User's Manual

Model 707702 Computation Function Setup Software

Yokogawa Meters & Instruments Corporation

IM 707702-61E
2nd Edition

Foreword

Thank you for purchasing the Computation Function Setup Software (Model: 707702). This User's Manual contains useful information about the operations and functions of the software.

To ensure correct use, please read this manual thoroughly before operating the software. Keep this manual in a safe place for quick reference in the event a question arises.

The computation functions provided by this software serve to extend the capabilities of the WE7000 Control Software's Waveform Monitor or Viewer. The functions and operating procedures of the WE7000 Control Software are described in the User's Manual listed below.

Manual Title	Manual No.	Description
WE7000 User's Manual	IM707001-01E	Included with the Measuring Station WE800/ WE400

This package contains the following items:
- Computation Function Setup Software (Model: 707702) setup disk: 1 floppy disk
- User's Manual IM707702-61E (this manual): 1 piece

Notes

- The WE7000 Control Software (Ver. 4.0.3.0 or later) must be installed on the PC in order to use the Computation Function Setup Software (Model: 707702)
- The contents of this manual describe Version 1.03 of the Computation Function Setup Software (Model: 707702). If you are using another version of the software, the operating procedures and/or figures given in this manual may differ from those corresponding to your version of the software.
- The contents of this manual are subject to change without prior notice as a result of continuing improvements to the instrument's performance and functions.
- 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 as listed on the back cover of this manual.
- Copying or reproducing all or any part of the contents of this manual without YOKOGAWA's permission is strictly prohibited.

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Revisions

1st edition: February 2000
2nd edition: January 2001

Disk No. WE13
2nd Edition: January 2001 (YK)
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Notes on Using This Product

Storing and Backing Up the Setup Disk

Please store the original setup disk (floppy disk) in a safe place. Back up the contents of the setup disk to another floppy disk (2HD: 1.44 MB). Use the backup copy for all future operations including installation to the hard disk.

Agreement

Restriction on Use

Use of this software by more than one computer at the same time is prohibited. Use by more than one user is also prohibited.

Transfer and Lending

Transfer or lending of this product to any third party is prohibited.

Guarantee

Should a physical deficiency be found on the original setup disk or this manual upon opening the product package, please promptly inform Yokogawa. The claim must be made within seven days from the date you received the product in order to receive a replacement free of charge.

Exemption from Responsibility

Yokogawa Electric Corporation provides no guarantees other than for physical deficiencies found on the original setup disk or this manual upon opening the product package. Yokogawa Electric Corporation shall not be held responsible by any party for any losses or damage, direct or indirect, caused by the use or any unpredictable defect of the product.

Conventions Used in this Manual

Unit

k: Denotes 1000. Example: 100 kHz
K: Denotes 1024. Example 720 KB

Displayed Characters

Alphanumeric characters enclosed with [ ] usually refer to characters or setting values that are displayed on the screen.

Symbols

Note   Provides important information for the proper operation of the software.

PC System Requirements

Hardware

PC

PC on which Windows 95/98/Me, Windows NT4.0, Windows 2000 Pro runs.
CPU: Pentium 133 MHz or higher

Internal Memory

48 MB or more (64 MB or more recommended)

Hard Disk

Free space of at least 20 MB.

Drive

One 3.5-inch floppy disk drive. The disk drive is used to install the software.

Display

Display supported by Windows95/98/Me, Windows NT4.0, or Windows 2000 Pro with a resolution of 800×600 or better. Analog RGB with 65,536 colors or more recommended.

Operating System

Microsoft Windows 95/98/Me, Windows NT4.0, Windows 2000 Pro.

Contents

Setting Up the Computation Function in the WE7000 Control Software

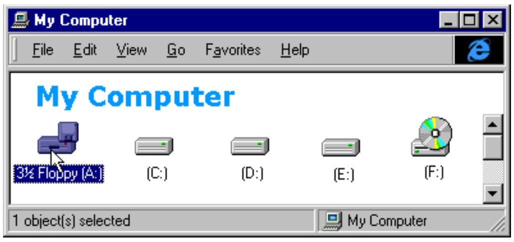
Before Installation

The WE7000 Control Software (Ver. 4.0.3.0 or later) must already be installed on the PC on which this software is being installed.

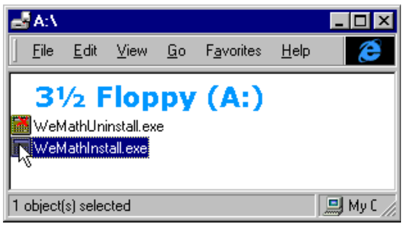
Have the setup disk (backup copy) ready. Exit all programs that are currently running before starting the installation.

Procedure

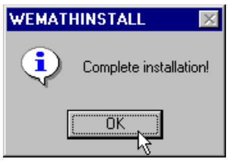
1. Start Windows.
2. Insert the setup disk in the floppy disk drive.
3. Select the floppy disk drive and display the file list.



4. Double-click “WeMathInstall.exe.”



If the following dialog box appears, the installation is complete.



5. Click the [OK] button to exit the installation program.

Note

In order to uninstall the computation function from the WE7000 Control Software, double-click “WeMathUninstall.exe” on the floppy disk. The following dialog box appears when the uninstallation is complete.

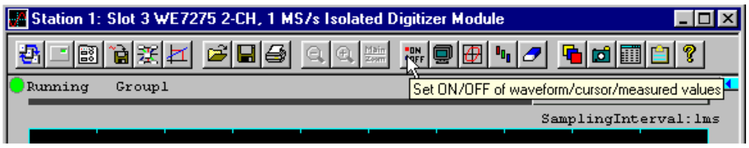
Checking the Computation Function Setup

The computation function is integrated as a function of the Waveform Monitor and Viewer.

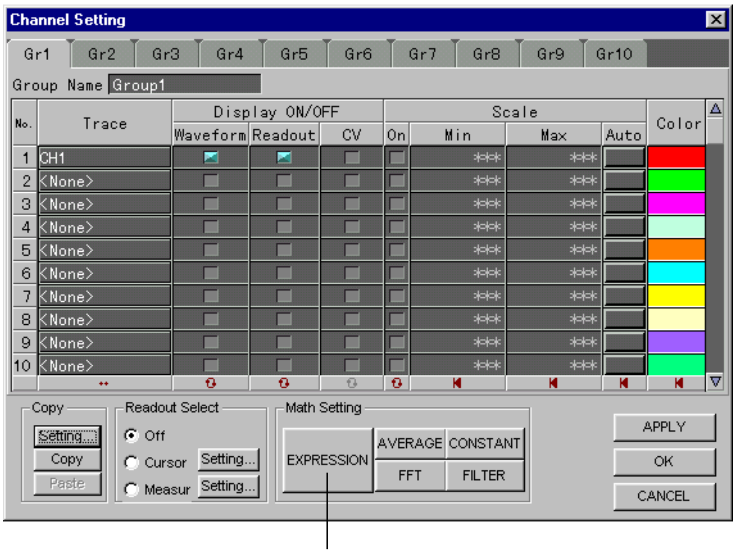
Note

There is no averaging function on the Viewer.

