User's Manual

# Model 734001
# AP9945 Portable BERT

YOKOGAWA
Yokogawa Electric Corporation

IM 734001-01E
2nd Edition

Thank you for purchasing the AP9945 Portable Bit Error Rate Tester (BERT).
This user's manual explains the functions and operating procedures of the AP9945. To ensure correct use, please read this manual thoroughly before beginning operation. After reading this manual, keep it in a convenient location for quick reference in the event a question arises during operation.

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## Revisions

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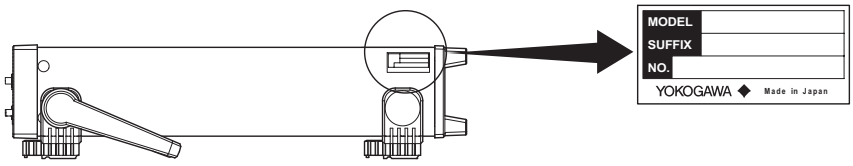
# Checking the Contents of the Package

Unpack the box and check the contents before operating the instrument. If any of the contents are incorrect, missing, or appear to be abnormal, please contact your YOKOGAWA dealer or representative.

### AP9945 Main Unit

Check that the model and suffix code on the name plate on the side panel of the instrument match those of your order.




- **Models and Suffix Codes**

| Model | SUFFIX | Specifications |
|---|---|---|
| 734001 | | AP9945 Portable BERT |
| SG | -SG0 | No SG (oscillator required) |
| | -SG1 | SG built in |
| Oscillator 1 | -F10 | No oscillator 1 (when SG built in) |
| | -F11 | Oscillator 1 frequency: 9.95328 GHz |
| | -F12 | Oscillator 1 frequency: 10.3125 GHz |
| | -F13 | Oscillator 1 frequency: 10.6642 GHz |
| | -F14 | Oscillator 1 frequency: 10.709 GHz |
| | -F15 | Oscillator 1 frequency: 11.095 GHz |
| Oscillator 2 | -F20 | No oscillator 2 (when SG built in, or with only oscillator 1) |
| | -F22 | Oscillator 2 frequency: 10.3125 GHz |
| | -F23 | Oscillator 2 frequency: 10.6642 GHz |
| | -F24 | Oscillator 2 frequency: 10.709 GHz |
| | -F25 | Oscillator 2 frequency: 11.095 GHz |
| Power cord | -E | VDE standard power cord<br>Maximum rated voltage: 250 VAC<br>Maximum rated current: 10 A |
| | -G | AS standard power cord<br>Maximum rated voltage: 250 VAC<br>Maximum rated current: 6 A |
| | -J | BS standard power cord<br>Maximum rated voltage: 250 VAC<br>Maximum rated current: 5 A |
| | -U | UL/CSA standard power cord<br>Maximum rated voltage: 125 VAC<br>Maximum rated current: 10 A |

Suffix Code Example

- When one oscillator (10.3125 GHz) is selected, with VDE power cord: 734001-SG0-F12-F20-E
- When two oscillators (10.3125 GHz and 11.095 GHz) are selected, with AS power cord: 734001-SG0-F12-F25-G
- When the built-in SG type is selected, with UL/CSA power cord: 734001-SG1-F10-F20-U

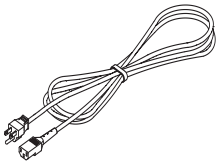
- **NO. (Instrument number)**
  Please have the instrument number (NO.) ready when contacting your dealer or representative.

## Accessories

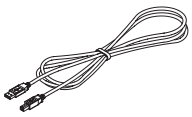
The standard accessories below are supplied with the instrument.

| Accessory Name | Q'ty | Remarks |
|---|---|---|
| Power cord | 1 | The power cord selected from the following is included.<br>VDE standard power cord<br>AS standard power cord<br>BS standard power cord<br>UL/CSA standard power cord |
| USB cable | 1 | |
| Terminators | 6 | Attached to the main unit 3.5 mm-Female: 2<br>SMA-Female: 4 |
| Protective caps | 5 | Attached to the main unit |
| Rubber feet | 1 | 2 pcs. per set, separated before use |
| Software CD | 1 | CD (part number: M3938MA):<br>AP9945 PORTABLE BERT Software |
| User's manual | 1 | AP9945 Portable BERT User's Manual (this manual)<br>:IM734001-01E |

Power cord



USB cable

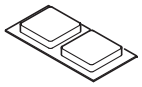


Terminators: 6

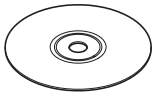
3.5 mm: 2 pc.
SMA: 4 pc.

Protective caps: 5

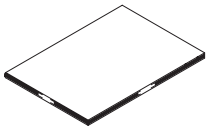
Rubber feet



Software CD (M3938MA)



User's manual



# Safety Precautions

This instrument is equivalent to an IEC standard safety class I device (with protective grounding terminal). To ensure safe and correct operation of the instrument, you must take the safety precautions given below. The instrument's protective functions may not work if used in a manner not described in this manual. Yokogawa Electric Corporation bears no responsibility for, nor implies any warranty against damages occurring as a result of failure to take these precautions.

**The following safety symbols and wording is used in this manual.**

Warning: Handle with care. Refer to the user's manual or service manual. This symbol appears on dangerous locations on the instrument which require special instructions for proper handling or use. The same symbol appears in the corresponding place in the manual to identify those instructions.

Alternating current



ON (power)

OFF (power)

Stand-by

The following precautions must be taken to prevent potentially fatal accidents.

**WARNING**

- **Use the Correct Power Supply**
  Before connecting the power cord, ensure that the power supply source voltage matches the rated supply voltage of the instrument and that it is within the maximum rated voltage of the provided power cord.
- **Use the Correct AC Power Cord and Adapter**
  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.
- **Use Protective Grounding**
  Make sure to connect the protective earth to prevent electric shock before turning ON the power to the instrument. The power cord that comes with the instrument is a three-prong power cord. Therefore the power cord should be connected to a properly grounded three-prong outlet.
- **Never Disable Protective Grounding**
  Never disable the instrument's internal or external protective earth wire or disconnect the wiring of the protective earth terminal. Doing so poses a potential shock hazard.
- **Never Use If You Suspect Protective Functions Are Defective**
  Do not operate the instrument if the protective earth or fuse might be defective. Always check these before operation.
- **Do Not Use Near Flammable Gases**
  Never use the instrument in locations with flammable or explosive gases or vapors. Doing so is extremely dangerous.
- **Do Not Remove the Case**
  Only qualified Yokogawa technicians may remove the case. Certain parts of the instrument carry high voltages, and are dangerous.

# Conventions Used in This Manual

## Safety Markings

The following markings are used in this manual.

*Improper handling or use can lead to injury to the user or damage to the instrument.* This symbol appears on the instrument to indicate that the user must refer to the user's manual for special instructions. The same symbol appears in the corresponding place in the user's manual to identify those instructions. In the manual, the symbol is used in conjunction with the word “WARNING” or “CAUTION.”

**WARNING** Calls attention to actions or conditions that could cause serious or fatal injury to the user, and precautions that can be taken to prevent such occurrences.

**CAUTION** Calls attentions to actions or conditions that could cause light injury to the user or damage to the instrument or user's data, and precautions that can be taken to prevent such occurrences.

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

## Notations Used in the Procedural Explanations

On pages that describe the operating procedures in chapters 3 through 4, the following notations are used to distinguish the procedure from their explanations.

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

Explanation This subsection describes the setup parameters and the limitations on the procedures. It may not give a detailed explanation of the function. For a detailed explanation of the function, see chapter 2.

**Notation of User Controls**

- Soft button: xxx button (Ex.) Click the **OK** button.
- Parameters: (Ex.) Select **TRAFFIC**.
- Switch: xxx switch (Ex.) Press the power switch.
- Hard key: xxx key (Ex.) Press a cursor key.
- Menu: YYY > ZZZ (menu) (Ex.) Choose **File** > **Login** in the menu.

## Units

k Denotes 1000. Example: 10 kHz, 10 kg
K Denotes 1024. Example: 100 KB
M Denotes 1000000 when the units are bps or Hz. Example: 100 Mbps, 10 MHz
Denotes 1048576 when the units are bytes. Example: 100 MB
G Denotes 1000000000 when the units are bps or Hz. Example: 10 Gbps, 10 GHz

# Contents

## Chapter 5 Troubleshooting, Maintenance, and Inspection



## Chapter 6 Specifications



## Appendix

# 1.1 Product Overview

The AP9945 is a 10 Gbit/s band bit error rate tester. It comprises a PPG*1 section for pattern generation, and an ED*2 section for error measurement, enabling BER measurement in a single unit.

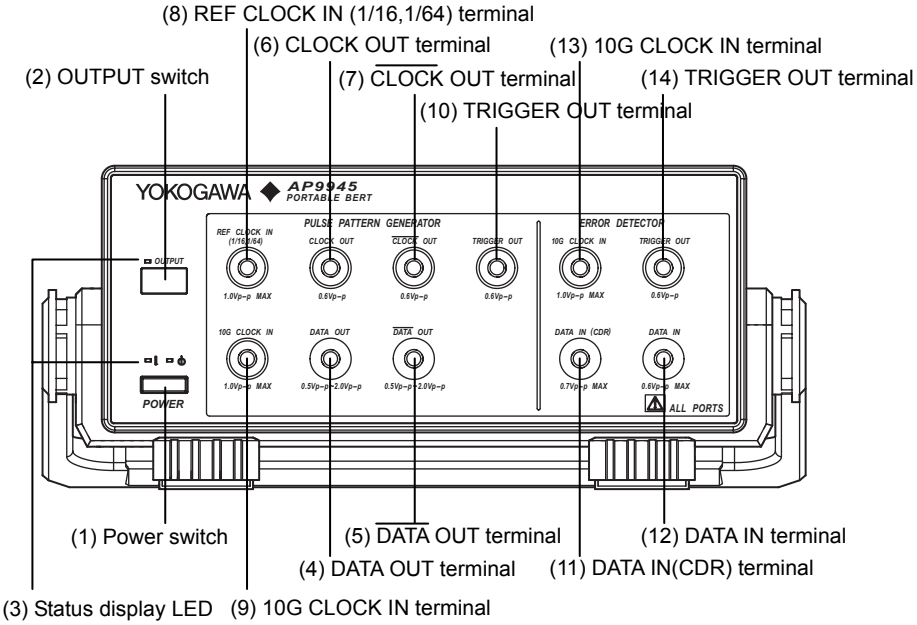
*1 Pulse pattern generator
*2 Error detector

### Main Features and Functions

- The AP9945 contains a PPG and ED in a single unit, allowing 10 Gbit/s band bit error testing.
- It supports multi bit rate patterns (built in SG type).
  Bit rate: 9.95 to 11.32 Gbit/s 1 kbit/s steps
- For the PPG output, the amplitude, offset, and cross point can be changed.
  - Data output amplitude: 0.50 to 2.00 Vp-p
  - Data offset: -2.00 to 3.00 V
  - Data cross point: 30 to 70 %
- CDR is built-into the ED. The bit error test can be performed without wiring of the clock signal.
- The receive threshold level of the data signal input to the ED can be changed.
- The AP9945 can generate low bit rate patterns (PPG):
  1/2 (5 Gbit/s band), 1/4 (2.5 Gbit/s band), and 1/8 (1.25 Gbit/s band)
- The unit is lightweight, compact, and highly portable.

# 1.2 Front Panel, Rear Panel, Top Panel

### Front Panel




(1) Power switch (POWER) -> section 3.4

When the rear panel main power switch is ON (in power standby mode), this switch can be used to turn the power ON and OFF.

(2) OUTPUT switch -> section 3.4

Switch for turning the PPG output ON and OFF.

