is determined through normal power supply analysis parameter measurement.
ON	Measures the corrected total loss P_T. The following equation is determined. P_T = Pon + Psw Pon: Loss during the calculation period Psw: Loss during the switching period (when the device is switching)

Measurement Items

Set measurement items related to power (such as P, S, Q, λ, Z, Wp, Wp+, Wp-, and Abs.Wp).

How Corrected Total Loss Is Determined

Loss Calculation Period

The loss when the device is ON, Pon, is calculated during the period when the sampled voltage is less than the set voltage level and the sampled current is greater than or equal to the set current level. This value is added to the total loss P_T.

Zero-Loss Period

When the sampled current is less than the set current level, the DL6000/DLM6000 assumes the current to be zero, and the loss to be zero.

- **Voltage and Current Levels**

  The selectable range is –10.00 to 10.00 divisions in 0.01-division steps.

Note

The ranges of selectable voltages and currents vary depending on the probe attenuation. For a description of probe attenuation and voltage scale, see section 5.1 in the *User's Manual IMDLM6054-01EN* .

- **Device Type**

  The equation for loss Pon varies depending on the device type.

  - Collector-Emitter Saturation Voltage

    If the device type is BJT/IGBT, set the device's saturation voltage Vce(SAT). The equation is as follows:

    $$Pon = \frac{Vce(SAT)}{Ton}\int_0^{Ton} i(t)\,dt$$

    i(t): Sampled current data
    Ton: Loss calculation period

  - On-Resistance

    If the device type is MOSFET, set the device's on-resistance RDS(on). The equation is as follows:

    $$Pon = \frac{RDS(on)}{Ton}\int_0^{Ton} i(t)^2 dt$$

    i(t): Sampled current data
    Ton: Loss calculation period

Loss during the Switching Period

The switching period is defined to be where the sampled voltage is greater than or equal to the set voltage level and the sampled current is greater than or equal to the set current level. The loss during this period, Psw, is added to the total loss P_T.

$$Psw = \frac{1}{Tsw}\int_0^{Tsw} u(t)\cdot i(t)\,dt$$

u(t): Sampled voltage data
i(t): Sampled current data
Tsw: Switching period

Note

The measured loss during the switching period here is different from the measured switching loss described in the next section, because the settings are different.

Measurement range

Selectable range: ±5 divisions with the center of the waveform area taken to be 0 divisions
Resolution: 0.01 divisions. The resolution in the zoom waveform area is based on the zoom ratio.

13 Measuring the Switching Loss

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.

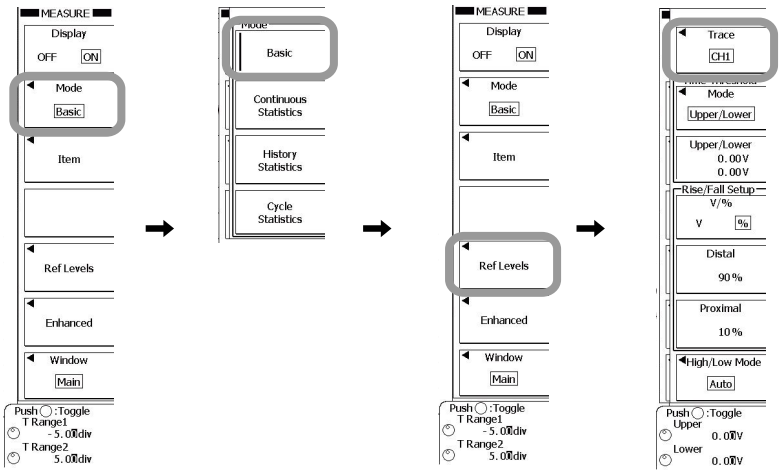
1. Press **MEASURE**.
   The MEASURE menu is displayed.
   You can also display the MEASURE menu by selecting To Measure on the Power Analysis Setup menu described in section 3 of this manual and pressing SET.
2. Press the **Mode** soft key.
   The Mode menu appears.
3. Press the **Basic** soft key.

Preparation

Setting Threshold Values

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

4. Press the **Ref Levels** soft key > **Trace** soft key.
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 **Mode** 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 11.

- **Auto**

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

  Proceed to step 13.

- **Level/Hys**

  9. Press the **Level/Hys** soft key.

  10. Use the **jog shuttle** to set the threshold level and hysteresis.
  Press the soft key to select the point that you want to set using the jog shuttle.

