VB8000
Arbitrary Waveform Generator
USER'S MANUAL

YOKOGAWA ◆
Yokogawa Electric Corporation

Foreword

Thank you for purchasing the Arbitrary Waveform Generator VB8000.
This user's manual contains useful information about the functions, operating procedures, and handling precautions of the VB8000. To ensure correct use, please read this manual thoroughly before operation.
Keep this manual in a safe place for quick reference in the event a question arises.
The following three manuals, are provided as manuals for the VB8000.

Manual Title	Manual No.	Description
VB8000 user's manual	IM 703150-01E	This manual. Explains all functions and procedures of the VB8000 excluding the communication functions.
VB8000 Communication Interface user's manual	IM 703150-11E	Explains the communication functions of the GP-IB and serial (RS-232) interfaces.
File Conversion Utility Software for VB8000 user's manual	IM 703150-61E	Explains how to use the software that converts files into data that the VB8000 can use.

Notes

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

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Checking the Contents of the Package

Unpack the box and check the contents before operating the instrument. If some of the contents are incorrect, missing, or physically damaged, contact the dealer from which you purchased them.

VB8000

Check that the model name and suffix code given on the name plate on the rear panel match those on your order. When contacting the dealer from which you purchased the instrument, please quote the instrument number (No.).
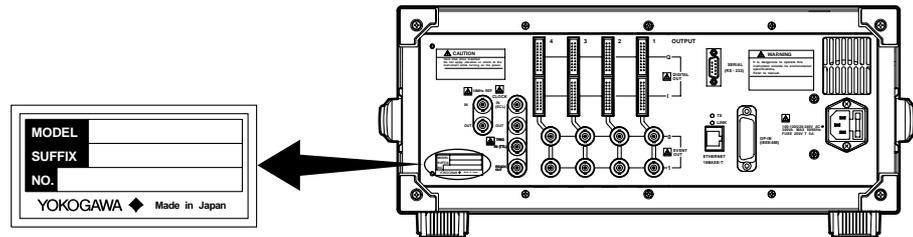

MODEL

703150

Suffix Code		Description
Power cord	-D	UL/CSA Standards Power Cord (Part No.: A1006WD)
		[Maximum Rated Voltage: 125 V, Maximum Rated Current: 7 A]
	-F	VDE Standard Power Cord (Part No.: A1009WD)
		[Maximum Rated Voltage: 250 V, Maximum Rated Current: 10 A]
	-Q	BS Standard Power Cord (Part No.: A1054WD)
		[Maximum Rated Voltage: 250 V, Maximum Rated Current: 10 A]
	-R	SAA Standard Power Cord (Part No.: A1024WD)
		[Maximum Rated Voltage: 240 V, Maximum Rated Current: 10 A]
Options	-162	16-Mpoint memory, 2 channels (1 OUTPUT, differential output)
	-164	16-Mpoint memory, 4 channels (2 OUTPUTs, differential outputs)
	-166	16-Mpoint memory, 6 channels (3 OUTPUTs, single-ended outputs)
	-168	16-Mpoint memory, 8 channels (4 OUTPUTs, single-ended outputs)
	-642	64-Mpoint memory, 2 channels (1 OUTPUT, differential output)
	-644	64-Mpoint memory, 4 channels (2 OUTPUTs, differential outputs)
	-646	64-Mpoint memory, 6 channels (3 OUTPUTs, single-ended outputs)
	-648	64-Mpoint memory, 8 channels (4 OUTPUTs, single-ended outputs)

NO. (Instrument Number)

When contacting the dealer from which you purchased the instrument, please quote the instrument number.

Standard Accessories

The standard accessories below are supplied with the instrument. Check that all contents are present and that they are undamaged.

Power cord (one of the following power cords is supplied according to the instrument's suffix codes)

UL/CSA standard A1006WD	VDE standard A1009WD	BS standard A1054WD	SAA standard A1024WD	Rubber feet (4 pieces) A9088ZM 2 pieces
D	F	Q	R	
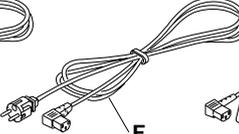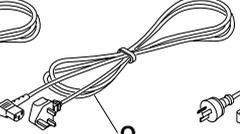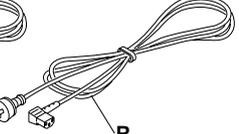
Power fuse (a spare, attached to the fuse holder) A1353EF

File Conversion Utility Software for VB8000 setup disk 3.5˝ floppy disk (1 piece) B8013UF

User's Manual (this manual) — 1 piece
Communication Interface User's Manual — 1 piece
File Conversion Utility Software for VB8000 User's Manual — 1 piece
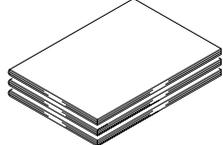
Optional Accessories (Sold Separately)

The optional accessories below are available for purchase separately. When you receive the order, check that all contents are present and that they are undamaged. For information and ordering, contact your nearest YOKOGAWA dealer.

BNC cable 366924 (1 m) 366925 (2 m)

IQ digital output cable (2 multi-channel coaxial cables in a single set) 703171
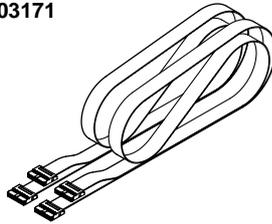
Optional softwares

Title	Manual No.	Part No.
Digital Modulation Signal Generation Software	IM703081-61E	B9972SA
OFDM Generation Utility Software	IM703082-01E	B9972SD
CCK Generation Utilit Software	IM703084-01E	B9972SG

Spare Parts (Sold Separately)

The spare parts below are available for purchase separately. When you receive the order, check that all contents are present and that they are undamaged.
For information about spare parts and ordering, contact your dealer.

Part Name	Part No.	Quantity	Note
Power fuse	A1353EF	2	5 A, 250 V
3.5˝ floppy disk	705900	10	Empty disk, 2HD

Note

We recommend you keep the packing box. The box is useful when you need to transport the instrument.

Safety Precautions

This instrument is an IEC safety class I instrument (provided with terminal for protective earth grounding).

The general safety precautions described herein must be observed during all phases of operation. If the instrument is used in a manner not specified in this manual, the protection provided by the instrument may be impaired. YOKOGAWA Electric Corporation assumes no liability for the customer's failure to comply with these requirements.

The following symbols are used on this instrument:

⚠ "Handle with care." (To avoid injury, death of personnel or damage to the instrument, the operator must refer to the explanation in the user's manual or service manual.)

⏚ Functional ground terminal. (Do not use this terminal as a protective ground terminal.)

∿ Alternating current.

| ON (power).

○ OFF (power).

▭ ON (power) state.

▭ OFF (power) state.

Make sure to comply with the precautions below. Failure to do so might result in injury or death.

WARNING

Power Supply

Ensure that the source voltage matches the voltage of the power supply before turning ON the power.

Power Cord and Plug

To prevent the possibility of electric shock or fire, be sure to use the power cord supplied by YOKOGAWA. The main power plug must be plugged into an outlet with a protective earth terminal. Do not invalidate this protection by using an extension cord without protective earth grounding.

Protective Grounding

Make sure to connect the protective earth grounding to prevent electric shock before turning ON the power. The power cord that comes with the instrument is a three-pin type power cord. Connect the power cord to a properly grounded three-pin outlet.

Necessity of Protective Grounding

Never cut off the internal or external protective earth wire or disconnect the wiring of the protective earth terminal. Doing so creates a potential shock hazard.

Defect of Protective Grounding

Do not operate the instrument if the protective earth or fuse might be defective. Make sure to check them before operation.

Fuse

To avoid the possibility of fire, only use a fuse that has a rating (voltage, current, and type) that is specified for the instrument. When replacing a fuse, turn OFF the power switch and unplug the power cord. Never short the fuse holder.

Do Not Operate near Flammable Materials

Do not operate the instrument in the presence of flammable liquids or vapors. Operation in such environments is very dangerous.

Do Not Remove Cover

The cover should be removed by YOKOGAWA qualified personnel only. Opening the cover is dangerous, because some areas inside the instrument have high voltages.

External Connection

Securely connect the protective grounding before connecting to the item under measurement or to an external control unit. If you are going to touch the circuit, make sure to turn OFF the circuit and check that no voltage is present.

How to Use This Manual

Structure of the Manual

This user's manual consists of the following sections.

Chapter	Title	Description
1	Explanation of Functions	Describes waveform generation principles and the functions of the instrument. Operating procedures are not given in this chapter. However, reading this chapter will help you understand the operating procedures given in the chapters that follow.
2	Names and Uses of Parts	Describes the names and uses of each part of the instrument. For keys, references are given to pages in the manual where operating procedures are explained.
3	Before Outputting Waveforms	Describes precautions on the use of the instrument, how to install it, how to connect it to the power supply, how to turn ON/OFF the power switch, how to set the date and time, and how to enter values.
4	Connecting to an Ethernet Network	Describes how to connect the instrument to an Ethernet network.
5	Uploading and Importing Waveform Data	Describes how to upload and import waveform data to the built-in hard disk.
6	Loading Waveform Data to the Waveform Memory	Describes how to load the waveform data that have been imported to the built-in hard disk to the waveform memory.
7	Outputting Waveforms	Describes how to set the output conditions such as attenuation, offset, and level errors, and how to output waveforms.
8	File Operation	Describes how to delete files and how to format the built-in hard disk and floppy disk.
9	Other Functions	Describes how to initialize the settings, how to check the setup conditions, and other information.
10	Auxiliary I/O	Describes digital output, event output, and trigger-ready output.
11	Troubleshooting and Maintenance	Describes probable causes of errors and their corrective actions, various messages that are displayed on the screen, and how to perform self-tests.
12	Specification	Summarizes the main specifications of the instrument in a table.
	Index	Index of contents.

Conventions Used in This Manual

Unit

k .... Denotes "1000." Example: 100 kpoints.

K ...... Denotes "1024." Example: 720 KB (storage capacity of floppy disks)

Displayed characters

Characters enclosed with [ ] mainly refer to characters or setting values that are displayed on the screen or panel.

Conventions

- Hexadecimal notation   Example: 0x123
- Decimal notation   Example: 123
- Binary notation   Example: 0011_2

Notes

The following symbols are used in this manual:

⚠   ffixed to the instrument. Indicates danger to personnel or instrument and the operator must refer to the user's manual. The symbol is used in the user's manual as a mark on the reference page.

WARNING   Describes precautions that should be observed to prevent injury or death to the user.

CAUTION   Describes precautions that should be observed to prevent minor or moderate injury, or damage to the instrument.

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

Symbols used in the explanation of operations

On pages that describe operating procedures in Chapter 3 through 11, the following symbols are used to distinguish the procedures from their explanations:

Function   Describes the details of the settings and the restrictions that exist with the operating procedure. A detailed description of the function is not provided in this section. For a detailed description of the function, see chapter 1.

Procedure   Carry out the procedure according to the step numbers. The procedure is given with the premise that the user is carrying out the procedure for the first time. Therefore, if you are modifying the settings, you may not need to carry out all the steps.

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Chapter 12 Specification

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1.1　Principles of Waveform Generation

The VB8000 is an arbitrary waveform generator that is characterized by its long waveform memory and multiple channels.

Settings such as IQ phase can be configured for generating baseband signals for communications.

Arbitrary waveform generator

The VB8000 is a digital signal generator. Waveform data that are created as digital data are written to the waveform memory, converted to analog signal by the D/A converter, and then output.

```
┌──────────┐      ┌──────────┐
│ Waveform │      │   D/A    │\
│  memory  │──────│converter │ >──○  Output
└──────────┘      └──────────┘/
```
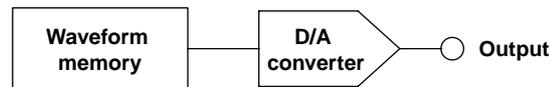
Waveform data

The VB8000 does not have functions that can be used to create waveform data. You can create waveform data on your PC by using tools such as waveform generator utility software that are sold separately.

The waveform data that are created are transfered to the hard disk via floppy disk or Ethernet.

The waveform data on the built-in hard disk are loaded to the waveform memory and then output.

Output condition settings

When creating the waveform data, only the shape of the output waveform is assigned. Parameters such as frequency, level, phase, and low-pass filter are set when the waveform is actually generated.

Functions for communication applications

The VB8000 handles two channels of output as a single set of I (in-phase) and Q (quadrature) components on the rectangular coordinate system for communication applications. The single set is referred to as OUTPUT.

Waveform data are created for each IQ set (each OUTPUT).

You can set parameters such as phase for each IQ set (OUTPUT). When you specify a phase, the IQ output waveform rotates on the rectangular coordinate system.
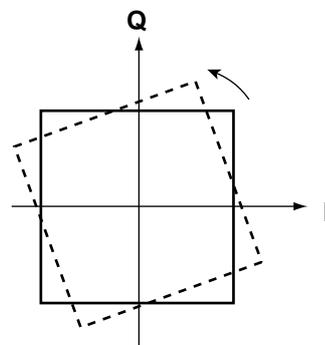
1.2 System Configuration and Block Diagram

System Configuration

Block Diagram

Clock Generator
- 10MHz REF IN
- 10MHz REF OUT
- CLOCK IN
- CLOCK OUT
- Trigger IN
- Trigger Ready OUT

Control & Interface

| HDD | FDD | Ethernet | GP-IB | Serial |

OUTPUT 4
OUTPUT 3
OUTPUT 2
OUTPUT 1

Digital OUT Q
Digital OUT I

Waveform Memory 16M/64M

DAC

DAC

Filter 6M/30M/Through

Filter 6M/30M/Through

I
Ī

Q
Q̄

Event OUT 0
Event OUT 1

DAC
DAC
DAC
DAC

Level/Phase

DAC
DAC
DAC
DAC

Differential Offset

Common Offset
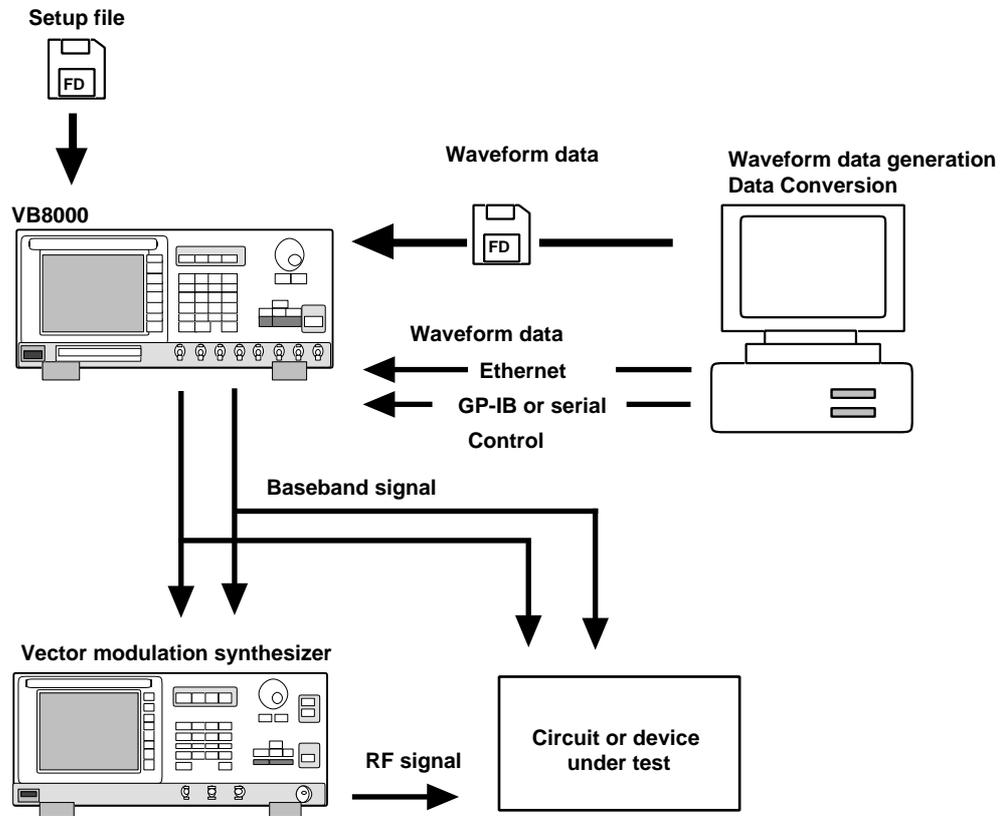
Signal flow

Preparing Waveform Data

1. Create waveform data on your PC.
2. Retrieve the waveform data that is created to the hard disk via the Ethernet network or floppy disk.
3. Convert the waveform data on the built-in hard disk into a data format that the VB8000 can use (RAW data) and load the data to the waveform memory.

Outputting Waveforms

Waveforms are output in the following fashion when waveform output operation is enabled.

The waveform data in the waveform memory is read according to the clock cycle and the 14-bit * 2 (set of I and Q data) data is passed to the D/A converter and the digital output (Digital OUT I/Q) terminal at the same time. In addition, 2-bit data (EVENT0 and EVENT1) is output from the event output (Event OUT 0/1) terminal.

The signal that is converted into an analog signal by the D/A converter is applied to a 2 x 2 matrix computing unit that consists of four multipliers and two adders. Attenuator, phase, and other parameters are set in the matrix-computing unit.

The signal output from the matrix computing unit is passed through the filter section (select from 6 MHz, 30 MHz, 90 MHz, and (Through)) where unneeded frequency components are removed. Then, differential offset voltage is added.

Next, the signal is converted to a differential output signal by the differential output amplifier, and common offset voltage is added. The signal is then passed to each output terminal (I, $\overline{\text{I}}$, Q, $\overline{\text{Q}}$).

1.3   Flow of Operation

The flow of operation up to waveform output is shown below.

PC
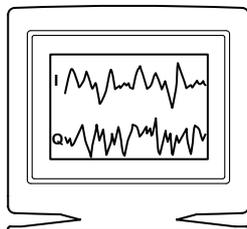
1. Create waveform data (page 1-6, section 1.4)

Create the waveform data using tools such as waveform generator utility software that are sold separately.

2. Retrieve waveform data to the built-in hard disk (page 1-6)

Retrieve the waveform data that were created into the VB8000 via a floppy disk or Ethernet network.

VB8000

Built-in HD

Waveform data A
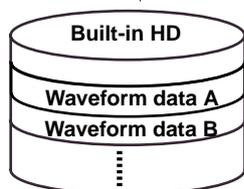
Waveform data B

Waveform group list

| 1 Waveform data A |
| 2 Waveform data B |
| 256 |

3. Register the file name (page 1-6)

Register the waveform data in the waveform group list.

4. Load the data into the waveform memory (page 1-6)

Load the selected waveform data from the waveform group list into the waveform memory.

Waveform memory

Waveform data A

I

Q

I   Q
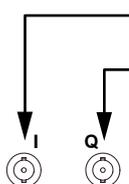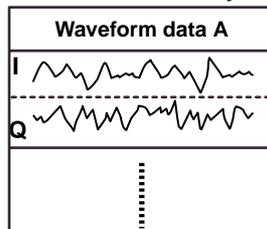
OUTPUT

5. Output the waveform (page 1-7)

Output the selected waveform data from the waveform memory.

I

OUTPUT

Q
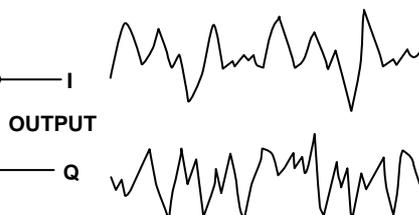
Creating Waveform Data

Create the waveform data using the methods shown below.
*   Using various waveform generator utility software sold separately
*   Creating waveform data manually according to the file format of the waveform data (without using various waveform generator utility software programs sold separately)

For the file format of waveform data, see section 1.4.

Retrieving Waveform Data to the Built-in Hard Disk

The waveform data that you created on your PC can be retrieved to the built-in hard disk of the VB8000 via the Ethernet network or floppy disk. Files in CSV format cannot be used as-is on the VB8000 and must be converted using the import function (see page 1-12).
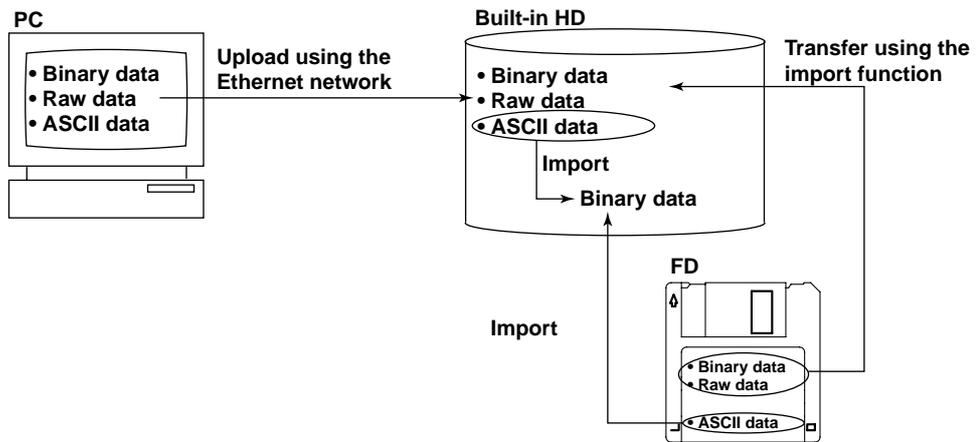
Loading Waveform Data into the Waveform Memory

Load the waveform data (binary data or raw data) on the built-in hard disk to the waveform memory.

First, register the file name of the waveform data you wish to load in the waveform group list. Then, select the waveform data from the waveform group list and load the data to the waveform memory.

The maximum number of waveform data that can be registered in a single waveform group list is 256. A waveform group list and waveform memory exists for each OUTPUT.
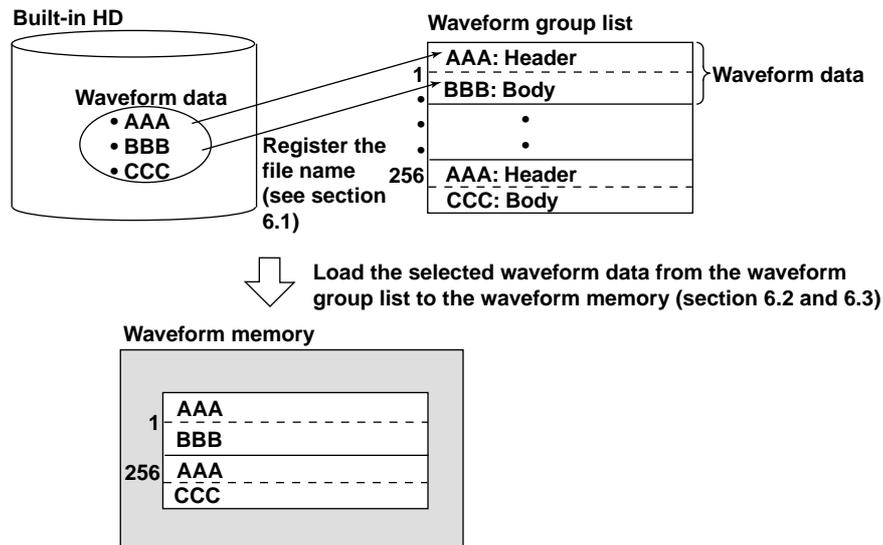
*   For details on the header and body, see page 1-13.

Explanation of Functions

Outputting Waveforms

Select a single set of waveform data you wish to output from the waveform memory. Set the output conditions such as attenuator/phase/offset, reference clock, and start trigger. Then, output the waveform.
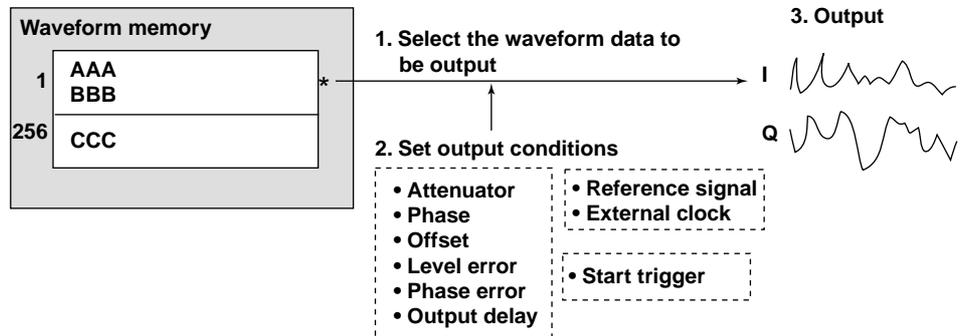
1.4 Creating Waveform Data

The VB8000 can handle the following three types of waveform data:

- ASCII data (CSV):   ASCII data cannot be loaded as-is to the waveform memory.
- Binary data (FLOAT): Double-precision real number. Automatically converted to raw data when loaded to the waveform memory.
- Raw data (RAW):   Data format that can be loaded as-is to the waveform memory.

By using the File Convert Utility for VB8000, the ASCII data that the user created can be converted into a data format that the VB8000 can use. In addition, by using various waveform generator utility software available for purchase separately, you can create waveform data and edit event data without having to worry about the data format.

If you are creating waveform data manually without using various waveform generator utility software (sold separately), follow the formats below.

Waveform Data Format

The different data formats are shown below.

In ASCII and binary formats, data that exceed the −2.0 to +2.0 (V) range are handled as −2.0 and 2.0, respectively.

The assignment of high/low bytes is Big endian. Create the data so that the lower address of the memory is set to high byte.

ASCII data

I_0 data	,	Q_0 data	Terminator*
⋮		⋮	⋮
I_{n-1} data	,	Q_{n-1} data	Terminator*

*   Terminator: LF or CR+LF

Binary data
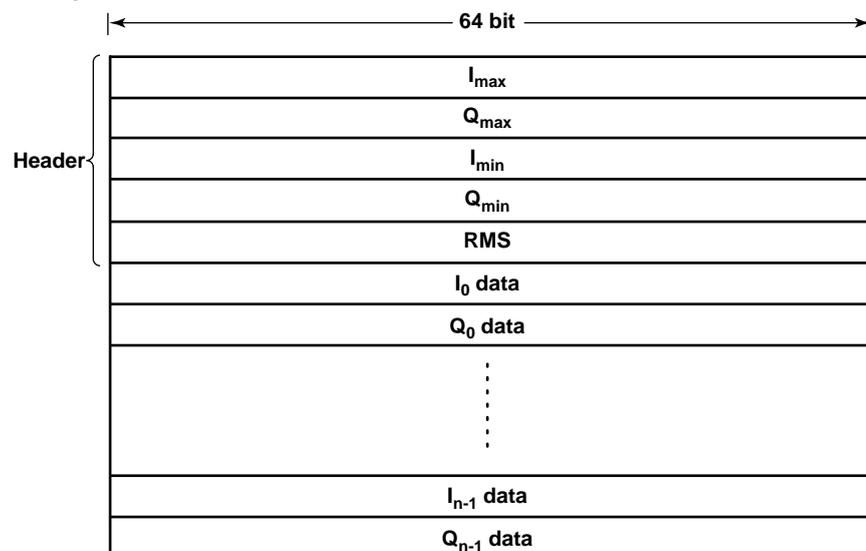
I_{max}, Q_{max} : Maximum value of I and Q data
I_{min}, Q_{min} : Minimum value of I and Q data

Raw data
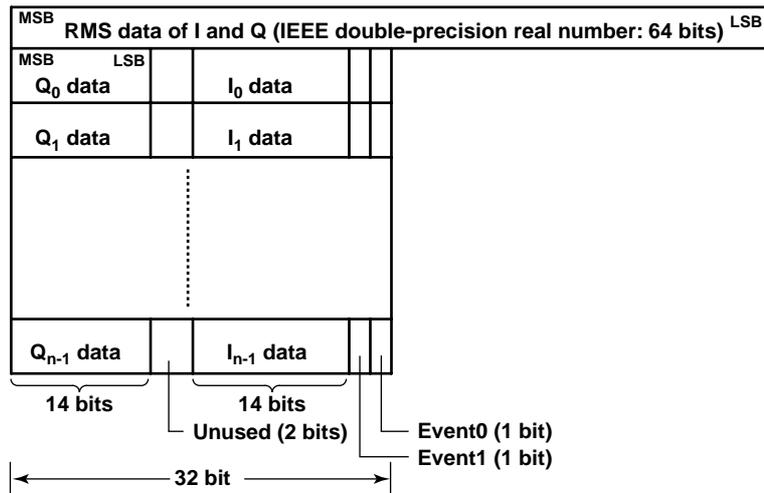
- **RMS value of I and Q**

  The RMS values are determined as follows:

  $$RMS = \sqrt{\frac{\sum_{k=0}^{n-1}(I_k^2 + Q_k^2)}{n}}$$

  However, if RMS = 0, set RMS to 1.