Open the Waveform Monitor and click the  button.



The [Channel Setting] dialog box below appears.
As shown in the figure below, check that [Math Setting] is activated.



[Math Setting] is activated

1.1 Overview of Functions

User-defined Computation

The following variables and operators can be combined to create an equation. The resulting computed waveform can then be displayed.

Variables

Variable	Example	Description
Cx	C1+C2	The measured value of the specified channel, CHx.
Mx	ABS(M1)	Computed (Math) value.
T	SIN(T)	The accumulated value of the number of data points on the time axis.

X: Number

Operators

If the acquisition mode is set to Free Run, the computed waveform that uses the operators in the table below starting with BIN cannot be displayed while the measurement is in progress. A and B represent the Upper and Lower threshold levels, respectively.

Operator	Example	Description
+, - , *, /	C1+C2	Four arithmetical operations of the two specified waveforms
ABS	ABS(M1)	The absolute value of the specified waveform
SQRT	SQRT(C2)	The square root of the specified waveform
LOG	LOG(C1)	The logarithm of the specified waveform
EXP	EXP(C1)	The exponent of the specified waveform
SIN	SIN(T)	The sine of the specified waveform
COS	COS(C1)	The cosine of the specified waveform
TAN	TAN(C1)	The tangent of the specified waveform
ATAN	ATAN(C1, C2)	The arc tangent of the two specified waveforms (a value within $\pm\pi$)
P2	P2(C1)	The square of the specified waveform
P3	P3(C1)	The cube of the specified waveform
F1	F1(C1, C2)	$\sqrt{\lvert C1^2+C2^2 \rvert}$ of the specified waveforms
F2	F2(C1, C2)	$\sqrt{\lvert C1^2-C2^2 \rvert}$ of the specified waveforms
K1-10	C1+K1	Constants (assign an arbitrary value)
BIN	BIN(C1, A, B)	The binary conversion of the specified waveform
PWHH	PWHH(M1, A, B)	Pulse width computation from the rising edge to the next rising edge.
PWHL	PWHL(C2, A, B)	Pulse width computation from the rising edge to the next falling edge.
PWLH	PWLH(C1, A, B)	Pulse width computation from the falling edge to the next rising edge.
PWLL	PWLL(C1, A, B)	Pulse width computation from the falling edge to the next falling edge.
PWXX	PWXX(C2, A, B)	Pulse width computation from the rising or falling edge to the next rising or falling edge
MEAN	MEAN(C1)	The 10th order moving average of the specified waveform
DIF	DIF(C1)	The derivative of the specified waveform
DDIF	DDIF(C1)	The second order derivative of the specified waveform
INTG	INTG(C1)	The integration of the specified waveform
IINTG	IINTG(C1)	The secondary integration of the specified waveform
PH	PH(C1, C2)	The phase difference between the two specified waveforms
HLBT	HLBT(C1)	The Hilbert transform of the specified waveform
FILT1	FILT1(C1)	Apply a filter to the specified waveform
FILT2	FILT2(C1)	Apply a filter to the specified waveform
LS-REAL	LS-REAL(C1)	The real part of the specified waveform’s linear spectrum
LS-IMAG	LS-IMAG(C1)	The imaginary part of the specified waveform’s linear spectrum
LS-MAG	LS-MAG(C1)	The amplitude of the specified waveform’s linear spectrum
LS-LOGMAG	LS-LOGMAG(C1)	The logarithmic amplitude of the specified waveform’s linear spectrum
LS-PHASE	LS-PHASE(C1)	The phase of the specified waveform’s linear spectrum
RS-RS-MAG	RS-MAG(C1)	The amplitude of the specified waveform’s rms spectrum

Operator	Example	Description
RS-LOGMAG	RS-LOGMAG(C1)	The logarithmic amplitude of the specified waveform's rms spectrum
PS-MAG	PS-MAG(C1)	The amplitude of the specified waveform's power spectrum
PS-LOGMAG	PS-LOGMAG(C1)	The logarithmic amplitude of the specified waveform's power spectrum
PSD-MAG	PSD-MAG(C1)	The amplitude of the specified waveform's power spectrum density
PSD-LOGMAG	PSD-LOGMAG(C1)	The logarithmic amplitude of the specified waveform's power spectrum density
CS-REAL	CS-REAL(C1, C2)	The real part of the cross spectrum of the two specified waveforms
CS-IMAG	CS-IMAG(C1, C2)	The imaginary part of the cross spectrum of the two specified waveforms
CS-MAG	CS-MAG(C1, C2)	The amplitude of the cross spectrum of the two specified waveforms
CS-LOGMAG	CS-LOGMAG(C1, C2)	The logarithmic amplitude of the cross spectrum of the two specified waveforms
CS-PHASE	CS-PHASE(C1, C2)	The phase of the cross spectrum of the two specified waveforms
TF-REAL	TF-REAL(C1, C2)	The real part of the transfer function of the two specified waveforms
TF-IMAG	TF-IMAG(C1, C2)	The imaginary part of the transfer function of the two specified waveforms
TF-MAG	TF-MAG(C1, C2)	The amplitude of the transfer function of the two specified waveforms
TF-LOGMAG	TF-LOGMAG(C1, C2)	The logarithmic amplitude of the transfer function of the two specified waveforms
TF-PHASE	TF-PHASE(C1, C2)	The phase of the transfer function of the two specified waveforms
CH-MAG	CH-MAG(C1, C2)	The amplitude of the coherence function of the two specified waveforms

Averaging

The measured waveform (before computation) and computed waveform are averaged (linearly averaged/exponentially averaged) or their peaks are computed. The resultant waveform is displayed. However, this is possible only when the acquisition mode is set to some mode other than free run and memory partition is disabled.

Note

There is no averaging function on the Viewer.

Linear Averaging

The specified number (averaging block length) of values are linearly summed and then divided by the number of points summed. The averaging block length can be in the range from 2 to 65536. The resultant waveform is displayed.

$$A_N = \frac{\sum_{n=1}^{N} X_n}{N}$$

Xn : nth measured value
N : averaging block length

Exponential Averaging

The average is determined by attenuating the effects of past data according to the specified attenuation constant (2 to 256, in 2^n steps). The resultant waveform is displayed.

$$An = \frac{1}{N}\{(N-1)A_{n-1}+X_n\}$$

An : nth averaged value
Xn : nth measured value
N : Attenuation constant

Peak Hold

The maximum value, among data located at the same time/frequency axis position of the waveform being updated using triggers or other events, is determined. The resultant waveform is displayed. For every computation, the new value is compared to the past value and the larger one is displayed.

Saving the Computed Waveform Data

Like the measured waveform, the user-defined computation waveform, average waveform, and peak-held waveform can be saved to a file.

Automated Measurement of Waveform Parameters

The twenty types of waveform parameter measurements (see page 2-6), that were previously only possible on the digital oscilloscope, can now, with the addition of this software, be performed on data from other modules. In addition, the range over which the waveform parameters are measured can be specified using cursors. The measurement results can be saved to a file.