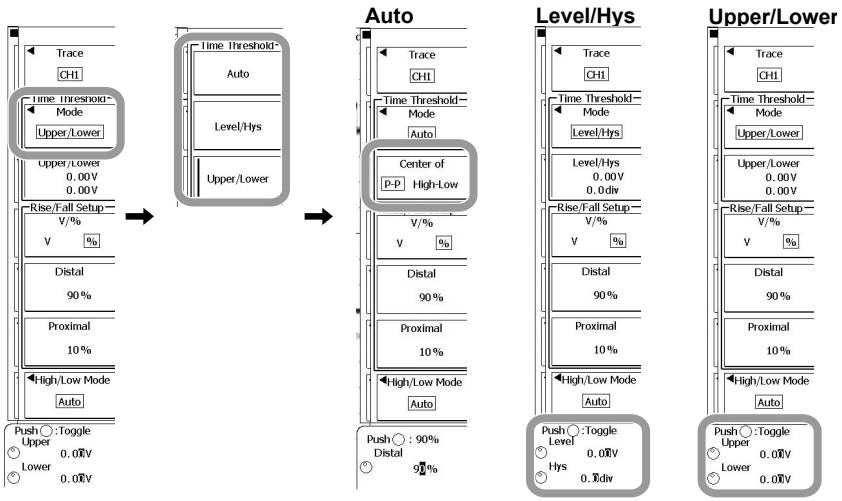
  Proceed to step 13.

- **Upper/Lower**

  11. Press the **Upper/Lower** soft key.

  12. Use the **jog shuttle** to set the upper and lower limits.
  Press the soft key to select the point that you want to set using the jog shuttle.

  13. Press **ESC**.
  The screen returns to the waveform parameter setup menu.



Selecting the Measurement Parameters

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

15. Press the **CH1** soft key .
If you select CH1, CH1 and CH2 are selected as voltage and current pairs.

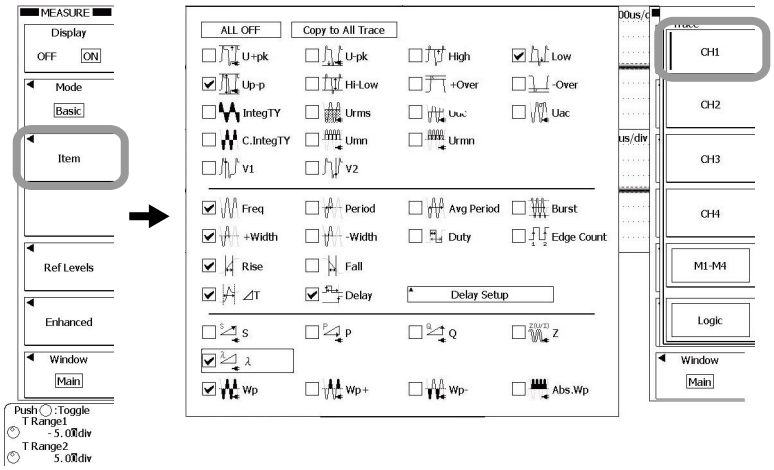
Note

- 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.
- You can measure the switching loss for CH1 and CH2 as a voltage and current pair.

Rise/Fall setup (the V/%, Distal, and Proximal soft keys)
Set the reference levels (distal and proximal) used to determine the total loss as percentages or as voltage values. The method used to set the levels is the same as the method used to set the reference levels for the automated measurement of waveform parameters.

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

Item Setup dialog box



17. Use **jog shuttle & SET** to select Power/SW Loss Setup.

18. Press the **Range Jump** soft key.
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**

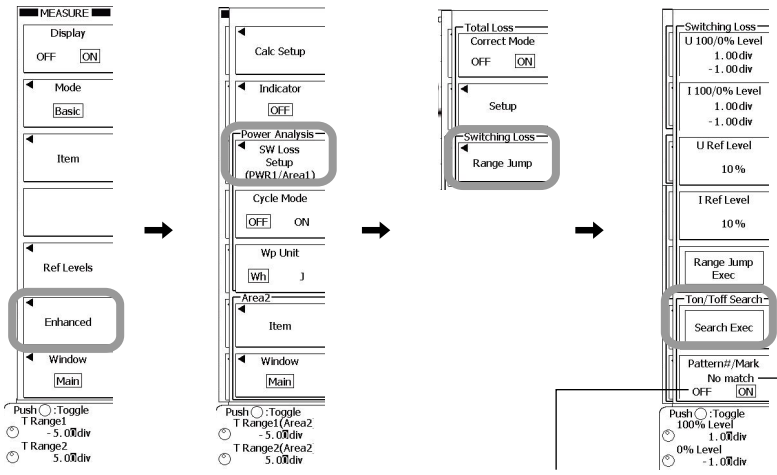
  19. Press the **Search Exec** soft key to execute the search.
  The Search Exec soft key changes to Search Abort. To stop the search, press the **Search Abort** soft key.

- **Selecting the Measurement Point**

  20. Turn the **jog shuttle** 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**

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



If a location that matches with the conditions is found, the search number is displayed here.

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**

  22. Press the **U 100/0% Level** soft key.

  23. Turn the **jog shuttle** to set the 100% and 0% voltage level.
  Press the soft key to select the point that you want to set using the jog shuttle

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

  24. Press the **I 100/0% Level** soft key.

  25. Turn the **jog shuttle** to set the 100% and 0% current level.
  Press the soft key to select the point that you want to set using the jog shuttle.