- **Event data**

  You can create two sets of event data (EVENT0 and 1) that are synchronized to the waveform data (I and Q) for each OUTPUT. Event data are created when waveform data are created.

  When you output the waveform, pulse signals that are synchronized to the waveform data are output from the event output terminal (EVENT OUT0 and 1) on the rear panel.

Example of creating waveform data

When $I_0 = 00110001001000_2$, Event0 = 1, Event1 = 1, and $Q_0 = 00010010001101_2$

I_0 + Event data = 0011000100100011_2 = 0x3123,

Q_0 + unused bit = 0001001000110100_2 = 0x1234

Because the bit ordering is big endian, store [I_0 + Event data] and [Q_0 + unused bit] as follows:
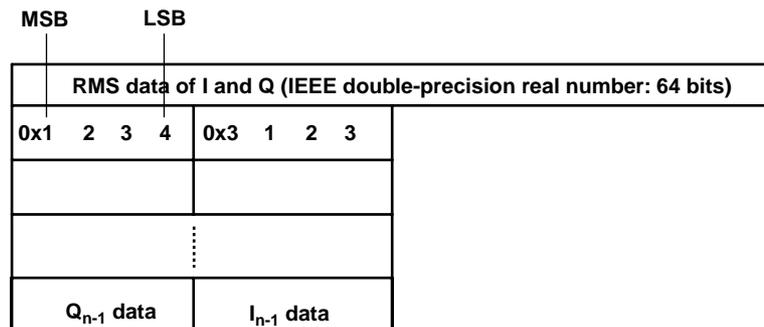
Data conversion

• **Example of a program that converts binary data into raw data**

(A function that converts −2.0≤ real number ≤+2.0 into 32-bit raw data)

```
/*
 * unsigned int Convert(double i, double q);
 *
 * Input : double i; ... Floating point I data
 *         double q; ... Floating point Q data
 * Output : None
 * Return value : I/Q  raw data
 *
 * Note       : Double type is IEEE double-precision real number format (64 bits)
 * Unsigned int type is assumed to be a 32-bit integer.
 *
 */


unsigned int
Convert( double i, double q ) {

#define      MaxData         2.0              /* Maximum floating point value */
#define      Normalize(X)    ((unsigned int)(8191.0 * ((X)/MaxData)) + 0x2000 )

  unsigned int      iu;                        /* Raw data value on the I side */
  unsigned int      qu;                        /* Raw data value on the Q side */
  unsigned int  raw;                           /* Raw data return value */

  if( i > MaxData )          i =  MaxData;
  else if( i < -MaxData )    i = -MaxData;
  if( q > MaxData )          q =  MaxData;
  else if( q < -MaxData )    q = -MaxData;

  iu = Normalize( i );                         /* Convert I data */
  qu = Normalize( q );                         /* Convert Q data */
  raw = ( qu << 18 ) | ( iu << 2 );            /* Create raw data */

  return raw;                                  /* Return raw data */
}
```

Note

The correspondence between voltage values and raw data is as follows:

• 2.0 V: 0x3FFF
• 0.0 V: 0x2000
• −2.0 V: 0x0001

- **Example of a program that converts endian**

```
/*
 * unsigned int Endian(unsigned int d);
 *
 * Input : unsigned int d; ... Data before the conversion
 * Output : None
 * Return value : Value that results from converting endian of the input data.
 *        In other words,
 *        BigEndian    = Endian( LittleEndian );
 *        LittleEndian = Endian( BigEndian );
 *
 * Note: Unsigned int type is assumed to be a 32-bit integer.
 *
 */

unsigned int
Endian( unsigned int d ) {
  unsigned char          c[sizeof(unsigned int)];
  unsigned char*    t = (unsigned char*)&d;
  int               i;

  for( i = 0; i < sizeof(c); i++ )
    c[sizeof(c)-1-i] = t[i];

  return *(unsigned int*)&c[0];
}
```

Extension

The extensions of various data formats are shown below.

- ASCII data: .csv
- Binary data: .bin
- Raw data: .raw

1.5 Uploading and Importing Waveform Data

Uploading

≡**See page 5-1 for the operating procedure**≡

You can upload the data that you have created on the PC to the built-in hard disk via the Ethernet. You must perform import operation on files in CSV format that are uploaded to the built-in hard disk.

Importing

≡**See page 5-2 for the operating procedure**≡

Importing refers to the action of converting waveform data in ASCII format (CSV format) into a data format that can be loaded to the waveform memory while retrieving the data to the built-in hard disk.

When retrieving data on the floppy disk to the built-in hard disk, the import function is used regardless of the data format.

The import operation for each data format is shown below.

Before Importing	After Importing	Note
*.csv	*.bin	Retrieve by converting to binary format
*.bin	*.bin	Retrieve data as-is without data conversion
*.raw	*.raw	Retrieve data as-is without data conversion

Note

You can also save the binary data on the built-in hard disk by converting the data into a data format that can be used externally (ASCII or binary). This operation is called exporting.

1.6 Loading Waveform Data to the Waveform Memory

Creating/Saving/Loading Waveform Group Lists

≡See page 6-1 for the operating procedure≡

Creating waveform group lists

Data that are loaded to the waveform memory are cleared when the power is turned OFF. It is inconvenient to search for data to be loaded to the waveform memory every time the power is turned ON. Therefore, VB8000 allows you to register a list of waveform data in a waveform group list so that you can select the waveform data from the list to be loaded from the built-in hard disk to the waveform memory.

A header file and a body file are registered for each set of waveform data.

Waveform group lists are created for each OUTPUT.

- **Data that can be registered**

  Waveform data on the built-in hard disk (binary or raw data)

- **Waveform data name**

  You will assign a name to the waveform data (header and body) that are registered in the waveform group list. The waveform data name is used as a label when loading data to the waveform memory. It is also used on the screen that displays setup information of each OUTPUT.

- **Header and body**

  Waveform data that are registered as a header are output once the first time. Waveform data that are registered as a body are repetitively output following the header. You do not have to register the header.

| Header | Body | Body | Body | Body | Body | Body |
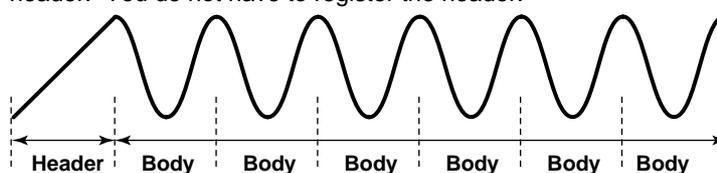
- **Example of creation**

  Register a file using a waveform data name of Sample1 into the OUTPUT1 waveform group file.

Saving/Loading waveform group lists

You can save the waveform group lists that are created by assigning names.

When a waveform group list is loaded, it is overwritten to the current list. In addition, all waveform data that are loaded in the waveform memory are cleared.

Loading Waveform Data to the Waveform Memory
≡See page 6-6 for the operating procedure≡

Loads the selected waveform data in the waveform group list to the waveform memory.
You can also load all the data in the waveform group list at once (all load, auto load).
Only raw data can be loaded to the waveform memory. Binary data are automatically
converted to raw data while the data are being loaded.

1.7   Setting Output Conditions

Attenuator   ≡**See page 7-1 for the operating procedure**≡

You can set a common peak-to-peak voltage to the I and Q waveforms in the range between 6 dB and −20 dB. If phase, I/Q gain ratio or quadrature offset is not specified, 2 Vp-p is set to 0 dB.
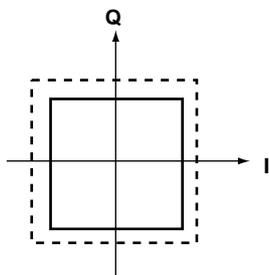
Phase   ≡**See page 7-2 for the operating procedure**≡

You can output I and Q waveforms by rotating the waveform by the specified angle on the I-Q plane.

You can use this to evaluate transmission diversity, for example.

Transmission diversity evaluation example

By setting phases to OUTPUT1 and OUTPUT2, you can simulate the phase difference between antenna 1 and 2.
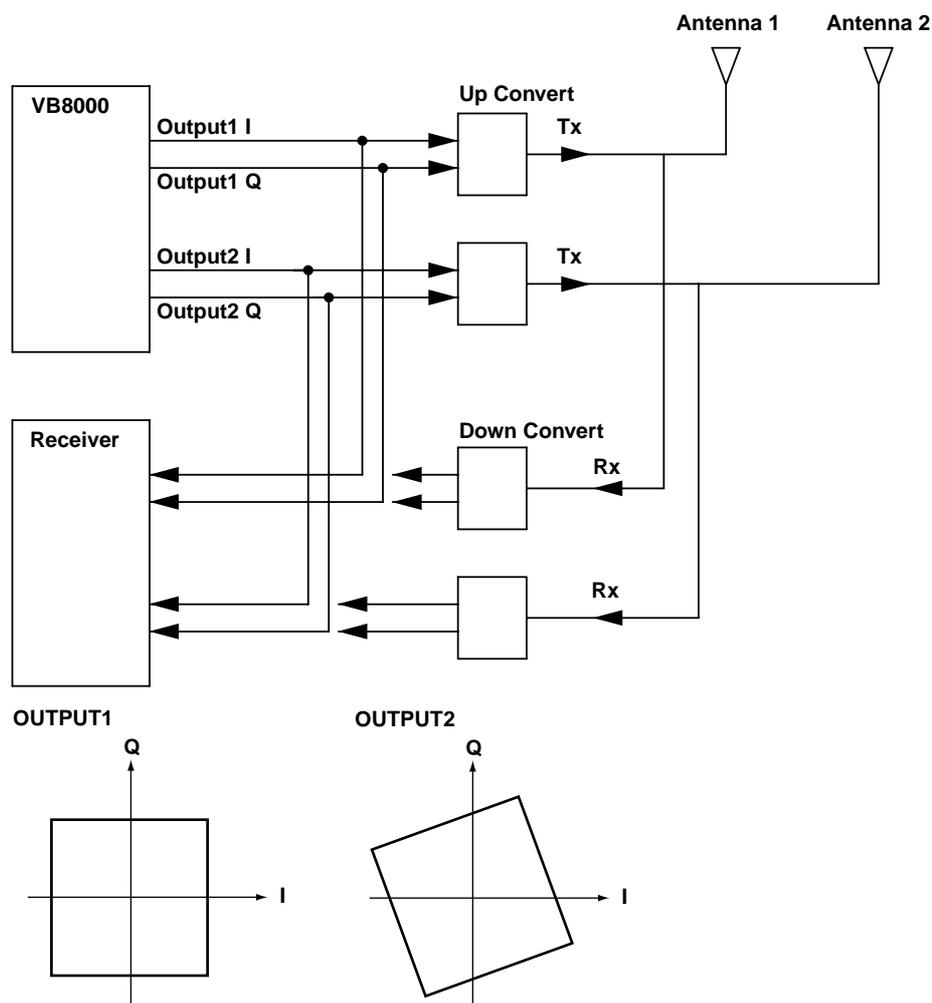
I/Q Gain Ratio   ≡**See page 7-2 for the operating procedure**≡

You can change the amplitude ratio of the I and Q waveforms. You can use this to simulate the amplitude error of a vector modulator/demodulator.
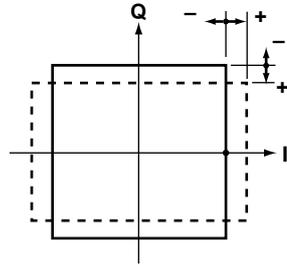
Quadrature Offset ≡**See page 7-2 for the operating procedure**≡

The angle at which the coordinate axes of the I-Q plane cross is changed according to the specified angle.

You can use this to simulate the phase error of a vector modulator/demodulator.
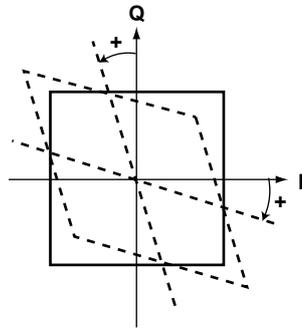
Offset   ≡**See page 7-2 for the operating procedure**≡

You can specify a DC offset voltage to I and Q waveforms, individually.

For differential output model

- Differential offset voltage: Add a specified offset voltage to I and Q. Subtract a specified offset voltage from $\overline{I}$ and $\overline{Q}$. (Selectable range: −100 mV to 100 mV at 0.2 mV resolution)

- Common offset voltage: Add a specified offset voltage to I/$\overline{I}$ or Q/$\overline{Q}$ (Selectable range: −500 mV to 1500 mV at 1 mV resolution)
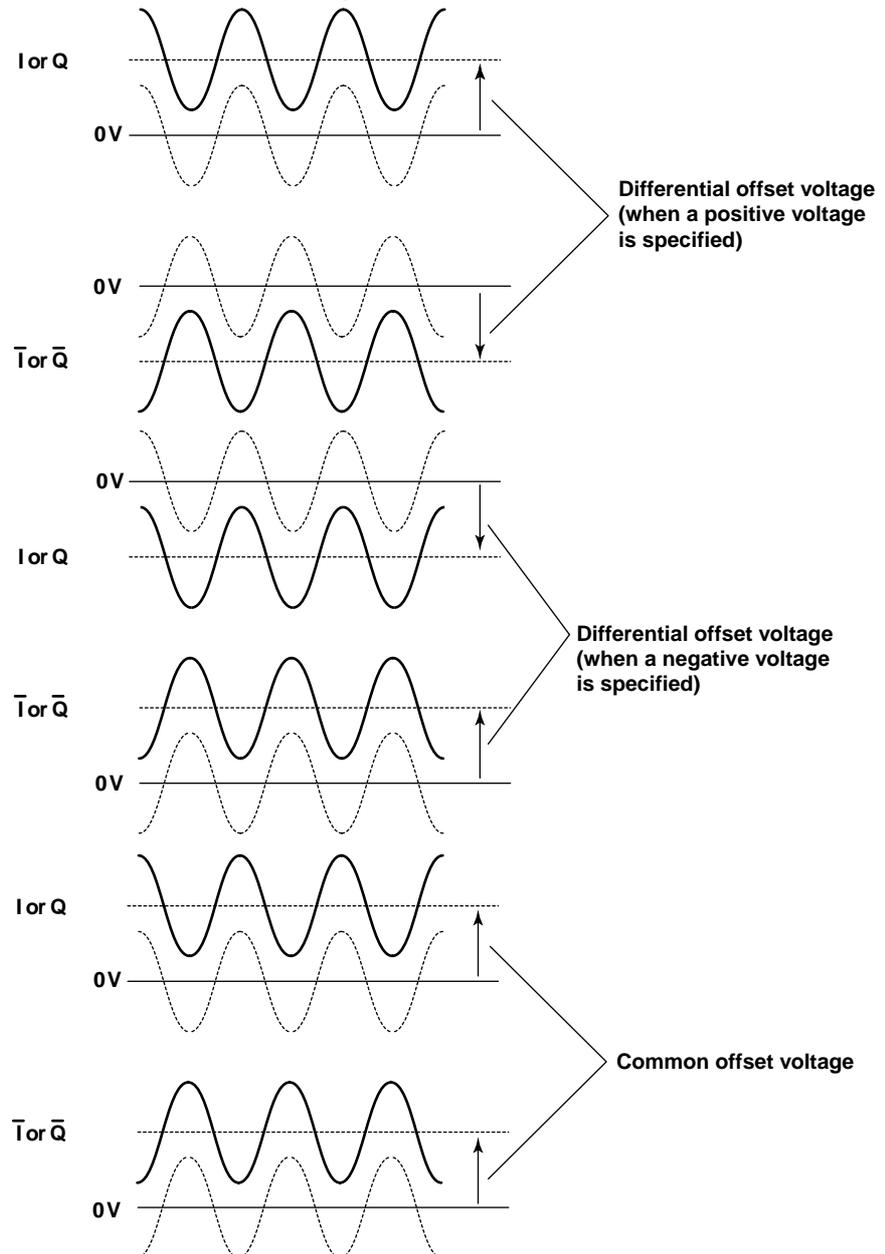
For single-ended output model

- Fine: Add offset voltage at 0.2 mV steps to I or Q (Selectable range: −100 mV to 100 mV)

- Coarse: Add offset voltage at 0.1 mV steps to I or Q (Selectable range: −500 mV to 1500 mV)

Selecting the 10-MHz Reference Signal
≡See page 7-5 for the operating procedure≡

The VB8000 has a 10-MHz reference signal used to generate the waveforms. However, you can also apply an external 10-MHz signal to the 10 MHz REF IN terminal and use it as the reference signal.

Internal Clock/External Clock   ≡See page 7-6 for the operating procedure≡

You can select whether to use the internal clock frequency created based on the 10-MHz reference signal to output the waveform data or output the waveform data by synchronizing to an external signal (external clock).

Clock Frequency   ≡See page 7-7 for the operating procedure≡

Outputs the waveform data using the specified clock frequency. The clock frequency is created from the 10-MHz reference signal. For example, if you specify a clock frequency of 100 MHz on a sine wave that contains 100 points for a single period, a sine waveform with a frequency of 1 MHz is output.

If you selected external clock, the waveform data are output by synchronizing to the external signal.

Start Trigger   ≡See page 7-8 for the operating procedure≡

You can select the method used to start the waveform generation from the following:

- **Internal start trigger (INT)**
  The START/STOP key on the front panel is used to generate the waveform.
- **External start trigger (EXT)**
  The trigger signal that is applied to the TRIG IN terminal (external start trigger input terminal) on the rear panel is used to generate the waveform.
  The waveform is generated on the trigger signal that is applied after the START/STOP key on the front panel is set to START.

Waveform generation is aborted when the START/STOP key is set to STOP.
The method to stop the waveform generation is the same for internal and external start triggers.

Timing chart when the external start trigger is used
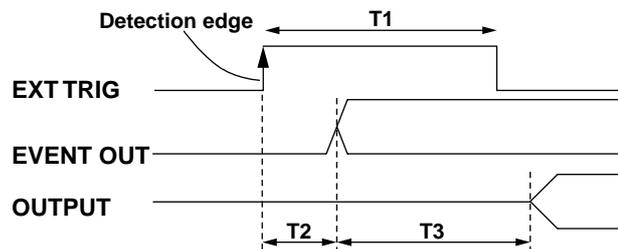
T1: Pulse width of the external trigger signal, 100 ns or more

T2: Delay time of event output

      $T2 = T4 + T5$

      $T4 = (1.5 \text{ to } 2.5 + \text{the specified delay value})*(1/\text{clock frequency})$

      $T5$ = approximately 50 ns

T3: Delay time of I/Q waveform output

      $T3$ = Approximately 2.5 ns to 165 ns (varies depending on the filter setting)

      When the filter is 6 MHz: Approx. 165 ns

      When the filter is 30 MHz: Approx. 33 ns

      When the filter is Off: Approx. 2.5 ns

Output Delay   ≡**See page 7-8 for the operating procedure**≡
You can delay the waveform output by the specified amount of clock cycles. The selectable range of clock cycles is 0 to 262143.

Low-Pass Filter   ≡**See page 7-10 for the operating procedure**≡
You can use a low-pass filter to remove unwanted frequency components that are generated by the D/A converter.

Digital Output   ≡**See page 7-12 for the operating procedure**≡
Outputs the 14-bit digital signal of the waveform data from the digital output terminal on the rear panel.

1.8   Outputting Waveforms

Turn ON/OFF Waveform Output   ≡**See page 7-16 for the operating procedure**≡

Sets whether or not to output signals from each OUTPUT.

The relationship between waveform generation start/stop, and waveform output ON/OFF is as follows:

	Waveform output ON	Waveform output OFF
Waveform generation start condition	0 V ——— Output offset + waveform data	——— Output 0 V
Waveform generation stop condition	——— 0 V ——— Output only the offset voltage	——— Output 0 V
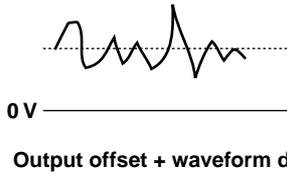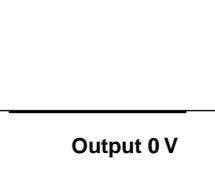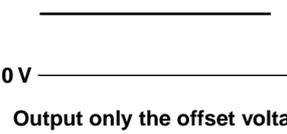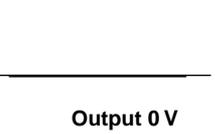
Starting/Stopping Waveform Generation

≡**See page 7-16 for the operating procedure**≡

The following two methods are available for starting/stopping waveform generation:

Manual start

Press the START/STOP key on the front panel once to start waveform generation.
Press the key again to stop.

Start using an external signal

Starts waveform generation using an external signal. When you press the START/STOP key on the front panel, the VB8000 enters the trigger-wait state. Waveform generation starts on the external start trigger signal that is generated after the trigger-ready signal is enabled.
Press the START/STOP key again to stop waveform generation.

Turn ON/OFF waveform output

START/STOP key

Trigger-ready signal (READY OUT)

External start trigger signal (TRIG IN)

Waveform generation
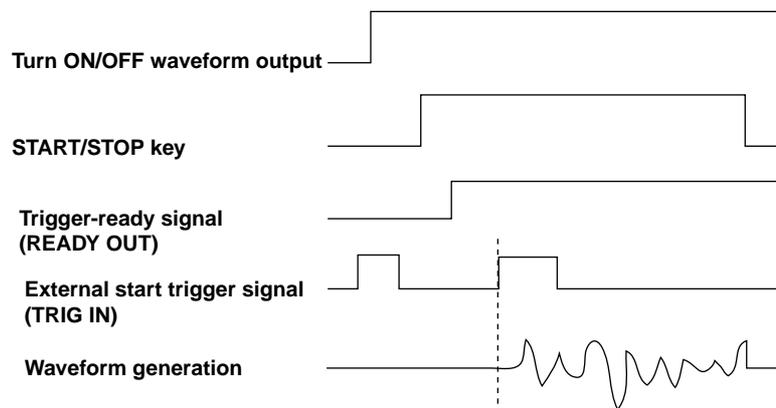
*   Trigger-ready signal.
     A signal provided internally by the VB8000. When the VB8000 is ready to receive trigger signals, the trigger-ready signal changes from Low level to High level.
     The trigger-ready signal is output from the READY OUT terminal on the rear panel.

Differential Output

In the differential output model, the $I/\bar{I}/Q/\bar{Q}$ waveform is output as follows:

I: Output I data of waveform data

$\bar{I}$:   Output an inverted waveform of I data

Q: Output Q data of waveform data

$\bar{Q}$:   Output an inverted waveform of Q data

I or Q

$\bar{I}$ or $\bar{Q}$
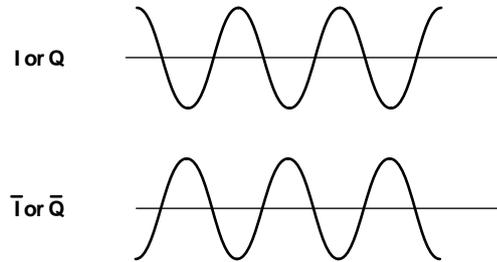
1.9 Synchronized Operation

You can connect multiple VB8000s for synchronized operation. You can also connect to YOKOGAWA's VB2000 for synchronized operation.

The connection method is shown below.

Connect VB8000s and VB2000s (clock synchronization)

VB8000

TRIGGER READY OUT

CLOCK OUT (rear panel)

I OUT   **Q OUT**

EXT I IN   **EXT Q IN (rear panel)**

M CLK IN (rear panel)

VB2000

TRIGGER IN

TRIGGER READY OUT (rear panel)

M CLK OUT (rear panel)

I OUT   **Q OUT**
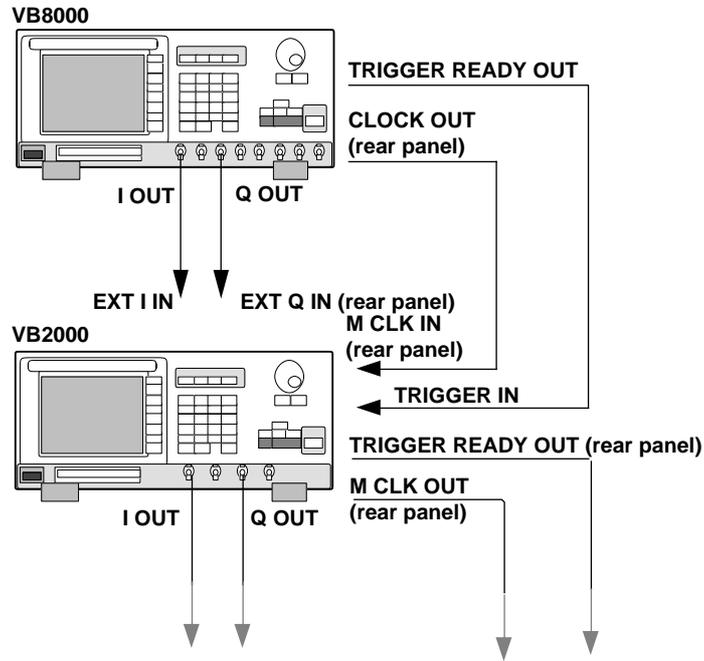
Connect in a similar fashion to succeeding slaves

Connect VB8000s and VB2000s (frequency synchronization)

VB8000

10MHz REF OUT (rear panel)

I OUT   **Q OUT**

EXT I IN   **EXT Q IN (rear panel)**

VB2000

10MHz REF IN (rear panel)

10MHz REF OUT (rear panel)

I OUT   **Q OUT**
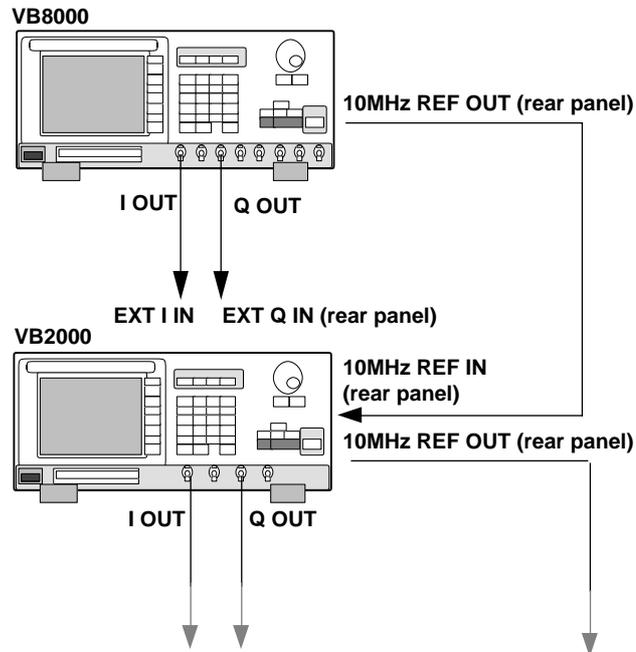
Connect in a similar fashion to succeeding slaves

Connect multiple VB8000s (clock synchronization)

VB8000

CLOCK OUT (rear panel)

VB8000

CLOCK IN (rear panel)

CLOCK OUT (rear panel)
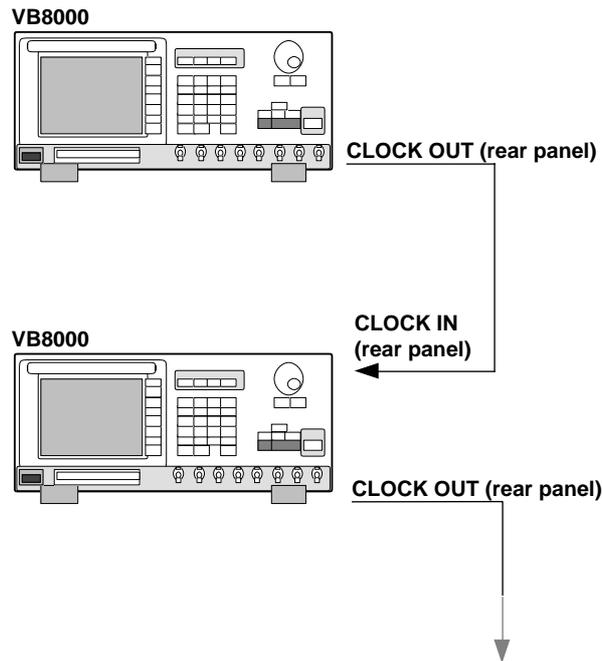
Connect in a similar fashion to succeeding slaves

Note

• When the external clock input of the VB8000 is used, the signal received from the external clock input terminal is valid starting with the rising edge of the third clock cycle.
• When synchronizing multiple VB8000s, you can match the start of the waveform by setting a delay on the VB8000 that is to output the external clock.