1.2 Details of Various Computations

Filter (FILT1/FILT2)

Type

Type	Bandwidth
Gauss	Lowpass
Sharp	Lowpass/Highpass/Bandpass
IIR (Butterworth)	Lowpass/Highpass/Bandpass

Filter Orders

See the following table for the filter orders.

Cutoff frequency/sampling frequency × 100		2%	5%	10%	20%	30%
Gauss	Lowpass	49	21	9	5	5
Sharp	Lowpass	88	36	18	9	8
	Highpass	159	65	33	17	13
IIR	Lowpass	4	4	4	3	2
	Highpass	4	4	4	4	3

Note

- You can set the cutoff frequency in the range from 2 to 30% of the sampling frequency (in 0.2% steps).
- The higher the filter order, the longer computation takes.

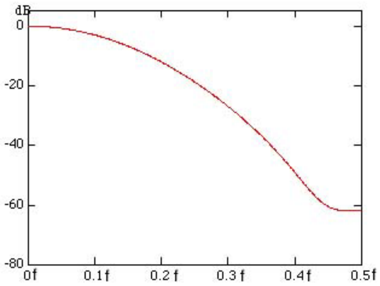
Filter Characteristics

Filter	Passband Ripple	Attenuation slope	Attenuation in the Stopband	Phase
Gauss	0 dB	*	-	Linear
Sharp	±0.3 dB	–40 dB at 1 oct (Lowpass), –40 dB at –1 oct (Highpass)	–40 dB	Linear
IIR	0 dB	–5 dB at 1/6 oct (Lowpass), –20 dB at –1 oct (Highpass)	-	Non-linear

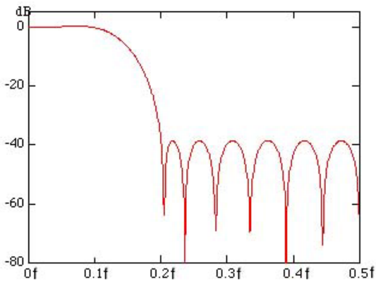
* Attenuation for a Gauss filter is $-3.0\times(f/fc)^2$ dB (where f is the frequency and fc is the cutoff frequency).

Examples of Frequency Characteristics for Various Filters

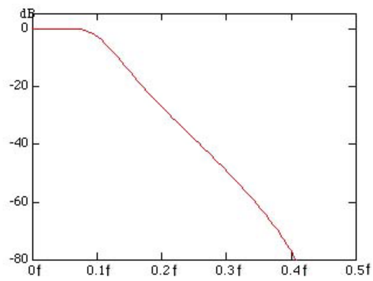
Gauss (cutoff 10%)



Sharp (Lowpass, cutoff 10%)



IIR (Lowpass, cutoff 10%)



f: Sampling frequency (Hz)

Hilbert Function (HLBT)

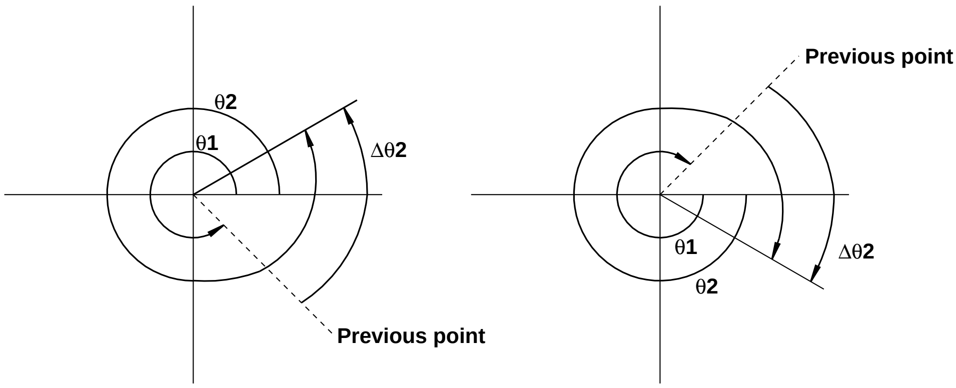
Normally, when we analyze a real time signal, it is convenient to think of the signal as the real part of a complex valued signal. Analysis is often more convenient when done using the complex signal. Given that the real time signal is considered to be the real part of the complex signal, the imaginary part is then equal to the Hilbert transform of the real part. When performing a Hilbert transform on a signal in the time domain, the signal is first transformed into the frequency domain using the Fourier transform. Next, the phase of each frequency component is shifted by -90 degrees if the frequency is positive and +90 degrees if negative. Lastly, the Hilbert transform is completed by taking the inverse Fourier transform. As can be seen from the above description, the Hilbert transform does not change the order of the individual variables. The Hilbert transform of a time signal results in another time signal.

Application Example

The Hilbert transform can be used to analyze an envelope waveform.
AM (amplitude modulation): SQRT(C1*C1+HLBT(C1)*HLBT(C1))
Demodulation of a FM signal: DIF(PH(C1, HLBT(C1)))

Phase Function (PH)

Phase function PH(C1, C2) computes $\tan^{-1}$ (C1/C2). However, the phase function takes the phase of the previous point into consideration and continues to sum even when the value exceeds $\pm\pi$ (The ATAN function reflects at $\pm\pi$). The unit is radians.

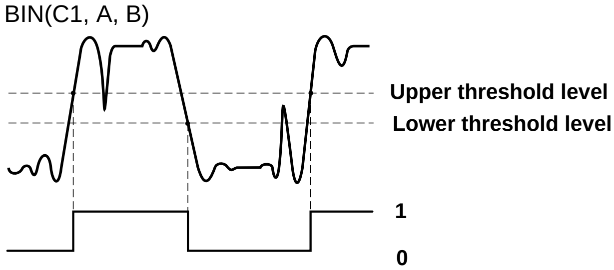


$\theta 2 = \theta 1 + \Delta\theta 2$　　　$\theta 2 = \theta 1 - \Delta\theta 2$

Binary Conversion (BIN)

Performs binary conversion with respect to the specified threshold level.

The threshold level is specified as follows:
A and B represent the Upper and Lower threshold levels, respectively.
BIN(C1, A, B)



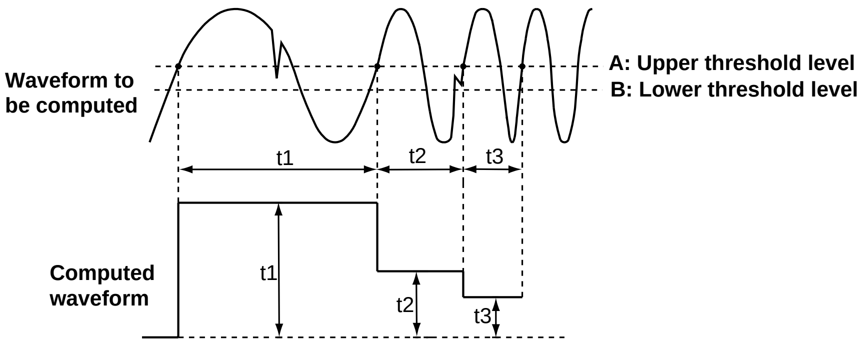
Pulse Width Computation (PWHH/PWHL/PWLH/PWLL/PWXX)

The signal is converted into binary values by comparing to a preset threshold level, and the time of the pulse width is plotted as the Y-axis value for that interval.