(3) Status display LED -> section 3.4

| Name | Indication | Illumination/Blinking |
|---|---|---|
| POWER | \| | Illuminated when the power is ON.<br>When the power switch and main power switch are turned ON. |
| STANDBY | ⏻ | Illuminates when in power standby mode.<br>When main power switch ON and power switch OFF. |
| OUTPUT | OUTPUT | Illuminates when PPG output is ON.<br>When the OUTPUT switch is turned ON. |

(4) DATA OUT terminal

A non-inverted data output terminal. Non-inverted data of 10 Gbit/s is output when the output is turned ON.

(5) $\overline{\text{DATA}}$ OUT terminal

An inverted data output terminal. Inverted data of 10 Gbit/s is output when the output is turned ON.

(6) CLOCK OUT terminal

A 10 GHz non-inverted clock signal output terminal. A non-inverted 10 GHz-band clock signal is output when the output is turned ON.

(7) $\overline{\text{CLOCK}}$ OUT terminal

A 10 GHz inverted clock signal output terminal. An inverted 10 GHz-band clock signal is output when the output is turned ON.

(8) REF CLOCK IN (1/16, 1/64) terminal

An external synchronization signal input terminal. A reference signal with a frequency 1/16 or 1/64 of the 10 Gbit/s rate is input when the PPG signal is generated and synchronized with an external clock signal, without use of the instrument's oscillator or SG. This clock is used not only for the PPG, but also for the reference clock signal to operate the CDR function of the ED.

(9) 10G CLOCK IN terminal

An external clock signal input terminal. A 10 Gbit/s rate clock is input when the unit is operated using an external 10 Gbit/s rate clock signal without use of the instrument's oscillator or SG. This clock is used not only for the PPG, but also for the reference clock signal to operate the CDR function of the ED.

(10) TRIGGER OUT terminal

An output terminal for the PPG trigger signal. A trigger signal selected from the following is output.

- Clock trigger (1/16 or 1/64)
  Outputs a clock signal that is 1/16 or 1/64 of the PPG clock rate.
- Pattern trigger
  Outputs a trigger signal synchronized to the pattern of the PPG.
- Low bit trigger
  Outputs a clock frequency signal interlocked with a low bit rate pattern.

(11) DATA IN (CDR) terminal

An ED data input terminal with a CDR function. Used when measuring with the CDR function. Since the clock is regenerated from the received data, the clock input is not needed.

(12) DATA IN terminal

An ED data input terminal. Used for measuring with the clock signal (10G CLOCK IN) synchronized to the data.

(13) 10G CLOCK IN terminal

An ED clock signal input terminal. When using the DATA IN terminal, input a clock signal synchronized to the data. Adjust the phase with an external phase shifter or other device so that the relationship between the data and clock phase is such that the data conversion point matches up with the falling of the clock.

(14) TRIGGER OUT terminal

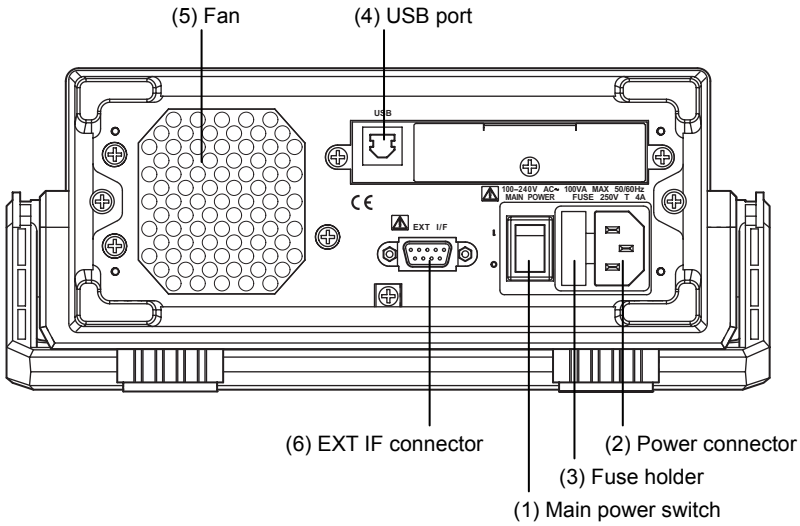
Trigger signal output terminal of the ED. A trigger signal selected from the following is output.

- Clock trigger (1/16 or 1/64)
  Outputs a clock signal that is 1/16 or 1/64 of the input data rate of the ED.
- Pattern trigger
  Outputs a trigger signal synchronized to the input pattern of the ED.

***Note***

For input/output terminal connections for (4) to (14), see section 3.8.

## Rear Panel




(1) Main power switch -> section 3.4
Turns the power ON and OFF. When OFF, all power supplies are OFF including the standby power.

(2) Power connector -> section 3.3
Connects the power supply. Connector with a protective grounding terminal. Connect the accessory power cord.

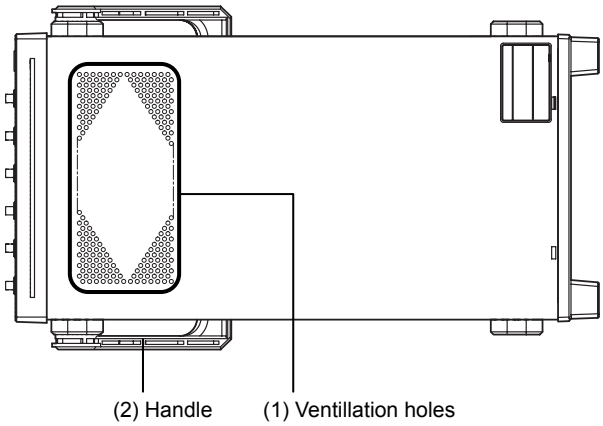
(3) Fuse holder -> section 5.4
Fuse holder for the power fuse.

(4) USB Port -> section 3.6
Connects to a controller PC using the accessory USB cable

(5) Fan
An exhaust fan.

(6) EXT IF connector
A connector for testing. Do not use it for connecting external instruments. Doing so can lead to malfunction.

## Top Panel




(1) Air inlet
Ventilation holes. Air inlets are also located on the underside of the instrument.

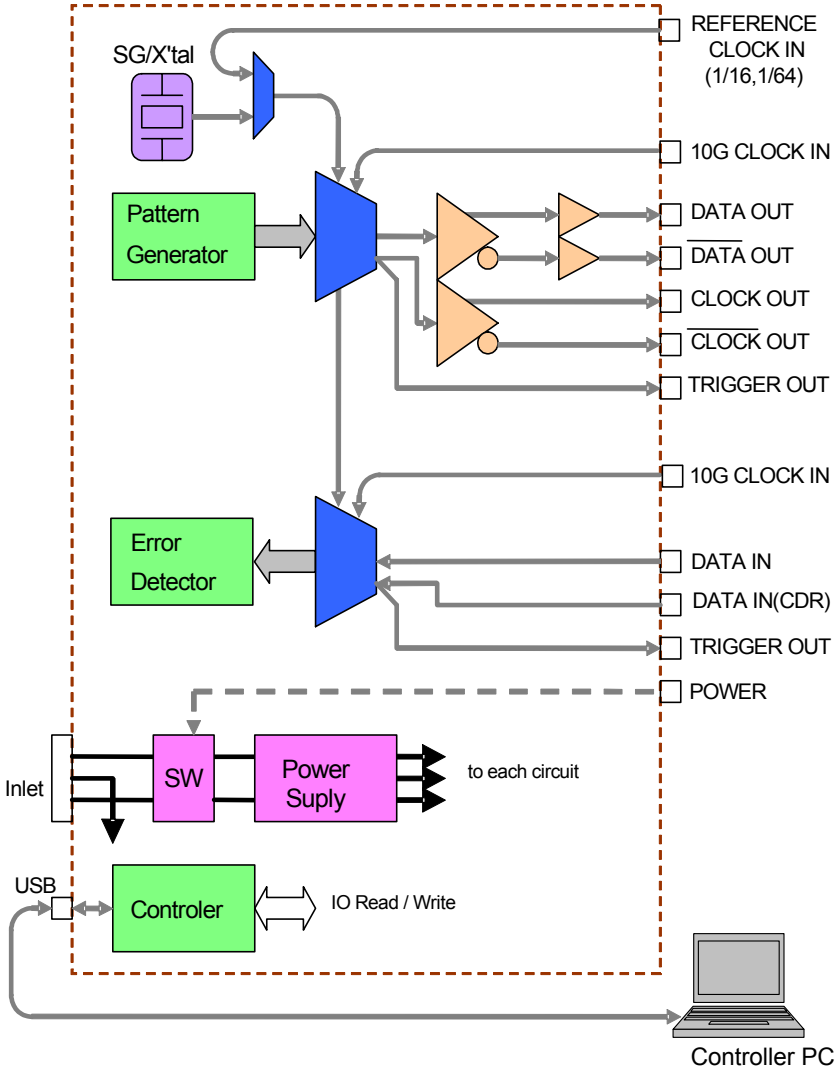
(2) Handle -> sections 3.1, 3.2
Use when carrying or placing the instrument.

# 2.1 Function Block



## Block Diagram

The following is a block diagram of the AP9945.




## Block Explanation

- SG (Signal Generator)/X'tal: Clock Generator
  In this circuit block, a highly accurate clock is generated based on the internal quartz oscillator. With the crystal type, the clock generator outputs the oscillator clock. With the SG type, you can change the frequency according to the bit rate setting.

- PPG (Pulse Pattern Generator)
  In this circuit block, PRBS* and program patterns are generated. Additionally, the offset can be changed in the AMP of the CLOCK OUT. The amplitude, offset, and cross point can be changed in the AMP of the DATA OUT.

- ED (Error Detector)
  In this circuit block, the bit error is detected from the PRBS pattern* and program pattern, and then counted. The bit error count results are sent to the controller PC via the USB cable in real-time.
  * Pseudo random bit sequence pattern

# 2.2 Data Logic Inverting Function

= For details about operation, see section 4.2 =

### Data Logic Inverting Function

This instrument is equipped with a data logic inverting function that inverts the logic of the data output signal of the PPG and the data input signal of the ED.

| | | |
|---|---|---|
| Polarity | Normal: | Positive logic |
| | Invert: | Negative logic |

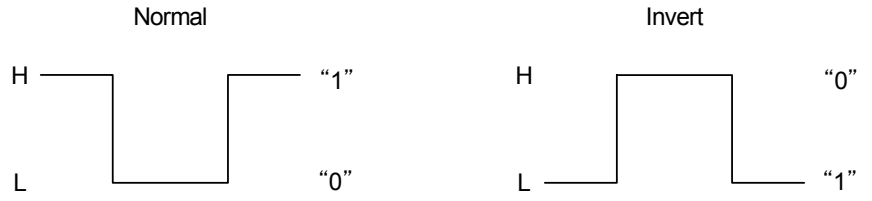
***Note***

The Normal/Invert logic is inverted at the data invert output terminal.

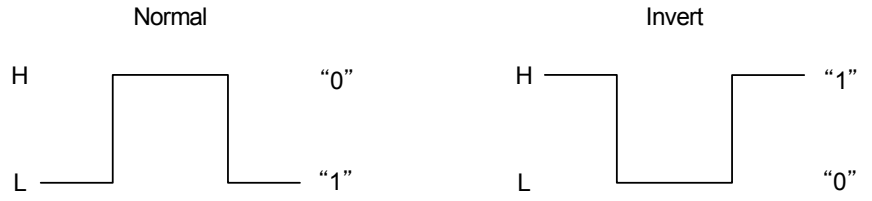
### Data Logic

Data logic is as follows.

- DATA OUT terminal




- $\overline{\text{DATA}}$ OUT terminal



# 2.3 Output Change Function

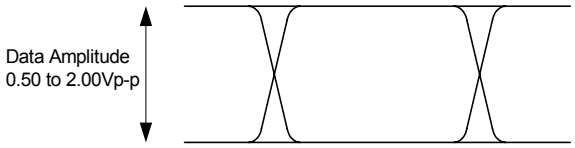
= For details about operation, see section 4.5 =

With this instrument, the outputs of the Data Amplitude, Data Offset, Data Cross Point, Bit Rate, and Clock Offset can be changed. The output change function allows testing corresponding to the interface conditions for the DUT. Additionally, the performance evaluation and other tests of the DUT can be performed by changing the output level.