- **Setting the Voltage Reference Level**

  26. Press the **U Ref Level** soft key.

  27. Use the **jog shuttle** to set the voltage reference level.

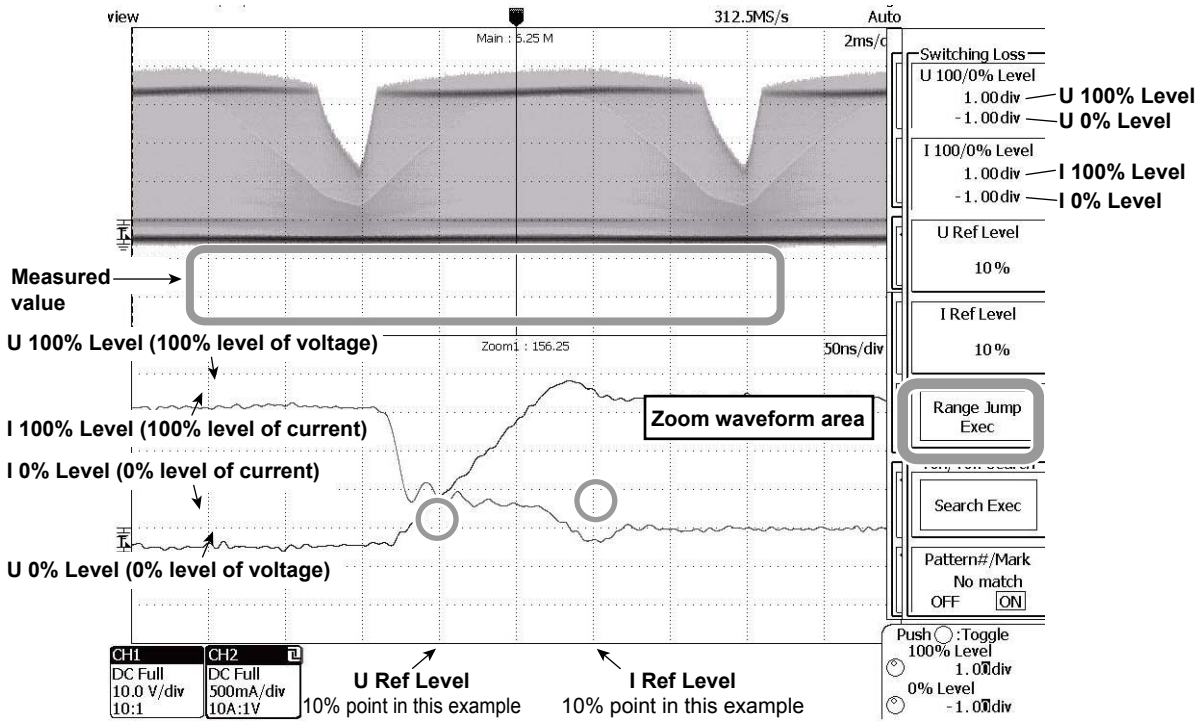
- **Setting the Current Reference Level**

  28. Press the **I Ref Level** soft key.

  29. Use the **jog shuttle** to set the current reference level.

Executing the Switching Loss Measurement

30. 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).

Switching Loss

The following equation is used to determine switching loss.

$$\text{Switching loss} = \frac{1}{Tref}\int_{0}^{Tref} u(t)\cdot i(t)\,dt$$

u(t): Sampled voltage data
i(t): Sampled current data
Tref: Time between the intersection of the voltage reference level (U Ref Level) and the voltage waveform and the intersection of the current reference level (I Ref Level) and the current waveform

Setting Threshold Values

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

Selecting the Measurement Parameters

Set measurement parameters related to power (such as P, 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

- **Voltage Reference Level**
  Set the voltage reference level that is used to determine the measurement range as a percentage of the “100% voltage level” described above.
  The selectable range is 0 to 100% in 1% steps.

- **Current Reference Level**
  Set the current reference level that is used to determine the measurement range as a percentage of the “100% current level” described above.
  The selectable range is 0 to 100% in 1% steps.

Executing the Switching Loss Measurement

When executed, the DL6000/DLM6000 searches the zoom waveform area from the left edge to the right edge. The DL6000/DLM6000 measures the power over the time range between the first points where the voltage and current waveforms intersect the voltage and current reference levels.

14 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 *Communication Interface User's Manual IM DLM6054-17EN* (on the CD).