The following 4 intervals are available:
PWHH: From the rising edge to the next rising edge.
PWHL: From the rising edge to the next falling edge.
PWLH: From the falling edge to the next rising edge.
PWLL: From the falling edge to the next falling edge.
PWXX: From the rising or falling edge to the next rising or falling edge.

The threshold level is specified as follows:
A and B represent the Upper and Lower threshold levels, respectively.
PWHH (C1, A, B)

When the Interval is Set to PWHH



FFT

Linear Spectrum (LS-REAL/LS-IMAG/LS-MAG/LS-LOGMAG/LS-PHASE)

The linear spectrum is directly determined by the FFT. The power spectrum and cross spectrum can be determined from one or two linear spectra.

The FFT is a complex function, and thus the linear spectrum is composed of both a real and an imaginary part. The magnitude and phase of the frequency components of the measured waveform can be derived from the real and imaginary parts of the FFT result. The following spectra can be determined:

Item	Expression	Computation
Real part	LS-REAL	R
Imaginary part	LS-IMAG	I
Magnitude	LS-MAG	$\sqrt{(R^2+I^2)}$
Log magnitude	LS-LOGMAG	$20\times\log\sqrt{(R^2+I^2)}$
Phase	LS-PHASE	$\tan^{-1}(I/R)$

Log magnitude reference (0 dB): 1 Vpeak
R, I: R and I represent the real part and the imaginary part, respectively, when each frequency component G of a linear spectrum is represented by "R+jI."

Rms Value Spectrum (RS-RS-MAG/RS-LOGMAG)

Rms value spectrum expresses the rms value of the magnitude of the linear spectrum. It does not contain phase information.

The following spectra can be determined:

Item	Expression	Computation
Magnitude	RS-MAG	$\sqrt{(R^2+I^2)/2}$
Log magnitude	RS-LOGMAG	$20\times\log\sqrt{(R^2+I^2)/2}$

Log magnitude reference (0 dB): 1 Vrms

Power Spectrum (PS-MAG/PS-LOGMAG/PSD-MAG/PSD-LOGMAG)

The power spectrum expresses the power of each frequency component included in the measured signal. It is determined by taking the product of the linear spectrum and its complex conjugate. It does not contain phase information.

The following spectra can be determined:

Item	Expression	Computation
Magnitude	PS-MAG	$(R^2+I^2)/2$
Log magnitude	PS-LOGMAG	$10*\log(R^2+I^2)/2$

Log magnitude reference (0 dB): 1 $Vrms^2$

Power Spectral Density (PSD-MAG/PSD-LOGMAG)

The power spectral density (PSD) expresses the power spectrum per unit frequency. It is determined by dividing the power spectrum by the frequency resolution Δf found during the analysis of the power spectrum. The results of the PSD computation vary depending on the window function chosen. The power spectral density is used to compare power spectra analyzed at different frequency bands. However, it is not necessary for signals having a line spectrum such as a sine wave.

The following spectra can be determined:

Item	Expression	Computation
Magnitude	PSD-MAG	PS-MAG/Δf (for rectangular window) PS-MAG/1.5Δf (for Hanning window)
Log magnitude	PSD-LOGMAG	10×logPS-MAG/Δf (for rectangular window) 10×logPS-MAG/1.5Δf (for Hanning window)

Log magnitude reference (0 dB): 1 $Vrms^2$

Cross Spectrum (CS-REAL/CS-IMAG/CS-MAG/CS-LOGMAG/CS-PHASE)

The cross spectrum is determined from 2 signals. It is found by taking the product of the linear spectrum of one signal(Gx) and the complex conjugate (Gx*) of the linear spectrum of the other signal (Gy).

If the linear spectra of the 2 signals are represented by

Gx=Rx+jIx

Gy=Ry+jIy

then the cross spectrum Gyx is

Gyx=Gy×Gx*

=(Ry+jIy)(Rx-jIx)=Ryx+jIyx

where Ryx=RyRx+IyIx

Iyx=RxIy-RyIx

The following spectra can be determined:

Item	Expression	Computation
Real part	CS-REAL	Ryx/2
Imaginary part	CS-IMAG	Iyx/2
Magnitude	CS-MAG	$\sqrt{(Ryx^2+Iyx^2)}/2$
Log magnitude	CS-LOGMAG	$10\times\log\sqrt{(Ryx^2+Iyx^2)}/2$
Phase	CS-PHASE	$\tan^{-1}(Iyx/Ryx)$

Transfer Function (TF-REAL/TF-IMAG/TF-MAG/TF-LOGMAG/TF-PHASE)

The transfer function expresses the frequency characteristics between the input and the output of a system. The transfer function is given by the ratio of the linear spectrum of the output(Gy) to the spectrum of the input(Gx) at each frequency. Also, as can be seen from the equation below, the transfer function can be defined as the ratio of the cross spectrum of the input and output (Gyx) and the input power spectrum (Gxx).

Transfer Function = $Gy/Gx = (Gy \times Gx^*)/(Gx \times Gx^*) = Gyx/Gxx = (Ryx+jIyx)/(Rx^2+Ix^2)$

The following items can be determined:

Item	Expression	Computation
Real part	TF-REAL	$Ryx/(Rx^2+Ix^2)$
Imaginary part	TF-IMAG	$Iyx/(Rx^2+Ix^2)$
Magnitude	TF-MAG	$\sqrt{(Ryx^2+Iyx^2)}/(Rx^2+Ix^2)$
Log magnitude	TF-LOGMAG	$20 \times \log \sqrt{(Ryx^2+Iyx^2)}/(Rx^2+Ix^2)$
Phase	TF-PHASE	$\tan^{-1}(Iyx/Ryx)$

The magnitude of the transfer function gives the ratio of the magnitudes of the linear spectra of the output and input, whereas phase of the transfer function gives the phase difference between the two.

Coherence Function (CH-MAG)

This function expresses the ratio of the output power generated by the input to the system to the total output power.

Coherence function = $Gyx \times Gyx^*/(Gxx \times Gyy)$

Item	Expression	Computation
Magnitude	CH-MAG	$(Ryx^2+Iyx^2)/(Gxx \times Gyy)$

If the output signal is due entirely to the input signal, the coherence function becomes 1. As the ratio decreases, it falls below 1. Thus, the coherence function always takes on a value between 0 and 1.

Note

- On one data acquisition, the coherence function becomes 1 across all frequencies.
- The computed waveform must be averaged.