### Data Amplitude

The amplitude of the data (DATA OUT/$\overline{\text{DATA}}$ OUT terminal) can be changed.

- Data Amplitude : 0.50 to 2.00 [Vp-p], in steps of 0.01 [Vp-p]




### Data Offset/Clock Offset

The DC offset voltage of the data (DATA OUT/$\overline{\text{DATA}}$ OUT terminal)/clock (CLOCK OUT/$\overline{\text{CLOCK}}$ OUT terminal) can be changed. For the DC offset voltage, the average value of the output level becomes the reference level.

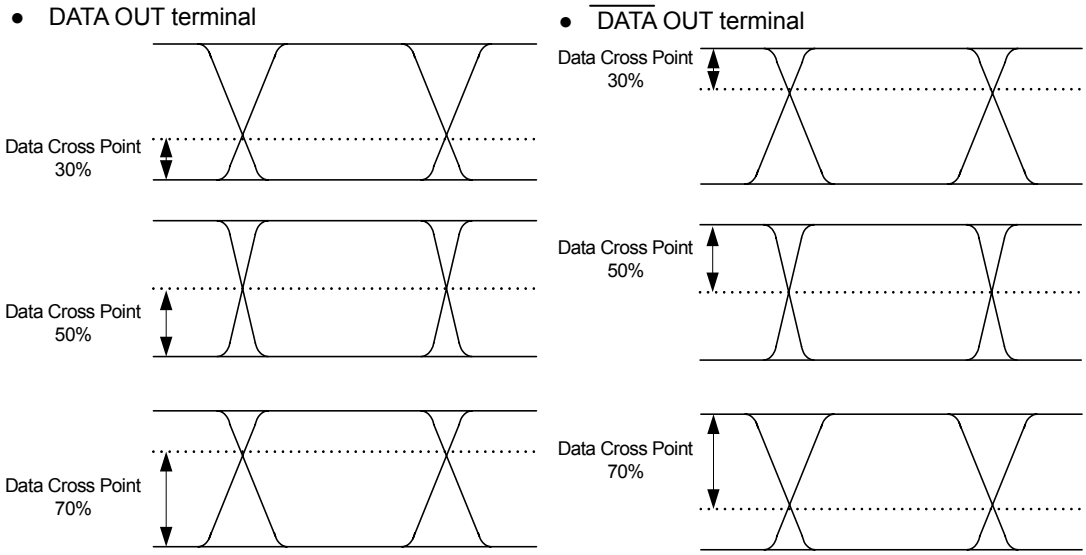
- Data Offset/Clock Offset : -2.00 to 2.00 [V], in steps of 0.01 [V]


The amplitude in case of Clock Offset is fixed at approximately 0.6 [Vp-p].

### Data Cross Point

The cross point of the H/L level of the data can be changed.

- Data Cross Point: 30 to 70 [%], in steps of 1 [%]



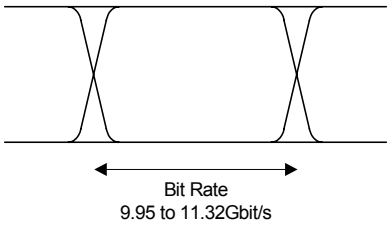

A cross point signal in which the Data Cross Point setting value is subtracted from 100% is output to the $\overline{\text{DATA}}$ OUT terminal.

The cross point shows the value at the end of the recommended coaxial cable Sucoflex104 (L=0.7m).

### Bit Rate

With the built in SG type, the bit rate of the internal SG can be changed.

- Bit Rate : 9.950000 to 11.320000 [Gbit/s], in steps of 0.000001 [Gbit/s]



# 2.4 Threshold Level Change Function

= For details about operation, see section 4.3 =



This instrument allows you to adjust the threshold of DATA IN (CDR) or DATA IN to an optimal level. As you adjust the threshold while measuring the bit error, you can find the points both in the positive and negative directions at which an error occurs. The threshold can be set to an optimal level by setting the threshold value at the center of the range where no error occurs.

(1) Adjustment when the received signal level is low

When the received signal level is low, an error may occur. Even so, you may remove the error by adjusting the threshold level.

(2) Adjustment when the upper and lower waveforms are not symmetrical.

When the mark ratio is not 50%, the center of the amplitude may not be an optimal threshold. Even though the upper and lower waveforms are not symmetrical, you may remove the error by adjusting the threshold level.

# 2.5 CDR Function

= For details about operation, see section 4.3 =

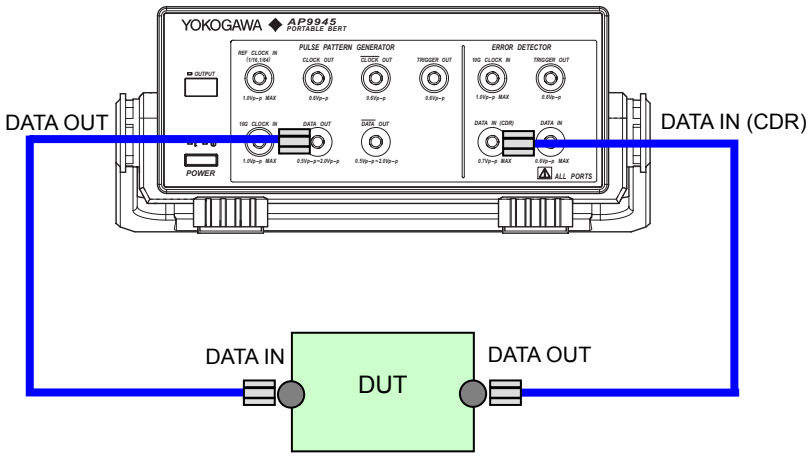
### CDR Function

Clock & Data Recovery
This CDR function recovers the clock from the received data signal and adjusts the timing of the data.

Since the CDR function is built in, the instrument can perform the BER measurement without connection of the clock.

### Example of Connection with the DUT

The following shows an example of connection between the instrument and the DUT using the CDR function.



# 2.6 Trigger Output Function

= For details about operation, see section 4.3 =



### Types of Triggers

The instrument provides a trigger output function. You can select one of each trigger signal for the PPG and the ED.

(1) Clock trigger: PPG1/16, PPG1/64, ED1/16, ED1/64

Outputs a clock signal that is 1/16 or 1/64 of the PPG send clock rate or the ED receive clock rate.

(2) Pattern trigger: PPG Pattern, ED Pattern

Outputs a trigger signal that is synchronized with the send pattern of the PPG or the receive pattern of the ED.

- PRBS pattern:
  Outputs 128 bits of a positive pulse signal at intervals 128 times the PRBS pattern.
- Program pattern:
  Repeatedly outputs a positive pulse signal and negative pulse signal 1024 bits in width.

(3) Low bit rate trigger: 1/1 (PPG only)

When the Divide Ratio is 1/2, 1/4, or 1/8, a clock signal synchronized to 1/2, 1/4, or 1/8 of the specified rate is output.

### Applications of Triggers

(1) Clock and pattern triggers used for waveform observation.

The trigger can be used as the trigger signal when observing a 10 Gbit/s waveform with a super-high frequency sampling oscilloscope.

(2) Clock trigger used as the frequency dividing clock signal for measurement of optical transceivers.

For optical transceivers or other devices, when a frequency 1/16 or 1/64 of 10 Gbit/s is input as the reference clock, the 10Gbit/s-clock signal is generated. When measuring the optical transceiver, such frequency dividing clock signals may be required.

(3) Clock trigger used as a reference clock to synchronize multiple module units.

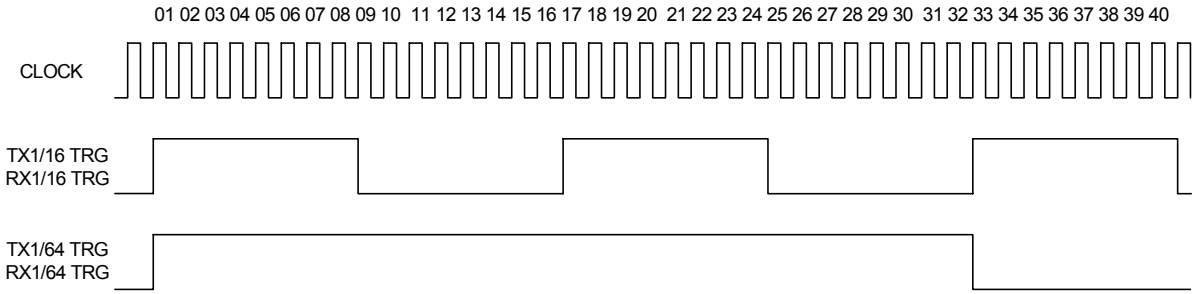
The trigger is used as a clock signal for synchronization of multiple units.

(4) Low bit rate trigger used as a trigger signal for observation of low bit rate patterns.

Can be used as a trigger signal for waveform observation of low bit rate patterns (1/2, 1/4, 1/8).