Connect multiple VB8000s (frequency synchronization)

VB8000

10MHz REF OUT (rear panel)

VB8000

10MHz REF IN (rear panel)

10MHz REF OUT (rear panel)
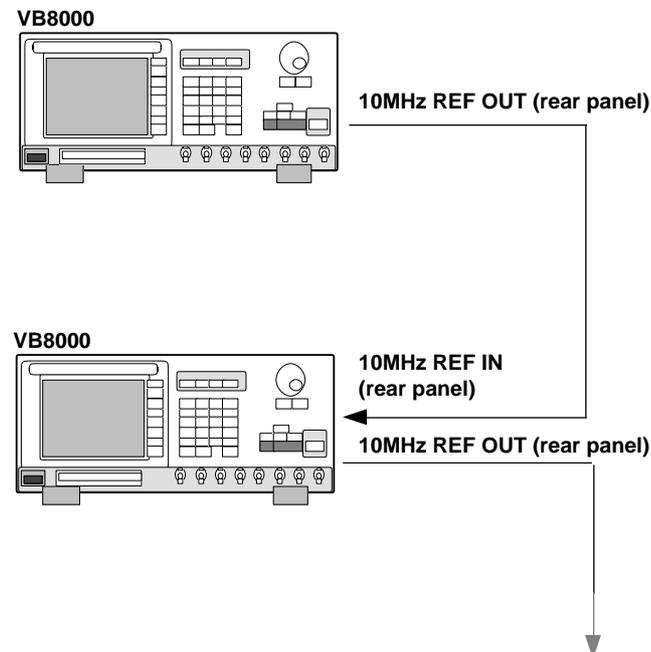
Connect in a similar fashion to succeeding slaves

Note

Make sure all cables are of the same length. Using cables of different length will cause skews.

1.10 Other Functions

Clock Output   ≡**See 7.3 and 10.3 for the operating procedure**≡
When using the internal clock, a clock signal of a specified frequency (clock frequency) is output from the CLK OUT terminal on the rear panel.
When using an external clock, the external clock signal is output.

Outputting the 10-MHz Reference Signal
   ≡**See 7.2 and 10.5 for the operating procedure**≡
When using the internal 10-MHz reference signal, the signal is output from the 10 MHz REF OUT terminal on the rear panel.
When using an external 10-MHz reference signal, the external reference signal is output.

Digital Output/Event Output   ≡**See 10.6 and 10.7 for the operating procedure**≡
   Digital output
   Outputs the waveform data independently for I and Q using a 14-bit digital signal from the DIGITAL OUT terminal on the rear panel.
   Event output
   Outputs event data from the EVENT OUT terminal on the rear panel. Event data are 1-bit data synchronized to the waveform data. The data are created when waveform data are created.

Trigger-Ready Output   ≡**See 10.8 for the operating procedure**≡
A signal that indicates that the VB8000 is ready to receive trigger signals is output from the READY OUT terminal on the rear panel.

Communication Interface
   ≡**See the Communication Interface User's manual (IM703150-11E)**≡
A GP-IB interface and a serial port (RS-232) come standard on the VB8000. Through the communication functions, you can retrieve waveform data from the PC to the VB8000 or control the VB8000 using an external controller.

Ethernet Connection   ≡**See chapter 4 for the operating procedure**≡
The VB8000 supports a DHCP client function and an FTP server function.
   FTP server function
   You can upload or download files from the built-in floppy disk or hard disk of the VB8000 by accessing the VB8000 using FTP from a PC or workstation on the network.
   This function can be used on PCs or workstations that have an operating FTP client function.
   DHCP client function
   Automatically retrieves information that is required in connecting to the network when the power is turned ON. The following information is retrieved:
   • IP address   • Subnet mask   • Default gateway

File Operation   ≡**See chapter 8 for the operating procedure**≡
You can delete files that are saved on the built-in hard disk or floppy disk or create directories.
You can also format a floppy disk with the VB8000.

Initializing Setup   ≡**See page 3-6 for the operating procedure**≡
You can reset the setup (configured using each key) to factory default. However, settings related to communications and Ethernet are not initialized.

2.1   Front Panel

ESC key
Clears the soft key menu. When a pop-up menu
is showing, the pop-up menu is cleared.

• **FILE key**: Save/Load data to the storage medium
(HD LED turns ON while the built-in hard disk is
being accessed)→See chapter 8.
• **CLOCK key**: Set the clock frequency/clock/reference clock
→See chapter 7.
• **MISC key**: Set communications/Ethernet/date and time/self-test
→See sections 3.6, 4.2, and chapter 11.
• **LOCAL key**: Clear remote mode (REMOTE LED turns ON
during remote mode)

SETUP key
Load waveform data to waveform memory (chapter 6),
Set the filter/attenuator/offset/phase (chapter 7)

• **RESET key**
• **SELECT key**

**Waveform generation
start/stop key**
(LED turns ON while started)
→See section 7.9.
LED backlight ON/OFF key
(LED turns ON while ON)
→See section 9.2.
Output ON/OFF key
(LED turns ON during output)
→See section 7.10.

OUTPUT terminal ⚠
(for single-ended output model)→See section 3.5.
• **Panel keys/Alphabet keys**
• **SHIFT key**: Switch numeric keys and alphabet keys
(When alphabet keys are enabled, the SHIFT LED turns ON)

Soft keys
Select an item from the soft key menu.→See section 3.7.

Floppy disk drive

Power switch→See section 3.4.

For differential output model

2.2 Rear Panel

10-MHz reference signal input terminal ⚠
(sections 7.2 and 10.4)

Clock output terminal ⚠
(section 10.3)

Clock input terminal ⚠
(sections 7.3 and 10.2)

Digital output connector ⚠
(section 10.6)

Serial port (RS-232) connector
For details on communications,
see the "Communication Interface
user's manual" (IM703150-11E).

Power connector ⚠
(section 3.3)

GP-IB connector
For details on communications,
see the "Communication Interface
user's manual" (IM703150-11E).

Ethernet interface connector (section 4.1)

Event output terminal ⚠
(section 10.7)

Trigger-ready output terminal ⚠
(section 10.8)

Trigger input terminal ⚠
(sections 7.5 and 10.1)

10-MHz reference signal output terminal ⚠
(section 10.5)

2.3   Screen Display

Operating condition display area

Date and time   **Displays error messages**

2000/07/18 09:55:35

STOP

Freq	: 100000000Hz			
	[Output1]	[Output2]		
Label	: Wave 1	Wave 2		
Power				
Effect	: 0.500(Vrms)			
Peak	: 2.000(Vpp)	2.000(Vpp)		
Waveform				
Name	: SQUARE			
Header	: SQR1K.RAW	Not Selected		
Body	: SQR1M.RAW			
Delay	: 0(clk)	0(clk)		
ATT	: 0.0(dB)	0.0(dB)		
Phase	: 0.0(deg)	0.0(deg)		
I/Q Gain	: 0.0(%)	0.0(%)		
Quadrature	: 0.0(deg)	0.0(deg)		
Offset				
Diff-I	: 0.0(mV)	0.0(mV)		
-Q	: 0.0(mV)	0.0(mV)		
Comm-I	: 0(mV)	0(mV)		
-Q	: 0(mV)	0(mV)		
Filter	: 90MHz	90MHz		
Dig-Out	: Off	Off		
Format	:			

Waveform #1
◄ Select Wave
SQUARE

◙ Delay
0

Setup WaveOut

Load Wave Gr.

Save Wave Gr.

Soft key menu

Display setup information for each OUTPUT

Date and time

For setting the date and time, see section 3.6.

Operating condition

The following messages are displayed in the operating condition display area to indicate the conditions:

- START: Generating waveforms
- STOP: Waveform generation stopped
- LOADED: Loading waveform data to the waveform memory

Setup information list display

The following information is displayed for each OUTPUT:

Freq   : Clock frequency (common to all OUTPUTs)

Label   : Label of the OUTPUT terminal

Power

- RMS   : RMS value of output waveform ($\sqrt{I^2+Q^2}$)
- Peak   : Maximum value that can be output (the largest value of I and Q)

Waveform

- Name   : Waveform data name
- Header   : File name of the header waveform
- Body   : File name of the body waveform
- Delay   : Output delay setting

ATT   : Attenuator setting

Phase   : Phase setting

I/Q Gain   : I/Q gain ratio setting

Quadrature : Quadrature offset setting

Offset

- Diff-I   : Differential offset voltage of the I waveform (or the Fine offset voltage of
  (Fine-I)   the I waveform)
- Diff-Q   : Differential offset voltage of the Q waveform (or the Fine offset voltage of
  (Fine-Q)   the Q waveform)
- Comm-I : Common offset voltage of the I waveform (or the Coarse offset voltage of
  (Coarse-I) the I waveform)
- Comm-Q : Common offset voltage of the Q waveform (or the Coarse offset voltage of
  (Coarse Q) the Q waveform)

Filter   : Filter setting

Dig-Out   : Digital output ON/OFF

• Format   : Digital output format

3.1 Precautions on the Use of the VB8000

Safety Precautions

When using the instrument for the first time, make sure to read the "Safety Precautions" given on pages iv and v.

Do not remove the cover

Do not remove the cover from the instrument. Some sections inside the instrument have high voltages that are extremely dangerous. For internal inspection or adjustment, contact your nearest YOKOGAWA dealer as listed on the back cover of this manual.

Do not operate if abnormal symptons occur

Stop using the instrument if there are any symptoms of trouble such as strange odors or smoke coming from the instrument. If these symptoms occur, immediately turn OFF the power and unplug the power cord. Contact your nearest YOKOGAWA dealer as listed on the back cover of this manual.

Turn OFF the power when the cooling fan stops

If error code 1017 appears on the display, the cooling fan is stopped. Immediately turn OFF the power switch. If error message 1017 appears when you turn ON the power switch again, it is probably a malfunction. Contact your nearest YOKOGAWA dealer as listed on the back cover of this manual.

```
2000/12/03 17:41:42  Fan Stopped!!

 STOP

Freq    │ Error code : #1017
Label   │ Fan stopped. Please turn power off.
Power   │
  RMS   │
  Peak  │
Wavefor │
  Name  :
  Header : Not Selected  Not Selected
  Body  :
  Delay :       0(clk)        0(clk)
```
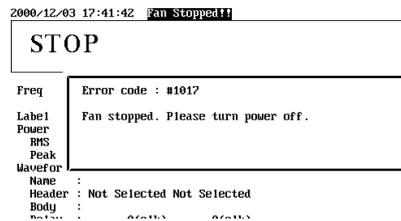
Handle the power cord with care

Nothing should be placed on top of the power cord. The power cord should also be kept away from any heat sources. When unplugging the power cord from the outlet, never pull by the cord itself. Always hold and pull by the plug. If the power cord is damaged, check the part number indicated on page ii and purchase a replacement.

General Handling Precautions

Do not place objects on top of the instrument

Never place any objects containing water on top of the instrument. Water spills can lead to malfunction.

Do not apply shock or vibration to the instrument

Shock or vibration can lead to malfunction. Take extra care when dealing with the internal floppy disk drive or the built-in hard disk, because they are prone to shock and vibrations. In addition, applying shock to the input/output terminal or the connected cable can cause electrical noise to enter or output from the instrument.

Do not damage the LCD

The LCD is very vulnerable to scratches. Therefore, be careful not to damage the surface with sharp objects. Also, do not apply vibration or shock to it.

**Do not bring charged objects near the instrument**

Do not bring charged objects near the input connector. This can damage the internal circuitry.

Remove cord during periods of non-use

Turn OFF the power switch and remove the power cord from the outlet.

Carry the instrument properly

First, remove the power cord and connection cables. The weight of the instrument is approximately 16 kg. To carry the instrument, hold the handle with both hands as shown in the figure below, and move it carefully.
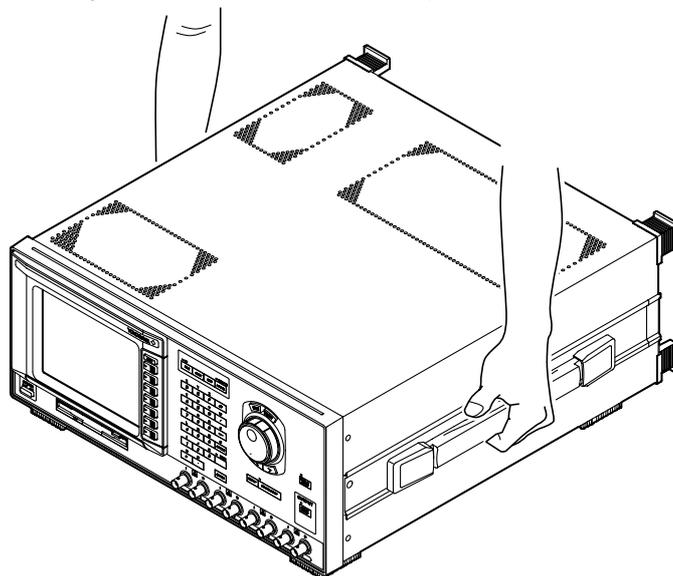
**Clean the instrument properly**

When wiping off dirt from the case or operation panel, turn OFF the power switch and remove the power cord from the outlet. Then, gently wipe with a soft dry clean cloth. Do not use volatile chemicals as this may cause discoloring and deformation.

3.2 Installing the VB8000

WARNING

To avoid the possibility of fire, never use the instrument with the rear panel facing down. There are vent holes for the cooling fan on the rear panel. Placing the instrument with the rear panel down can cause a fire when the instrument malfunctions. If you must use the instrument with the rear panel down, place a metal plate or a flame-resistive barrier (grade UL94V-1 or higher) beneath the instrument.
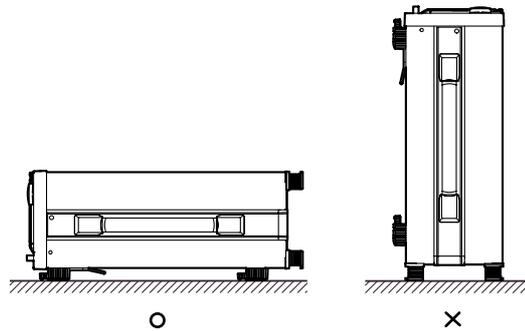

Installation Environment

Install the instrument in the following manner.

Flat and even surface

Install the instrument on a stable horizontal surface. Accurate measurements may be hindered when the instrument is used in an unstable surface or in a tilted position.

Well-ventilated location

There are vent holes on the topside of the instrument. In addition, there are vent holes for the cooling fan on the rear panel. To prevent internal overheating, allow for enough space around the instrument (see the figure below) and do not block the vent holes.
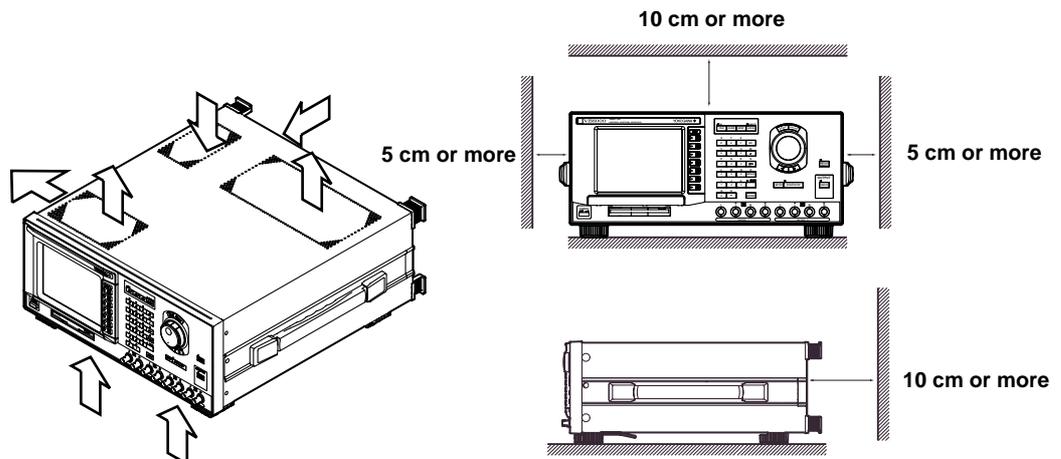
Ambient temperature and humidity

Use the instrument in the following environment:

- Ambient temperature: 5 to 40°C
  However, in order to obtain highly accurate measurements, operate the instrument in the 23±5°C temperature range.
- Ambient humidity: 20 to 80%RH
  No condensation should be present. However, in order to obtain highly accurate measurements, operate the instrument in the 50±10%RH range.

Note

Condensation may occur if the instrument is moved to another place where the ambient temperature is higher, or if the temperature changes rapidly. In this case, let the instrument adjust to the new environment for at least an hour before using the instrument.

Do not Install the Instrument in the Following Places:

- In direct sunlight or near heat sources.
- Where an excessive amount of soot, steam, dust, or corrosive gas is present.
- Near strong magnetic field sources.
- Near high voltage equipment or power lines.
- Where the level of mechanical vibration is high.
- In an unstable location.

Storage Location

When storing the VB8000, avoid the following locations:

- A place with a relative humidity of 80% or more.
- In direct sunlight.
- A hot place with a temperature of 60°C or more.
- Near a high humidity or heat source.
- Where mechanical vibration is high.
- A place with corrosive gases or flammable gases.
- A place with a lot of dust, trash, salt, or iron powder.
- A place where water, oil, or chemicals may splash.

We strongly recommend you store the VB8000 in an environment with a temperature between 5 and 40°C and a relative humidity between 20 to 80%RH.

Installation Position

Place the instrument in a horizontal position or inclined position using the stand as shown in the figure below.

When using the stand, pull the stand forward until it locks (perpendicular to the bottom surface of the instrument). If you are installing the instrument on a slippery surface, attach the rubber feet (two pieces, included in the package) to the hind feet. If you are not using the stand, return it to the original position while pressing the leg section of the stand inward.
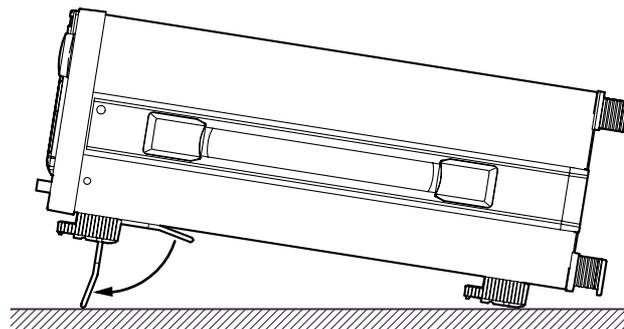
3.3 Connecting the Power Supply

Before Connecting the Power Supply

To prevent the possibility of electric shock and damage to the instrument, follow the warnings below.

WARNING

- Ensure that the supply voltage matches the rated supply voltage of the instrument before connecting the power cord.
- Check that the power switch is turned OFF before connecting the power cord.
- To prevent the possibility of electric shock or fire, be sure to use the power cord supplied by YOKOGAWA.
- Make sure to perform protective grounding to prevent the possibility of electric shock. Connect the power cord to a three-pin power outlet with a protective earth terminal.
- Do not use an extension cord without protective earth ground. Doing so will invalidate the protection.

Connecting the Power Cord

1. Check that the power switch on the front panel of the instrument is turned OFF.
2. Connect the power cord plug to the power connector on the rear panel. (Use the power cord that came with the package.)
3. Connect the plug on the other end of the power cord to the outlet that meets the conditions below. The AC outlet must be of a three-pin type with a protective earth ground terminal.

| Item	Specifications
Rated supply voltage	100-120 VAC/220-240 VAC
Permitted supply voltage range	90-132 VAC/180-250 VAC
Rated supply voltage frequency	50/60 Hz
Permitted supply voltage frequency range	48 to 63 Hz
Maximum power consumption	300 VA
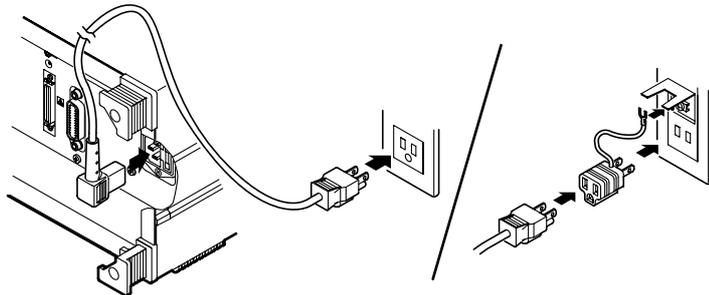
3.4   Turning ON/OFF the Power Switch

Things to Check before Turning ON the Power

- Is the instrument properly installed?→ Section 3.2, "Installing the Instrument"
- Is the power cord properly connected?→ Section 3.3, "Connecting the Power Supply"

Location of the Power Switch and ON/OFF Operation

The power switch is a push button located at the lower left corner of the front panel.
Press once to turn it "ON" and press again to turn it "OFF."

OFF   ON
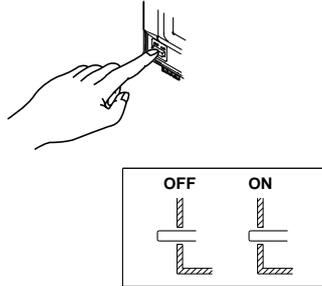
Power Up Operation

When the power switch is turned ON, calibration is automatically started. If calibration completes normally, a normal display screen appears (see page 2-3).

Note

If the VB8000 does not operate as described above when the power switch is turned ON, turn OFF the power switch and check the following points:

- Is the power cord securely connected?
- Is the correct voltage coming to the power outlet?→ See section 3.3.
- If you turn ON the power switch while pressing the SETUP key, the setup information is initialized (reset to the factory default condition). For initializing the settings, see the next section.

  If the instrument still fails to power up when the power switch is turned ON after checking these points, it is probably a malfunction. Please contact your nearest YOKOGAWA dealer.

Initializing Settings

Restoring the settings back to factory default setting is called initializing.

When initialization is executed by turning ON the power switch while pressing the SETUP key, the settings are reset to the values below.

Item	Setting
START/STOP key	STOP
DISPLAY ON/OFF key	ON
ON/OFF key (waveform output)	OFF
CLOCK key	
Frequency	1 MHz
10MHz In	INT (internal)
Clock In	INT (internal clock)
Trigger In	INT (internal)
MISC key (Communication)	
Communication	GPIB
GPIB Address	1
MISC key (TCP/IP)	
Host Name	"localhost.localdomain"
Password	""
DHCP	OFF
IP Address	127.0.0.1
Netmask	255.0.0.0
Gateway	0.0.0.0
SETUP key	
Setup information of each OUTPUT (common to OUTPUT 1, OUTPUT 2, OUTPUT 3, and OUTPUT 4)	
Label Name	"Wave 1"
Delay	0 [clock]
ATT	0 [dB]
Phase	0 [degree]
I/Q Gain	0 [%]
Quadrature	0 [degree]
Offset	
I-Fine or I-Difference	0 [mV]
Q-Fine or Q-Difference	0 [mV]
I-Coarse or I-Common	0 [mV]
Q-Coarse or Q-Common	0 [mV]
Filter	6 MHz
Digital Out	OFF
Format	Offset Binary
Contents of the waveform group list of each OUTPUT	Registered list is empty

Items that cannot be initialized

Date and time settings

To Output Accurate Waveforms

Under the installation condition indicated in section 3.2, allow the instrument to warm up for at least 30 minutes after the power switch is turned ON. Then, calibrate the instrument.

Shutdown Operation

The setup information that exists immediately before the power switch is turned OFF is stored. It is also stored when the power cord becomes unplugged.

However, note that the following items are not stored:

• Data in the waveform memory
• Start/Stop condition of waveform generation (when the power switch is turned ON: stop)
• LCD backlight ON/OFF (when the power switch is turned ON: ON)
• Waveform output ON/OFF (when the power switch is turned ON: OFF)

Note

The lithium battery that is used to store the setup information has a limited life span. When the voltage level of the lithium battery drops below a given level, [035 Lithium battery voltage low.] is displayed to the right of the date and time display. In such case, you must quickly replace the lithium battery. The user cannot replace the lithium battery. Contact your nearest YOKOGAWA dealer.

3.5 Connecting Cables to the Waveform Output Terminals

Position of the Waveform Output Terminal

The terminal is located at the lower right section of the front panel. Connect a cable with a BNC connector.

For differential output model (with 8 terminals)
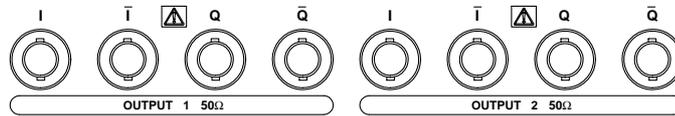
For single-ended output model (with 8 terminals)
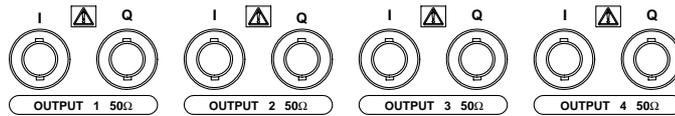
Specifications of the Waveform Output Terminal

Item	Specifications
Connector type	BNC
Number of terminals	4 (Model 703150-162, -642: differential output, 1 OUTPUT)
	6 (Model 703150-166, -646: single-ended output, 3 OUTPUTs)
	8 (Model 703150-164, -644: differential output, 2 OUTPUTs
	Model 703150-168, -648: single-ended output, 4 OUTPUTs)
Output impedance	50±1 Ω (DC)
Ground	Connect to the case ground

CAUTION

Do not apply voltage to the output terminals. This may cause damage to the output section.

3.6 Setting the Date and Time

Function

Date

Set the Year/Month/Day.

Time

Set the time using a 24-hour clock.