Command	Function	Page
ANALysis Group		
:ANALysis:HARMonics<x>?	Queries all settings related to the harmonic computation function	48
:ANALysis:HARMonics<x>:CCLass?	Queries all settings related to harmonic computation class C	48
:ANALysis:HARMonics<x>:CCLass:LAMBda	Sets the harmonic computation class C power factor or queries the current setting	48
:ANALysis:HARMonics<x>:CCLass:MAXCurrent	Sets the harmonic computation class C fundamental current or queries the current setting	48
:ANALysis:HARMonics<x>:CCLass:OPOWer	Sets whether or not the harmonic computation class C active power exceeds 25 W or queries the current setting	48
:ANALysis:HARMonics<x>:CLASs	Sets the applicable class of the harmonic computation target instrument or queries the current setting	48
:ANALysis:HARMonics<x>:DCLass?	Queries all settings related to harmonic computation class D	48
:ANALysis:HARMonics<x>:DCLass:POWer	Sets the harmonic computation class D power value or queries the current setting	49
:ANALysis:HARMonics<x>:GROuping	Sets the harmonic computation grouping or queries the current setting	49
:ANALysis:HARMonics<x>:LIST?	Queries all settings related to the harmonic computation list display	49
:ANALysis:HARMonics<x>:LIST:ITEM?	Queries the harmonic computation list display items	49
:ANALysis:HARMonics<x>:LIST:SCRoll	Sets the scroll direction for the harmonic computation list display or queries the current setting	49
:ANALysis:HARMonics<x>:LIST:VALue?	Queries the computed values of harmonics and limits defined by the standard for each order	49
:ANALysis:HARMonics<x>:Mode	Sets the harmonic computation display mode or queries the current setting	49
:ANALysis:HARMonics<x>:SOURce	Sets the harmonic computation source or queries the current setting	49
:ANALysis:HARMonics<x>:SPOint	Sets the harmonic computation start point or queries the current setting	49
:ANALysis:HARMonics<x>:SVOLtage	Sets the harmonic computation supply voltage or queries the current setting	50
:ANALysis:TYPE<x>	Sets the analysis function type or queries the current setting	50
:ANALysis:WPARameter<x>:TRACe<x>:AREA<x>:TYPE	Sets the waveform parameters to be measured or queries the current setting	50
FILE Group		
:FILE:SAVE:HARMonics:ABORt	Stops saving harmonic computation results	50
:FILE:SAVE:HARMonics[:EXECute]	Executes saving of harmonic computation results	50
:FILE:SAVE:HARMonics:ANALysis	Sets the analysis trace to which to save harmonic computation results or queries the current setting	50
GONogo Group		
:GONogo:ZPARameter:SELect<x>:PARameter:MEASure:TRACe<x>:AREA<x>:TYPE:<parameter>	Sets the upper and lower limits of the power supply analysis parameters for measurement judgement or or queries the current setting	51
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	51
MATH Group		
:MATH<x>:I2T:ARANging	Executes auto ranging of the Joule-integral computation	52
:MATH<x>:I2T:HISTory:ABORt	Cancels history computation for Joule integral computation.	52
:MATH<x>:I2T:HISTory:EXECute	Executes history computation for Joule integral computation.	52

Command	Function	Page
:MATH<x>:I2T:UNIT?	Queries all settings related to the units of Joule integral computation or queries the current setting.	52
:MATH<x>:I2T:UNIT[:DEFine]	Sets the units of Joule integral computation or queries the current setting.	52
:MATH<x>:OPERation	Sets operators for power supply analysis or queries the current setting	52
:MATH<x>:Z:ARANging	Executes auto ranging of the impedance computation	52
:MATH<x>:Z:HISTory:ABORt	Cancels history computation for impedance computation.	52
:MATH<x>:Z:HISTory:EXECute	Executes history computation for impedance computation.	52

MEASure Group

:MEASure:TRACe<x>:AREA<x>:CMODe	Turns ON/OFF the cycle mode or queries the current setting.	53
:MEASure:TRACe<x>:AREA<x>:<parameter>:COUNt?	Queries the count for continuous statistical processing of power supply analysis parameter.	53
:MEASure:TRACe<x>:AREA<x>:<parameter>:{MAXimum|MEAN|MINimum|SDEViation}?	Queries each statistical value of the power supply analysis parameter.	53
:MEASure:TRACe<x>:AREA<x>:<parameter>:STATe	Turns ON/OFF the power supply analysis parameter or queries the current setting.	54
:MEASure:TRACe<x>:AREA<x>:<parameter>:VALue?	Queries automatically measured values of the power supply analysis parameter.	54
:MEASure:TRACe<x>:AREA<x>:SWLoss?	Queries all settings related to the switching loss.	54
:MEASure:TRACe<x>:AREA<x>:SWLoss:ILEVel	Sets the current level of the switching loss or queries the current setting.	55
:MEASure:TRACe<x>:AREA<x>:SWLoss:RJUMp:ABORt	Aborts the range jumping of the switching loss.	55
:MEASure:TRACe<x>:AREA<x>:SWLoss:RJUMp:EXECute	Executes the range jumping of the switching loss.	55
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch?	Queries all settings related to the switching loss search function.	55
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:ABORt	Aborts the switching loss search.	55
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:EXECute	Executes the switching loss search.	55
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:MARK	Turns ON/OFF the switching loss search marks or queries the current setting.	55
:MEASure:TRACe<x>:AREA<x>:SWLoss:SEARch:SELect	Sets the search number of the switching loss search function or queries the current setting.	56
:MEASure:TRACe<x>:AREA<x>:SWLoss:UIRLevel	Sets the range level percentage of the switching loss or queries the current setting.	56
:MEASure:TRACe<x>:AREA<x>:SWLoss:ULEVel	Sets the voltage level of the switching loss or queries the current setting.	56
:MEASure:TRACe<x>:AREA<x>:TSWLoss?	Queries all settings related to total loss measurement.	56
:MEASure:TRACe<x>:AREA<x>:TSWLoss:DTYPe	Sets the device type for the total loss measurement or queries the current setting.	56
:MEASure:TRACe<x>:AREA<x>:TSWLoss:ILEVel	Sets the current level that the DL6000/DLM6000 will assume the current to be zero in the total loss measurement or queries the current setting.	57
:MEASure:TRACe<x>:AREA<x>:TSWLoss:MODE	Enables or disables the total loss measurement or queries the current setting.	57
:MEASure:TRACe<x>:AREA<x>:TSWLoss:RDS	Sets the on-resistance for the total loss measurement or queries the current setting.	57
:MEASure:TRACe<x>:AREA<x>:TSWLoss:ULEVel	Sets the voltage level used to calculate the total loss in correction mode or queries the current setting.	57
:MEASure:TRACe<x>:AREA<x>:TSWLoss:VCE	Sets the collector-emitter saturation voltage for the total loss measurement or queries the current setting.	57
:MEASure:TRACe<x>:AREA<x>:WPUNit	Sets or queries the power unit.	57