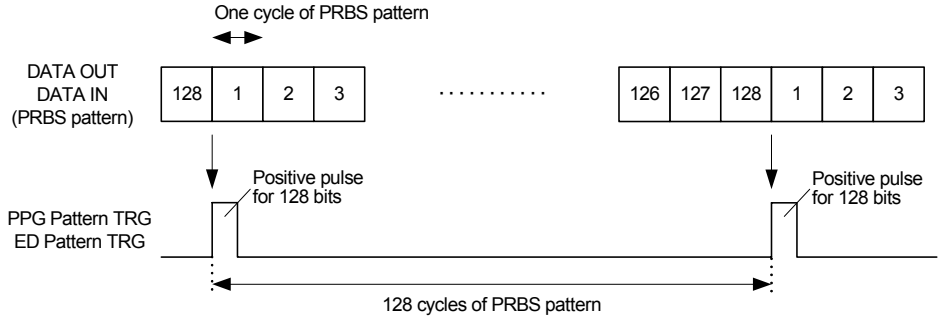
## Trigger Waveforms

(1) Clock trigger

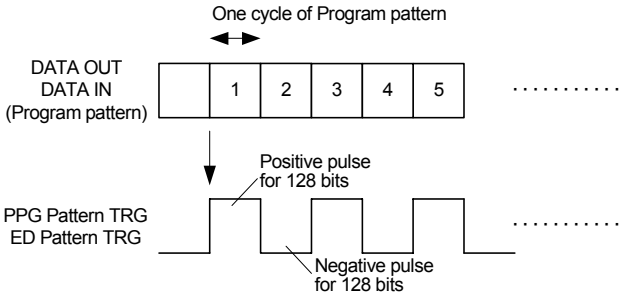



(2) Pattern trigger

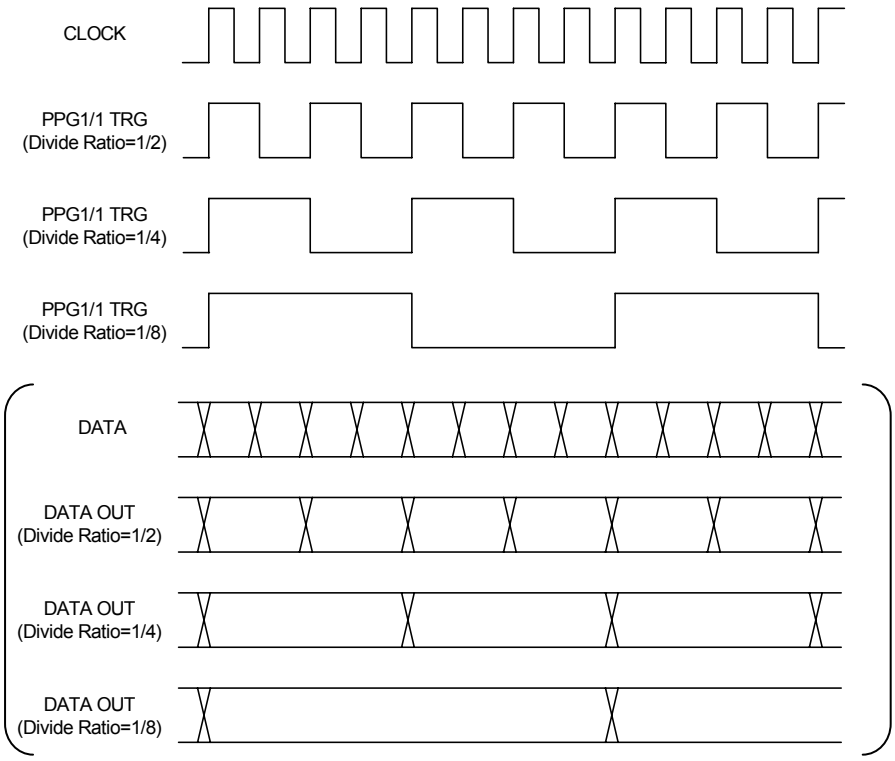
- PRBS pattern




- Program pattern



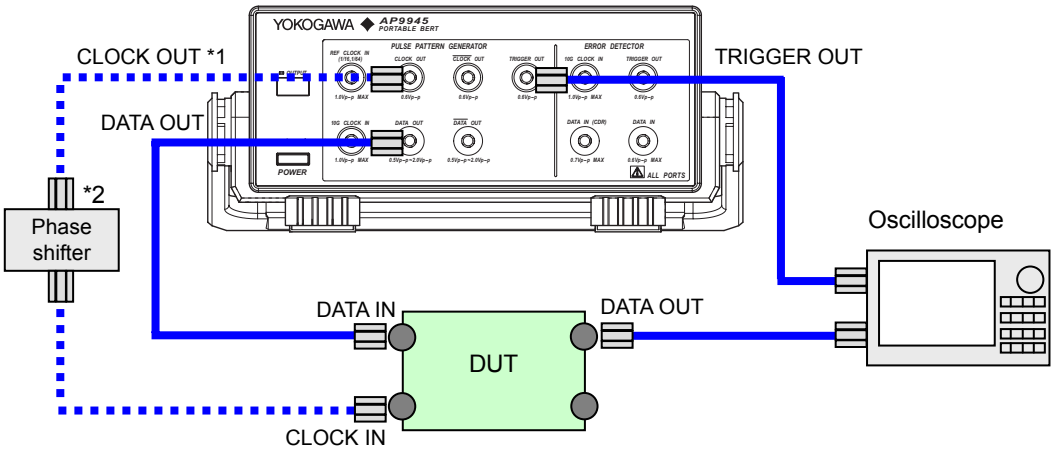
(3) Low bit rate trigger




*: Data synchronized to a low bit rate trigger is output on the DATA OUT terminal.

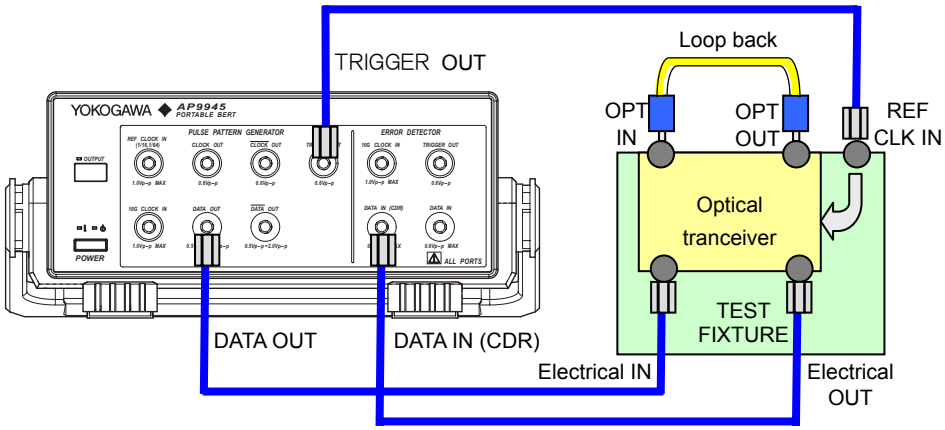
## Connection Examples

(1) Used as trigger signal for observation of waveforms.

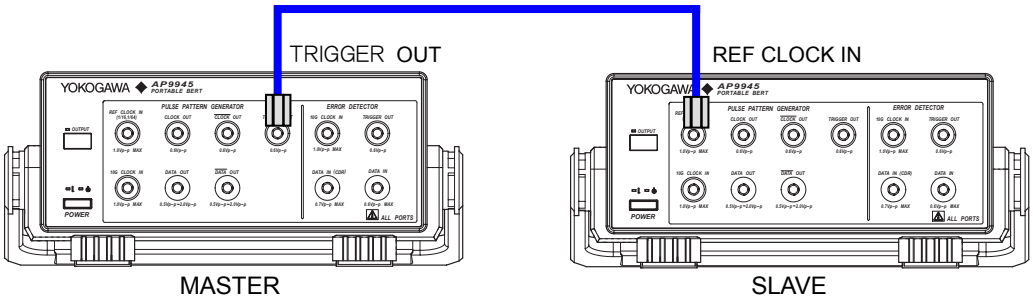



*1: If the DUT needs a CLOCK, connect it to the CLOCK OUT terminal.
*2: With the phase shifter, the phase is adjusted to a level suitable for the input of the DUT.

(2) Used as a reference clock for an optical transceiver.




(3) Used as reference clock to synchronize multiple units.



# 3.1 Handling Precautions

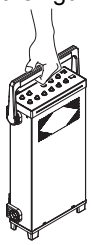


## Safety Precautions

- **Safety Precautions**
  If you are using this instrument for the first time, make sure to thoroughly read the safety precautions given on pages vi and vii.
- **Do Not Remove Covers**
  Do not remove the case. The instrument's internal components carry high voltages and are extremely dangerous. For internal inspection or adjustment, contact your nearest YOKOGAWA dealer.
- **In Case of Abnormality**
  If there are any symptoms of trouble such as strange smells or smoke coming from the instrument, turn the main power OFF immediately, and remove the power cord from the outlet. If such an irregularity occurs, contact your YOKOGAWA dealer.
- **Handle the Power Cord Correctly**
  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 any of the contents listed on page v are incorrect, missing, or appear to be abnormal, please contact your YOKOGAWA dealer or representative.

## General Handling Precautions

- **Do Not Place Anything on Top of the Instrument**
  Never place other instruments or objects containing water on top of the instrument. Doing so can lead to malfunction.
- **Do Not Apply Shock or Vibration**
  Do not apply shock or vibration to the instrument. Doing so can lead to malfunction. Also, if shock is applied to the signal input/output terminals or connection cables, signals modified by electrical noise may be input or output.
- **Do Not Bring Charged Objects Near the Instrument**
  Do not bring charged objects near the input terminals. Doing so can damage the internal circuitry.
- **Unplug During Periods of Extended Non-Use**
  Disconnect the power to the instrument, and remove the power cord from the outlet.
- **Take Proper Care When Carrying the Instrument**
  First, disconnect the power to the instrument, then remove the power cord and connection cables. When carrying the instrument, always hold by the handle with two hands as shown in the figure below.



- **Clean the Instrument Properly**
  When removing dirt from the case or unit, disconnect the power to the instrument, remove the power cord from the power outlet, then wipe gently with a clean, dry cloth. Do not use volatile chemicals since this might cause discoloring and deformation.

# 3.2 Installing the Instrument

### Install the Instrument under the Proper Conditions

Install the instrument only in indoor locations that meet the following conditions.

- **Flat, Horizontal Surface**
  Place the instrument in the correct orientation, and in a stable location that is horizontal in all directions.
- **Well Ventilated Locations**
  Ventilation holes are present on the top and bottom of the instrument, and an exhaust fan is located on the back of the instrument. To prevent internal overheating, do not obstruct the vent holes or the exhaust fan.
- **Ambient Temperature and Humidity**
  Ambient temperature: 5 to 40°C
  Ambient humidity: 20 to 80%RH
  Note that no condensation can be present.
- **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 place.

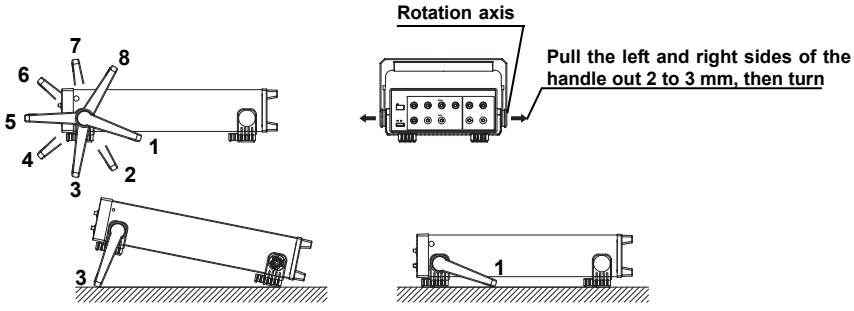
***Note***

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 temperature for at least an hour, and ensure that no condensation is present before using the instrument.

### Orientation

- **Desktop**
  Install the instrument in a flat, horizontal location as shown in the figure below. When installing the instrument with the handle turned upward, make sure that the handle is securely fastened. Pull the handle out approximately 2 to 3 mm to the left and right of the handle rotation axis, then slowly rotate the handle to the stop position.

  **Handle Stop Position**
  It is recommended to use the instrument with the handle in the 1, 3, 5, or 8 stop position. When using the instrument in the 2 or 4 stop position, do not place any objects on top of the instrument.




***Note***

When the instrument's handle stop position is 1, two units can be stacked together. When installing two stacked units, make sure that vibrations or shocks will not knock the instrument over or out of alignment.

# 3.3 Connecting the Power Supply



### Before Connecting the Power

Heed the following warnings to avoid electric shock or damage to instruments.

**WARNING**

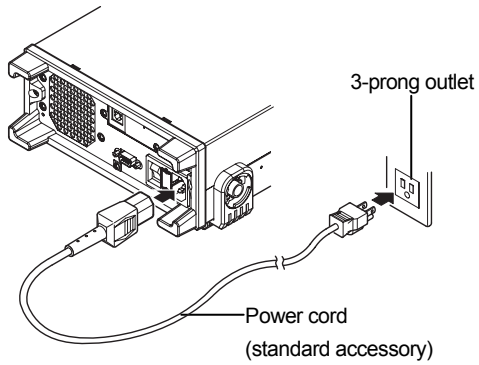
- Check that the supply voltage matches the instrument's rated power supply voltage before connecting the power cord.
- Check that the instrument's main power switch is OFF before connecting the power cord.
- To prevent shock or fires, only use the power cord supplied by YOKOGAWA.
- Make sure to perform protective earth grounding to prevent electric shock. Connect the instrument's power cord into a three-prong electrical outlet with a protective grounding terminal.
- Do not use an extension cord without protective earth ground. Otherwise, the protection function will be compromised.
- Use an outlet that is compatible with the accessory power cord, and be sure to connect protective grounding. Do not use the instrument if the power outlet does not provide appropriate protective grounding.

### Connecting the Power Cord

1. Check that the main power switch on the rear panel is OFF.
2. Connect the accessory power cord plug to the power connector on the rear panel.
3. Connect the plug at other end of the cord to a power outlet that satisfies the conditions below. The AC outlet must be of a three-prong type with a protective earth ground terminal.

| Item | Specifications |
|---|---|
| Rated supply voltage | 100 to 240 VAC |
| Allowed supply voltage fluctuation range | 90 to 264 VAC |
| Rated supply voltage frequency | 50/60 Hz |
| Power supply frequency variation range | 48 to 63 Hz |
| Maximum power consumption | 100 VA |

*: The instrument can use a 100-V or a 200-V power supply. Check that the voltage supplied to the instrument is less than or equal to the maximum rated voltage of the provided power cord (see page iv) before using it.