Procedure

1. Press MISC .
2. Press the [Date/Time] soft key to display the Date and Time menu.
3. Press the soft key corresponding to the item you wish to change.
4. Turn the rotary knob to set the value.
5. Press the [Set] soft key to set the specified date or time.
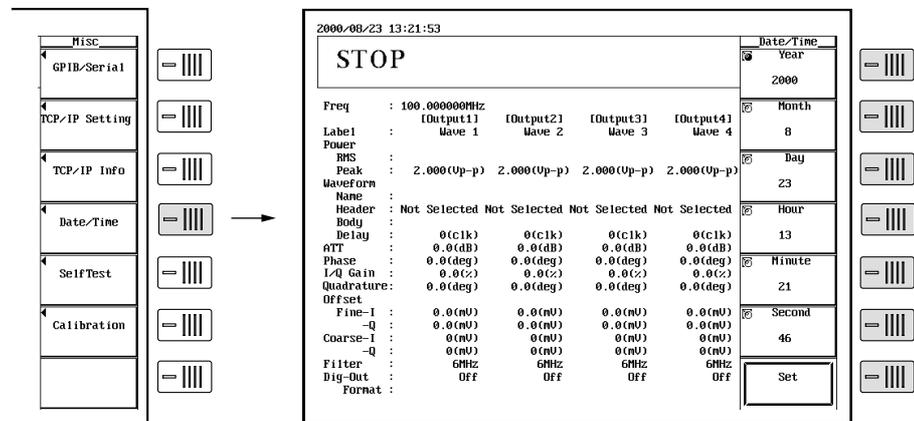
3.7 Key Operations (Basic Operations)
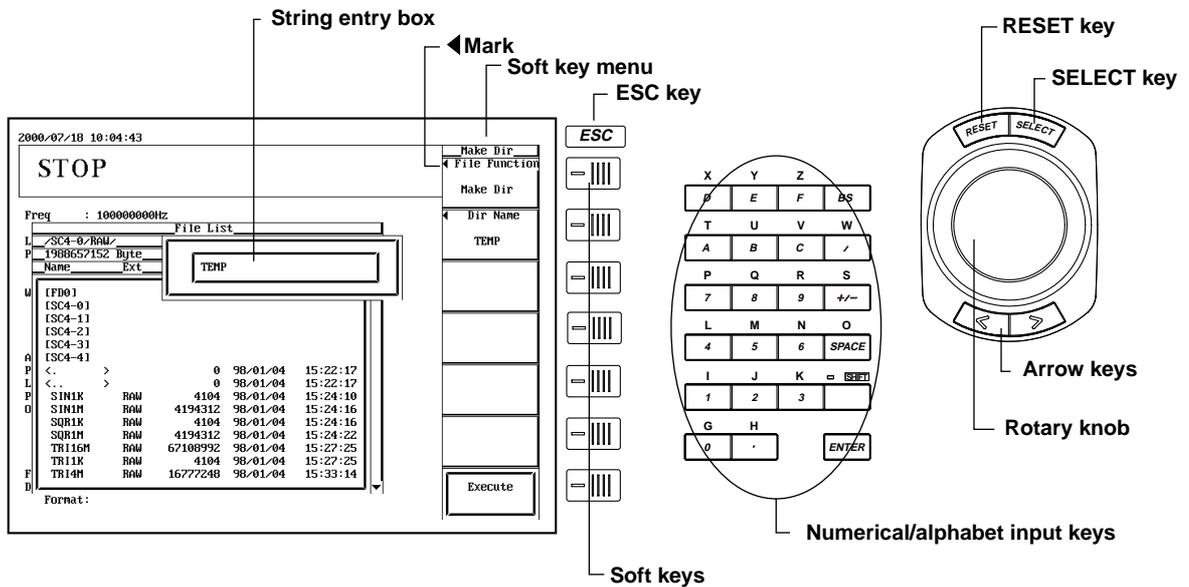
Soft key menu

Press an operation key to display the soft key menu. Press the soft key corresponding to the item and set or select the item.

- **◀ Mark**

 When there are more items for you to configure, a ◀ is displayed on the soft key menu.

  If you select a soft key menu with the ◀ mark, a pop-up menu or a string entry box opens.

Value entry

- **Entering values using numeric keys**

  On menus that require a value to be input, use the numeric keys to input the value.
  Press the ENTER key to confirm the value.
  You can press the BS (backspace) key to delete the input value one digit at a time.

  A value entry box opens when a numerical key is pressed.
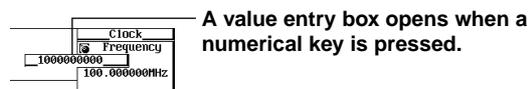
- **Entering values using the rotary knob**

  On menus that require a value to be entered, use the arrow keys to move the cursor to the appropriate digit and change the value using the rotary knob.

String entry

When a string entry box opens, enter the string using numerical/alphabet keys.
Press the ENTER key to confirm the value.
When the SHIFT key is pressed and the LED is turned ON, functions indicated by purple labels become active.

ESC key

Clears the soft key menu. When a pop-up menu or a string entry box is displayed, the pop-up menu or string entry box is cleared.

SELECT key

Use this key to select directories or to confirm a selected item.

RESET key

Resets the value to the initial value.

Note

- Strings are entered using upper-case letters. However, the host name of TCP/IP setting is converted to lower-case letters when it is confirmed.
- Due to the restrictions of MS-DOS, the following five file names cannot be used:
  AUX, CON, PRN, NUL, and CLOCK
- When using the communication interface commands to enter file names, the following symbols can also be used:
 !#$&'-^@{}

4.1 Connecting to the Ethernet Interface

≡**For a functional description, see page 1-23.**≡

When connecting to the Ethernet interface, always use a category 3, 4, or 5 UTP (Unshielded Twisted Pair) cable.

Connecting to the Network

The Ethernet connector of the VB8000 is a 10BASE-T connector. Connect the VB8000 to the network via a network switch such as a hub as shown below. If the connector type is different, use an adapter or other similar devices.

For details, consult your system or network administrator.
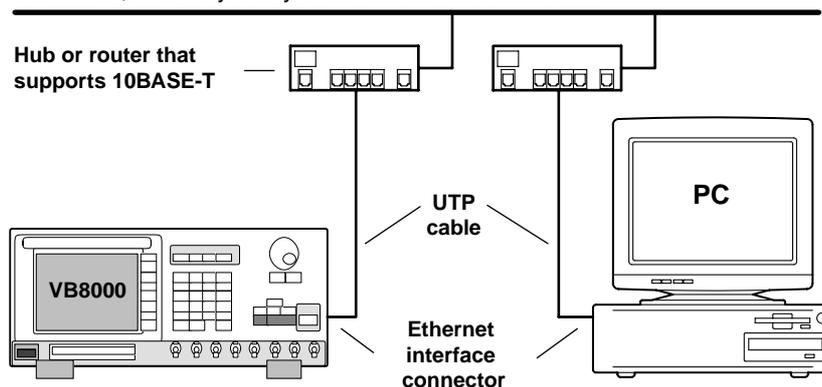
One-to-One Connection with a PC

Connect the VB8000 via a network switch such as a hub as shown below.
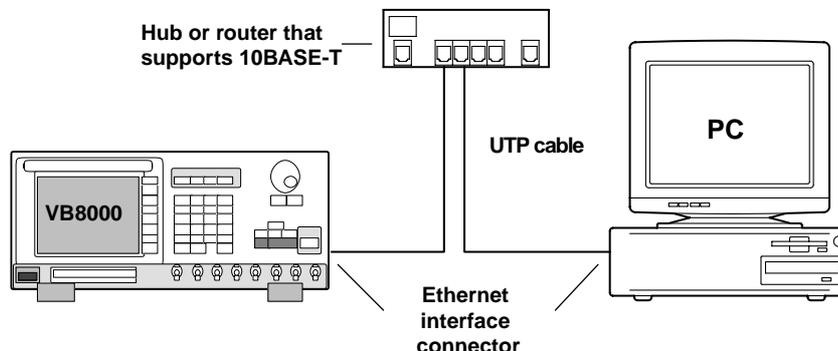
Note

• The VB8000 supports only a single client. You cannot access the VB8000 simultaneously from multiple PCs, workstations, or multiple software applications.

• When connecting the VB8000 and the PC in a one-to-one configuration, use a 10BASE-T or a 10BaseT/100BaseT auto-switching NIC on the PC side. In addition, set the default gateway to [0.0.0.0].

• In some cases, not all the transmitted data may be retrieved by the PC depending on the network conditions such as when there is excessive amount of traffic or when external noise affects the network.

4.2 Setting the TCP/IP

Function

To use the Ethernet communication functions of the VB8000, the following settings are required:

- Host name
- Password
- DHCP setting
- IP address
- Subnet mask
- Default gateway

Consult your system or network administrator when setting these parameters.

Host name

Set the host name of the VB8000 using up to 40 characters. Upper-case letters are used to enter the host name, but they are set to lower-case letters after the entry is confirmed.

Password

If you set a password, the password must be entered when accessing the VB8000 using FTP. This allows only particular users to access the data on the VB8000.

DHCP (Dynamic Host Configuration Protocol)

If you use DHCP, the following contents are automatically configured:

- IP address
- Subnet mask
- Default gateway

To use DHCP, the network must have a DHCP server.

Consult your network administrator to find out if DHCP can be used.

If you use DHCP, a different IP address may be assigned every time the VB8000 is powered up.

IP address (Internet Protocol Address)

Set the IP address to assign to the VB8000. The default setting is [127.0.0.1].
The IP address is used to uniquely identify a device on the Internet when using TCP/IP.
The address is a 32-bit value expressed in four octets (each 0 to 255), each separated by a period as in [192.168.111.24]. A unique ID must be acquired from the network administrator.
If DHCP can be used, the address is automatically assigned.

Subnet mask

Set the mask value used when determining the subnet network address from the IP address. The default setting is [255.0.0.0]. Consult your network administrator for the appropriate value.
If DHCP can be used, the mask is automatically assigned.

Default gateway

Specify the IP address of the default gateway that is used when communicating with other devices on a different segment (network unit). The default setting is [0.0.0.0].
Consult your network administrator for the appropriate value.
If DHCP can be used, the gateway is automatically assigned.
The gateway may not be required (set to [0.0.0.0] when connecting the PC and the VB8000 one-to-one).

TCP/IP-related setup information

Lists the setup information related to TCP/IP and the MAC address. MAC address is a unique address that is pre-assigned to the VB8000.

- **Settings that are listed**
  Host name
  DHCP ON/OFF
  IP address
  Subnet mask
  Default gateway
  MAC address

Note

When changing the TCP/IP settings, have the VB8000 connected to the network.

Procedure

1. Press MISC .
2. Press the [TCP/IP Setting] soft key to display the TCP/IP Setup menu.

Setting the host name

3. Press the [Host Name] soft key to display the host name entry box. Enter the host name using the numerical/alphabet keys.

Setting the password

4. Press the [Password] soft key to display the password entry box. Enter the password using numerical/alphabet keys.
   If you do not need to set the password, do not enter anything in the password entry box.

DHCP ON/OFF

5. Press the [DHCP] soft key to select [On] or [Off].

Setting the IP address

If DHCP was set to Off in step 5, set the IP address.

6. Press the [IP Address] soft key to display the IP address entry box. Enter the value using numeric keys. Select the value in the range from 0 to 255.

Setting the subnet mask

If DHCP was set to Off in step 5, set the subnet mask.

7. Press the [Netmask] soft key to display the subnet mask entry box. Enter the value using numeric keys. Select the value in the range from 0 to 255.

4

Connecting to an Ethernet Network

Setting the default gateway

If DHCP was set to Off in step 5, set the default gateway address.

8. Press [Gateway] soft key to display the default gateway entry box. Enter the value using numeric keys. Select the value in the range from 0 to 255.

Confirming the settings

9. Press the [Set] soft key to confirm the settings made in steps 3 through 8.
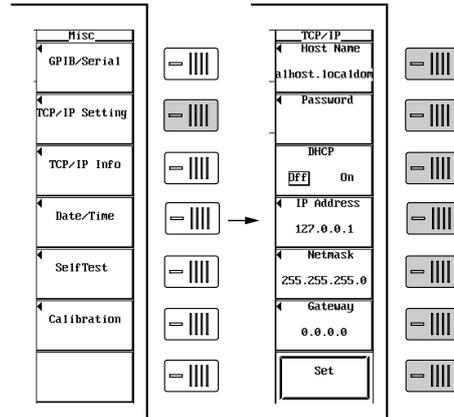
Confirming the TCP/IP settings and MAC address

10. After step 1, press the [TCP/IP Info] soft key.
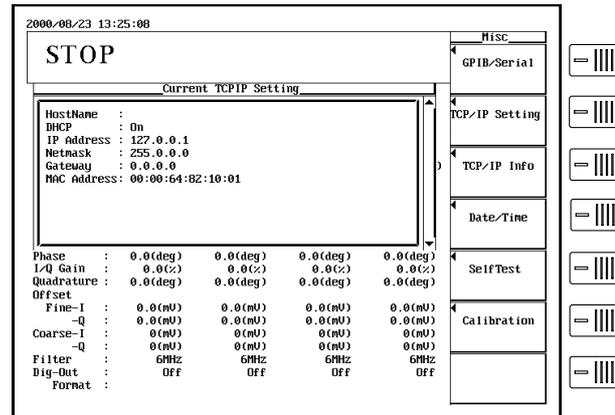
4.3   FTP Connection

Function

You can access the built-in hard disk or floppy disk of the VB8000 via the Ethernet from
a PC or workstation.
To access the VB8000, an internet file transfer client program is required.
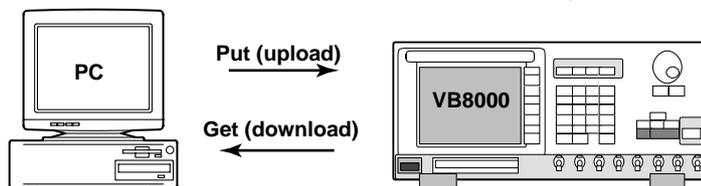
Precautions to Be Taken during Connection

Set the user name (user ID) to ftp or anonymous.

Procedure

1.   Configure the TCP/IP settings of the VB8000 according to the steps given in
section 4.2.
2.   Configure the TCP/IP settings of the PC or workstation.
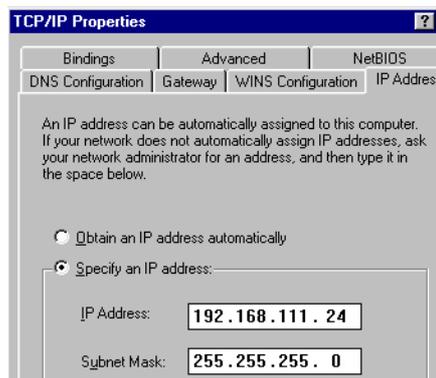
<Example of TCP/IP settings of the VB8000> <Example of TCP/IP settings of the PC>

3.   Execute an FTP client software program on the PC or workstation.

4.   Set the host name, user name, and other information and connect to the VB8000.

<Setting example>

<Example of connecting to the VB8000>

Displays the built-in hard disk (SC4-0, SC4-1, SC4-2, SC4-3, and SC4-4) and the floppy disk (FD0) of the VB8000.
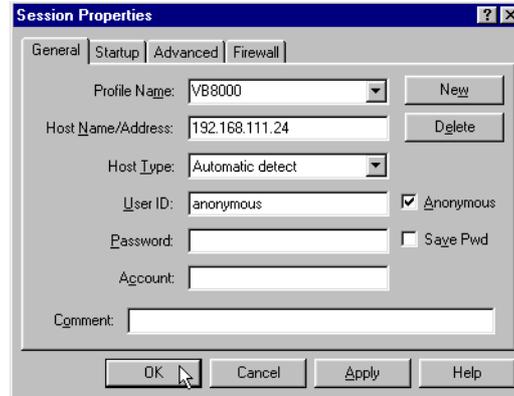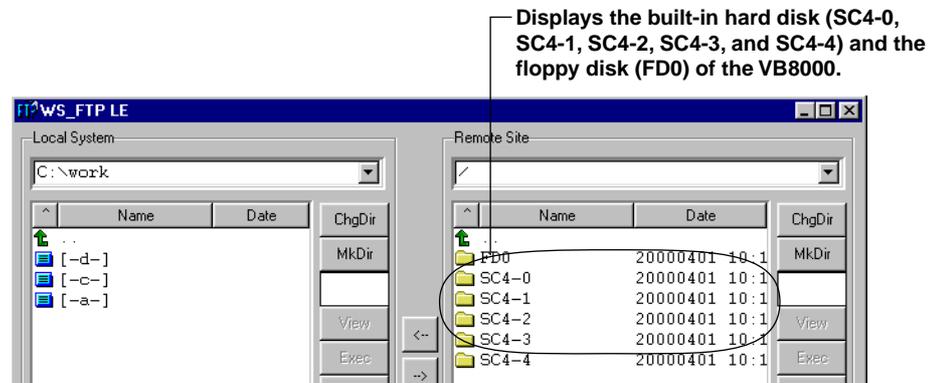
Note

• For approved FTP client software, contact your nearest YOKOGAWA dealer.

• The VB8000 supports only a single client. You cannot access the VB8000 from multiple PCs, workstations, or multiple software applications.

• When the VB8000 is accessed from the PC or workstation (login), < 🖳 > is displayed at the upper right corner of the screen.

Blinks while the VB8000 is being accessed
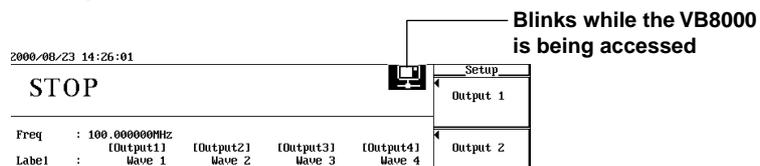
• The following folders are displayed in the root directory:

   • FD0:   Floppy disk

   • SC4-0 to SC4-4: The built-in HD is initially divided into five partitions. The values 0 through 4 indicate those partitions. You cannot change the number of partitions.

   • To use this function, configure the TCP/IP settings beforehand according to section 4.2, "Setting the TCP/IP."

5.1 Uploading Waveform Data

≡**For a functional description, see page 1-12.**≡

Function

Waveform data that you created on your PC can be uploaded (Put) to the built-in hard disk or floppy disk of the VB8000 using FTP.

To upload data, you need a PC or a workstation that is running an FTP client function.
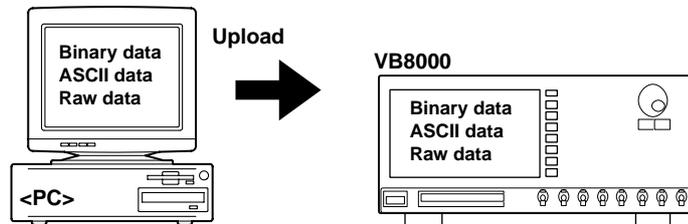
Note

You can also download (Get) the data from the VB8000 to the PC.

Procedure

1. Connect the VB8000 to the network.
2. Access the VB8000 via FTP using internet file transfer client software according to the procedure given in section 4.3.
3. Select the upload destination directory.
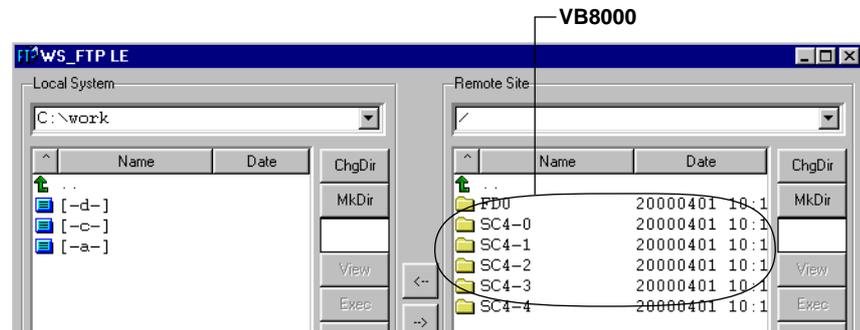
4. Select the data to be uploaded and upload it to the VB8000.
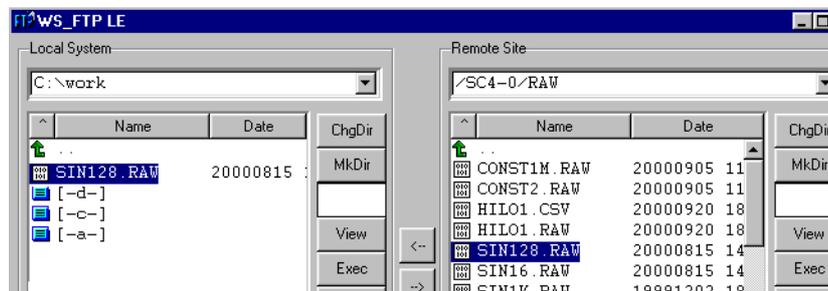
5.2 Importing/Exporting Waveform Data

Function

Importing

The import function is used to retrieve waveform data in ASCII format (CSV format) to the built-in hard disk while converting the data format to one that can be loaded into the waveform memory. It is also used to retrieve waveform data on the floppy disk to the built-in hard disk.

You can select the directory and file name of the import destination.

- **Data format**

  Select the format of the data to be imported. The import operation for each data format is shown below.

Data To Be Imported	After Importing	Note
ASCII data	Binary data	
Binary data	Binary data	Save without data conversion
Raw data	Raw data	Save without data conversion

- **File name**

  Specify the import destination file name using up to eight characters.
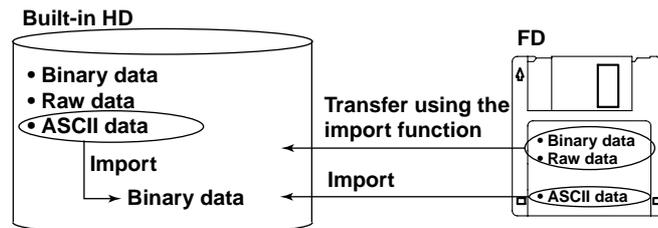
Note

If the data to be imported does not fit on a single floppy disk, divide the data and save to multiple floppy disks. Set the extension for the divided file to [.1], [.2], [.3] and so on.

To import data that are stored on multiple floppy disks, follow the instructions on the screen to insert the succeeding disks.

Exporting

Exporting refers to resaving the binary or raw waveform data by converting the data format to one that can be used on the PC, etc.

Data that have been exported can be downloaded (Get) to the PC or workstation using FTP.

Data formats that can be exported and the data format after exporting are shown below.

Data To Be Exported	After Exporting	Note
Binary data	Binary or ASCII data	Select either one
Raw data	Raw data	Save as-is without data conversion
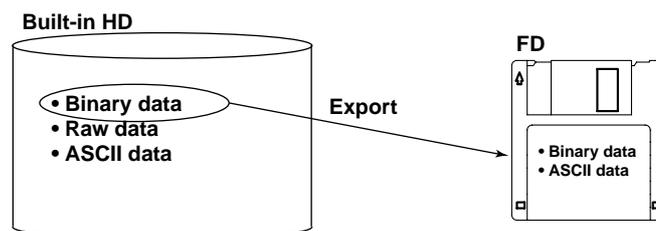
Procedure

1. Press FILE .
2. Press the [File Function] soft key to display the selection menu.

Importing

3. Turn the rotary knob to select [Import] and press the SELECT key.
4. Press the [Import Mode] soft key to display the Data Format Selection menu.
5. Press the soft key corresponding to the format of the data to be imported.
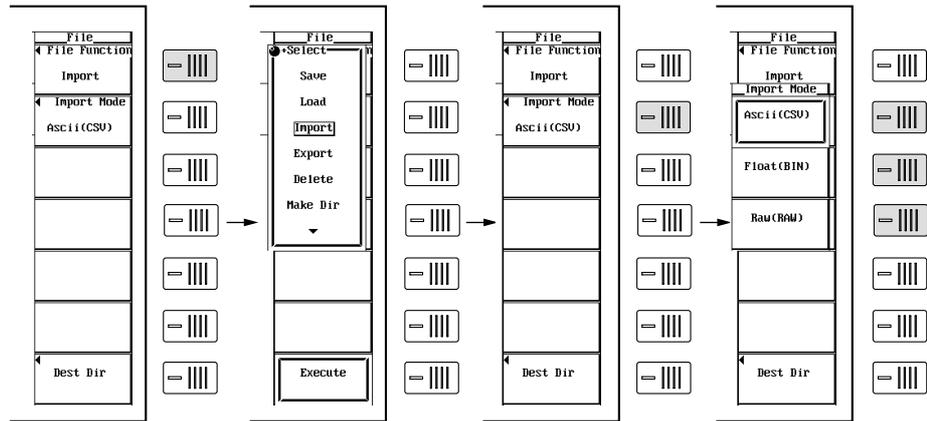
6. Select the file to be imported from the file list according to the procedure given in section 8.3. The highlighted file is the file to be imported.
7. Press the [Dest Dir] soft key to display a file list.
   Select the import destination directory according to the procedure given in section 8.3.
8. Press the [File Name] soft key to display a string entry box. By default, the name of the file to be imported is displayed.
   Enter the file name of the import destination according to the procedure given in section 3.7.

Executing the import operation

9. Press the [Execute] soft key to execute the import operation.

Import destination directory

File to be imported

5
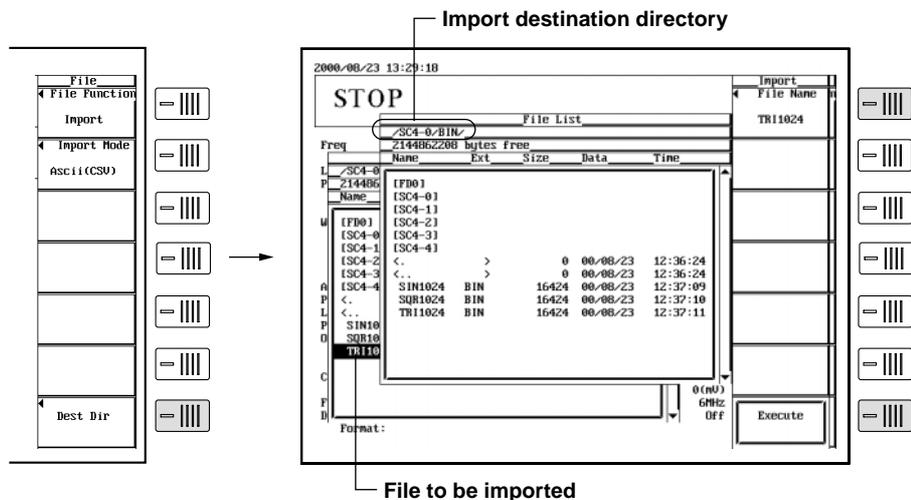
Uploading and Importing Waveform Data

Exporting

3.　After step 2, turn the rotary knob to select [Export] and press the SELECT key.
4.　Press the [Export Mode] soft key to display the Data Format Selection menu.
5.　Press the soft key corresponding to the format of the data to be exported.
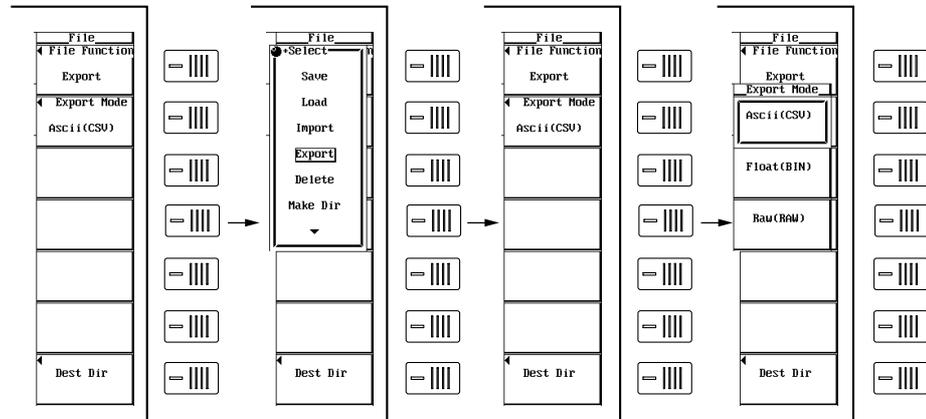
6.　Select the export destination file according to the procedure given in section 8.3.
　　The highlighted file is the file to be exported.
7.　Press the [Dest Dir] soft key to display a file list.
　　Select the export destination directory according to the procedure given in section 8.3.
8.　Press the [File Name] soft key to display a string entry box. By default, the name of the file to be exported is displayed.
　　Select the file name of the export destination according to the procedure given in section 3.7.