PANalyze Group

:PANalyze?	Enters all settings related to power supply analysis or queries the current settings.	58
:PANalyze:MATH<x>?	Enters all settings related to each computed waveform for power supply analysis or queries the current settings.	58
:PANalyze:MATH<x>:Mode	Sets active/reactive power of ecah computed waveform for power supply analysis or queries the current setting.	58

Command	Function	Page
:PANalyze:PWR<x>?	Enters all settings related to power supply analysis input or queries the current settings.	58
:PANalyze:PWR<x>:DESKew?	Enters all settings related to power supply analysis skew correction or queries the current settings.	58
:PANalyze:PWR<x>:DESKew:AEXeute	Executes power supply analysis auto skew correction.	58
:PANalyze:PWR<x>:DESKew:RTRace	Sets the target trace for power supply analysis skew correction or queries the current setting.	58
:PANalyze:PWR<x>:DESKew:TIME<x>	Sets the power supply analysis skew correction or queries the current setting.	58
:PANalyze:PWR<x>:I?	Queries all settings related to power supply analysis current input channels.	58
:PANalyze:PWR<x>:I:PROBe?	Queries all settings related to the current-to-voltage conversion ratio of the probe that is connected to the power supply analysis current input channel.	58
:PANalyze:PWR<x>:I:PROBe:AUTO?	Queries the current-to-voltage conversion ratio of the probe that is connected to the power supply analysis current input channel during AUTO mode.	59
:PANalyze:PWR<x>:I:PROBe[:MODE]	Sets the current-to-voltage conversion ratio of the probe that is connected to the power supply analysis current input channel or queries the current setting.	59
:PANalyze:PWR<x>:Mode	Sets active/reactive power supply analysis or queries the current setting.	59
:PANalyze:PWR<x>:U?	Queries all settings related to the power supply analysis voltage input channel.	59
:PANalyze:PWR<x>:U:PROBe?	Queries all settings related to the attenuation of the probe that is connected to the power supply analysis voltage input channel.	59
:PANalyze:PWR<x>:U:PROBe:AUTO?	Queries the attenuation of the probe that is connected to the power supply analysis voltage input channel during AUTO mode.	59
:PANalyze:PWR<x>:U:PROBe[:MODE]	Sets the attenuation of the probe that is connected to the power supply analysis voltage input channel or queries the current setting.	59

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 or 2

:ANALysis:HARMonics<x>:CCLass?

Function Queries all settings related to harmonic computation class C.

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

: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 or 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 or 2
<NRf>, <current> = 0.001 to 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 or 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 or 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 or 2

: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 or 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 or 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 or 2

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

Function Queries the harmonic computation list display items.

Syntax
```
:ANALysis:HARMonics<x>:LIST:ITEM?
```
<x> = 1 or 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 or 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 or 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 or 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 or 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 or 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 or 2
<NRf>, <voltage> = 90 to 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 or 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 or 2
<x> of TRACe<x> = 1 to 4
<x> of AREA<x> = 1 or 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
```

Description
- 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)
```

Description
- 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 Description 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 or 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
<x> of TRACe<x> = 1 to 4
<x> of AREA<x> = 1 or 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
```

Description
- 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>)|(<volta
ge>,<voltage>)|(<current>,<current>)}
:HISTory[:CURRent][:SEARch]:SELect<x>:
PARameter:MEASure:TRACe<x>:AREA<x>:
TYPE:<parameter>?
```
SELect<x>: <x> = 1 to 4
<x> of TRACe<x> = 1 to 4
<x> of AREA<x> = 1 or 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
```

Description
- 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

: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,<NRf>|POWer,<NRf>,<NRf>|Z,<NRf>,<NRf>|USERdefine}`
`:MATH<x>:OPERation?`

<x> = 1 to 4

<NRf> = 1 to 4

Example `:MATH1:OPERATION I2T,2`
`:MATH1:OPERATION?`
`-> :MATH1:OPERATION I2T,2`

Description
- 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 or 2

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

Description 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 S, P, Q, Z, λ, 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?
```
<x> of TRACe<x> = 1 to 4
<x> of AREA<x> = 1 or 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
```

Description
- 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}?
```
<x> of TRACe<x> = 1 to 4
<x> of AREA<x> = 1 or 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
```

Description
- 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?
```
<x> of TRACe<x> = 1 to 4
<x> of AREA<x> = 1 or 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
```

Description
- 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>:VALue?

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

Syntax
```
:MEASure:TRACe<x>:AREA<x>:
<parameter>:VALue? {<NRf>}
```
<x> of TRACe<x> = 1 to 4
<x> of AREA<x> = 1 or 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
```