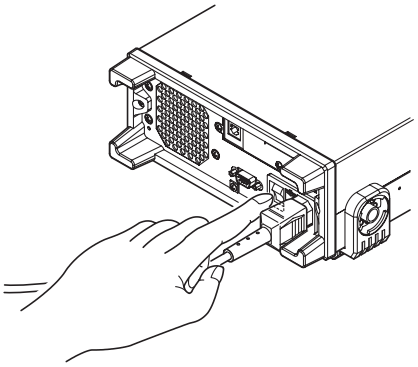
# 3.4 Turning the Power ON and OFF

### Check the Following before Turning ON the Main Power Switch

- Whether the instrument is installed correctly -> 3.2 Installation
- Whether the power cord is connected correctly -> 3.3 Connecting the Power Supply

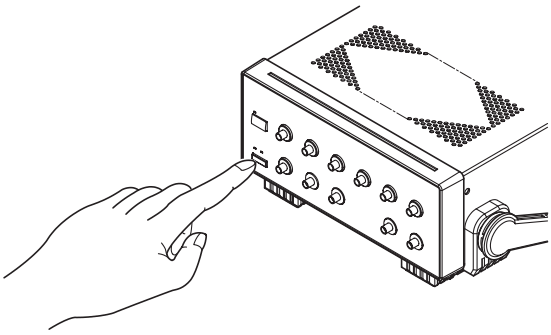
### Turning ON the Main Power Switch

1. Turn the main power switch on the rear panel to the ON (I) position.
   The instrument enters standby mode. The STANDBY LED on the lower left of the front panel illuminates.



### Turning ON the Front Panel Power Switch

2. Press the power switch on the front panel.
   The power is turned ON, the STANDBY LED in the lower left of the front panel turns OFF, and the POWER LED illuminates.



***Note***

If the POWER LED does not illuminate even if the power switch is turned ON, turn OFF the power switch and main power switch, then check the following.

- Whether the power cord is plugged in properly.
- Whether the power supply outlet is of the correct voltage.
- Whether the power fuse is blown.

If there is no change after turning on the main power switch and power switch, please contact your nearest YOKOGAWA dealer for repairs.

### Turning OFF the Front Panel Power Switch

1. Turn OFF the OUTPUT switch. The OUTPUT LED turns OFF.
2. Press the power switch on the front panel.
   The instrument enters STANDBY mode. (The STANDBY LED illuminates, and the POWER LED turns OFF.)

**CAUTION**

When OUTPUT is ON, do not turn OFF the power switch. Doing so can lead to malfunction.

### Turning OFF the Main Power Switch

3. Turn the main power switch on the rear panel to the OFF (0) position.
   The STANDBY LED on the lower left of the front panel turns OFF.

**CAUTION**

When the power switch on the front panel is turned ON, do not turn the main power switch on the rear panel OFF. Doing so can lead to malfunction.

***Note***

When not using the instrument, turn OFF the main power switch.

# 3.5 Setting Up the Application

## System Requirements

- PC: A PC/AT compatible personal computer
- OS: Windows 2000 or Windows XP
- CPU: Pentium III, 500 MHz or faster
- Memory: 256 MB or more
- Hard disc: 10 MB or more of free space
- Disc drive: CD-ROM Drive
- USB Port: 1 (USB 1.1, USB 2.0)

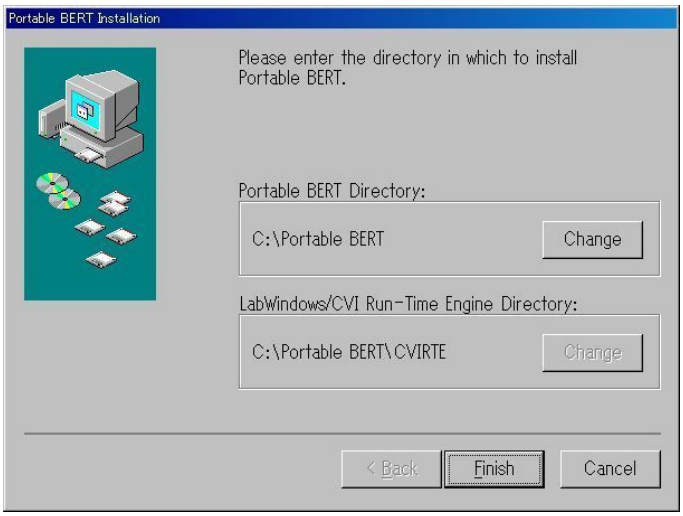
***Note***

Set the PC power setting mode to Presentation or Always On.

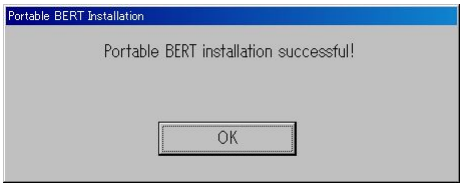
1. Choose **Start** > **Control panel** > **Power options** to open the power options properties dialog box.
2. Click the **Power settings** tab, select **Presentation** or **Always On** from the power settings menu, then click the **OK** button.

## Installing the Software

1. Log in with administrator privileges (under user name Administrator), then start Windows.
2. Insert the AP9945 Portable BERT Software CD into the CD-ROM drive.
3. Choose **My Computer** > **CD-ROM**. The CD-ROM dialog box is displayed. Double-click the **setup.exe** file in the CD-ROM. The Portable BERT Installation dialog box opens.
4. Specify an installation location, then click the **Finish** button to start the installation.




5. The message, “Portable BERT installation Successful!” is displayed. Click the **OK** button.



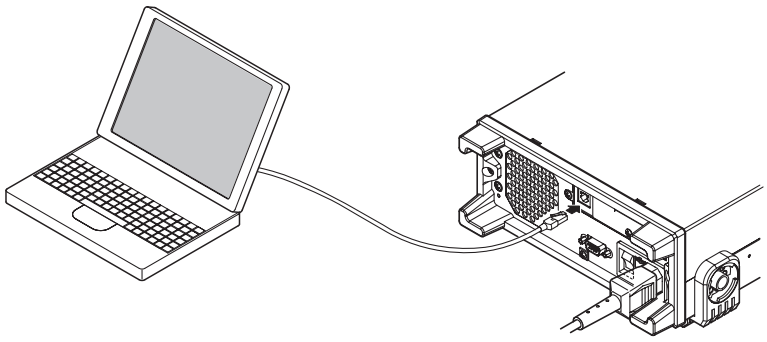

## Uninstalling the Software

1. Log in with administrator privileges (under user name Administrator), then start Windows. Choose **Start** > **Programs** > **Portable BERT** > **Uninstall Portable BERT**. Uninstallation begins.
2. Follow the on-screen instructions.

# 3.6 Connecting to a PC

### Connecting to a PC

Check that the power to the PC and AP9945 are OFF, then connect the AP9945's USB port to the PC's USB port using the accessory USB cable.

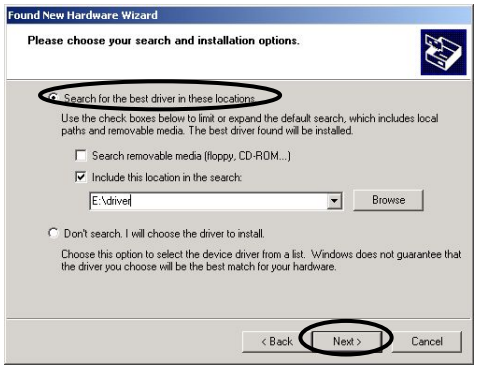


# 3.7 Installing and Uninstalling USB Drivers

## Installing USB Drivers

1. Use the accessory USB cable to connect the PC's USB port to the AP9945's USB port.
2. Turn ON the power to the PC, then log in with administrator privileges (under user name Administrator).
3. Insert the AP9945 Portable BERT Software CD into the CD-ROM drive.
4. Turn ON the power switches to the AP9945 (on the rear and front panels). The Found New Hardware Wizard (USB <-> Serial) is displayed on the PC.

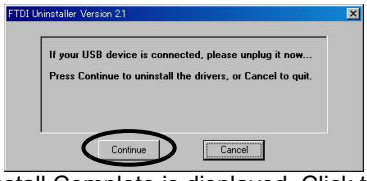

5. Choose **Install from a list or specific location (Advanced)**, then click the **Next** button.




6. Choose **Search for the best driver in these locations**, then click the **Next** button. Installation begins, then Found New Hardware Wizard Complete is displayed.
7. Click the **Finish** button. The Found New Hardware Wizard (USB Serial Port) is displayed.
8. Perform steps 5 and 6 in the same manner, then click the **Finish** button.

## Uninstalling USB Drivers

1. Remove the USB cable from the PC's USB port and the AP9945's USB port.
2. Turn ON the power to the PC, then log in with administrator privileges (under user name, Administrator).
3. Insert the AP9945 Portable BERT Software CD into the CD-ROM drive.
4. Select the following files from the CD-ROM drive folder, then double-click.
   *CD-ROM drive*¥driver¥FTDIUNIN.EXE
   The uninstaller launches.
5. Click the **Continue** button to execute the Uninstallation.




6 Uninstall Complete is displayed. Click the **Finish** button.

# 3.8 Setting Up a COM Port

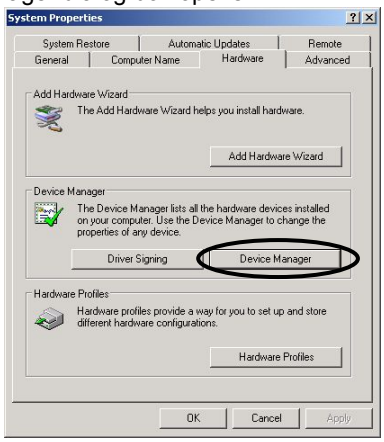
***Note***

- When setting up a COM port, connect the AP9945's USB port to the PC's USB port using the accessory USB cable, then turn ON the power to the PC and AP9945.
- Log in with administrator privileges (under user name Administrator) and install the application (Portable BERT Software) and the USB drivers on the PC.

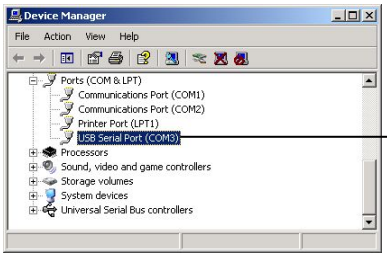


### Setting Up a COM Port

1. Choose **Start** > **Control panel** > **System**. The system properties dialog box opens.
2. Select the **Hardware** tab, then click the **Device Manager** button. The device manager dialog box opens.

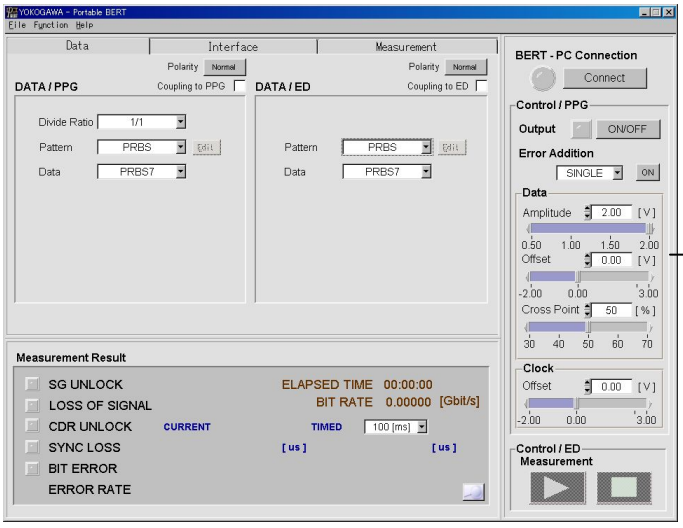



3. Check the port number used by the PC next to USB Serial Port (COMn) under Ports (COM and LPT).



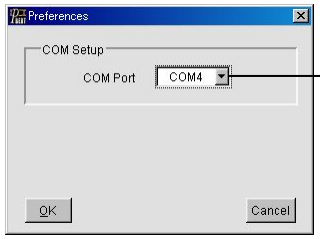

Check the port number used by the PC for USB

4. Choose **Start** > **Programs** > **Portable BERT** > **pbert**. The application launches, and the main screen is displayed.