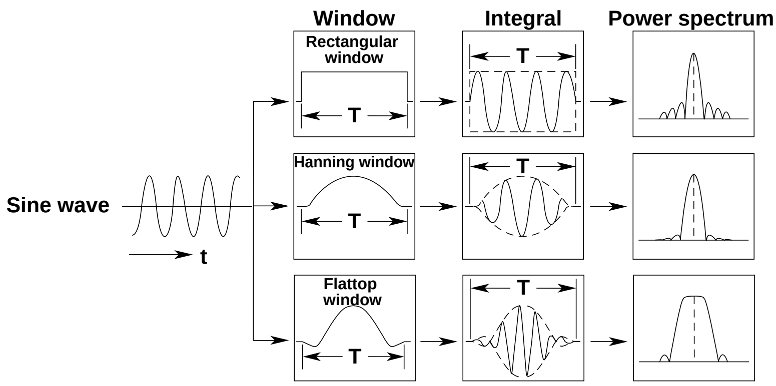
Number of Computed Points

You can select 1000 points, 2000 points, or 10000 points for the number of computed points.

About Time Windows

You can select rectangular, Hanning, or flattop as the time window.

The rectangular window is best suited to transient signals, such as an impulse wave, that attenuate completely within the time window. The Hanning window allows continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the "0" level. Hence, it is best suited to continuous signals. The frequency resolution of the Hanning window is higher compared with the Flattop window. However, the flattop window has a higher level of accuracy of the spectrum. When the waveform being analyzed is a continuous signal, consider the above characteristics when selecting the proper window to use.



Rectangular window : $W(t)=u(t)-u(t-T)$ U(t) : Step function

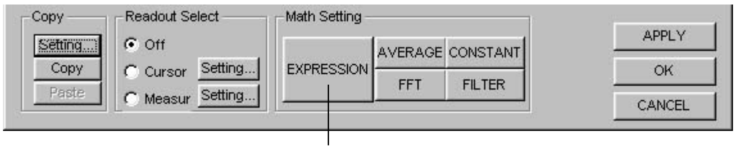
Hanning window : $W(t)=0.5-0.5\cos(2\pi \frac{t}{T})$

Flattop window : $W(t)=\{0.54-0.46\cos(2\pi \frac{t}{T})\} \frac{\sin\{2\pi(1-2t/T)\}}{2\pi(1-2t/T)}$

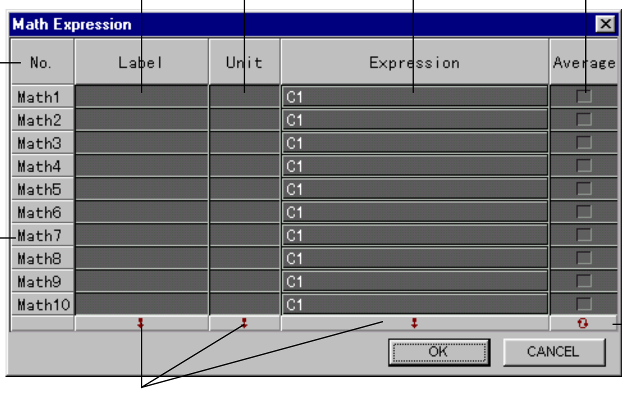
2.1 User-defined Computation

Procedure

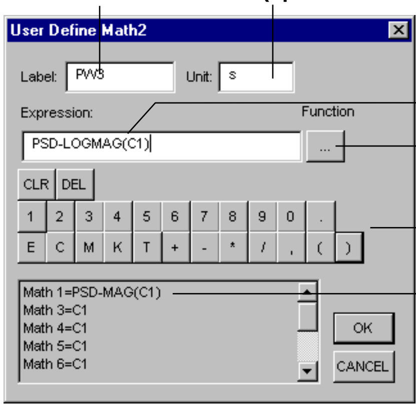
1. Click the [EXPRESSION] button of the [Channel Setting] dialog box.



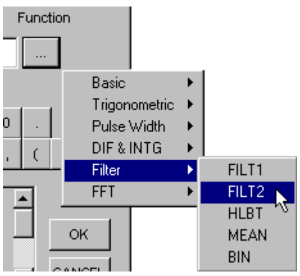
2. In the [Math Expression] dialog box below, set the expression, label, unit, and the ON/OFF condition of the averaging of the computed waveform.
   Up to 10 expressions can be specified.
   If you select multiple [Math] buttons by dragging the mouse (the characters of the selected button turn red) and click the copy & paste button, the first [Math] setting is copied to the other [Math] settings. If you click the Average all ON/OFF button, the averaging function of the selected [Math] settings are turn ON/OFF at once.



Click the expression setting box to display the following dialog box.



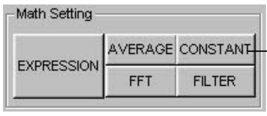
Displaying the Operator Selection Menu



In the menu, the operators are classified into the following groups:
Basic: ABS, SQRT, LOG, EXP, P2, P3, F1, F2
Trigonometric: SIN, COS, TAN, ATAN, PH
Pulse Width: PWHH, PWHL, PWLH, PWLL, PWXX
DIF & INTG: DIF, DDIF, INTG, IINTG
Filter: FILT1, FILT2, HLBT, MEAN, BIN
FFT > LS: LS-REAL, LS-IMAG, LS-MAG, LS-LOGMAG, LS-PHASE
RS: RS-MAG, RS-LOGMAG
PS: PS-MAG, PS-LOGMAG, PSD-MAG, PSD-LOGMAG
CS: CS-REAL, CS-IMAG, CS-MAG, CS-LOGMAG, CS-PHASE
TF: TF-REAL, TF-IMAG, TF-MAG, TF-LOGMAG, TF-PHASE
CH: CH-MAG

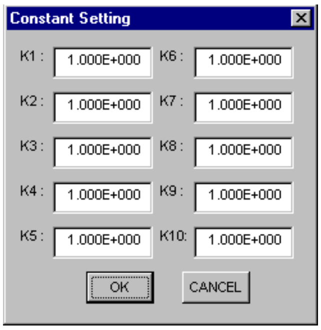
Setting the Constants K1 through K10

1. Click the [CONSTANT] button of the [Channel Setting] dialog box.



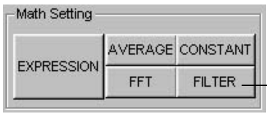
[CONSTANT] button

2. Set the necessary constants, K1 through K10, in the [Constant Setting] dialog box.
   The numerical range allowed is -1.0000E+30 to 1.0000E+30.



Setting the Filters (FILT1/FILT2)

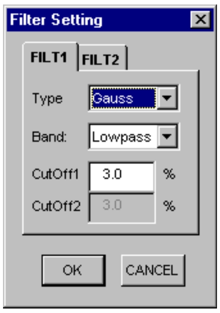
1. Click the [FILTER] button of the [Channel Setting] dialog box.



[FILTER] button

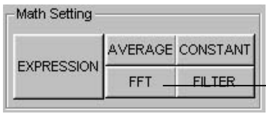
2. Set the [Type], [Band], and [CutOff1] in the [Filter Setting] dialog box.
   Select the type and bandwidth from the following list of choices:
   Gauss: Lowpass
   Sharp: Lowpass/Highpass/Bandpass
   IIR (Butterworth): Lowpass/Highpass/Bandpass

   The cutoff frequency is specified as a percentage of the sampling frequency. The range is from 2.0% to 30.0% (0.2% resolution). If the bandwidth is set to [Bandpass], specify both cutoff frequencies, [CutOff1] and [CutOff2].