Description
- 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
```

: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
<x> of AREA<x> = 1

: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
<x> of AREA<x> = 1
<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
```

Description The first <NRf> corresponds to 100% level, and the second <NRf> corresponds to 0% level.

: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
<x> of AREA<x> = 1

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
<x> of AREA<x> = 1

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
<x> of AREA<x> = 1

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
<x> of AREA<x> = 1

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
<x> of AREA<x> = 1

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
<x> of AREA<x> = 1

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
<x> of AREA<x> = 1
<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 reference level for the switching-loss measurement 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
<x> of AREA<x> = 1
<NRf> = 0 to 100(%)

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

Description The first <NRf> corresponds to the voltage reference level, and the second <NRf> corresponds to the current reference level.

: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
<x> of AREA<x> = 1
<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
```

Description The first <NRf> corresponds to 100% level, and the second <NRf> corresponds to 0% level.

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

Function Queries all settings related to the total loss measurement.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:TSWLoss?
```
<x> of TRACe<x> = 1 to 8
<x> of AREA<x> = 1

Example
```
:MEASURE:TRACE1:AREA1:TSWLOSS?
-> :MEAS:TRAC1:AREA1:TSWL:DTYP IGBT;ILEV 0.000E+00;MODE 0;RDS 20.00E-03;ULEV 0.000E+00;VCE 2.000E+00
```

:MEASure:TRACe<x>:AREA<x>:TSWLoss:DTYPe

Function Sets the device type for the total loss measurement or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:TSWLoss:DTYPe {IGBT|MOSFET}
:MEASure:TRACe<x>:AREA<x>:TSWLoss:DTYPe?
```
<x> of TRACe<x> = 1 to 8
<x> of AREA<x> = 1

Example
```
:MEASURE:TRACE1:AREA1:TSWLOSS:DTYPE IGBT
:MEASURE:TRACE1:AREA1:TSWLOSS:DTYPE?
-> :MEASURE:TRACE1:AREA1:TSWLOSS:DTYPE IGBT
```

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

Function Sets the current level that the DL6000/DLM6000 will assume the current to be zero in the total loss measurement or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:TSWLoss:
ILEVel {<current>}
:MEASure:TRACe<x>:AREA<x>:TSWLoss:
ILEVel?
```
<x> of TRACe<x> = 1 to 8
<x> of AREA<x> = 1
<current> = See section 12.

Example
```
:MEASURE:TRACE1:AREA1:TSWLOSS:
ILEVEL 1A
:MEASURE:TRACE1:AREA1:TSWLOSS:ILEVEL?
-> :MEASURE:TRACE1:AREA1:TSWLOSS:
ILEVEL 1.000E+00
```

:MEASure:TRACe<x>:AREA<x>:TSWLoss:MODE

Function Enables or disables the total loss measurement or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:TSWLoss:
MODE {<Boolean>}
:MEASure:TRACe<x>:AREA<x>:TSWLoss:
MODE?
```
<x> of TRACe<x> = 1 to 8
<x> of AREA<x> = 1

Example
```
:MEASURE:TRACE1:AREA1:TSWLOSS:MODE ON
:MEASURE:TRACE1:AREA1:TSWLOSS:MODE?
-> :MEASURE:TRACE1:AREA1:TSWLOSS:
MODE 1
```

:MEASure:TRACe<x>:AREA<x>:TSWLoss:RDS

Function Sets the on-resistance for the total loss measurement or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:TSWLoss:
RDS {<NRf>}
:MEASure:TRACe<x>:AREA<x>:TSWLoss:RDS?
```
<x> of TRACe<x> = 1 to 8
<x> of AREA<x> = 1
<NRf> = 0 to 50 (in 1-mΩ steps)

Example
```
:MEASURE:TRACE1:AREA1:TSWLOSS:RDS 1
:MEASURE:TRACE1:AREA1:TSWLOSS:RDS?
-> :MEASURE:TRACE1:AREA1:TSWLOSS:
RDS 1.000E+00
```