Main screen

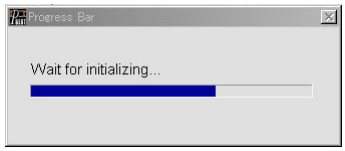
5. Choose **File** > **Preference** from the menu. The Preference dialog box opens.
6. Select the number used by the PC's USB port in the COM Port menu, then click the **OK** button.



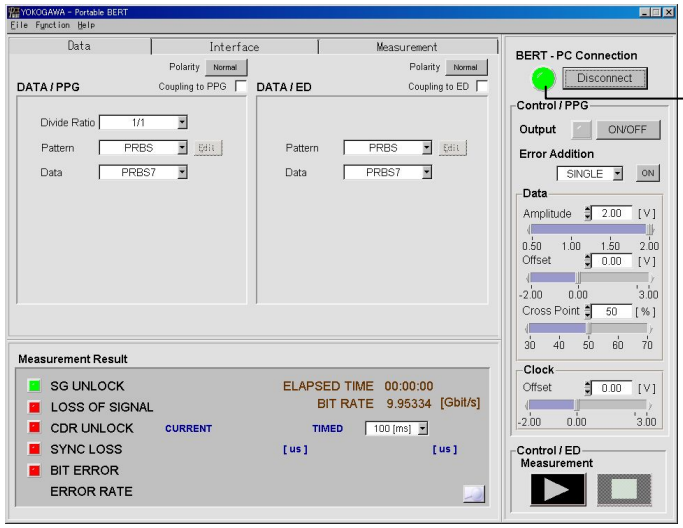

Select the USB port number determined in step 3

## Checking Communications

7. Click the **Connect** button. The Progress Bar popup screen will appear.

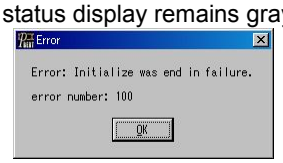



- When the AP9945 and PC are connected
  If a connection is successfully opened between the AP9945 and PC, the BERT-PC Connection status display turns green.




Status indicator: green

- When the AP9945 and PC are not connected
  If a connection failed to be opened between the AP9945 and PC, an error dialog box appears. The BERT-PC Connection status display remains gray.


8. Click the **OK** button. (-> For corrective actions, see section 5.2. )

***Note***

- After installing the application (Portable BERT Software) on the PC, it may take up to two minutes to connect to the AP9945 on the first attempt. From the second attempt, it should only take a few seconds.
- The AP9945 is ready for normal operation when the BERT-PC Connection status display turns green. It cannot be used if the status display is gray.

# 3.9 Connecting the DUT

1. Check whether the AP9945's OUTPUT is turned OFF.
2. Connect the AP9945's I/O terminal to the DUT's I/O terminal with a coaxial cable.



**CAUTION**

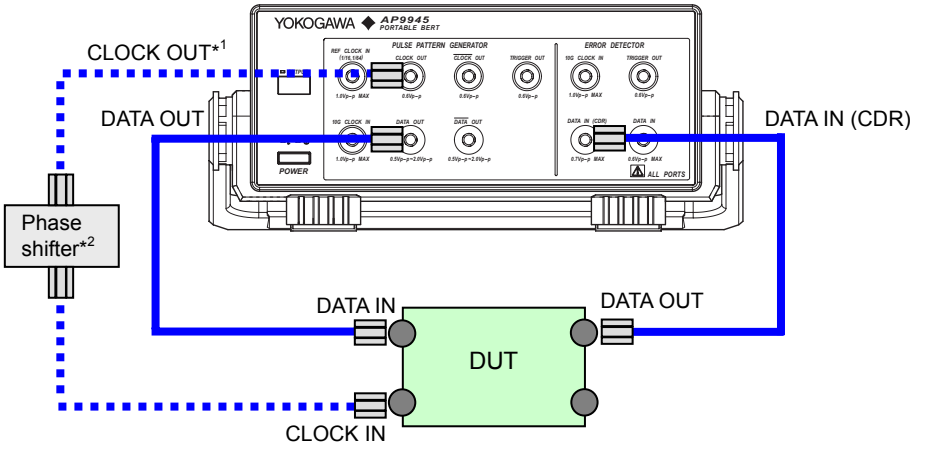
- Do not apply a voltage to the input terminals exceeding the maximum input voltage. Damage to the instrument can result.
- Do not apply an external voltage to the output terminals. Damage to the instrument can result.
- When connecting or disconnecting the cable to/from the input/output terminal, always turn OUTPUT OFF.
- When connecting or disconnecting the cable to/from the input/output terminal, tighten the connector at the specified tightening torque (0.9 N-m) using a torque wrench.
- Do not open output terminals. Terminate them with 50 Ω (terminators supplied with the instrument). Additionally, terminate the end of the cable to be connected to the output terminal with 50 Ω in the same manner as described above.
- When making connections with the input/output terminals, use a grounding wrist strap so that the terminals are not charged by static electricity. If the connection cable is charged by static electricity, this may cause the unit to malfunction. Therefore, only make connections after the cables have been discharged.
- When connecting to the DUT, turn OUTPUT OFF.
- Use the specified connectors for connections to input/output terminals. If the terminal is connected to a connector other than one specified, this may cause the input/output terminal or the connector to break. Additionally, when connecting the input/output terminal to the connector, always connect it straight so that the input/output terminal and the connector do not slant. If they are connected in a slanted manner, this may cause the core wire of the input/output terminal or the connector to break.

***Note***

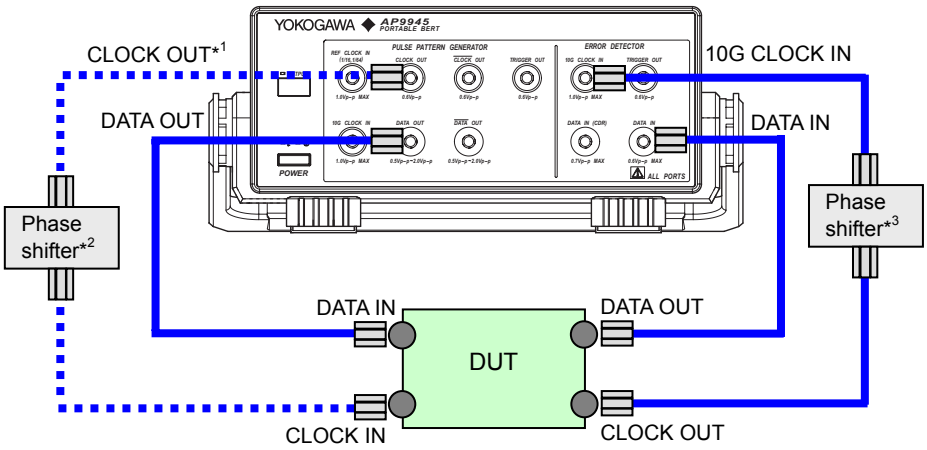
- **When using DATA IN (CDR) and REF CLOCK IN**
  When the input signal of DATA IN (CDR) of the ED is not synchronized with the PPG, enter settings so that a frequency 16 or 64 times larger than the reference signal to be input to REF CLOCK IN is within ±100 ppm of the input data rate.
- **When using DATA IN (CDR) and 10G CLOCK IN**
  When the input signal of DATA IN (CDR) of the ED is not synchronized with the PPG, enter settings so that a frequency 16 or 64 times larger than the clock signal to be input to 10G CLOCK IN is within ±100 ppm of the input data rate.

## Connecting the DUT

- Use CDR




- Do not use CDR

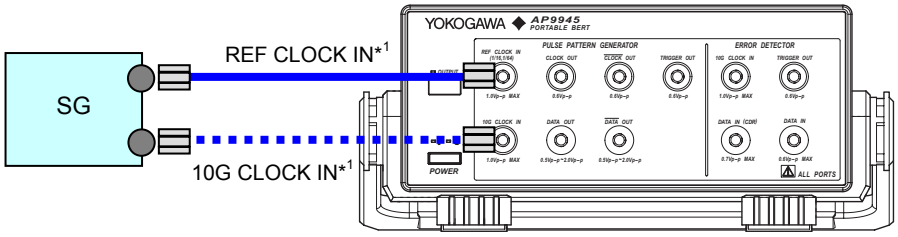



*1: If the DUT needs a CLOCK, connect it to the CLOCK OUT terminal.

*2: With the phase shifter, the phase is adjusted to a level suitable for the DUT's input.

*3: The 10G CLOCK IN (1/16, 1/64) terminal of the ED does not have a phase adjustment function. Adjust the phase to a level suitable for phase of the ED using a phase shifter.

## Connecting the External SG




*1: When using the REF CLOCK (1/16 or 1/64 of the bit rate) of the external SG, connect it to the REF CLOCK IN (1/16, 1/64) terminal of the AP9945. When using the EXT CLOCK of the external SG, connect it to the 10G CLOCK IN terminal of the AP9945's PPG.

***Note***

When using the REF CLOCK (1/16 or 1/64 of the bit rate), the signal of the external SG must be a square waveform.

## Connecting the Trigger Terminal

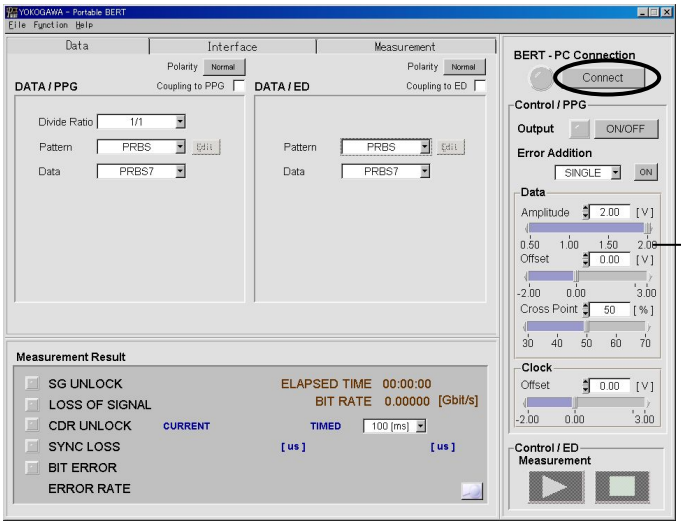
See section 2.6.

# 4.1 Starting/Exiting the Application

Procedure

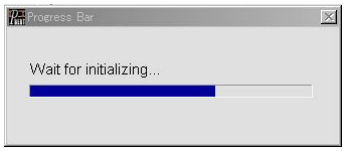
### Starting the Application and Connecting to the AP9945

1. On the PC, choose **Start** > **Programs** > **Portable BERT** > **pbert**. The application launches, and the main screen is displayed.