Executing the export operation

9.　Press the [Execute] soft key to execute the export operation.

Export destination directory

File to be exported
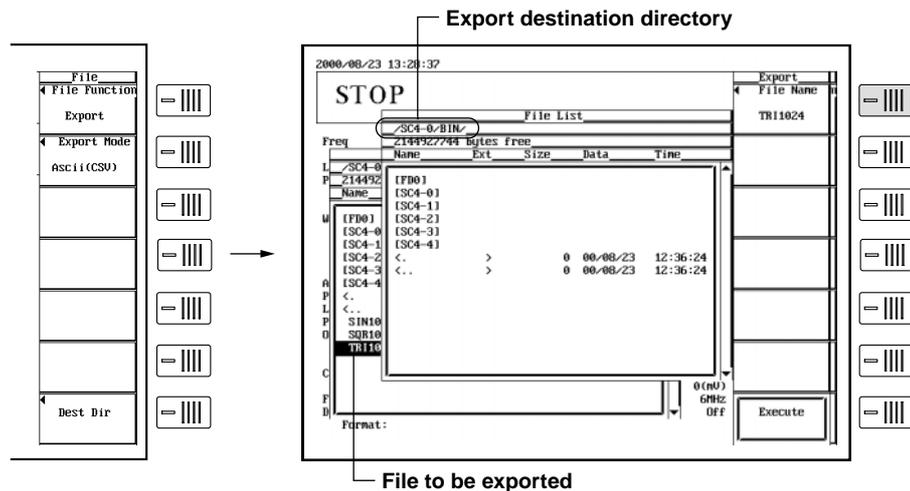
Note

Up to 512 directories and files (including media) can be displayed on the file list. Files after the 512th file cannot be displayed on the file list. For details on media and directories, see section 8.3.

6.1 Creating/Saving/Loading Waveform Group Lists

≡For a functional description, see page 1-13.≡

Function

Creating Waveform Group Lists

Register the file name of the waveform data you wish to load to the waveform memory in the waveform group list.

Waveform group list

A list exists for each OUTPUT.

```
                        ┌─Waveform data name
                        │  ┌─File name of the header
                        │  │  ┌─File name of the body
         ┌──────────Setup WaveOut──────────┐
         │Waveform (Output 1)               │
         │No.  C Waveform Name  Header    Body       │
         │                                  │
         │ 0  U SIN         SIN1K.RAW   SIN1M.RAW  │
         │ 1  U SQUARE      SQR1K.RAW   SQR1M.RAW  │
         │ 2  U TRI         TRI1K.RAW   TRI16M.RAW │
         │ 3  U 123         SIN1M.RAW   TRI1M.RAW  │
         │ 4  U                         SIN1K.RAW  │
         │ 5  E                                    │
         │ 6  E                                    │
         │ 7  E─── U: Registered                   │
              E: Not registered or registration error
              L: Loaded to the waveform memory
```

Data that can be registered in the waveform group list

Binary or raw data on the built-in hard disk can be registered.

For each set of waveform data, you can register two files, a header file and a body file. If you register a header file, the header file is output once the first time and the body file is repetitively output. You do not have to register a header file, but you must register a body file. An error will result otherwise.

Waveform data name

Enter up to 15 characters.

Number of waveform data that can be registered in the waveform group list

Up to 256 files (a header and a body constitutes a single file) can be registered.

However, you may not be able to register 256 files, because the waveform memory size cannot be exceeded.

The waveform memory size varies depending on the model as follows:

Model	Memory Size
16-Mpoint memory model (Suffix Code: -162, -164, -166, and -168)	64 MB
64-Mpoint memory model (Suffix Code: -642, -644, -646, and -648)	256 MB

Saving/Loading Waveform Group Lists

You can save the waveform group lists that are created by assigning names. If you load a waveform group list that had been saved before, it is overwritten to the current waveform group list.

Data that are registered in the waveform group list that you specify can be loaded to the waveform memory.

Note that the following file names cannot be assigned to files under the [SC4-0] directory:

- VB8000R1.IDX
- VB8000R2.IDX
- VB8000R3.IDX
- VB8000R4.IDX

Procedure

1. Press [SETUP] to display the OUTPUT selection menu.
2. Press the soft key corresponding to the OUTPUT you wish to configure.

Creating Waveform Group Lists

3. Press the [Waveform] soft key.
4. Press the [Setup WaveOut] soft key to display the waveform group list.
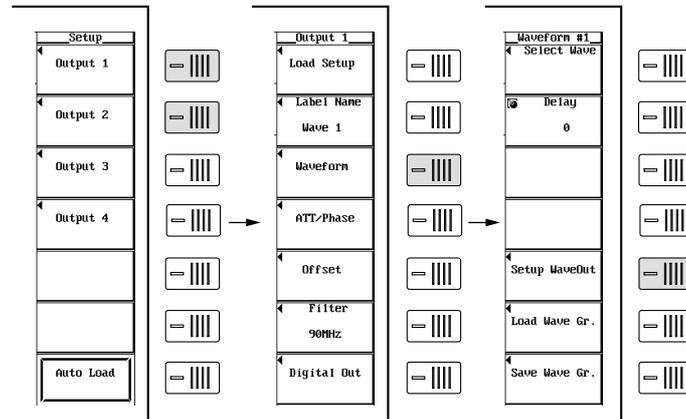
Setting the waveform data name

5. Press the [Function] soft key to display the Function selection menu.
6. Press the [Regist] soft key.
7. Press the [Waveform Name] soft key to display a string entry box.

   Select the waveform data name according to the procedure given in section 3.7.
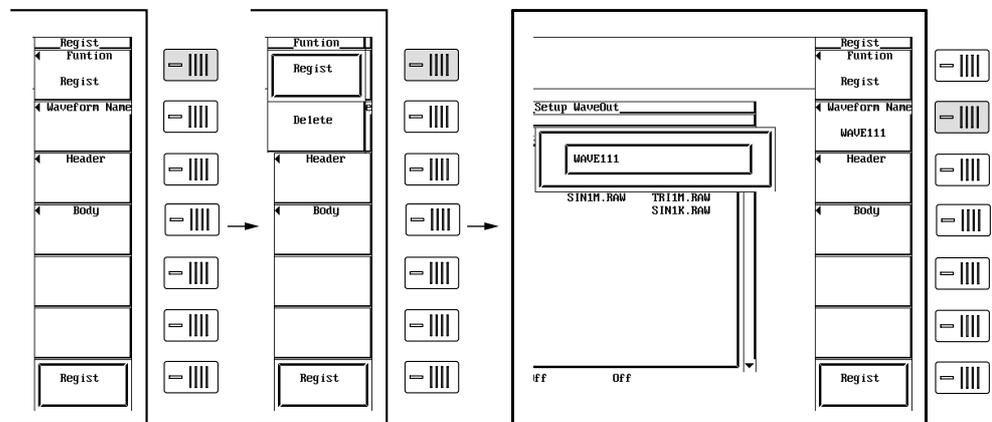
Registering the header or body

8.   Press the [Header] or [Body] soft key to display a file list.

9.   Select the file to be registered as a header or body according to the procedure given in section 8.3.

10.   Press the [Select] soft key to enter the file name to the [Header] or [Body] soft key menu.
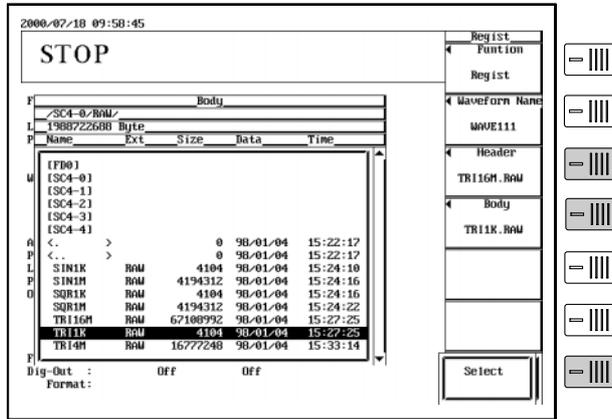
Registering waveform data

11.   Turn the rotary knob to highlight the number you wish to register.

12.   Press the [Regist] soft key while the waveform data name and the file name to be registered are displayed in the appropriate columns of [Waveform Name], [Header], and/or [Body] to register the waveform data to the selected number.

[WAVE111] has been registered.

Saving Waveform Group Files

3. After step 2, press the [Save Wave Gr.] soft key to display a file list.
4. Select the save destination medium and directory according to the procedure given in section 8.3.
5. Press the [File Name] soft key to display a string entry box.
   Select the name of the file to be saved according to the procedure given in section 3.7.
6. Press the [Execute] soft key to save the file.
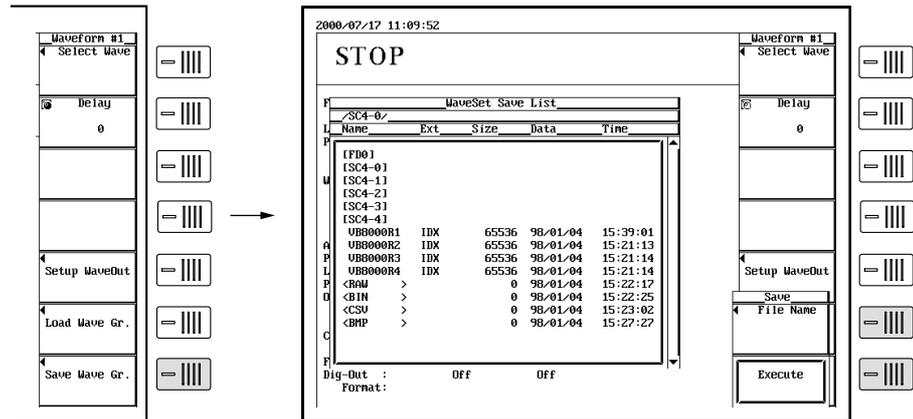
Loading Waveform Group Files

3. After step 2, press the [Load Wave Gr.] soft key to display a file list.
4. Select the file you wish to load according to the procedure given in section 8.3.
5. Press the [Execute] soft key to overwrite to the current waveform group list. In addition, all waveform data that are loaded in the waveform memory are cleared.
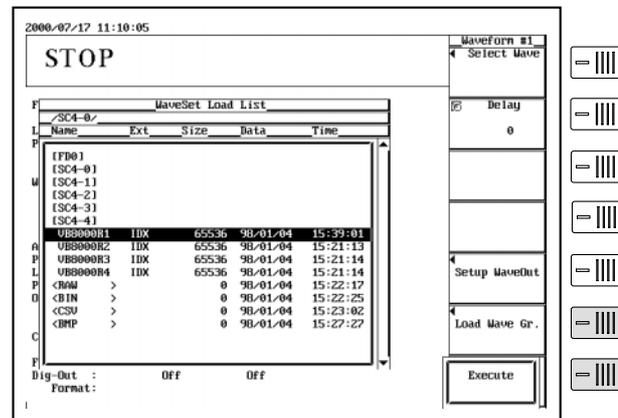
Deleting a Registration

6. After step 5 of the procedure to set the waveform data name given on page 6-2, press the [Delete] soft key.

7. Turn the rotary knob to select the file you wish to delete.

8. Press the [Mark] soft key to place a [*] mark.

9. Press the [Execute] soft key to delete the registration.
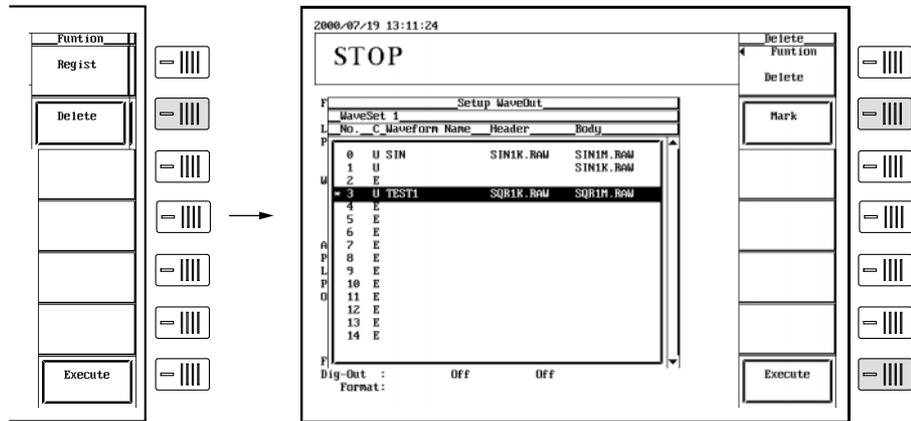
6

Loading Waveform Data to the Waveform Memory

6.2 Loading Waveform Data to the Waveform Memory

Function

Loads the selected waveform data in the waveform group list to the waveform memory.

Binary data are automatically converted while being loaded to the waveform memory.

A waveform memory exists for each OUTPUT.

The following three methods are available for loading the waveform data to the waveform memory:

- **Load the selected waveform data**
  Select one set of waveform data you wish to load.
- **Load all the waveform data in the waveform group list (all load)**
  Loads all the waveform data that are registered in the waveform group list to the target OUTPUT waveform memory.
- **Load waveform data of all waveform group lists (auto load)**
  Loads all the waveform data that are registered in each waveform group list to each OUTPUT waveform memory.

Selecting the waveform data to be output

The waveform data to be output are automatically selected when the data are loaded to the waveform memory. The file with a [*] mark in the waveform group list is the file that is going to be output. For selecting the file to be output, see section 6.3.

The method in which the files to be output are automatically selected varies depending on the load method as follows:

- Load the selected waveform data: After loading the data, the waveform data become the data to be output.
- Auto load/all load: If the data to be output are already selected before loading, the data to be output are not changed. If not, the first waveform data that are loaded become the data to be output.

Completion of loading

The progress of loading waveform data to the waveform memory is indicated as a percentage on the operating condition display area. When the loading operation completes, [L] is displayed before the waveform group name of the waveform group list.

Waveform group list

```
          ┌─Select Wave─────
Waveform (Output 2)
No._C_Waveform Name__Header_____Body____
  0  U SIN         SIN1K.RAW    SIN1M.RAW  ─┐
 *1  L SQUARE      SQR1K.RAW    SQR1M.RAW   │
  2  U TRI         TRI1K.RAW    TRI16M.RAW  ├── Lists only the waveform data that can
  3  U 123         SIN1M.RAW    TRI1M.RAW   │   be loaded to the waveform memory
  4  U                          SIN1K.RAW  ─┘
```

─ **U: Not loaded to the waveform memory**
  L: Loaded to the waveform memory
  E: Load error

─**Marks on the data to be output**

Procedure

1. Press SETUP.
2. Press the soft key corresponding to the OUTPUT you wish to configure.
3. Press the [Waveform] soft key to display the waveform output settings menu.
4. Press the [Select Wave] soft key to display the waveform group list.
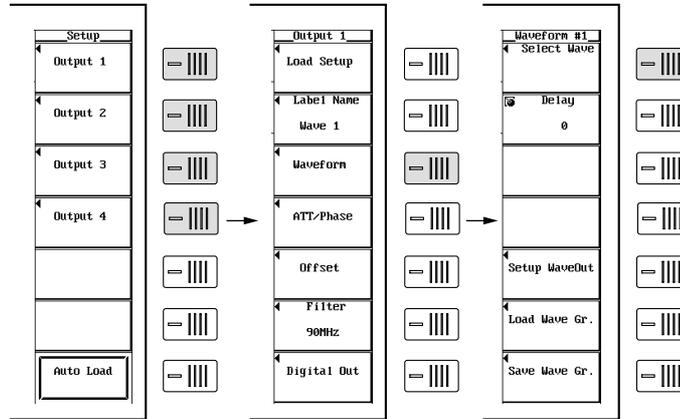
5. Turn the rotary knob to highlight the file you wish to load to the waveform memory.
6. Press the [Load] soft key to load the file.

All load

5. After step 4, press the [Load All] soft key to load all the waveform data that are registered in the waveform group file.

Displays the progress
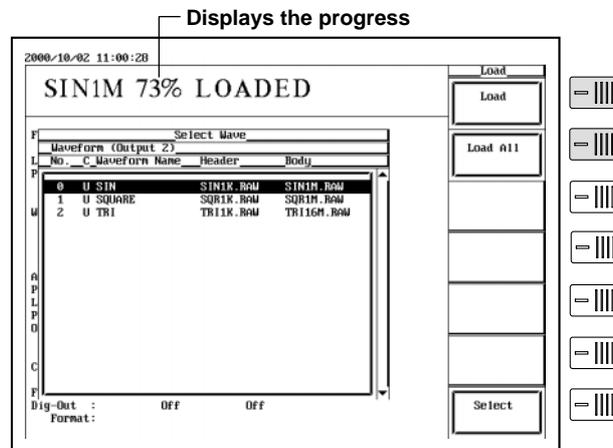
Auto load

2. After step 1, press the [Auto Load] soft key.

Note

- You cannot load waveform data while the waveform is being generated (when the START/STOP LED is turned ON).
- Loading to the waveform memory may take some time. This is especially true when loading a high volume of data using auto load or all load.

6

Loading Waveform Data to the Waveform Memory

6.3   Selecting the Waveform Data to Be Output

Function

Select one set of data from the waveform memory and output the data.

The file with a [*] mark in the waveform group list is the file that is going to be output.

When data are loaded to the waveform memory, the data to be output are automatically selected. However, you can select any waveform data in the waveform memory to be output.

Procedure

1.   Press [SETUP].
2.   Press the soft key corresponding to the OUTPUT you wish to configure.
3.   Press the [Waveform] soft key to display the waveform output settings menu.
4.   Press the [Select Wave] soft key to display the waveform group file.
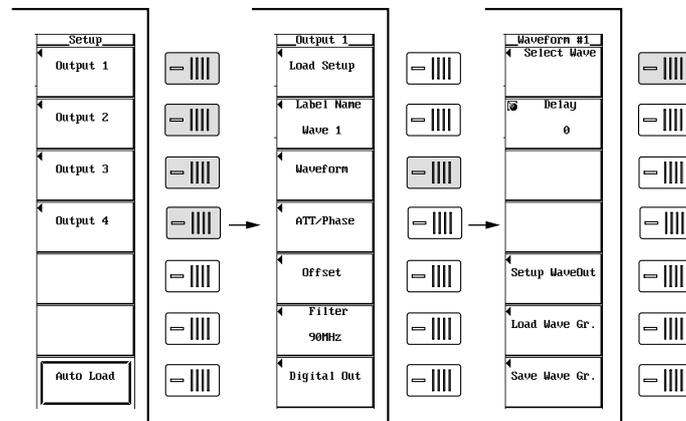
5.   Turn the rotary knob to select the file you wish to output and press the [Select] soft key.
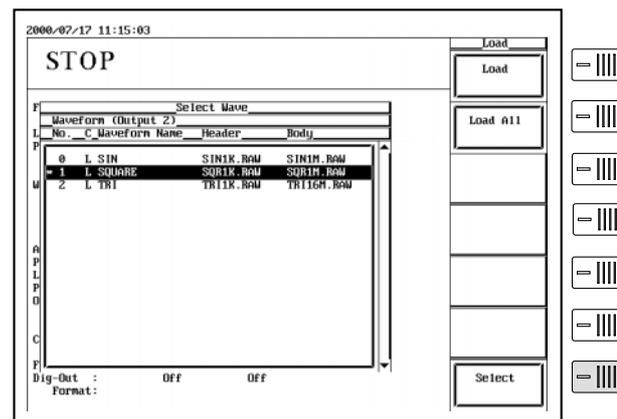
7.1   Setting Output Conditions

Function

You can specify the following conditions on the data in the waveform memory to be output.

- Attenuator
- Phase
- I/Q gain ratio
- Quadrature offset
- Offset

These parameters are specified for each OUTPUT independently.

Offset can be specified for each I and Q.

Attenuator

Phase(when θ is positive)

θ: Specified value (deg)

Offset

I/Q gain ratio (when the setting is positive)

Quadrature offset (when θ is positive)

θ: Specified value (deg)
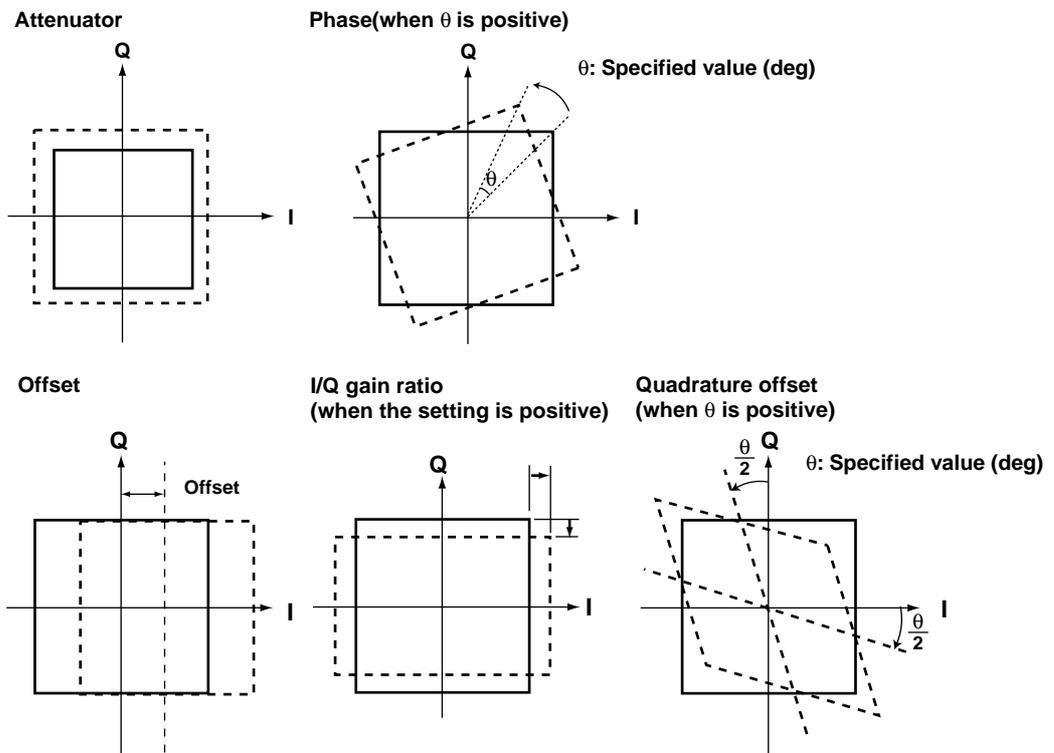
Attenuator

Sets the output attenuator for the waveform data.

The selectable range is from 6.0 dB to -20 dB (0.1 dB resolution).

If you specify the output attenuator, the RMS value and peak value corresponding to the specified value are displayed.

```
┌──Peak voltage
├──RMS value
│  Freq      : 100000000Hz
│                 [Output1]      [Output2]
│  Label     :     Wave 1        Wave 2
│  Power
├── RMS      : 0.500(Vrms)
└── Peak     : 2.000(Vpp)     2.000(Vpp)
   Waveform
     Name    :     SQUARE
     Header  : SQR1K.RAW Not Selected
     Body    : SQR1M.RAW
     Delay   :       0(clk)         0(clk)
   ATT       :     0.0(dB)        0.0(dB)
   Phase     :    0.0(deg)       0.0(deg)
   I/Q Gain  :     0.0(%)         0.0(%)
   Quadrature:    0.0(deg)       0.0(deg)
   Offset
     Diff-I  :    0.0(mV)        0.0(mV)
        -Q   :    0.0(mV)        0.0(mV)
     Comm-I  :      0(mV)          0(mV)
        -Q   :      0(mV)          0(mV)
   Filter    :      90MHz          90MHz
   Dig-Out   :        Off            Off
     Format  :
```

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Outputting Waveforms

Phase

Rotates the output waveform by the specified angle on the IQ plane.

I/Q gain ratio

Changes the amplitude ratio of I and Q waveforms.

x: Specified level error value

$$\frac{I}{Q} = (1 + \frac{x}{100})$$

Quadrature offset

The angle at which the coordinate axes of the I-Q plane cross is changed according to the specified angle.

Offset

The setting varies between the differential output model and single-ended output model as indicated below.

You can change the offset even while the waveform is being output.

- **Differential output model**

  Differential offset voltage: Set an offset voltage between I/$\overline{I}$ or Q/$\overline{Q}$ (–100 mV to 100 mV at 0.2 mV resolution)

  Common offset voltage: Set an offset voltage to I/$\overline{I}$ or Q/$\overline{Q}$ (–500 mV to 1500 mV at 1 mV resolution)

- **Single-ended output model**

  Fine: Set an offset voltage to I or Q (–100 mV to 100 mV at 0.2-mV resolution)

  Coarse: Set an offset voltage to I or Q (–500 mV to 1500 mV at 1 mV resolution)

Procedure

1. Press [SETUP] to display the OUTPUT Selection menu.
2. Press the one of the OUTPUT soft keys to display the waveform settings menu.
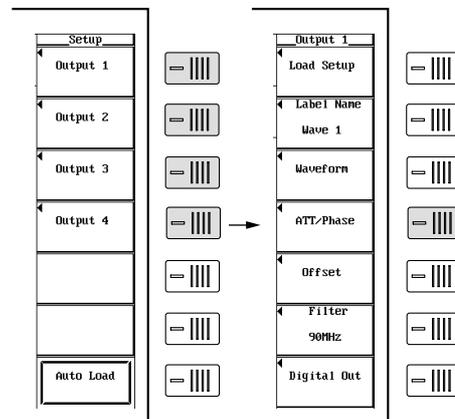
Setting the attenuator

3. Press the [ATT/Phase] soft key to display the Attenuator/Phase Setting menu.
4. Press the [ATT] soft key.
5. Use the arrow keys and rotary knob to set the value. You can also use the numeric keys to enter the value.

Setting the phase

4. After step 3, press the [Phase] soft key.
5. Use the arrow keys and rotary knob to set the value. You can also use the numeral keys to enter the value.