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

Function Sets the voltage level used to calculate the total loss in correction mode or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:TSWLoss:
ULEVel {<voltage>}
:MEASure:TRACe<x>:AREA<x>:TSWLoss:
ULEVel?
```
<x> of TRACe<x> = 1 to 8
<x> of AREA<x> = 1
<voltage> = See section 12.

Example
```
:MEASURE:TRACE1:AREA1:TSWLOSS:
ULEVEL 1V
:MEASURE:TRACE1:AREA1:TSWLOSS:ULEVEL?
-> :MEASURE:TRACE1:AREA1:TSWLOSS:
ULEVEL 1.000E+00
```

:MEASure:TRACe<x>:AREA<x>:TSWLoss:VCE

Function Sets the saturation voltage drop for the total loss measurement or queries the current setting.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:TSWLoss:
VCE {<NRf>}
:MEASure:TRACe<x>:AREA<x>:TSWLoss:VCE?
```
<x> of TRACe<x> = 1 to 8
<x> of AREA<x> = 1
<voltage> = 0 to 50 V (in 100-mV steps)

Example
```
:MEASURE:TRACE1:AREA1:TSWLOSS:VCE 1V
:MEASURE:TRACE1:AREA1:TSWLOSS:VCE?
-> :MEASURE:TRACE1:AREA1:TSWLOSS:
VCE 1.000E+00
```

:MEASure:TRACe<x>:AREA<x>:WPUNit

Function Sets or queries the power unit.

Syntax
```
:MEASure:TRACe<x>:AREA<x>:WPUNit {J|WH}
:MEASure:TRACe<x>:AREA<x>:WPUNit?
```
<x> of TRACe<x> = 1 to 8
<x> of AREA<x> = 1

Example
```
:MEASURE:TRAC1:AREA1:WPUNIT WH
:MEASURE:TRAC1:AREA1:WPUNIT?
-> :MEASURE:TRAC1:AREA1:WPUNIT WH
```

PANalyze Group

:PANalyze?

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

Syntax `:PANalyze?`

: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

: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 or 2

: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 or 2

:PANalyze:PWR<x>:DESKew:AEXeute

Function Executes power supply analysis auto skew correction.