Setting the FFT

1. Click the [FFT] button of the [Channel Setting] dialog box.



[FFT] button

2. Set the number of points to be computed [Points] and the time window [Window] in the [FFT Setting] dialog box.
   Select 1000 points, 2000 points, or 10000 points for the number of points to be computed. Select [Rect], [Hanning], or [FlatTop] for the time window.

Explanation

Operators and Variables

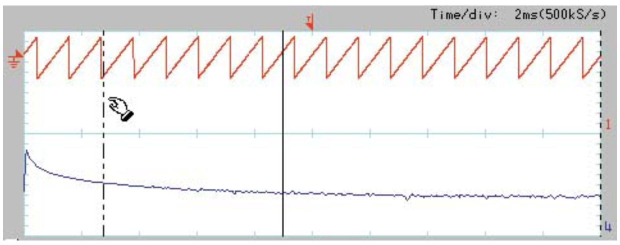
- For the operators and variables that can be used, see pages 1-1 and 1-2.
  If the acquisition mode is set to Free Run, a waveform that was computed using operators and variables other than the ones listed below cannot be displayed while the measurement is in progress. This is because the data being computed cannot be determined at that time. The computation is started when the measurement is stopped and the computed waveform is then displayed.
  +, - , *, /, ABS, SQRT, LOG, EXP, SIN, COS, TAN, ATAN, P2, P3, F1, F2, K1 to 10, Cx, Mx (x: number)
- For a detailed explanation of the filter, the Hilbert function, the phase function, the pulse width computation and the FFT, see pages 1-2 to 1-9.
- Up to 63 characters can be used to create an equation.

Limitations on Equations

- If m ≤ n, the variable Mn (computation of Mathn) cannot be included in the Mathm equation.
  Example of an illegal equation: Math5 = M6 + M3
- For a FFT, only one waveform can be specified.
  Example of an illegal equation: PS - MAG(C1+C2)
- Other computations cannot be performed on the result of the FFT.
  Example of an illegal equation: PS - MAG(C1) +C2
- Other computations cannot be performed on the result of the pulse width computation.
  Example of an illegal equation: PWHH(C1, 0.8, -0.8)+C2

Specifying the Start Position of the Computation

The start position of the computation can only be specified for FFTs. The start position of a FFT is specified by dragging the two-point dot-dash cursor that is displayed within the waveform display frame (see below). The initial position of the cursor is at the left end.



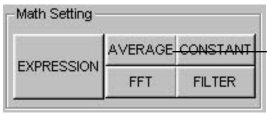
Notes When Performing Computation

- You cannot perform computations by shifting the phase between channels.
- FFTs cannot be computed if the display record length of the waveform is less than the selected number of computation points.

2.2 Averaging

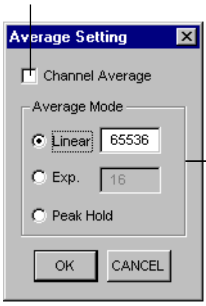
Procedure

1. Click the [AVERAGE] button of the [Channel Setting] dialog box.



2. Select [Linear], exponential averaging [Exp.], or [Peak Hold] for the averaging method in the [Average Setting] dialog box.
   If [Linear] is selected, specify the average count in the range from 2 to 65536. In linear averaging, the measurement is automatically stopped upon reaching the specified average count regardless of whether the measured waveform or the computed waveform is being averaged.
   If exponential averaging [Exp.] is selected, specify the attenuation constant in the range from 2 to 256 (in 2^n steps).
   Select the [Channel Average] check box when you wish to average the measured waveform. In this case, if the measured waveform data of each channel (C1 and C2, for example) are used as variables in an equation, the averaged values are used to compute the equation.

Check when averaging the measured data



Explanation

For details on the various averaging methods, see page 1-2.

Initializing the Averaging

Click the waveform clear button ( ) of the Waveform Monitor or Viewer to clear the displayed waveform. The averaging will be restarted and a new waveform will be displayed.

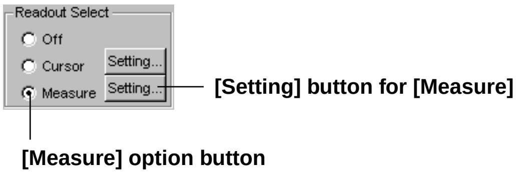
Precautions and Limitations on Averaging

- Time domain computations are averaged in the time domain.
- For FFTs, averaging is performed in the frequency domain.
- When a computation condition is changed, averaging is restarted using the new condition. Thus, the waveform data displayed before the change will be cleared.
- If a computation condition is changed while averaging the computed waveform, all the computed waveform data up to that point are cleared.
- If the measurement (waveform acquisition) is restarted, averaging is also restarted and the new waveform is displayed.
- Averaging cannot be performed when the acquisition mode is set to free run or when memory partition is enabled.
- Averaging cannot be performed on pulse width computation waveforms.
- There is no averaging function on the Viewer.

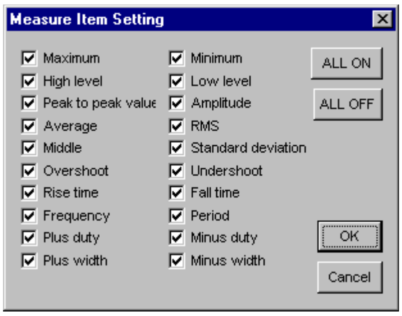
2.3 Automated Measurement of Waveform Parameters

Procedure

1. Select [Measure] under the [Readout Select] option button of the [Channel Setting] dialog box.
2. Click the [Setting] button located to the right of [Measure].



3. In the [Measure Item Setting] dialog box, check the boxes corresponding to the waveform parameters to be measured.
   To check all waveform parameters, click the [ALL ON] button. To remove all checks, click the [ALL OFF] button.

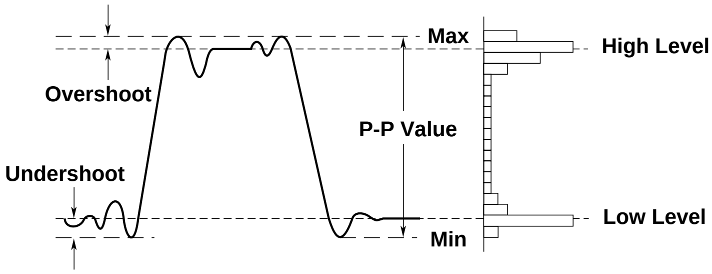


Explanation

Waveform Parameters

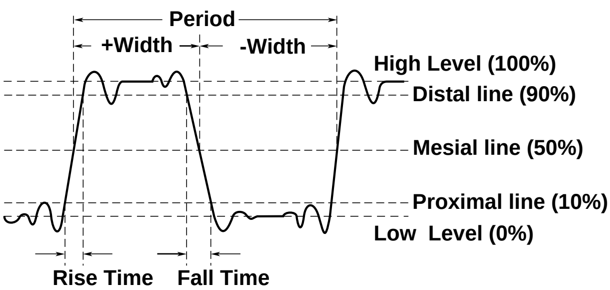
- Voltage-axis parameters

Maximum: Maximum voltage [V]
Minimum: Minimum voltage [V]
High level: High level voltage [V]
Low level: Low level voltage [V]
Peak to peak value: P-P value (Max - Min) [V]
Amplitude: (High - Low) [V]
Average: Average voltage $(1/n)\Sigma xi$ [V]
RMS: rms value $(1/\sqrt{n})(\Sigma(xi)^2)^{1/2}$ [V]
Middle: Center value of the amplitude (Max+Min)/2 [V]
Standard deviation: Standard deviation $(1/n(\Sigma x^2-(\Sigma x^2)/n))^{1/2}$
Overshoot: (Max–High)/(High–Low)×100 [%]
Undershoot: (Low–Min)/(High–Low)×100 [%]