I, Q gain ratio/quadrature

4. After step 3, press the [I/Q Gain] or [Quadrature] soft key.

5. Use the arrow keys and rotary knob to set the value. You can also use the numeric keys to enter the value.

```
2000/08/23 13:49:58                                          ┌─Output 1──┐
                                                             │    ATT    │   ─|||
STOP                                                         │   0.0dB   │
                                                             ├───────────┤
Freq     : 100.000000MHz                                     │   Phase   │   ─|||
              [Output1]   [Output2]   [Output3]   [Output4]  │   0.0deg  │
Label    :    Wave 1      Wave 2      Wave 3      Wave 4      ├───────────┤
Power                                                        │  I/Q Gain │   ─|||
  RMS    :  0.354(Vrms)  0.500(Vrms)                         │   0.0%    │
  Peak   :  2.000(Vp-p)  2.000(Vp-p)  2.000(Vp-p) 2.000(Vp-p)├───────────┤
Waveform                                                     │ Quadrature│   ─|||
  Name   :    TEST1       SQUARE1                            │   0.0deg  │
  Header : TRI1024.RAW  TRI1024.RAW Not Selected Not Selected└───────────┘
  Body   : SIN1024.RAW  SQR1024.RAW                                          ─|||
  Delay  :    0(clk)      0(clk)      0(clk)      0(clk)
ATT      :    0.0(dB)     0.0(dB)     0.0(dB)     0.0(dB)
Phase    :    0.0(deg)    0.0(deg)    0.0(deg)    0.0(deg)                    ─|||
I/Q Gain :    0.0(%)      0.0(%)      0.0(%)      0.0(%)
Quadrature:   0.0(deg)    0.0(deg)    0.0(deg)    0.0(deg)
Offset
  Fine-I :    0.0(mV)     0.0(mV)     0.0(mV)     0.0(mV)                     ─|||
     -Q  :    0.0(mV)     0.0(mV)     0.0(mV)     0.0(mV)
  Coarse-I:   0(mV)       0(mV)       0(mV)       0(mV)
     -Q  :    0(mV)       0(mV)       0(mV)       0(mV)
Filter   :    6MHz        6MHz        6MHz        6MHz
Dig-Out  :    Off         Off         Off         Off
  Format :
```

Offset

3. After step 2, press the [Offset] soft key to display the Offset Setting menu.

• **For differential output model**

4. Press the [I-Difference], [Q-Difference], [I-Common], or [Q-Common] soft key.

5. Use the arrow keys and rotary knob to set the value. You can also use the numeric keys to enter the value.

```
┌─Output 1──┐
│Load Setup │  ─|||
├───────────┤
│Label Name │  ─|||
│  Wave 1   │
├───────────┤
│ Waveform  │  ─|||
├───────────┤
│ ATT/Phase │  ─|||       →
├───────────┤
│  Offset   │  ─|||
├───────────┤
│  Filter   │  ─|||
│  90MHz    │
├───────────┤
│Digital Out│  ─|||
└───────────┘
```

```
1998/01/01 16:55:28                                          ┌─Output 1──┐
                                                             │I-Difference│  ─|||
STOP                                                         │   0.0mV   │
                                                             ├───────────┤
Freq     : 100.000000MHz                                     │Q-Difference│  ─|||
              [Output1]   [Output2]   [Output3]   [Output4]  │   0.0mV   │
Label    :    Wave 1      Wave 2      Wave 3      Wave 4      ├───────────┤
Power                                                        │ I-Common  │   ─|||
  RMS    :  0.354(Vrms)  0.500(Vrms)                         │  1500mV   │
  Peak   :  2.000(Vp-p)  2.000(Vp-p)  2.000(Vp-p) 2.000(Vp-p)├───────────┤
Waveform                                                     │ Q-Common  │   ─|||
  Name   :    TEST1       SQUARE1                            │    0mV    │
  Header : TRI1024.RAW  TRI1024.RAW Not Selected Not Selected└───────────┘
  Body   : SIN1024.RAW  SQR1024.RAW
  Delay  :    0(clk)      0(clk)      0(clk)      0(clk)                      ─|||
ATT      :    0.0(dB)     0.0(dB)     0.0(dB)     0.0(dB)
Phase    :    0.0(deg)    0.0(deg)    0.0(deg)    0.0(deg)
I/Q Gain :    0.0(%)      0.0(%)      0.0(%)      0.0(%)                      ─|||
Quadrature:   0.0(deg)    0.0(deg)    0.0(deg)    0.0(deg)
Offset
  Diff-I :    0.0(mV)     0.0(mV)     0.0(mV)     0.0(mV)
     -Q  :    0.0(mV)     0.0(mV)     0.0(mV)     0.0(mV)                     ─|||
  Comm-I :    0(mV)       0(mV)       0(mV)       0(mV)
     -Q  :    0(mV)       0(mV)       0(mV)       0(mV)
Filter   :    6MHz        6MHz        6MHz        6MHz
Dig-Out  :    Off         Off         Off         Off
  Format :
```

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Outputting Waveforms

- **For single-ended output model**

4. Press the [I-Fine], [Q-Fine], [I-Coarse], or [Q-Coarse] soft key.

5. Use the arrow keys and rotary knob to set the value. You can also use the numeric keys to enter the value.
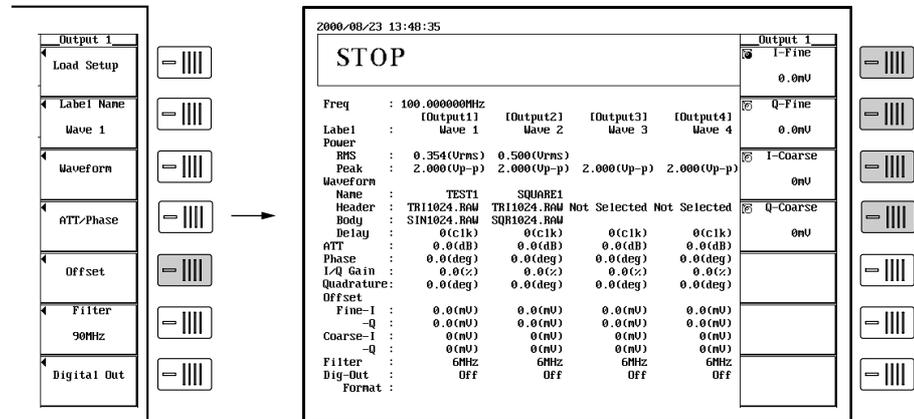
7.2   Selecting the 10-MH Reference Signal

Function

You can select whether to use the internal 10-MHz reference signal or an external reference signal.

When using an external reference signal, connect a BNC cable to the 10 MHz REF IN terminal on the rear panel and input the reference signal.

Specifications of the external reference signal

Apply a reference signal that meets the following specifications:

- Input frequency range: 10 MHz $\pm$ 50 ppm
- Input impedance: 50 Ω
- Input coupling: AC
- Input level: 0 dBm to 10 dBm
- Maximum input voltage: 3 Vrms and 6 Vpeak

CAUTION

Applying a voltage that exceeds the maximum input voltage indicated above to the 10 MHz REF IN terminal can damage the instrument.

Procedure

1.   Press $\boxed{\textit{CLOCK}}$.
2.   Press the [10MHz In] soft key to select [INT] or [EXT].

```
2000/08/23 13:51:29                                          Clock
                                                          Frequency
STOP                                                    100.000000MHz

Freq    : 100.000000MHz                                     10MHz In
          [Output1]   [Output2]   [Output3]   [Output4]
Label   :    Wave 1     Wave 2     Wave 3     Wave 4    INT     EXT
Power
  RMS   : 0.354(Vrms) 0.500(Vrms)                          Clock In
  Peak  : 2.000(Vp-p) 2.000(Vp-p) 2.000(Vp-p) 2.000(Vp-p)
Waveform                                                  INT     EXT
  Name  :    TEST1    SQUARE1
  Header: TRI1024.RAW TRI1024.RAW Not Selected Not Selected Trigger In
  Body  : SIN1024.RAW SQR1024.RAW
  Delay :    0(clk)     0(clk)     0(clk)     0(clk)     INT     EXT
ATT     :   0.0(dB)    0.0(dB)    0.0(dB)    0.0(dB)
Phase   :  0.0(deg)   0.0(deg)   0.0(deg)   0.0(deg)
I/Q Gain:   0.0(%)     0.0(%)     0.0(%)     0.0(%)
Quadrature: 0.0(deg)   0.0(deg)   0.0(deg)   0.0(deg)
Offset
  Fine-I :  0.0(mV)    0.0(mV)    0.0(mV)    0.0(mV)
     -Q :   0.0(mV)    0.0(mV)    0.0(mV)    0.0(mV)
  Coarse-I:   0(mV)      0(mV)      0(mV)      0(mV)
     -Q :     0(mV)      0(mV)      0(mV)      0(mV)
Filter  :    6MHz       6MHz       6MHz       6MHz
Dig-Out :     Off        Off        Off        Off
  Format:
```

7.3 Selecting the Clock

Function

You can select whether to generate the waveform by synchronizing to the internal clock
or the external clock. For the procedure in setting the frequency of the internal clock,
see the next section.
When using an external clock, connect a BNC cable to the CLOCK IN terminal on the
rear panel and input the clock signal.

Specifications of the external clock

- Input Frequency: 128 kHz to 100 MHz
- Input level: ECL
- Input impedance: 5 kΩ or more
- Allowable input level range: −5.5 V to +0 V
- Connector type: BNC

⚠ CAUTION

Applying a voltage that exceeds the maximum input voltage indicated above to
the external CLOCK IN terminal can damage the instrument.

Procedure

1. Press CLOCK.
2. Press the [Clock In] soft key to select [INT] or [EXT].

```
2000/08/23 13:51:29                                          Clock
                                                          ◉ Frequency
  STOP
                                                           100.000000MHz

 Freq      : 100.000000MHz                                    10MHz In
             [Output1]   [Output2]   [Output3]   [Output4]
 Label     :   Wave 1      Wave 2      Wave 3      Wave 4    [INT]   EXT
 Power
   RMS     :  0.354(Vrms) 0.500(Vrms)                        Clock In
   Peak    :  2.000(Vp-p) 2.000(Vp-p) 2.000(Vp-p) 2.000(Vp-p)
 Waveform                                                    [INT]   EXT
   Name    :    TEST1      SQUARE1
   Header  : TRI1024.RAW TRI1024.RAW Not Selected Not Selected  Trigger In
   Body    : SIN1024.RAW SQR1024.RAW
   Delay   :    0(clk)     0(clk)      0(clk)      0(clk)     [INT]   EXT
 ATT       :    0.0(dB)    0.0(dB)     0.0(dB)     0.0(dB)
 Phase     :    0.0(deg)   0.0(deg)    0.0(deg)    0.0(deg)
 I/Q Gain  :    0.0(%)     0.0(%)      0.0(%)      0.0(%)
 Quadrature:    0.0(deg)   0.0(deg)    0.0(deg)    0.0(deg)
 Offset
   Fine-I  :    0.0(mV)    0.0(mV)     0.0(mV)     0.0(mV)
     -Q    :    0.0(mV)    0.0(mV)     0.0(mV)     0.0(mV)
   Coarse-I:    0(mV)      0(mV)       0(mV)       0(mV)
     -Q    :    0(mV)      0(mV)       0(mV)       0(mV)
 Filter    :    6MHz       6MHz        6MHz        6MHz
 Dig-Out   :    Off        Off         Off         Off
   Format  :
```

# 7.4 Setting the Clock Frequency

Function

The VB8000 generates the waveform using the specified clock frequency. You can select the internal or external reference signal for the 10-MHz reference signal that the clock frequency is based on (section 7.2).

If you select the external clock, the clock frequency setting is void.

Procedure

1. Press CLOCK.
2. Use the numeric keys or the rotary knob/arrow keys to enter the value.

   If you use the numeric keys, a value entry box is displayed. Enter a value without the unit.
   Press the ENTER key to confirm the value.

Value entry box
(when using the numerical keys)

```
2000/08/24 08:35:57

STOP                                                100          Clock
                                                                 Frequency
                                                                 15.360000MHz
Freq      :  15.360000MHz                                        10MHz In
             [Output1]    [Output2]    [Output3]    [Output4]
Label     :   Wave 1       Wave 2       Wave 3       Wave 4     INT    EXT
Power
  RMS     :                                                      Clock In
  Peak    :  2.643(Vp-p)  2.023(Vp-p)  2.000(Vp-p)  2.000(Vp-p)
Waveform                                                        INT    EXT
  Name    :   SQUARE
  Header  :  SQR1K.RAW  Not Selected Not Selected Not Selected   Trigger In
  Body    :  SQR1M.RAW
  Delay   :      0(clk)       0(clk)       0(clk)       0(clk)  INT    EXT
ATT       :      0.1(dB)      0.1(dB)      0.0(dB)      0.0(dB)
Phase     :     22.5(deg)     0.0(deg)     0.0(deg)     0.0(deg)
I/Q Gain  :      0.0(%)       0.0(%)       0.0(%)       0.0(%)
Quadrature:      0.0(deg)     0.0(deg)     0.0(deg)     0.0(deg)
Offset
  Fine-I  :      0.0(mV)      0.0(mV)      0.0(mV)      0.0(mV)
     -Q   :      0.0(mV)      0.0(mV)      0.0(mV)      0.0(mV)
  Coarse-I:        0(mV)        0(mV)        0(mV)        0(mV)
       -Q :        0(mV)        0(mV)        0(mV)        0(mV)
Filter    :      6MHz         6MHz         6MHz         6MHz
Dig-Out   :       Off          Off          Off          Off
  Format  :
```

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Outputting Waveforms

7.5 Delay/Start Trigger

Function

Delay

Waveform output is started after delaying for the specified clock cycles. The delay can be specified for each OUTPUT.

The range is as follows:

0 to 262143 clock cycles (1 step)

Start trigger

You can select the method used to start the waveform generation from the following two selections:

- **Internal start trigger (INT)**

  Press $\boxed{\textit{START/STOP}}$ to start waveform generation. Press it again to stop.

- **External start trigger (EXT)**

  Press $\boxed{\textit{START/STOP}}$ to enter the external start trigger wait state. When a trigger signal is applied to the external start trigger input terminal on the rear panel, waveform generation starts.

  Press $\boxed{\textit{START/STOP}}$ again to stop waveform generation.

  The green LED above the key turns ON while the waveform is being generated.

Note

If waveform output is turned OFF with the ON/OFF key, waveform is not output even if waveform generation is started.

Procedure

Setting the delay

1. Press [SETUP].
2. Press the soft key corresponding to the OUTPUT you wish to configure.
3. Press the [Waveform] soft key.
4. Use the numeric keys or the rotary knob/arrow keys to enter the value.

Value entry box (when using the numerical keys)
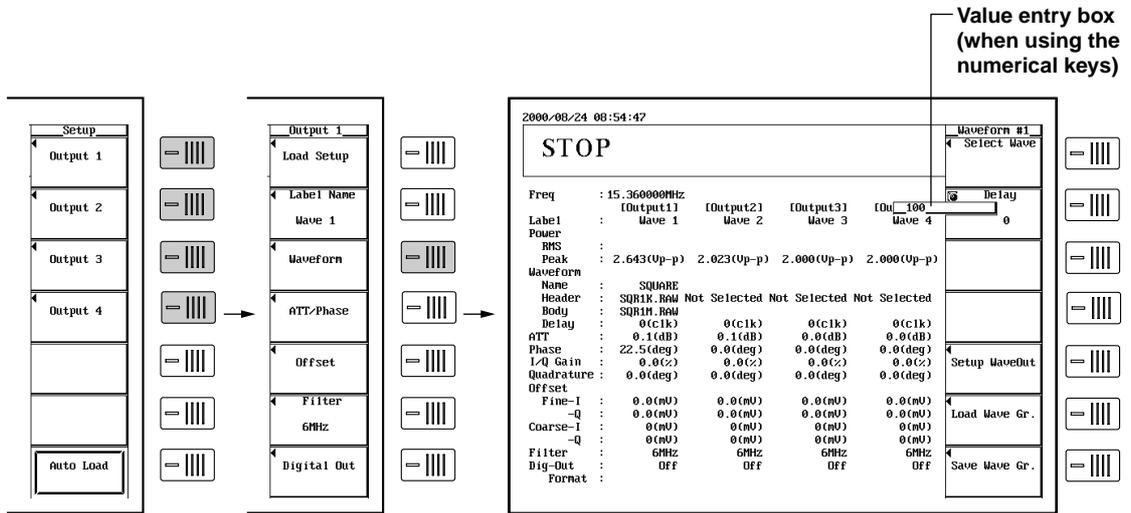
Setting the start trigger

1. Press [CLOCK].
2. Press the [Trigger In] soft key to select [INT] or [EXT].

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Outputting Waveforms
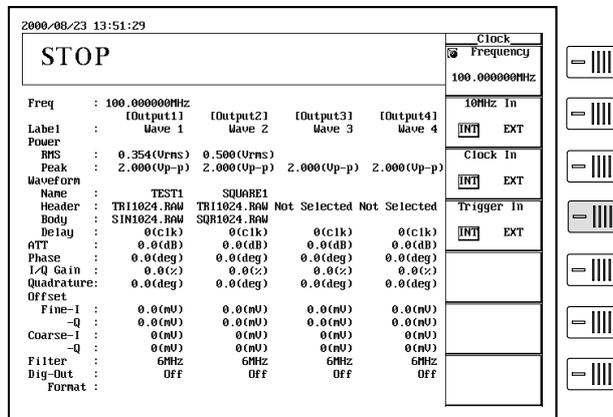
7.6 Low-Pass Filter

Function

You can select a low-pass filter to remove unwanted frequency components that are generated with the waveform output. You can specify a filter for each OUTPUT.

- 6 MHz
- 30 MHz
- 90 MHz

Select 90 MHz to output waveforms without going through a filter.

Procedure

1. Press SETUP.
2. Press the soft key corresponding to the OUTPUT you wish to configure.
3. Press the [Filter] soft key to display the Low-Pass Filter Selection menu.
4. Press the [6 MHz], [30 MHz], or [90 MHz] soft key to select the filter.
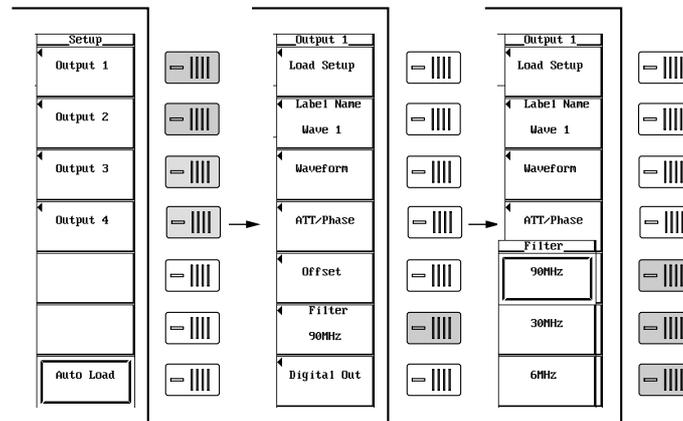
7.7 Output Terminal Label

Function

You can assign a label to each OUTPUT. The label specified here is used on the screen that displays the setup information of each OUTPUT.
You can enter up to 15 characters.

Procedure

1. Press $\boxed{SETUP}$.
2. Press the soft key corresponding to the OUTPUT you wish to name.
3. Press the [Label Name] soft key to display a string entry box.
4. Enter the label using numeric keys according to the procedure given in section 3.7.

Label   String entry box

```
2000/08/23 13:58:11
  STOP                                              Output 2
                                                   Load Setup
Freq    : 100.000000MHz
          [Output1]  [Output2]   [Output3]    [Output4]      Label Name
Label   :   Wave                           ve 4             Wave 2
Power
  RMS   :  0.354(Ur                                          Waveform
  Peak  :  2.000(Up        Wave 2               Up-p)
Waveform
  Name  :     TEST1     SQUARE1
  Header:  TRI1024.RAW TRI1024.RAW Not Selected Not Selected  ATT/Phase
  Body  :  SIN1024.RAW SQR1024.RAW
  Delay :     0(clk)     0(clk)      0(clk)      0(clk)
ATT     :    0.0(dB)    0.0(dB)     0.0(dB)     0.0(dB)
Phase   :    0.0(deg)   0.0(deg)    0.0(deg)    0.0(deg)     Offset
I/Q Gain :   0.0(%)     0.0(%)      0.0(%)      0.0(%)
Quadrature: 0.0(deg)   0.0(deg)    0.0(deg)    0.0(deg)
Offset
  Fine-I :   0.0(mV)    0.0(mV)     0.0(mV)     0.0(mV)       Filter
     -Q :    0.0(mV)    0.0(mV)     0.0(mV)     0.0(mV)
Coarse-I :    0(mV)      0(mV)       0(mV)       0(mV)       6MHz
     -Q :     0(mV)      0(mV)       0(mV)       0(mV)
Filter  :     6MHz       6MHz        6MHz        6MHz
Dig-Out :      Off        Off         Off         Off       Digital Out
  Format :
```

7

Outputting Waveforms

7.8 Turning ON/OFF the Digital Output

Function

Digital Output

By turning ON the digital output, you can output a 14-bit digital signal of the waveform data from the digital output terminal on the rear panel.

Output Format

Select the output format from the following:
- 2 Complement: Output by inverting the highest bit (2's complement)
- Offset Binary: Output raw data.

Output Example (Output 1.0 V)
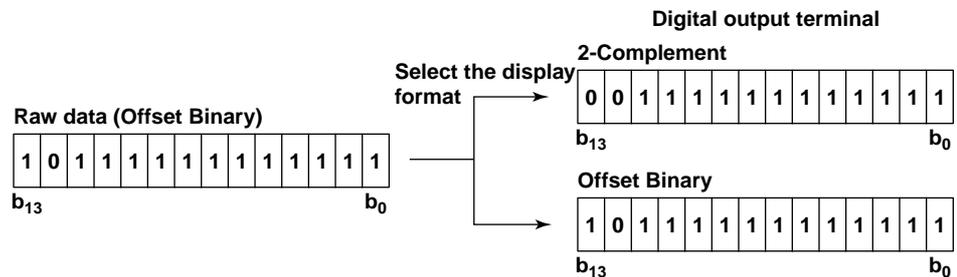
Note

The data format of the raw data of the VB8000 is offset binary.

Procedure

1. Press SETUP.
2. Press the soft key corresponding to the OUTPUT you wish to configure.
3. Press the Digital Out soft key to display the digital output ON/OFF menu.
4. Press the Digital Out soft key to select ON or OFF.
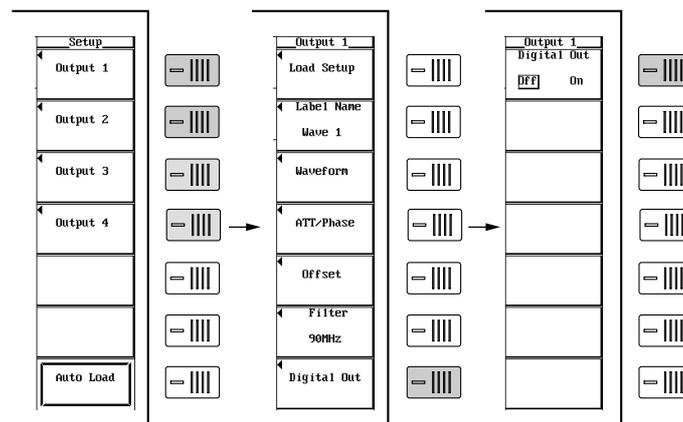
Selecting the Output Format (only when the digital output is turned ON)

5. Press the Format soft key to select 2 Complement or Offset Binary.
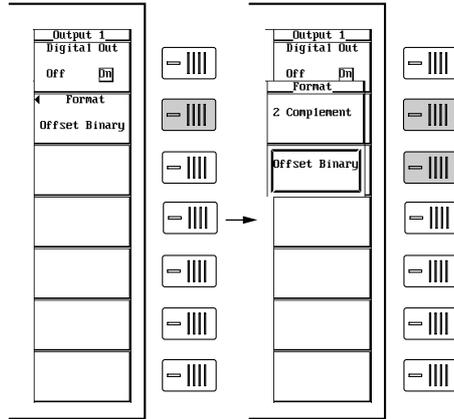
7.9 Saving and Loading Setup Information

Function

You can save and load setup information on the VB8000.

The setup information that is saved is as follows:

Item	Note
START/STOP key	STOP always
DISPLAY ON/OFF key	ON always
ON/OFF key	
CLOCK key	
Frequency	Clock frequency
10MHz In	10 MHz reference signal
Clock In	–
Trigger In	–
SETUP key	
Setup information of each OUTPUT (common to OUTPUT 1, OUTPUT 2, OUTPUT 3, and OUTPUT 4)	
Label Name	Label for each OUTPUT
Delay	–
ATT	Attenuator
Phase	–
I/Q Gain	I/Q gain ratio
Quadrature	Quadrature offset
Offset	Offset voltage
I-Fine or I-Difference	
Q-Fine or Q-Difference	
I-Coarse or I-Common	0 [mV]
Q-Coarse or Q-Common	0 [mV]
Filter	Low-pass filter
Digital Out	Digital output ON/OFF setting
Format	Digital output format

Setup information to be saved

Select from the following:

- Output1 to Output4*: Save/Load the setup information for each OUTPUT
- All: Save/Load setup information of all OUTPUTs at once
  * The number varies depending on the model.

Extension

- ch: When setup information for each OUTPUT is saved
- all: When setup information of all OUTPUTs is saved at once

Procedure

1. Press ⌷ FILE ⌷.
2. Press the [File Function] soft key to display the selection menu.

Saving setup information

3. Turn the rotary knob to select [Save] and press the SELECT key.
4. Press the [Save Mode] soft key to display the Save Setup Selection menu.
5. Press [All] or the soft key corresponding to the OUTPUT you wish to save.

6. Press the [File Name] soft key to display a string entry box.
   Enter the file name of the save destination according to the procedure given in section 3.7.
7. Press the [Execute] soft key to save the file.

7

Outputting Waveforms

Loading setup information

3. After step 2, turn the rotary knob to select [Load] and press the SELECT key.
4. Press the [Load Mode] soft key to display the Load Setup Selection menu.
5. Press [All] or the soft key corresponding to the OUTPUT for which you wish to load the setup information.
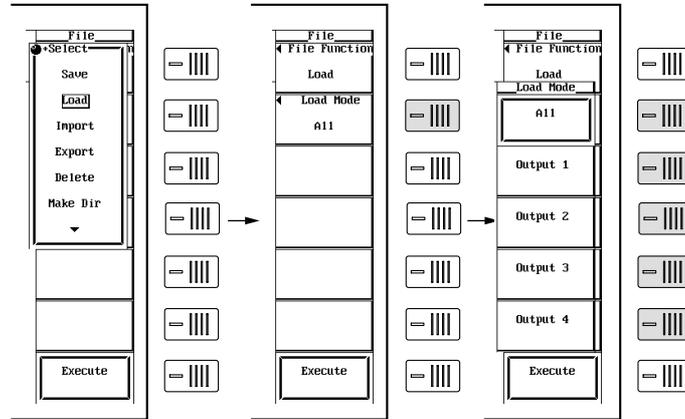
6. Select the file you wish to load according to the procedure given in section 8.3 and press the [Execute] soft key to load the file.

Select the file
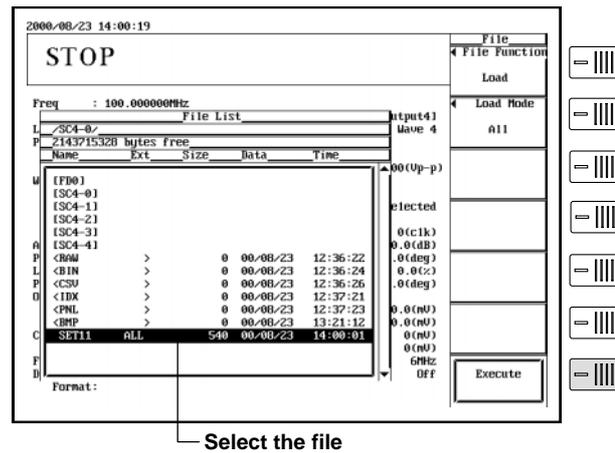
Note

You can also use the [Load Setup] soft key of the SETUP key to load the setup information for each OUTPUT.

7.10 Output Timing

Function

Starting/Stopping waveform generation

You can start waveform generation by synchronizing all OUTPUTs.

The green LED above the | START/STOP | key turns ON while the waveform is being generated.

The following two methods are available for starting/stopping:

- Manual start   Use the | START/STOP | key on the front panel
- Start on an external signal   Use the signal that is applied to the TRIG IN terminal on the rear panel

The OUTPUT key controls the waveform output. Therefore, if the OUTPUT LED is OFF, waveform is not output even if waveform is being generated.

Turning ON/OFF waveform output

Turns ON/OFF waveform output. When turned OFF, the output is forcibly dropped to GND level via a 50-Ω resistor.

The green LED above the OUTPUT ON/OFF key turns ON while the waveform is being output.

For the relationship between waveform generation and waveform output, see section 1.8.

Note ———————————————————————————————————

To output the waveform data from the top, turn ON the waveform output first, and then start waveform generation.

Procedure

Manual starting waveform generation

1. Set the start trigger to internal according to the procedure given in section 7.5.
2. Press | START/STOP |. When the LED turns ON, waveform generation starts.

Starting waveform generation using an external trigger

1. Set the start trigger to external according to the procedure given in section 7.5.
2. Press | START/STOP |. The LED turns ON.
   When a trigger signal is input after the trigger-ready signal is ready, waveform generation starts.

Turning ON/OFF waveform output

Press the ON/OFF key. When the LED turns ON, the waveform is output.

7

Outputting Waveforms

8.1   Formatting Floppy Disks

Function

Floppy Disks

Approved floppy disks

The 3.5˝ floppy disks below can be used with the VB8000. You can format the floppy disks on the VB8000.

2HD: 1.2 MB or 1.44 MB MS-DOS format
2DD: 640 KB or 720 KB MS-DOS format

Inserting the floppy disk to the floppy disk drive

With the label facing up, insert the disk into the floppy disk drive. Insert the disk until the eject button pops out.