Syntax `:PANalyze:PWR<x>:DESKew:AEXeute`
<x> = 1 or 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 or 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>?
```
<x> of PWR<x> = 1 or 2
<x> of TIME<x> = 1 or 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 or 2

:PANalyze:PWR<x>:I:PROBe?

Function Queries all settings related to the current-to-voltage conversion ratio of the probe that is connected to the power supply analysis current input channel.

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

:PANalyze:PWR<x>:I:PROBe:AUTO?

Function Queries the current-to-voltage conversion ratio of the probe that is connected to the power supply analysis current input channel during AUTO mode.

Syntax `:PANalyze:PWR<x>:I:PROBe:AUTO?`
<x> = 1 or 2

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

:PANalyze:PWR<x>:I:PROBe[:MODE]

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

Syntax `:PANalyze:PWR<x>:I:PROBe`
`[:MODE] {AUTO|C1|C10|C100}`
`:PANalyze:PWR<x>:I:PROBe[:MODE]?`
<x> = 1 or 2

Example `:PANALYZE:PWR1:I:PROBE:MODE AUTO`
`:PANALYZE:PWR1:I:PROBE:MODE?`
`-> :PANALYZE:PWR1:I:PROBE:MODE AUTO`

: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 or 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 or 2

:PANalyze:PWR<x>:U:PROBe?

Function Queries all settings related to the attenuation of the probe that is connected to the power supply analysis voltage input channel.

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

:PANalyze:PWR<x>:U:PROBe:AUTO?

Function Queries the attenuation of the probe that is connected to the power supply analysis voltage input channel during AUTO mode.

Syntax `:PANalyze:PWR<x>:U:PROBe:AUTO?`
<x> = 1 or 2

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

:PANalyze:PWR<x>:U:PROBe[:MODE]

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

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

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

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
	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
MATH/REF		
	Mode	OFF
ACQ		
	Mode	Normal
	Record Len	12.5 k
	Interpolation	OFF
	Repetitive	ON
	Interleave	OFF
TIME/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
DISPLAY		
	Format	Single

Appendix 2 Record Length and TIME/DIV Settings That Allow Waveform Computation of Harmonics

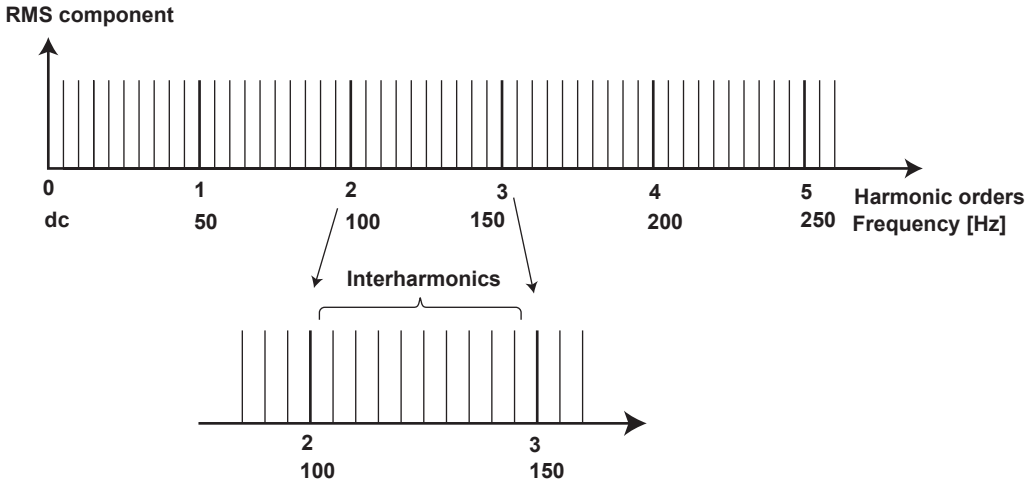
The record lengths and T/div settings that allow waveform computation of harmonics are as follows.

	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

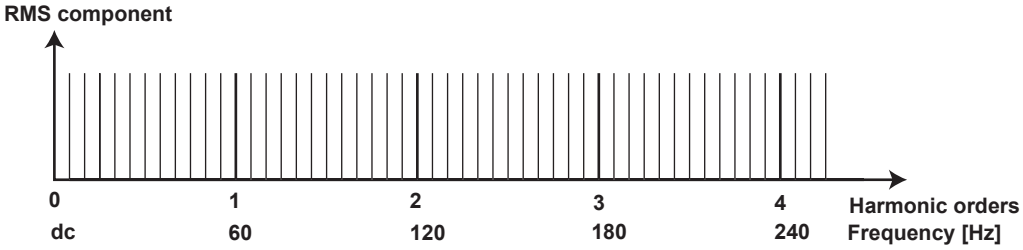
Appendix 3 Interharmonics and Groups

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.

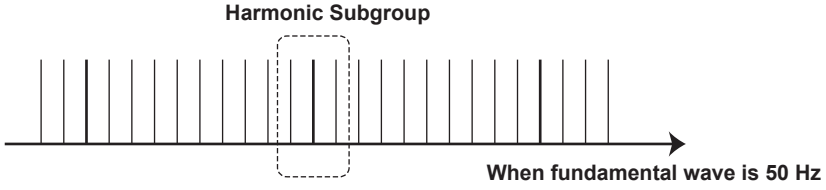


If the input signal is 60 Hz, twelve periods of the waveform are divided in 5-Hz resolution. Thus, the section between each harmonic order is divided into twelve sections.



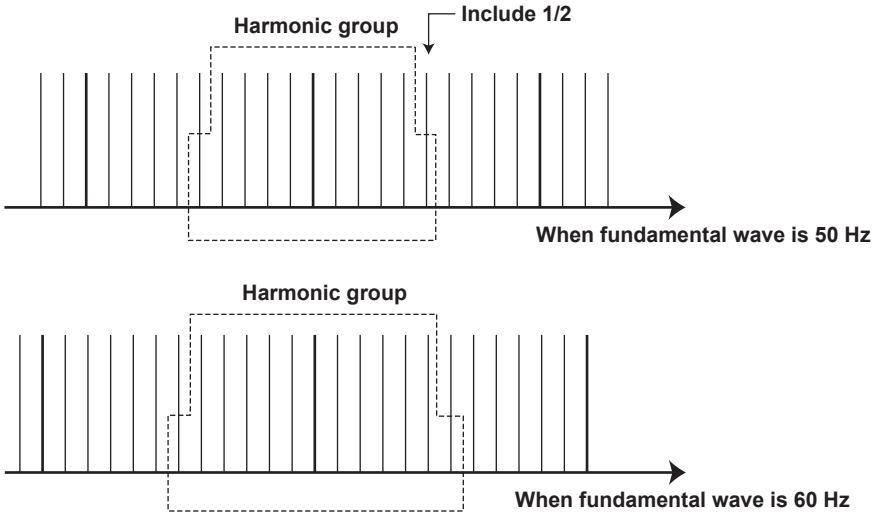
Harmonic Subgroup

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

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

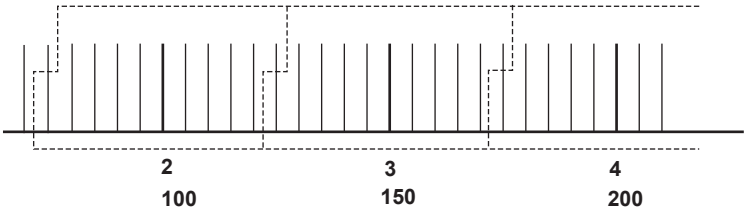
When frequency of item under test is 60 Hz

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

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.

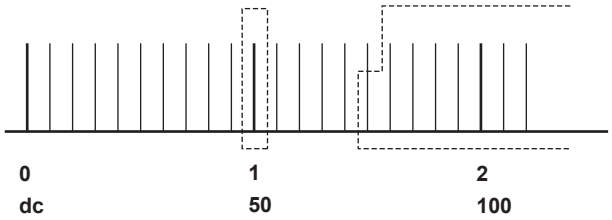
- 1/2 of the 125-Hz component — The other 1/2 is included in the 2nd order (100-Hz) component.
- 130-Hz component
- 135-Hz component
- 140-Hz component
- 145-Hz component
- 150-Hz component — 3rd order harmonic
- 155-Hz component
- 160-Hz component
- 165-Hz component
- 170-Hz component
- 1/2 of the 175-Hz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