- Time-axis parameters

Rise time: Rise time [s]
Fall time: Fall time [s]
Frequency: Frequency [Hz]
Period : Period [s]
+Duty: Duty cycle Width1/Period×100 [%]
- Duty: Duty cycle Width2/Period×100 [%]
+ Width: Time width above the mesial value [s]
- Width: Time width below the mesial value [s]



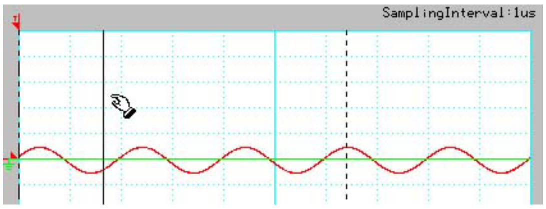
The high level is defined to be the highest amplitude level (100% level) within the measurement range based on the frequency of voltage levels of the waveform while taking into account the effects of ringing, spikes, and other phenomena. Low is the lowest amplitude level (0% level). With these levels as references, the distal, mesial, and proximal values are defined to be the 90%, 50%, and 10% levels, respectively.

Limitations When Performing Automated Measurement of Waveform Parameters

- Automated measurement of waveform parameters cannot be performed on snapshot waveforms and accumulated waveforms.
- If the [Measure] box is checked in the operation panel of the Digital Oscilloscope Module WE7111, automated measurement of waveform parameters is performed on the module. However, the results of this computation function are displayed in place of the results from the module. (The computed results of this computation function have precedence over the results obtained on the module.) Therefore, remove the check from the [Measure] box.

Specifying the Range for Automated Measurement of Waveform Parameters

You can specify the range over which the automated measurement of waveform parameters is performed. As in the following figure, the range is specified by dragging the two cursors (solid and dotted lines) displayed within the waveform display frame.



Saving the Results of the Automated Measurement of Waveform Parameters

When the automated measurement of waveform parameters is performed, up to 1000 points of the measured data are saved. The data are cleared when the measurement range is changed, the measurement item is changed, or the measurement is restarted. For details related to saving the data, see page 2-11.

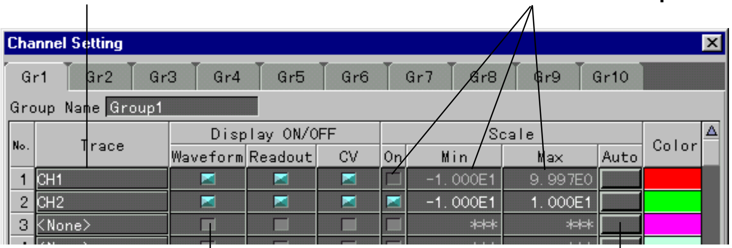
2.4 Displaying the Computation Results

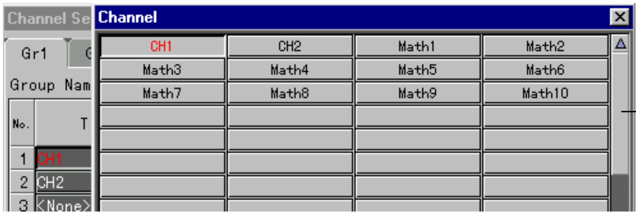
Displaying the Waveform of the User-defined Computation Results

Selecting the Computed Waveform, Turning ON the Display, and Setting the Scale

Click the trace selection box on the [Channel Setting] dialog box to display the waveform selection dialog box. On this dialog box, select the computed waveforms (Math1 to 10) that you wish to display.

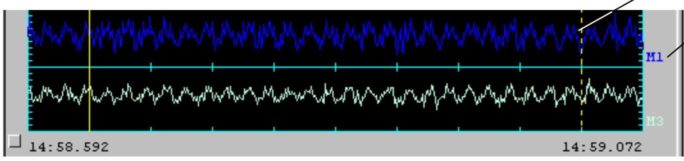
To change the display scale of the computed waveforms, click the [On] button under scale and enter the maximum and minimum values of the scale in the respective entry boxes. Click the [Auto] button to automatically set the scale to match the amplitude of the displayed waveform.





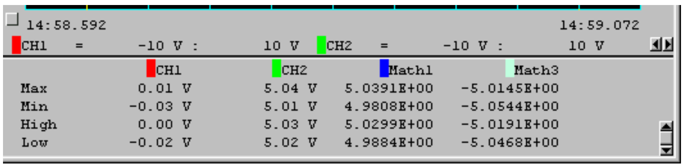
Display Example of a Computed Result

When split display is being used to display the waveforms, the waveform numbers are displayed as shown below. For example, the computed waveform of [Math1] is assigned the number “M1.” As with the normal measured waveform, cursor measurement is possible on the computed waveform.

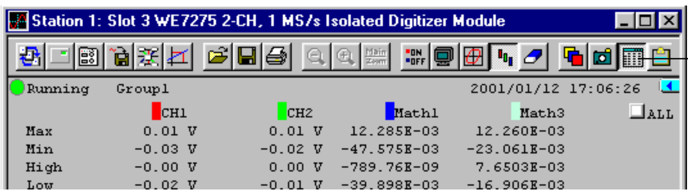


Display Example of the Results of the Automated Measurement of Waveform Parameters

Like the cursor measurement values, the measured results are displayed underneath the waveform display frame (see below).



Click the measured value list button to display the measured values in place of waveforms.

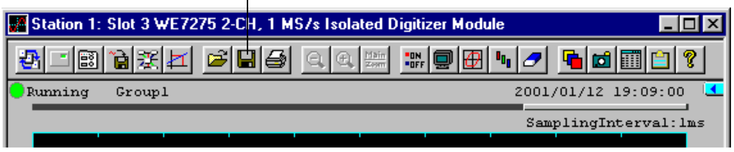


2.5 Saving the Computation Results

Procedure

1. Click the data save button of the waveform viewer.

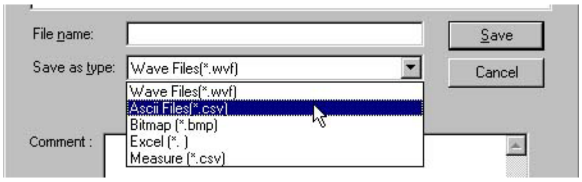
Data save button



Saving the Computed Waveform Data

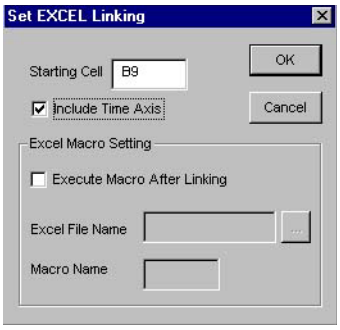
2. The save dialog box opens (see figure below). Select the save format and name the file. Select binary data ("*.wvf" extension), ASCII data in CSV format ("*.csv" extension), or Excel link "*." for the save format.