Removing the floppy disk from the floppy disk drive

Check that the access indicator is turned OFF and press the eject button.
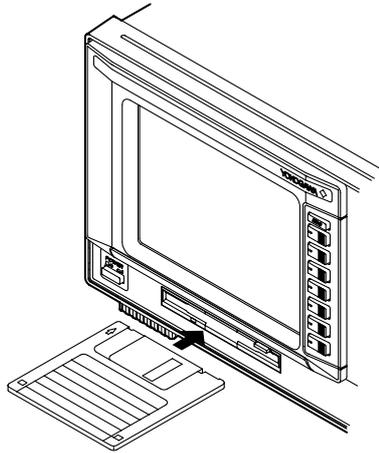
CAUTION

Removing the floppy disk while the access indicator or icon is blinking can damage the magnetic head of the floppy disk drive or destroy the data on the floppy disk.

General handling precautions of floppy disks

For the general handling precautions of the floppy disk, read the instruction manual that came with the floppy disk.

8

File Operation

Formatting Floppy Disks

CAUTION

- Do not remove the disk or turn OFF the power while formatting the disk. Doing so can damage the disk or destroy the data on it.
- If the VB8000 cannot recognize a formatted medium, format the disk again on the VB8000. Note that all the data on the disk are erased when the disk is formatted. Make sure to back up important data beforehand.

Format

When using a new floppy disk, you must format it. Select the appropriate format below that matches the floppy disk that you are using.

- 2DD 640 KB: Format a 2DD floppy disk to 640 KB/8 sectors.
- 2DD 720 KB: Format a 2DD floppy disk to 720 KB/9 sectors.
- 2HD 1.2 MB: Format a 2HD floppy disk to 1.2 MB/8 sectors.
- 2HD 1.44 MB: Format a 2HD floppy disk to 1.44 MB/18 sectors.

Precautions to be taken when formatting disks

- If you format a disk that has data stored on it, all the data are erased when the disk is formatted.
- It takes approximately a minute and a half to format a disk.
- You cannot format a floppy disk if the write-protect is ON.
- Check that the type and format of the floppy disk match before carrying out the format operation.

Note

- Floppy disks that are formatted to formats other than those listed above cannot be used.
- If an error message is displayed after the format operation, the floppy disk may be damaged.
- You can use disks that are formatted using MS-DOS on a PC.

Procedure

1. Press [FILE].
2. Press the [File Function] soft key to display the File Operation Selection menu.
3. Turn the rotary knob to select [Format] and press the SELECT key.
4. Press the [Format Type] soft key to display the Format Type Selection menu.
5. Press the [1.44 M], [1.2 M], [720 k], or [640 k] soft key.
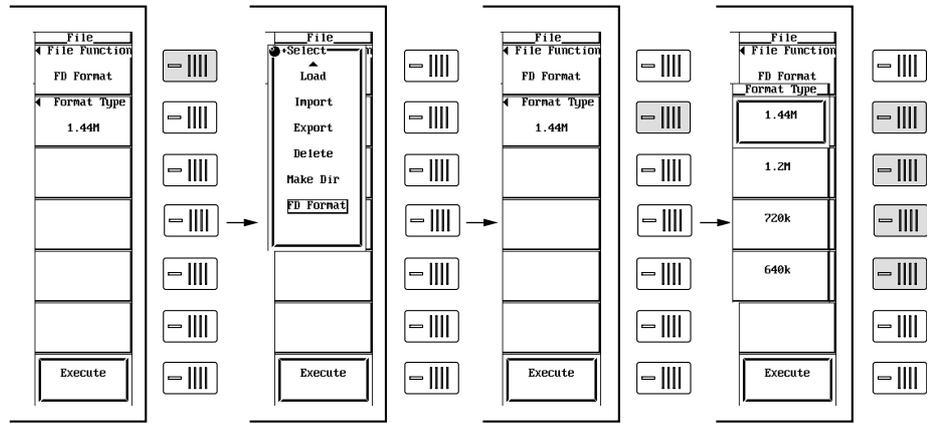
6. Press the [Execute] soft key to execute the format operation.

8

File Operation

8.2   File Types

The VB8000 can handle the following types of files:

Setup information file

A file containing setup information used to generate waveforms.

The two extensions are as follows:

- [.ch]:   Saves setup information for each OUTPUT
- [.all]:   Saves setup information for all OUTPUTs

Waveform data file

A file containing data which I and Q waveforms are based on.

The three extensions are as follows:

[.csv], [.bin], and [.raw]

Waveform group list

A file containing registrations of waveform data to be uploaded to the waveform memory.

The extension is [.idx].

8.3 Selecting Media and Directories

Function

Selectable media are as follows:

- FD0:   Built-in floppy disk
- SC4-0 to SC4-4*: Built-in hard disk
    -   *   The built-in hard disk of the VB8000 has five partitions. The user cannot set partitions. The number of partitions may change without notice in the future.

Selecting media and directories

Displays accessible media and directories in a file list as follows:

Media: []

Directories: <>

Media

```
                    File List
/SC4-0/
1985019904 bytes free
Name        Ext     Size     Data       Time

[FD0]
[SC4-0]
[SC4-1]
[SC4-2]
[SC4-3]
[SC4-4]
<RAW    >            0   98/01/04   15:22:17
<BIN    >            0   98/01/04   15:22:25
<CSV    >            0   98/01/04   15:23:02
<BMP    >            0   98/01/04   15:27:27
 AAA     ALL       532   00/07/18   10:01:25
<DEST   >            0   00/07/19   15:36:12
```

Directories

Procedure

1. Press ⌈ FILE ⌉.
2. Press the [File Function] soft key to display the File Operation Selection menu.
3. Turn the rotary knob to select the desired operation and press the SELECT key to display a file list.

Selecting the medium

4. Turn the rotary knob to select the desired medium and press the SELECT key.
   The top left column of the file list is set to the selected medium.

⌐ **Currently selected medium**
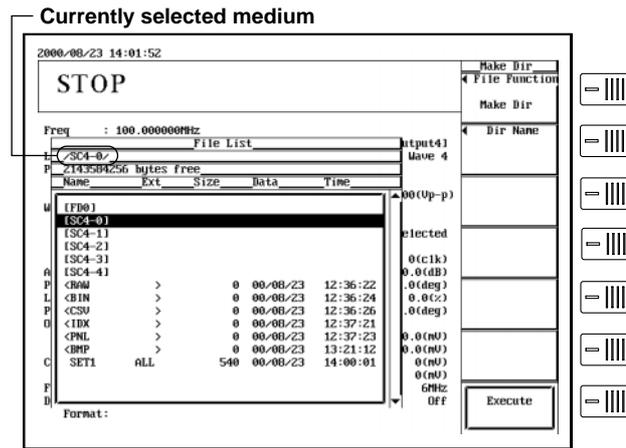
Selecting the directory

5. Turn the rotary knob to select the desired directory and press the SELECT key.
   The top left column of the file list is set to the selected directory.

⌐ **Currently selected medium/directory**
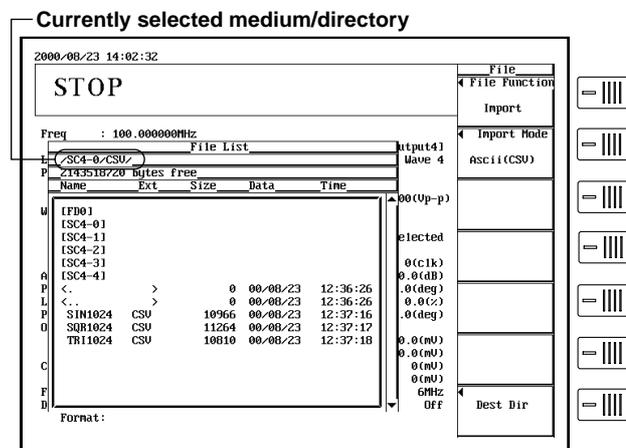
8.4   Creating Directories

Function

You can create directories on the floppy disk and on the partitions of the built-in hard disk.

Procedure

1. Press │ FILE │.
2. Press the [File Function] soft key to display the File Operation Selection menu.

Creating directories

3. Turn the rotary knob to select [Make Dir] and press the SELECT key.
4. Press the [Dir Name] soft key to display a string entry box.
   Select the directory name according to the procedure given in section 3.7.
5. Select the destination in which to create the directory according to the procedure given in section 8.3.
6. Press the [Execute] soft key to create the directory.

8

File Operation
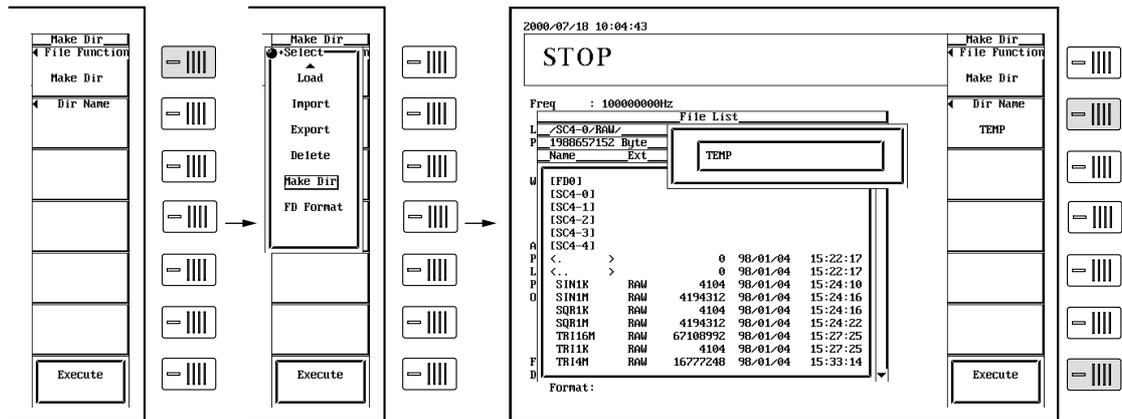
8.5 Deleting Directories and Files

Function

Deletes files on the floppy disk or built-in hard disk.

The directories or files with [*] marks in the file list are deleted.

If there is a file within a directory, the directory cannot be deleted. Delete the files in the directory first and then delete the directory.

Procedure

1. Press FILE .
2. Press the [File Function] soft key to display the File Operation Selection menu.
3. Turn the rotary knob to select [Delete] and press the SELECT key.
4. Select the files or directories to be deleted from the file list according to the procedure given in section 8.3.
5. Press the [Mark] soft key to place a [*] mark.
6. Press the [Execute] soft key to delete the file or directory.
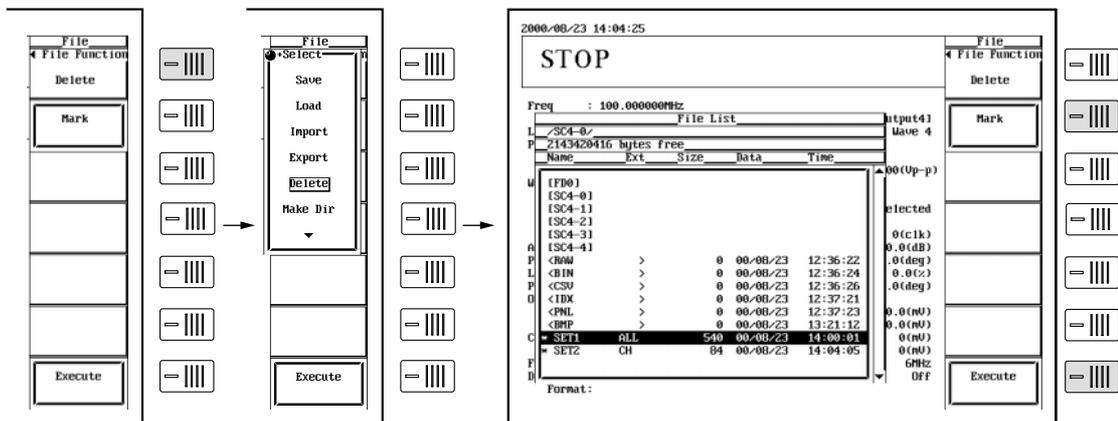
9.1 Checking the Configuration and Version of the VB8000

Function

You can check the hardware configuration and the hardware and software versions of the VB8000.

Procedure

1. Press MISC.
2. Press the [SelfTest] soft key.
3. Press the [Next1/2] soft key to display the [Next2/2] menu.
4. Press the [Information] soft key.
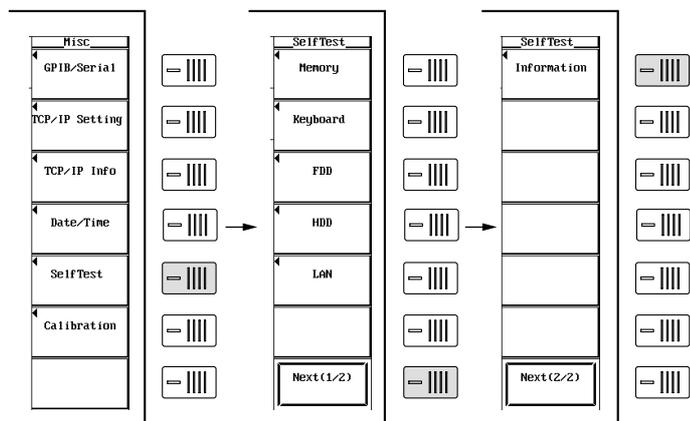
5. Press the [Execute] soft key to display a list of setup conditions.

9

Other Functions
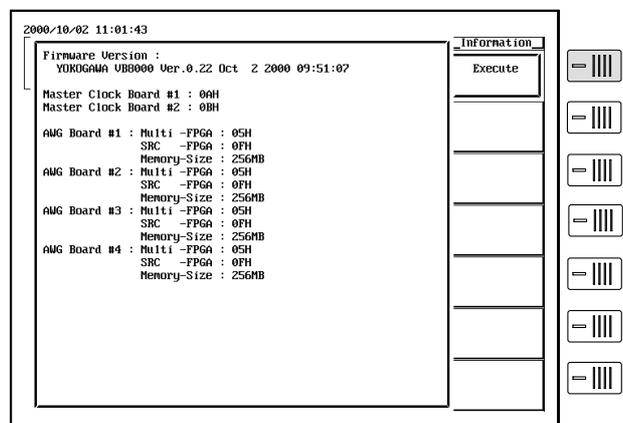
9.2 Turning ON/OFF the LCD Backlight

Function

You can turn ON/OFF the backlight of the LCD screen. If you press any key when the backlight is OFF, the LCD backlight turns ON, and the screen returns to the screen that is displayed when $\boxed{\textit{SETUP}}$ is pressed.

The LED located above $\boxed{\substack{\textit{DISPLAY} \\ \textit{ON/OFF}}}$ turns ON when the LCD backlight is turned ON.

Procedure

Press $\boxed{\substack{\textit{DISPLAY} \\ \textit{ON/OFF}}}$ to toggle the LCD backlight.

10.1 External Start Trigger Input

CAUTION

Only input signals that meet the specifications below. Otherwise, excessive voltage may damage the VB8000.

External Start Trigger Input Terminal (TRIG IN)

The terminal is used when the waveform generation start trigger is set to external (see section 7.5).

Specifications

Input level:	TTL
Input impedance:	Approx. 10 kΩ
Allowable input level range:	0 to 5.5 V
Connector type:	BNC

10

Auxiliary I/O

10.2 External Clock Input

<table>
<tr><td>⚠</td><td>

CAUTION

Only input signals that meet the specifications below. Otherwise, excessive voltage may damage the VB8000.
</td></tr>
</table>

External Clock Input Terminal (CLOCK IN)

CLOCK
IN
(ECL)

OUT
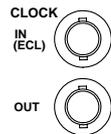
The terminal is used when applying a clock signal externally (see section 7.4).

Specifications

Input frequency:	128 kHz to 100 MHz
Input level:	ECL
Input impedance:	5 kΩ or more
Allowable input level range:	–5.5 to +0.0 V
Connector type:	BNC

Note

When the external clock input of the VB8000 is used, the signal received from the external clock input terminal is valid starting with the rising edge of the third clock cycle.

10.3 External Clock Output

⚠

CAUTION

Do not apply external voltage to the CLOCK OUT connector. This may cause damage to the VB8000.

External Clock Output Terminal (CLOCK OUT)

CLOCK
IN
(ECL)

OUT
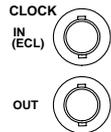
When using the internal clock, clock frequency at the specified frequency (clock frequency) is output. When using an external clock, the external clock signal is output. For selecting the internal/external clock, see section 7.4.

Specifications

Output level: ECL (open termination)
Output impedance: 50 Ω
Connector type: BNC

Circuit Diagram of the Output Section

ECL
10E Series

51 Ω

330 Ω

−5.2 V
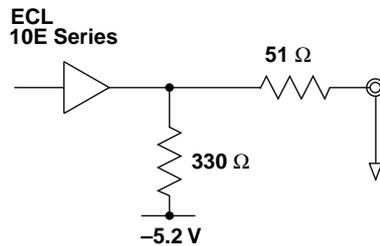
Note

Synchronized operation using the external clock output is possible. For details on synchronized operation of multiple waveform generators, see section 1.9.

10.4 10-MHz Reference Signal Input

CAUTION

Only input signals that meet the specifications below. Otherwise, excessive voltage may damage the VB8000.

10-MHz Reference Signal Input Terminal (10MHz REF IN)
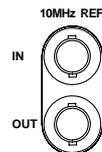
The terminal is used when applying a 10-MHz reference signal externally (see section 7.3).

Specifications

Input frequency:	10 MHz $\pm$ 50 ppm
Input level:	0 dBm to 10 dBm
Input impedance:	50 Ω
Input coupling:	AC
Maximum input voltage:	3 Vrms and 6 Vpeak
Connector type:	BNC

Note

Synchronized operation using the 10-MHz reference signal input is possible. For details on synchronized operation of multiple waveform generators, see section 1.9.

10.5 10-MHz Reference Signal Output

⚠

CAUTION

Do not apply external voltage to the REFERENCE OUT terminal. This may cause damage to the VB8000.

10-MHz Reference Signal Output Terminal (10MHz REF OUT)
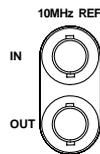
When using the internal 10-MHz reference signal, the internal reference signal is output.
When using an external 10-MHz reference signal, the external reference signal is output.
For the procedure in selecting the internal/external reference clock, see section 7.3.

Specifications

Output frequency: 10 MHz $\pm$ 1 ppm
Output level: TTL
Output impedance: Approxmately 50 Ω
Connector type: BNC

Circuit Diagram of the Output Section
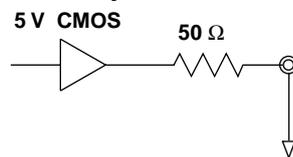
Note

Synchronized operation using the 10-MHz reference signal output is possible. For details on synchronized operation of multiple waveform generators, see section 1.9.

10

Auxiliary I/O

10.6 Digital Output

⚠️

CAUTION

Do not short the DIGITAL OUT terminal or apply external voltage to it. This may cause damage to the VB8000.

Digital Output Terminal (DIGITAL OUT)
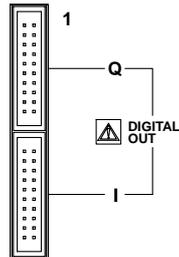
There is a digital output terminal for each OUTPUT. The waveform data are output using a 14-bit digital signal for I and Q independently. In addition, the clock signal is output differentially.

Specifications

Output level:	3.3 V CMOS
Output impedance:	75 Ω
Connector type:	2.54-mm pitch 20-pin 2-row pin header for I and Q
	HIF3 Series made by HRS, FRC5 Series made by DDK, and PS Series made by JAE.
Number of connectors:	2/4/6/8 (Corresponds to OUTPUT1 through 4. The number of connectors varies depending on the model.)
Connector pin assignment:	Unbalanced (single-ended), see table below.

| Pin No.	Signal Name	Pin No.	Signal Name
1	GND	11	bit5
2	CLOCK-P[*1]	12	bit6
3	GND	13	bit7
4	CLOCK-N[*2]	14	bit8
5	GND	15	bit9
6	bit0[*3]	16	bit10
7	bit1	17	bit11
8	bit2	18	bit12
9	bit3	19	bit13[*3]
10	bit4	20	GND

*1 Outputs the clock signal using positive logic.
*2 Outputs the clock signal using negative logic.
*3 bit0: LSB and bit13: MSB

Cable

A dedicated cable (Model: 703171) is sold separately.
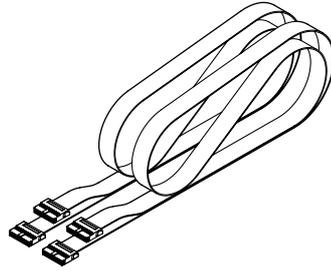
Circuit Diagram of the Output Section and the Recommended Input Circuit Diagram
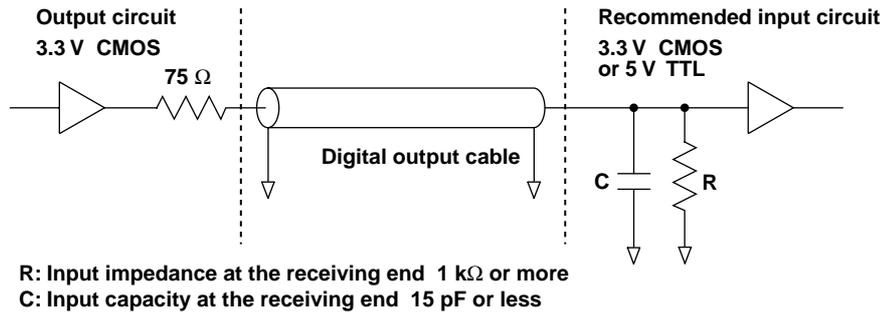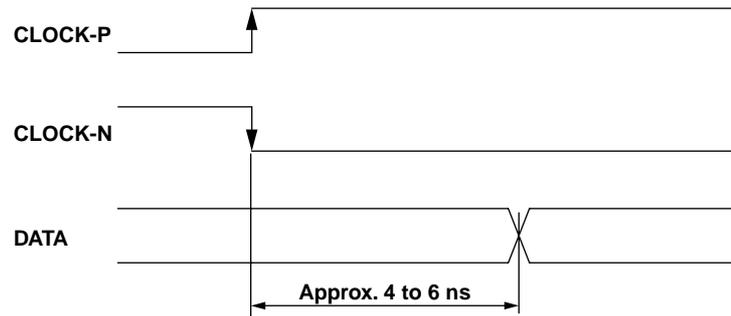
Output circuit
3.3 V CMOS

75 Ω

Digital output cable

Recommended input circuit
3.3 V CMOS
or 5 V TTL

C **R**

R: Input impedance at the receiving end 1 kΩ or more
**C: Input capacity at the receiving end 15 pF or less**

Timing Chart

CLOCK-P

CLOCK-N

DATA

Approx. 4 to 6 ns

10

Auxiliary I/O

10.7 Event Output

Event Output Terminal (EVENT OUT)
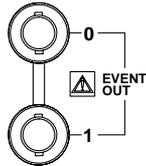
There is an event output terminal for each OUTPUT.
Event data are 1-bit data that are synchronized to the 14-bit waveform data. When creating the waveform data, two sets of event data that are synchronized to the I and Q waveform data are created.

Specifications

Output level:	3.3 V CMOS
Output impedance:	50 Ω
Connector type:	BNC
Number of connectors:	2/4/6/8

Circuit Diagram of the Output Section
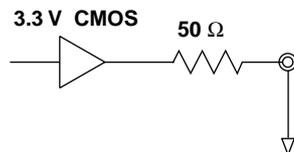
10.8 Trigger-Ready Output

CAUTION

Do not apply external voltage to the TRIG READY terminal. This may cause damage to the VB8000.

Trigger-Ready Output Terminal (READY OUT)

READY
OUT

When the waveform generation start trigger is set to external, a signal indicating that it is ready to receive triggers is output. A high TTL level signal indicates the external trigger receive ready state.

In addition, when operating multiple waveform generators in sync, the signal can be applied to the external start trigger input of lower slave units.

For details on synchronized operation of multiple waveform generators, see section 1.9.

Specifications

Output level: TTL
Output impedance: 50 Ω
Connector type: BNC

Circuit Diagram of the Output Section

5 V CMOS   **50 Ω**
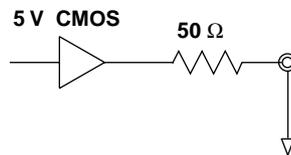
11.1 Troubleshooting

Counter Action for Errors

- If a message is displayed on the screen, read the succeeding pages.
- If servicing is necessary, or if the instrument is not operating correctly after performing the corrective actions below, contact your nearest YOKOGAWA dealer.

Description	Probable Cause	Corrective Action	Reference
The power does not turn ON.	Using a power supply outside the ratings.	Use a correct power supply.	3-5
Nothing appears on the screen.	The LCD backlight is OFF.	Turn ON the LCD backlight.	9-2
The display is odd.	The system is abnormal.	Reboot the system.	3-6
Cannot operate the keys.	Message is displayed.	Press the ESC key to clear the message.	3-11
	The keys are in shift mode (alphabet entry mode) when entering decimal values.	Press the SHIFT key to turn OFF the LED of the SHIFT key.	2-1
	The VB8000 is in the remote mode.	Press the LOCAL key to enter the LOCAL mode.	2-1
	Others	Perform a key test. If the test fails, servicing is required.	11.3 section
Output waveform is odd.	Insufficient warm-up.	Warm up the VB8000 for 30 minutes after turning on the power.	3-7
	Not calibrated.	Perform a calibration.	11-8
	Offset voltage is added.	Check the offset voltage setting.	7.1 section
	Others	Initialize and/or perform a calibration. If the output waveform is still odd, servicing is required.	3-7, 11-8
Cannot save data to the specified medium.	The medium is not formatted.	Format the medium.	8-1
	The medium is write-protected.	Release the medium's write-protect.	–
	No more free space on the medium.	Delete unneeded files or use a new medium.	–
Cannot change settings or control the operation of the VB8000 via the communication interface.	The address of the VB8000 used by the program is different from the specified address.	Match the address used in the program to the address of the VB8000.	Communication Interface
	The interface is not used in a way that conforms to the electrical or mechanical specifications of IEEE St'd 488-1978.	Use it in a way that conforms to the specifications.	User's Manual

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11.2 Messages

Error Messages

An message may appear while you are using the VB8000. This section will describe the meanings of the messages and the corrective actions. If the corrective action indicates servicing, please contact your nearest YOKOGAWA dealer.

In addition to the error messages below, there are communication error messages (0 to 500 and 912 to 915). These messages are described in the Communication Interface user's manual (separate manual).

Code	Message	Corrective Action
1001	Parameter error.	There is a parameter error.
1002	Path name is too long.	Path name is too long.
1003	Hostname is too long.	Host name is too long. Use 40 characters or less.
1004	Password is too long.	Password is too long. Use eight characters or less.
1005	Illegal date and time.	Date/Time setting is not correct.
1006	Incorrect IP address.	IP address is not correct.
1007	Waveform name is too long.	Waveform name is too long. Use eight characters or less.
1008	Body waveform is not specified.	Body waveform is not specified.
1009	Not enough memory in waveform memory.	No free memory in waveform memory.
1010	Specified entry does not exist.	The specified entry number does not exist.
1011	No more selections allowed.	No more selections allowed.
1012	Entry not selected.	Entry not selected.
1013	Cannot load files during waveform generation.	Cannot load to the SDRAM during waveform generation.
1014	Selected waveform still not loaded.	The selected waveform has not been loaded.
1015	Please enter a new name.	Specify a new name.
1016	Device name has been selected.	Device name has been selected. Select a file name.
1017	Fan stopped. Please turn power Off.	Fan has stopped. Turn OFF the power immediately.
1018	Calibration error.	Calibration error.
1019	Load Error in Output1.	Error in loading to the waveform memory of Output1. Check the waveform data that caused the error.
1020	Load Error in Output2.	Error in loading to the waveform memory of Output2. Check the waveform data that caused the error.
1021	Load Error in Output3.	Error in loading to the waveform memory of Output3. Check the waveform data that caused the error.
1022	Load Error in Output4.	Error in loading to the waveform memory of Output4. Check the waveform data that caused the error.
1023	Load Error in Output1/2.	Error in loading to the waveform memory of Output1/2. Check the waveform data that caused the error.
1024	Load Error in Output1/3.	Error in loading to the waveform memory of Output1/3. Check the waveform data that caused the error.
1025	Load Error in Output1/4.	Error in loading to the waveform memory of Output1/4. Check the waveform data that caused the error.
1026	Load Error in Output2/3.	Error in loading to the waveform memory of Output2/3. Check the waveform data that caused the error.
1027	Load Error in Output2/4.	Error in loading to the waveform memory of Output2/4. Check the waveform data that caused the error.
1028	Load Error in Output3/4.	Error in loading to the waveform memory of Output3/4. Check the waveform data that caused the error.
1029	Load Error in Output1/2/3.	Error in loading to the waveform memory of Output1/2/3. Check the waveform data that caused the error.