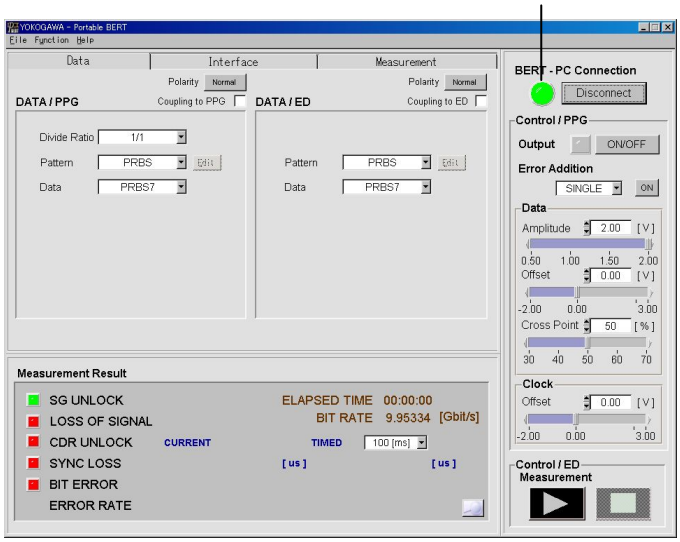

Main screen

2. Click the **Connect** button. The Progress Bar popup screen will appear.




If a connection is successfully opened between the AP9945 and PC, the BERT-PC Connection status display turns green, and the button display changes to Disconnect. The button toggles between Connect and Disconnect.

Green



### Disconnecting from the AP9945 and Exiting the Application

1. Click the **Disconnect** button. The BERT-PC Connection status display turns gray, and the button display changes to Connect.
2. Choose **File** > **Quit** from the menu. The application closes.

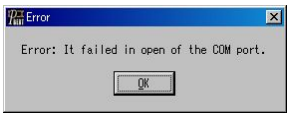
Explanation

### Starting the Application and Connecting to the AP9945

- Starting using the desktop icon
  You can also start the application by double-clicking the pbert icon on the desktop.


- You can also connect to the AP9945 by choosing **Function > Connect** from the menu.

- When the AP9945 and PC are not connected
  If a connection failed to be opened between the AP9945 and PC, an error dialog box appears. The BERT-PC Connection status display remains gray.





For the procedure, see section 5.2.

### Disconnecting from the AP9945 and Exiting the Application

- You can also disconnect from the AP9945 by choosing **Function > Disconnect** from the menu.

- Auto-saving settings
  You can have the application automatically save current settings to hard disk when closing the application, and automatically restore the settings upon the next session. Note that Output is forcibly turned OFF.

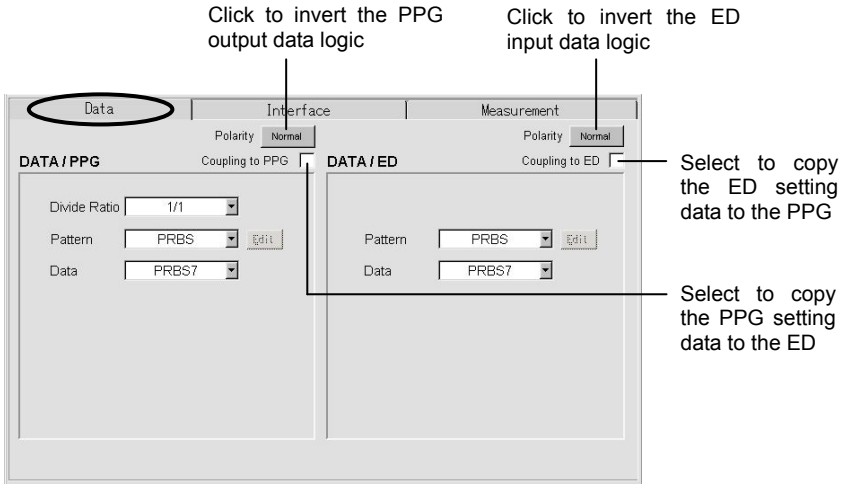
# 4.2 Setting Data Items

= For details about the function, see section 2.2 =

The items in the Data tab let you set PPG and ED send/receive data patterns.

**Procedure**

1. Click the **Data** tab in the main screen. The Data item screen is displayed.




### PPG Item

- Divide Ratio Setting

2. Select the divide ratio (1/1, 1/2, 1/7, or 1/8) from the Divide Ratio list.

### PPG/ED Common Items

- When Using a PRBS
  - Pattern Settings

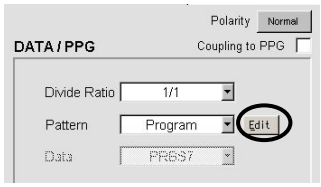
3. Select **PRBS** from the Pattern list. The Data list is enabled.

  - Data Settings

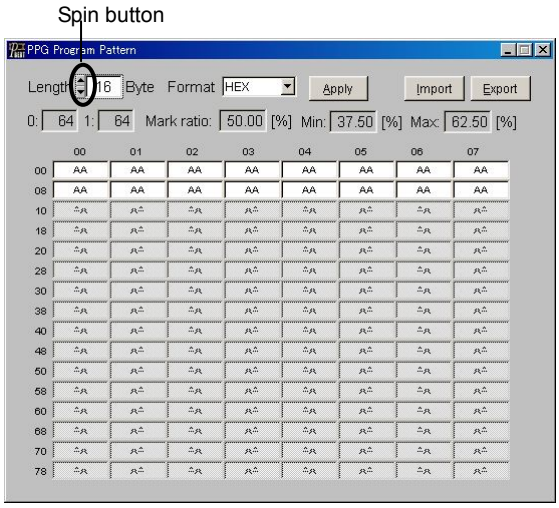
4. Select a PRBS pattern (PRBS7, PRBS15, PRBS23, PRBS31) from the Data list.

- When Using a Program
  - Pattern Settings

3. Select **Program** from the Pattern list. The Edit button is enabled.



4. Click the **Edit** button. The PPG Program Pattern (ED Program Pattern) dialog box opens.

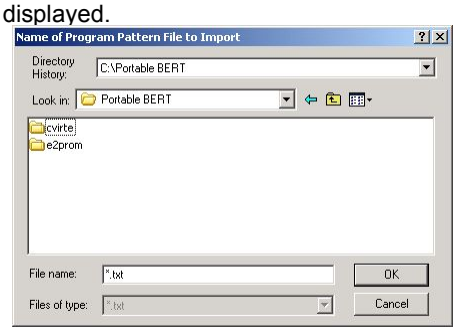



- Program Pattern Settings

5. Set the pattern length by entering a number in the Length box, or by selecting a number in the spin box (2, 4, 8, 16, 32, 64, or 128 Bytes). The pattern input area is ready to accept the specified number of bytes.
6. Select a pattern input format (HEX, BIN) from the Format list.
7. In the pattern input area, input a program pattern of the format specified in step 6.
8. Click the **Apply** button. The settings are applied to the AP9945.

- Loading Program Patterns

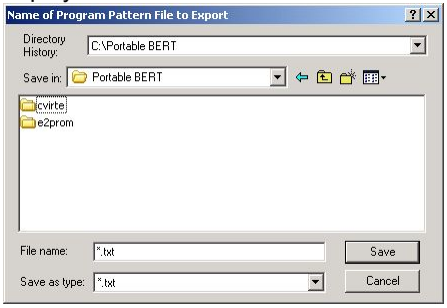
5. Click the **Import** button. The Name of Program Pattern File to Import dialog box is displayed.




6. Select the file to load, then click the **OK** button.

- Saving Program Patterns

5. Click the **Export** button. The Name of Program Pattern File to Export dialog box is displayed.




6. Input a file name, then click the **Save** button.

• Setting the Polarity

Inverting the data logic

9. Click the **Normal** button. The button display changes to Invert, the color changes to yellow, and the data's logic is inverted. The button toggles between Normal and Invert.


Restoring the original data logic

10. Click the **Invert** button. The button display changes to Normal, the color changes to gray, and the data's original logic is restored.

• Setting the Coupling

Copying the setting data of the PPG to the ED

11. Select the **Coupling to PPG** check box. The Coupling to ED check box is selected, and the PPG setting data is copied to the ED.

Copying the setting data of the ED to the PPG

11. Select the **Coupling to ED** check box. The Coupling to PPG check box is selected, and the ED setting data is copied to the PPG.



## Explanation

- Divide Ratio

  You can set the output data rate of $\overline{\text{DATA}}$ OUT and the DATA OUT terminal. You can select a 10 Gbit/s band data rate, or a low bit rate of 5, 2.5, or 1.25 Gbit band. Only valid for the PPG.

  1/1: 10 Gbit/s band data rate
  1/2: 5 Gbit/s band data rate
  1/4: 2.5 Gbit/s band data rate
  1/8: 1.25 Gbit/s band data rate

- Pattern:

  You can set output data terminal (DATA OUT, $\overline{\text{DATA}}$ OUT) patterns with the PPG, and input data terminal (DATA IN, DATA IN (CDR)) patterns with the ED. You can select a PRBS or Program pattern.

  PRBS: PRBS pattern
  Program: Program pattern

- Data

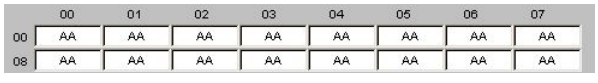
  You can set the number of stages for the PRBS pattern. This is enabled when PRBS is selected for the Pattern.

  PRBS7, PRBS15, PRBS23, PRBS31

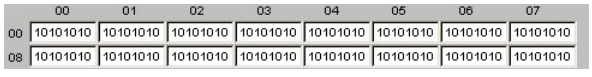
- Format

  You can select BIN or HEX for the input format for the program pattern.

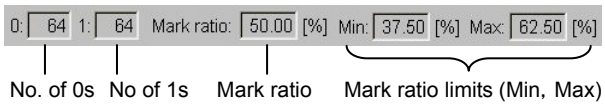
  • HEX




  • BIN



- Program Pattern
  The current program pattern's number of zeros, number of ones, mark ratio, and mark ratio limit values (Min and Max) are displayed as shown below.




  The program patterns that can be set are limited by the mark ratio. Set the program patterns so that the (mark limitation is fixed) current mark ratio is restricted to the range indicated by the mark ratio limit values.

  Click the **Apply** button to copy the program pattern data from the PC to the AP9945.

- Loading Program Patterns
  Text files created in HEX and BIN format are loaded as program pattern files. These files can be edited in a text editor or other program.
  - HEX format:
    Consists of 0x followed by two characters (0 to F), followed by a newline.

```
0x00
0x01
0x02
:
0xFF
```

  - BIN format:
    Consists of eight characters (zeros and ones), followed by a newline.

```
00000000
00000001
00000010
   :
11111111
```

***Note***

Set the pattern length of the loaded pattern file to 2, 4, 8, 16, 32, 64, or 128 Bytes. If the pattern file is of another length, an error will be displayed and the file will not be loaded.

- Saving Program Patterns
  You can save program patterns created on the AP9945 as text files. They are saved to the format specified under Format (HEX or BIN).

- Polarity
  For the PPG, the logic of the output data (DATA OUT, $\overline{\text{DATA}}$ OUT) is inverted.
  For the ED, the logic of the input data (DATA IN, DATA IN (CDR)) is inverted.

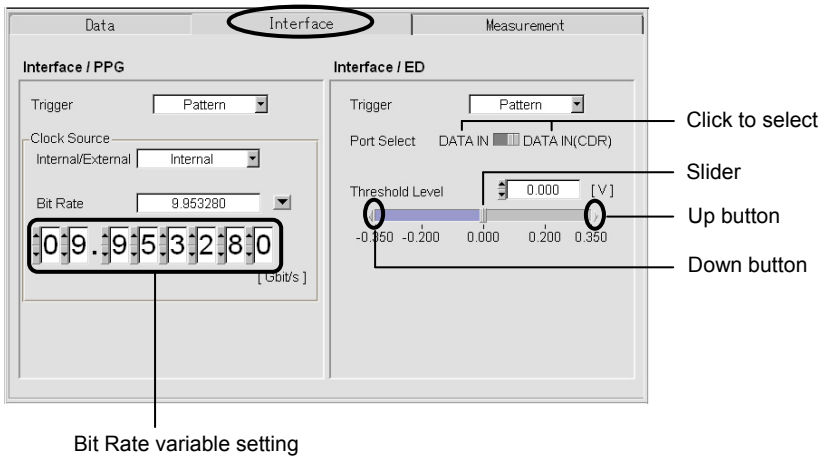
# 4.3 Setting Interface Items

= For details about the function, see sections 2.3, 2.4, 2.5, and 2.6 =

For the interface items, set the Trigger, Clock Source, and Bit Rate of the PPG, and the Trigger, Port Select, and Threshold Level of the ED.