   When the Save button is clicked when saving to CSV format, a dialog box appears for you to select whether or not to include time axis information. Comments can be saved to the file by entering text in the Comment box unless the file is saved in Excel format. Select [Bitmap (*.bmp)] when you wish to save the displayed waveform as image data in bitmap format. In this case, only one line of comment is saved as image data.



Saving after Excel Linking

When [Excel (*.)] is selected, the displayed waveform data can be transferred directly to Excel*. Clicking the [Save] button displays the dialog box shown below.



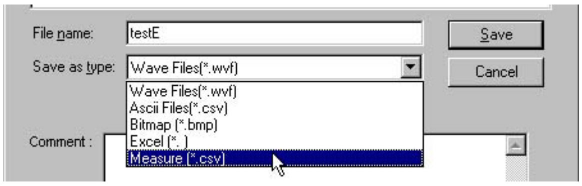
In this dialog box, enter the first cell to which to transfer the measured data in the [Starting Cell] entry box and set whether or not to include time axis information using the [Include Time Axis] check box. Set the starting cell to B3 or larger (B9 is default) to allocate the minimum number of cells needed to transfer the data information. Otherwise, an error will occur. All of the data information is transferred when you select B9 as the starting cell.

To execute an Excel macro after transferring the data, check the [Execute Macro After Linking] box and set the file name and macro name.
When you are ready, clicking the [OK] button starts Excel and the data are transferred. Use the operations in Excel to manually save the data if you did not specify a macro save operation.

* Operation guaranteed on Microsoft Excel 97 only.

Saving the Results of the Automated Measurement of Waveform Parameters

2. The following save dialog box appears. Select [Measure (*.csv)] for the file type. The comment is not saved in this case.



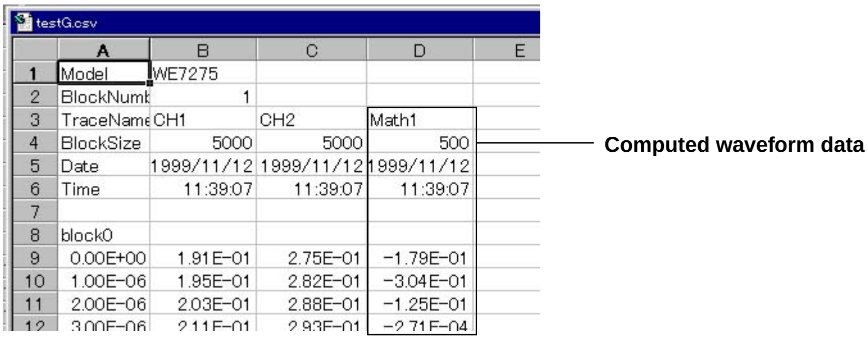
Explanation

Saving the Computed Waveform Data

When saving the computed waveform data, it is added to the same file as the measured waveform data.

When the computation function is being used and memory partition is enabled, only the data corresponding to the measured waveform and the computed waveform of the memory block that is currently displayed in the waveform viewer are saved.

The following figure shows how the data are saved when CSV format is specified.

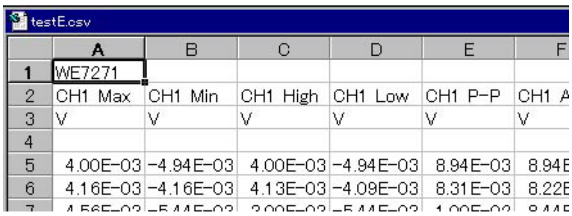


	A	B	C	D	E
1	Model	WE7275			
2	BlockNumb	1			
3	TraceName	CH1	CH2	Math1	
4	BlockSize	5000	5000	500	
5	Date	1999/11/12	1999/11/12	1999/11/12	
6	Time	11:39:07	11:39:07	11:39:07	
7					
8	block0				
9	0.00E+00	1.91E-01	2.75E-01	-1.79E-01	
10	1.00E-06	1.95E-01	2.82E-01	-3.04E-01	
11	2.00E-06	2.03E-01	2.88E-01	-1.25E-01	
12	3.00E-06	2.11E-01	2.93E-01	-2.71E-04	

Saving the Results of the Automated Measurement of Waveform Parameters

When the automated measurement of waveform parameters is performed, up to 1000 points of the measured data are saved.

The measured waveform data and computed waveform data are saved separately. You can only specify the CSV format as the save format (binary and bmp formats are not available).



	A	B	C	D	E	F
1	WE7271					
2	CH1 Max	CH1 Min	CH1 High	CH1 Low	CH1 P-P	CH1 A
3	V	V	V	V	V	V
4						
5	4.00E-03	-4.94E-03	4.00E-03	-4.94E-03	8.94E-03	8.94E
6	4.16E-03	-4.16E-03	4.13E-03	-4.09E-03	8.31E-03	8.22E

Specifications

User-defined Computation

Number of Display Channels for Computed Waveforms

10

Waveforms on Which Computation Is to Be Performed

Measured waveforms and computed waveforms

Applicable Acquisition Modes

Trigger mode and free run mode (limitations on displaying the waveform while the measurement is in progress)

Computation Accuracy

Single-precision floating point

Types of Computations

Operator types: four arithmetical operations, absolute value, square root, logarithm, exponent, trigonometric functions, differentiation, integration, filter, Hilbert transform, phase function, pulse width function, FFT, etc. (for details, see page 1-1)

Constants: Up to 10 constants can be specified

Number of characters that can be entered for creating equations: 63

Filter bandwidths: Select Low pass, high pass, or band pass.

Filter characteristics: Select Gaussian, sharp, or Butterworth

Number of points for taking the FFT: Select 1000, 2000, or 10000 points.

FFT window: Select rectangular, Hanning, or flattop.

Saving the computed waveform

Save as physical values to the same file as the measured waveform data.

Averaging

Data to Be Averaged

Measured data and computed data

Types

Linear averaging: Select the average count in the range from 2 to 65536.

Exponential averaging: Select the attenuation constant in the range from 2 to 256 (in 2^n steps).

Peak hold: Displays the maximum value among the data at the same time/frequency axis position of the waveform.

Automated Measurement of Waveform Parameters

Measurement Parameters

Twenty parameters such as the maximum/minimum voltage, average voltage, rms value, P-P value, overshoot, and undershoot (for details, see page 2-6).

Specifying the Measurement Range

Specify the measurement range using two cursors.

Saving the Measured Data

Up to 1000 points of measured data can be saved. The save format is CSV.

Index

O

P

R

S

T

U

V

W