Code	Message	Corrective Action
1030	Load Error in Output1/2/4.	Error in loading to the waveform memory of Output1/2/4. Check the waveform data that caused the error.
1031	Load Error in Output1/3/4.	Error in loading to the waveform memory of Output1/3/4. Check the waveform data that caused the error.
1032	Load Error in Output2/3/4.	Error in loading to the waveform memory of Output2/3/4. Check the waveform data that caused the error.
1033	Load Error in Output1/2/3/4.	Error in loading to the waveform memory of Output1/2/3/4. Check the waveform data that caused the error.
1034	Incorrect file extension.	File name extension is invalid.
1035	Lithium battery voltage low.	Lithium battery voltage is low.
1036	File changed. Please re-register.	File has been changed. Re-register.
1100	An error occurred during file operation.	An error occurred during file operation.
1101	Incorrect path name.	Path name is invalid.
1102	Floppy disk not inserted.	Floppy disk is not inserted.
1103	Specified SCSI device not found.	The specified SCSI device does not exist.
1104	Storage media is defective.	Storage media is defective.
1105	File not found.	The specified file does not exist.
1106	Floppy disk is write-protected.	Floppy disk is write-protected.
1107	Floppy disk was changed.	Floppy disk has been changed.
1108	Path name already exists.	Path name already exists.
1109	File name already exists. Could not create new file.	Cannot create the file because the same file name already exists.
1110	Reserved file name or illegal character.	Specified a reserved file name or an illegal character.
1111	Directory is full. No more files can be created.	The directory entry is full. No more files can be created.
1112	Insufficient space for creating a file.	Not enough free space to create a file.
1113	Can't delete directory. Directory not empty.	Attempted to delete a directory containing files or child directories.
1114	File is write-protected.	File is write-protected.
1115	Formatting Error.	Disk format error.
1116	Can't write to a read only file.	Cannot write to a read-only file.
1117	Input path name is a file. Please enter a directory name.	The specified path name is a file. Specify a directory name.
1118	Input path name is a directory. Please enter a file name.	The specified path name is a directory. Specify a file name.
1119	Input path name is a volume label. Please enter a directory or file name.	The specified path name is a volume label. Specify a directory name or a file name.
1120	Can't find directory.	Cannot find the directory.
1121	End of file.	Reached the end of the file.
1122	File size is 0.	File size is 0.
1123	Can't open system file.	Cannot open a system file.
1124	Can't open hidden file.	Cannot open a hidden file.
1125	Can't open volume label.	Cannot open a volume label.
1126	Requested number of bytes incorrect.	Requested number of bytes is incorrect.
1127	Can't move file pointer outside file range.	Attempted to move the file pointer outside the file range.
1128	Opened with read only file.	Read-only file.
1129	Current directory not set.	Current directory has not been specified.
1130	Invalid key.	File key is invalid.
1131	Can't set volume label.	Cannot set the volume label.
1132	Incorrect volume size.	Volume size is invalid.
1133	Too big to save to floppy/hard disk.	The total volume size is greater than the medium size.
1134	Wrong medium. Select hard disk.	The specified medium is not a hard disk.

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Code	Message	Corrective Action
1135	File access error.	Other file access error.
1136	Unexpected file format.	Unexpected file.
1200	Flash ROM : Erase error.	Error occurred in clearing the flash ROM. Servicing required.
1201	Flash ROM : Write Error.	Error occurred in writing to the flash ROM. Servicing required.
1202	Flash ROM : Verify Error.	Verify error occurred while writing to the flash ROM. Servicing required.
1250	Ethernet : Internal loop back error.	Transmission error occurred during internal loopback. Servicing required.
1251	Ethernet : Internal loop back error.	Transmission error occurred during internal loopback. Servicing required.
1252	Ethernet : Internal loop back error.	Transmission error occurred during internal loopback. Servicing required.
1253	Ethernet : Internal loop back error.	Transmission error occurred during internal loopback. Servicing required.
1254	Ethernet : External loop back error.	Transmission error occurred during external loopback. Servicing required.
1255	Ethernet : External loop back error.	Transmission error occurred during external loopback. Servicing required.
1256	Ethernet : External loop back error.	Transmission error occurred during external loopback. Servicing required.
1257	Ethernet : External loop back error.	Transmission error occurred during external loopback. Servicing required.
1258	Ethernet : No response from DHCP server.	No response from the DHCP server.
1259	Ethernet : Can't find LAN controller.	Cannot detect the LAN controller. Servicing required.
1260	Ethernet : LAN controller is busy.	LAN controller is busy.
1261	Ethernet : Parameter setting error.	The Ethernet configuration parameter is invalid.
1300	Frequency of master clock is outside allowable range.	Specified a clock frequency outside the allowed range.
1301	Frequency of master clock is outside allowable range.	Specified a clock frequency outside the allowed range.
1302	Frequency of master clock is outside allowable range.	Specified a clock frequency outside the allowed range.
1303	Please stop waveform generation before changing settings.	Cannot execute while waveform generation is in progress. Stop waveform generation.
1304	Error occurred while starting the clock. Check external clock and reference.	Start execution error occurred. Check the external clock and reference.
1305	Can't find 10 MHz input.	Cannot detect the 10-MHz input.
1306	Can't find 10 MHz reference.	Cannot detect the 10-MHz reference.
1307	Can't find external clock.	Cannot detect the external clock input.
1308	External clock found.	Detected the external clock input.

11.3 Self-Test

Function

Memory test

Tests whether the memory that is used inside the VB8000 is operating properly. If [OK] is displayed, the memory is operating properly. If not, contact your nearest YOKOGAWA dealer.

Keyboard

Tests whether the control panel keys are operating properly. If the corresponding key graphic on the LCD screen is highlighted when the key is pressed, the key is operating properly. For the SHIFT key, if the LED turns ON/OFF each time the key is pressed, it is operating properly. While the test is in progress, the LEDs for LOCAL, START/STOP, and OUTPUT blinks in order. If it is abnormal, contact your nearest YOKOGAWA dealer.

Floppy disk (FDD)

Performs a floppy disk test. If [OK] is displayed, the floppy disk is operating properly. If not, change the floppy disk.

Hard disk (HDD)

Tests whether the hard disk that is used inside the VB8000 is operating properly. If [OK] is displayed, the hard disk is operating properly. If not, contact your nearest YOKOGAWA dealer.

LAN

Performs an Ethernet loopback test. If [OK] is displayed, it is operating properly. If not, contact your nearest YOKOGAWA dealer.

Note

Perform the loopback test after connecting the VB8000 to the network.

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Procedure

Displaying the self-test menu

1. Press MISC .
2. Press the [SelfTest] soft key to display the self-test screen.
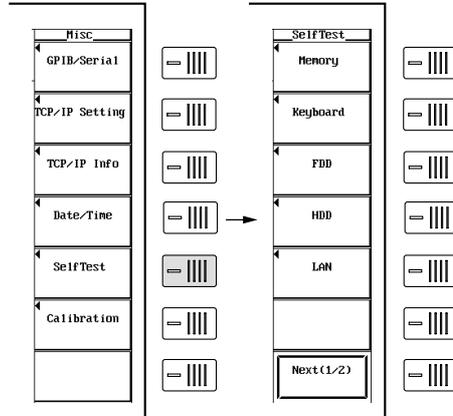
Executing the memory test

3. After step 2, press the [Memory] soft key.
4. Press the [Execute] soft key to execute the memory test.
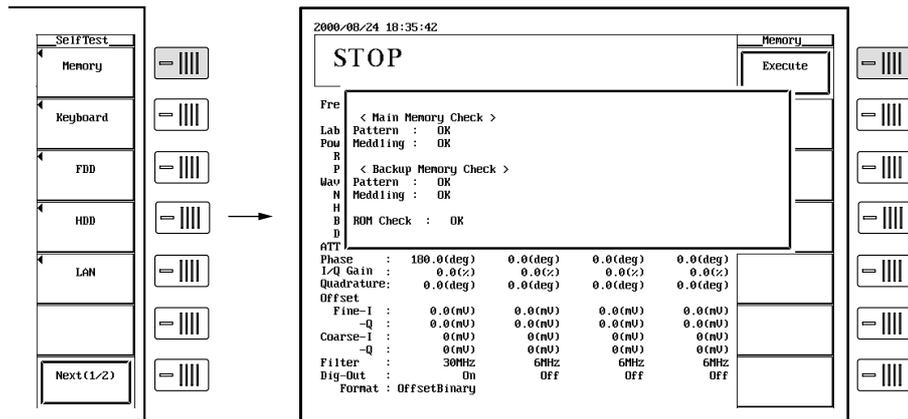
Executing the keyboard test

5. After step 2, press the [Keyboard] soft key.
6. Press the [Execute] soft key. A keyboard appears on the screen.
7. Press each key to execute the keyboard test.
8. Press the ESC key twice to exit the keyboard test.
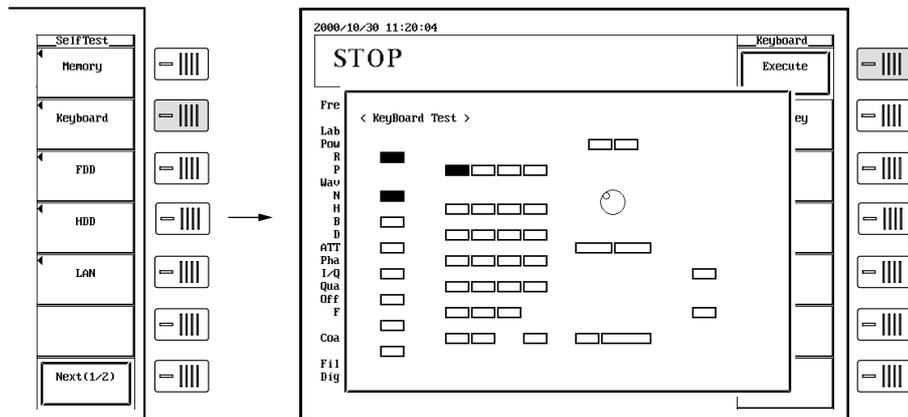
Executing the floppy disk test

9. After step 2, press the [FDD] soft key.

10. Press the [Execute] soft key to execute the floppy disk test.
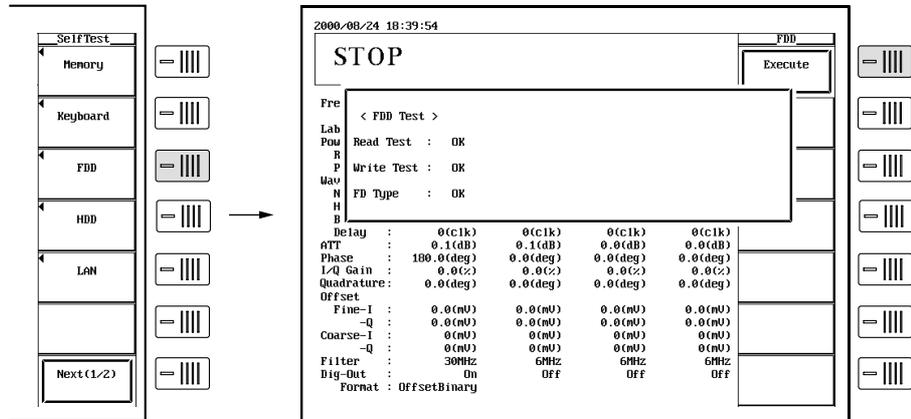
Executing the hard disk test

11. After step 2, press the [HDD] soft key.

12. Press the [Execute] soft key to execute the hard disk test.
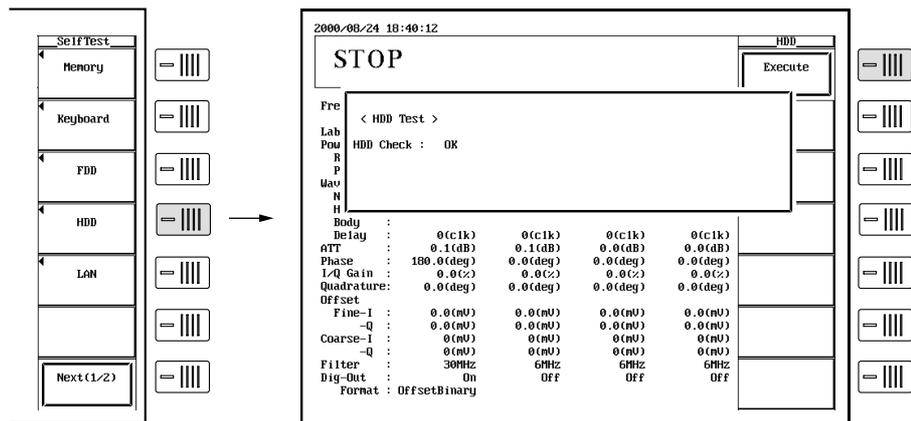
Executing the loopback test

13. After step 2, press the [LAN] soft key.

14. Press the [Execute] soft key to execute the loopback test.

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Troubleshooting and Maintenance
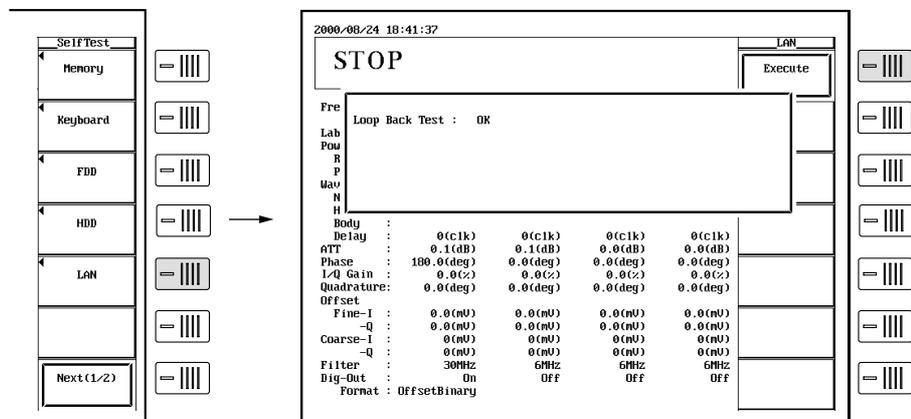
11.4 Calibration

Function

Performs calibration on the items below. Perform calibration when you wish to output accurate waveforms.

- Gain
- Offset

If the calibration completes successfully, nothing appears on the screen. If it fails, an error list is displayed. If an error list is displayed, contact your nearest YOKOGAWA dealer.

Procedure

1. Press MISC .
2. Press the [Calibration] soft key.
3. Press the [Execute] soft key to execute the calibration.
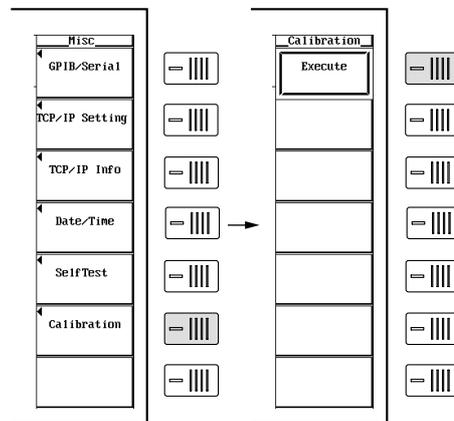
11.5 Replacing the Power Fuse

⚠️

WARNING

- To prevent the possibility of fire, only use a fuse with the specified rating (current, voltage, and type).
- When replacing a fuse, always turn OFF the power switch and unplug the power cord.
- Never short the fuse holder.

Specified rating

The VB8000 uses the following power fuse:

- Maximum rated voltage: 250 V
- Maximum rated current: 5 A
- Type: Time lag
- Standard: VDE/SEMKO/UL/CSA/SEV certified
- Part No.:   A1353EF

Replacement procedure

Replace the power fuse according to the procedure below.

1. Turn OFF the power switch.
2. Remove the power cord from the power connector.
3. Insert the tip of a flat head screwdriver in the dented section of the fuse holder on the power connector side, pull it toward you, and remove the fuse holder.
4. Remove the blown fuse that is attached to the tip of the fuse holder.
5. Attach a new fuse to the fuse holder and attach the fuse holder back in the original place.
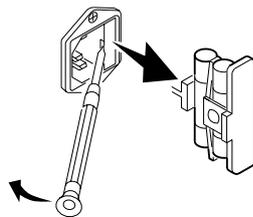
Note

The fuse inside the case cannot be replaced by the user. If you believe the fuse inside the case is blown, contact your nearest YOKOGAWA dealer. The ratings of the fuse that is used inside the case are shown below.

Location	Max. Rated Voltage	Max. Rated Current	Type	Standard
Inlet	250 V	3 A	Time lag	UL/CSA certified

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11.6 Recommended Replacement Parts

The one-year warranty applies only to the main unit of the instrument (starting from the day of delivery) and does not cover any other items. The replacement period for expendable items varies depending on the conditions of use. Refer to the table below as a general guideline.

Contact your nearest YOKOGAWA dealer for replacement parts.

Parts Name	Recommended Replacement Period (Reference)
LCD backlight	25,000 hours
Cooling fan	30,000 hours
Backup battery	3 years
Built-in hard disk	One year after purchase (data are excluded)

12.1 Performance Specifications

IQ Signal Output Section

Item	Specification	
Number of channels	2 or 4 channels (differential output) 6 or 8 channels (single-ended output)	
Waveform memory size	16 Mpoints or 64 Mpoints	
Output resolution	14 bits	
Output resistance (DC)	50±1 Ω	
Rated load	50 Ω	
Output range	with 50 Ω load	−1.5 to +2.5 V (ACpeak + DC offset) 3.0 Vp-p AC
	With an open load	−3.0 to +5.0 V (ACpeak + DC offset) 6.0 Vp-p AC
Attenuator accuracy[1]	±0.2 dB	
DC voltage offset accuracy[1]	with 50 Ω load	±(specified value × 1%)±2 mV
	With an open load	±(specified value × 1%)±4 mV
Skew (between outputs) Skew (between I and Q)	Within ±2.0 ns (when smoothing filter is Through) Within ±2.0 ns (when smoothing filter is Through)	
Smoothing filter (−3 dB, nominal value)	Through (90 MHz), 30 MHz, 6 MHz	

Reference Clock Section

Item	Specification
Frequency range	128 kHz to 100 MHz
Frequency resolution	1 Hz
Frequency stability[2]	±1 ppm
Aging	±1 ppm/year

[1] Under standard operating conditions (see page 12-6) after the 30-minute warm-up time has passed after calibration.
[2] Unser standard operating conditions (see page 12-6) after the 30-minute warm-up time has passed.

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12.2 Functional Specifications

Waveform Memory Section

Item	Specification
Header data length	Arbitrary number of points between 1 and (Installed memory size - body data length -256)
Body data length	Arbitrary number of points between 1 and installed memory size

Waveform Output Control Section

Item	Specification
Delay	Arbitrary number of clock cycles between 0 and 262143
Start trigger	Switch between internal and external
Waveform output sequence	Output the header once and repetitively output the body or repetitively output only the body

Waveform Output Section

Item	Specification
Output attenuator setting	+6.0 to −20.0 dB (resolution: 0.1 dB)
Output phase setting	−180 to +180° (resolution: 0.5°)
Amplitude error setting	−30 to +30% (resolution: 0.5%)
Phase error setting	−30 to 30 ° (resolution: 0.5°)
DC voltage offset setting (Common-mode)	−500 to +1500 mV (resolution: 1 mV)
DC voltage offset setting (Differential)	−100 to +100 mV (resolution: 0.2 mV)

Digital Output Section

Item	Specification
Output format	Switchable between 2's complement and offset binary

12.3 Auxiliary I/O Specifications

Item	Specification	
DOUT	Output level	3.3 V CMOS level
	Output impedance	Approx. 75 Ω
	Connector type	PS Series by JAE
EVENT OUT 0, 1	Output level	3.3 V CMOS level
	Output impedance	50 Ω
	Connector type	BNC
Clock input	Input frequency	128 kHz to 100 MHz
	Input level	ECL
	Input impedance	5 kΩ or more
	Allowable input level range	-–5.5 V to +0 V
	Connector type	BNC
Clock output	Output level	ECL (Use at open termination)
	Output impedance	50 Ω
	Connector type	BNC
10-MHz reference input	Input frequency	10 MHz ± 50 ppm
	Input level	0 dBm to 10 dBm
	Input impedance	50 Ω
	Input coupling	AC
	Allowable input level range	3 Vrms and 6 Vpeak
	Connector type	BNC
10-MHz reference output	Output frequency	10 MHz ± 1 ppm
	Output level	TTL
	Output impedance	Approxmately 50 Ω
	Connector type	BNC
External start trigger input	Input level	TTL
	Input impedance	10 kΩ
	Allowable input level range	0 V to 5.5 V
	Connector type	BNC
Trigger-ready output	Output level	TTL
	Output impedance	50 Ω
	Connector type	BNC

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12.4 Display Section Specifications

Item	Specification
Display	6.4″ color TFT LCD
Display screen size	130.6 (H) $\times$ 97.0 (H) [mm]
Total number of pixels	640 $\times$ 480

*   The LCD screen may be 0.02% defective with respect to the total number of pixels.

12.5 Serial (RS-232) Interface Specifications

Item	Specification
Connector type	D-sub 9-pin
Electrical specifications	Conforms to EIA RS-232
Connection format	Point-to-point
Communication format	Full-duplex
Synchronization	Start-stop synchronization
Baud rate	Select from the following: 1200/2400/4800/9600/19200/38400
Functional specifications	SH1, AH1, T5, LA, SR1, RL1, PP0, DC1, DT0, and C0

12.6 GP-IB Interface Specifications

Item	Specification
Electrical and mechanical specifications	Conforms to IEEE St'd 488-1978 (JIS C1901-1987)
Functional specifications	SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, and C0
Protocol	Conforms to IEEE St'd 488.2-1987
Code	ISO (ASCII) code
Mode	Addressable
Address	Specify a talker/listener address between 0 and 30
Clear remote mode	Clear remote mode using the LOCAL key

12.7 Ethernet Interface Specifications

Item	Specification
Number of communication ports	1
Electrical and mechanical specifications	Conforms to IEEE802.3
Media system	Ethernet (10BASE-T)
Transmission speed	10 Mbps
Communication protocol	TCP/IP
Services supported	FTP server DHCP
Connector type	RJ-45 connector

12.8 Built-in Floppy Disk Drive Specifications

Item	Specification
Number of drives	1
Size	3.5˝
Size	640 KB/720 KB/1.2 MB/1.44 MB

12.9 Built-in Hard Disk Specifications

Item	Specification
Number of drives	1
Size	10 GB (IBM format)

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12.10 General Specifications

Item	Specification	
Standard operating conditions	Ambient temperature	23±5°C
	Ambient humidity	55±10%RH
	Error in supply voltage and frequency	within 1% of rating
Warm-up time	At least 30 minutes	
Storage conditions	Temperature	−20 to 60°C
	Humidity	20 to 80%RH (no condensation)
Operating conditions	Temperature	5 to 40°C
	Humidity	20 to 80%RH (no condensation)
Storage altitude	3000 m or less	
Operating altitude	2000 m or less	
Rated supply voltage	100 to 120 VAC/220 to 240 VAC (auto switch between 100 V and 200 V systems)	
Permitted supply voltage range	90 to 132 VAC/180 to 250 VAC	
Rated supply voltage frequency	50/60 Hz	
Allowable supply voltage frequency range	48 to 63 Hz	
Power fuse	250 V/5 A time lag, VDE/SEMKO/UL/CSA/SEV certified	
Maximum power consumption	300 VA or less	
Withstanding voltage (between power supply and case)	1.5 kVAC for one minute	
Insulation resistance (between power supply and case)	10 MΩ or more (500 VDC)	
External dimensions (details on the next page)	426 mm(W) × 176 mm(H) × 450 mm(D) (excludes the handle and other projections)	
Weight	Approx. 16 kg (for Model 703150-648)	
Instrument's cooling method	Forced air cooling	
Installation position	Horizontal (however, the stand can be used)	
Battery backup	Setup information and clock are backed up with the internal lithium battery Battery life Approx. 5 years (at ambient temperature of 23°C)	
Standard accessories	• Power cord	1 piece
	• Power fuse (attached to the fuse holder)	
	• Rubber hind feet	1 piece
	• user's manual	1 piece (this manual)
	• Communication Interface user's manual	1 piece
	• File Conversion Utility Software for VB8000 user's manual	1 piece
	• Floppy disk for installing the File Conversion Utility Software for VB8000	1 piece

12.11 External Dimensions
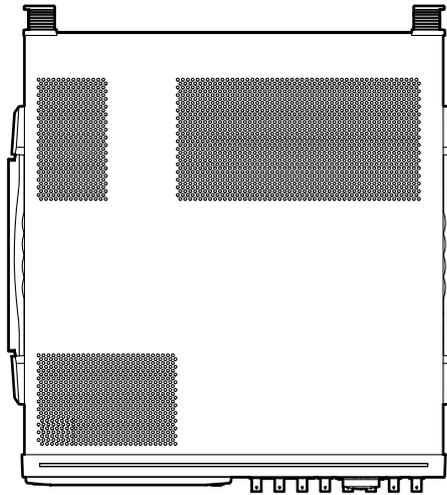
Rear View
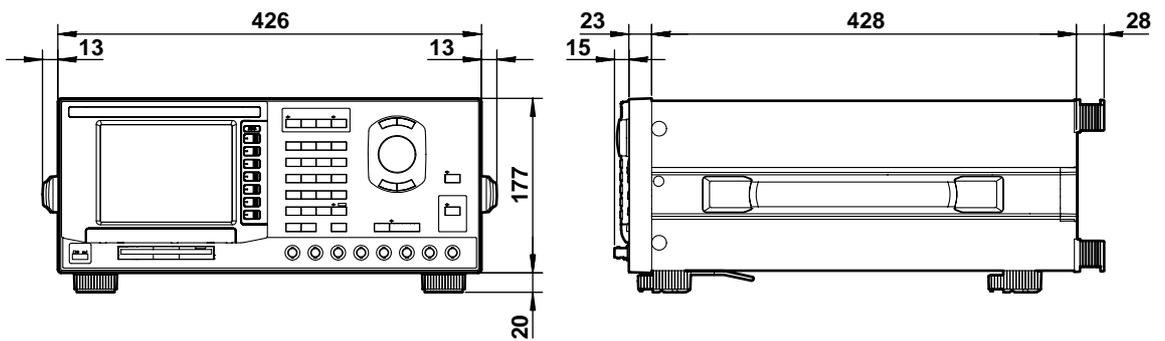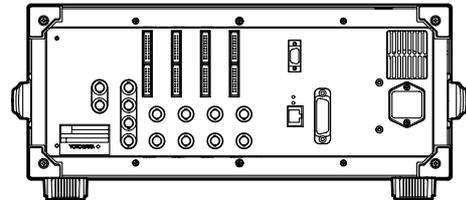
If not specified, the tolerance is ±3%. However, in cases of less than 10 mm, the tolerance is ±0.3 mm.

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