Procedure

1. Click the **Interface** tab in the main screen. The Interface item screen is displayed.




### Interface/PPG

- Trigger Setting
  2. Select a trigger output for the PPG from the Trigger list.
  (When the Divide Ratio=1/1: Pattern, 1/16, 1/64; when the Divide Ratio=1/2, 1/4, or 1/8: Pattern, 1/1)

- Clock Source Setting
  - Internal/External Setting
  3. Select the clock that drives the PPG (Internal, External 1/16, External 1/64, or External 10G) from the Internal/External list.

  - Bit Rate Setting

  Can be selected when Internal is set
  4. Select a bit rate band to use from the Bit Rate list.

  - Bit Rate Variable Setting

  Can be set when SG is set
  5. Set the bit rate by entering a number in the Bit Rate variable setting box, or by selecting a number in the spin box.

### Interface/ED

- Trigger Setting
  6. Select a trigger output for the ED from the Trigger list (Pattern, 1/16, 1/64).

- Port Select Setting
  7. Click to select **DATA IN** or **DATA IN (CDR)** under Port Select.

- Threshold Level Setting
  8. Set the threshold level by entering a number in the Threshold Level box, or by selecting a level in the spin box.

Explanation

### Interface/PPG

- Trigger

  You can select a trigger signal to be output from the TRIGGER OUT terminal of the PPG.

  The items that can be set differ depending on the divide ratio.

  Divide Ratio=1/1: Pattern, 1/16, 1/64

  Divide Ratio=1/2, 1/4, 1/8: Pattern, 1/1

  - Pattern

    You can output a trigger signal synchronized to the pattern of the PPG.

    For PRBS, a positive pulse signal is output once every 128 cycles.

    For Program, a repeating pulse signal of 0 and 1 is output every 1024 bits of the output pattern rate regardless of the Length setting.
  - 1/16:

    A clock signal is output which is 1/16 of the output pattern rate of the PPG.
  - 1/64:

    A clock signal is output which is 1/64 of the output pattern rate of the PPG.
  - 1/1:

    A clock signal of 1/2, 1/4, or 1/8 is output corresponding to the low bit rate.

- Clock Source

  You can select a clock source that drives the PPG.
  - Internal:

    An internal clock source is used.
  - External 1/16 or External 1/64:

    Use a clock of 1/16 (External 1/16) or 1/64 (External 1/64) of the output bit rate that was input to the REF CLOCK IN (1/16, 1/64) terminal.
  - External 10G:

    Use a clock of 1/1 of the output bit rate that was input to the 10G CLOCK IN terminal.

- Bit Rate

  You can set the bit rate.
  - For SG

    All items below are displayed, and one can be selected.
  - When there is one oscillator

    One of the bit rates of the oscillators listed in the items below is displayed. It cannot be selected.
  - When there are two oscillators

    Two of the bit rates of the oscillators listed in the items below are displayed and one can be selected.

  List items

  9.953280 [Gbit/s] OC-192/STM64, 10GBASE-W

  10.312500 [Gbit/s] 10GBASE-R

  10.664229 [Gbit/s] OC-192/STM64 FEC (10.664229=9.953280*15/14)

  10.709225 [Gbit/s] G.709 (10.709225=9.953280*255/237)

  11.095728 [Gbit/s] 10GBASE-R FEC (11.095728=10.312500*255/237)

  11.317642 [Gbit/s] 10G Fiber Channel FEC (11.317642=10.518750*255/237)

- Bit Rate Variable Setting

  You can set the bit rate when SG is set. In the case of a oscillator, it is dimmed and cannot be selected.

  Setting range: 9.95 to 11.32 [Gbit/s], in steps of 0.00001 [Gbit/s]

### Interface/ED

- Trigger

  You can select a trigger signal to be output from the TRIGGER OUT terminal of the ED.

  • Pattern:
  Outputs a trigger signal synchronized to the pattern of the ED.
  For PRBS, a positive pulse signal is output once every 128 cycles.
  For Program, a repeating pulse signal of 0 and 1 is output every 1024 bits of the input pattern rate regardless of the length setting.

  • 1/16:
  A clock signal is output which is 1/16 of the input pattern rate of the ED.

  • 1/64:
  A clock signal is output which is 1/64 of the input pattern rate of the PPG.

- Port Select

  You can set up the data input terminal of the ED.

  • DATA IN:
  Select when not using CDR. Input a clock signal synchronized to the data signal to the DATA IN and 10G CLOCK IN terminals. Adjust with a phase shifter or other device so that the relationship between the data and clock phases is such that the data conversion point matches up with the falling of the clock.

  • DATA IN (CDR):
  Select when using CDR. The DATA IN (CDR) terminal is used.

- Threshold Level Setting

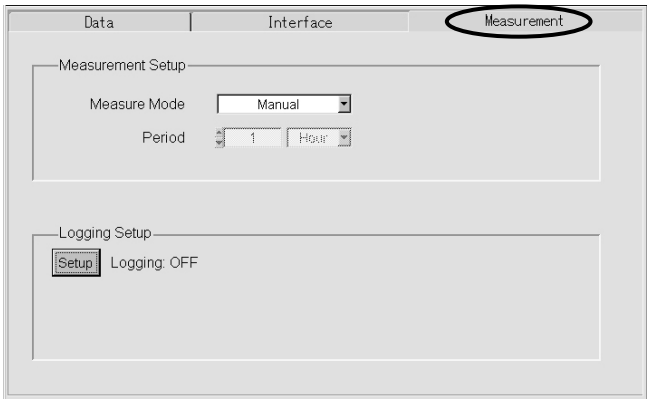
  You can click the slider Up and Down buttons, or drag the slider to set the Threshold Level.
  Setting range: -0.350 to 0.350 [V], in steps of 0.001 [V]

# 4.4 Setting Measurement Items

With Measurement items, you can set the measurement mode and log function.

Procedure

1. Click the **Measurement** tab in the main screen. The Measurement item screen is displayed.



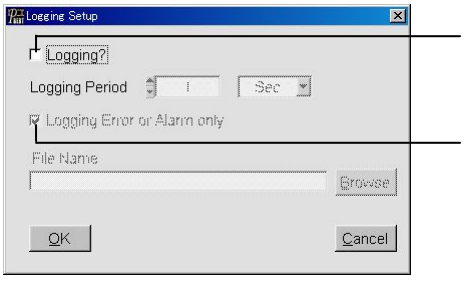

### Measurement Setup

- Using Manual Measure Mode
  2. Select **Manual** from the Measure Mode list. Period is dimmed and cannot be selected.

- Using Single Measure Mode
  2. Select **Single** from the Measure Mode list. Period is enabled and can be selected.
  3. Set the measurement time by entering a number in the Period box, or by selecting a number in the spin box. (1 to 99)
  4. Select the units for the measurement time (Sec, Min, Hour) from the Period units list.

### Logging Setup

5. Click the **Setup** button. The Logging Setup dialog box opens.




Select to use the logging

Select to save a log at the logging interval whenever an error/alarm occurs.
To save all logs at the logging interval, clear the check box.

- Enabling the Logging Function.
  6. Select the **Logging?** check box. The logging items become enabled for setting.
  - Logging Period Setting
  7. Set the logging period by entering a number in the Logging Period box, or by selecting a number in the spin box. (1 to 99)
  8. Select the units for the logging period (Sec, Min, Hour) from the logging period units list.

- Logs are saved at the logging period only when an error or alarm occurs

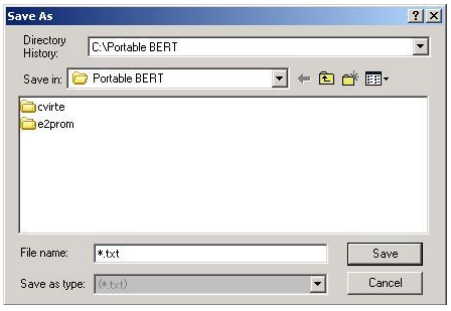
9. Select the **Logging Error or Alarm only** check box.

- All logs are saved at the logging period

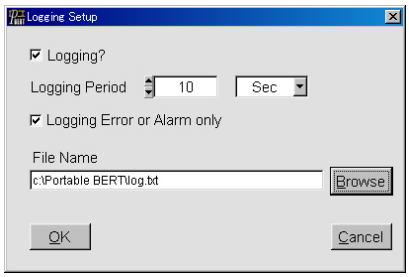
9. Clear the **Logging Error or Alarm only** check box.

- Enter a file name

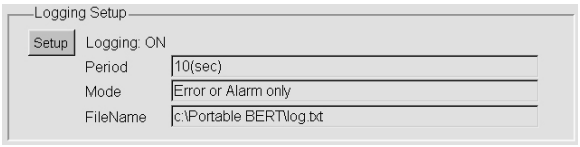
10. Click the **Browse** button to open the Save as dialog box.




11. Input a save destination and file name, then click the **Save** button. The Save as dialog box closes, and the specified directory and file name are displayed under File Name in the Logging Setup dialog box.




12. Click the **OK** button. The Logging Setup item displays Logging: ON, and the Period, Mode, and File Name are displayed.




- Disabling the Logging Function

6. Clear the **Logging?** check box. The logging item becomes dimmed and cannot be set.
7. Click the **OK** button. The Logging Setup item displays Logging: OFF.

## Explanation

- Measure Mode
  - Single

    Click the **Start** button to start measurement. When the measurement time as specified under Period elapses, measurement automatically stops. The measurement time can be set from 1 second to 99 minutes.
  - Manual

    Click the **Start** button to continue measurement until the **Stop** button is clicked.

- Format of the Log File

  The log file is in text format. It can be loaded by a text editor or spreadsheet program.

  If the same file name already exists when setting files, it is added to the end of the log.

  Logging period: 1 sec. to 99 minutes

Example)

Logging period: 10 sec., measurement time: 1 minute, Logging Error or Alarm only: Log file when selected

```
1) Start              10-28-2005    11:47:36
2) Clock Source Int   9.95334 [Gbit/s]
3) Period             10sec
4) NO.      Elapsed   Time      ErrorCount      SyncLoss        CdrUnlock  LossOfSignal  SgUnlock
   000001   000010    11:47:46  8.000000E+00    0.000000E+00    0          0             0
   000002   000020    11:47:56  2.000000E+00    0.000000E+00    0          0             0
   000003   000030    11:48:06  2.000000E+00    0.000000E+00    0          0             0
   000004   000060    11:48:36  3.000000E+00    0.000000E+00    0          0             0
5) Stop               10-28-2005    11:48:36
6) Elapsed Time       00:01:00
7) Last Result
   SyncLoss           0.000000E+00
   ErrorCount         1.500000E+01
   ErrorRate          2.511719E-11
```

| No | Item | Description |
|---|---|---|
| 1) | Start | Shows the measurement start time. MM-DD-YYYY hh: mm: ss |
| 2) | Clock Source | Shows the clock source and bit rate. |
| 3) | Period | Shows the logging period. |
| 4) | (Logging period data) | Shows the logging period data.<br>No., measurement elapsed time (Elapsed), log time (Time), ErrorCount value, SyncLoss value [µsec], CdrUnlock*1 value, LossOfSignal value, SgUnlock*2 value. |
| 5) | Stop | Shows the measurement stop time. MM-DD-YYYY hh: mm: ss |
| 6) | Elapsed Time | |
| 7) | Last Result | Displays the final results.<br>SyncLoss value [µsec], ErrorCount value, ErrorRate value |

*1 Enabled when set to DATA IN (CDR).

*2 Enabled with the SG type and when Clock Source is set to Internal.

***Note***

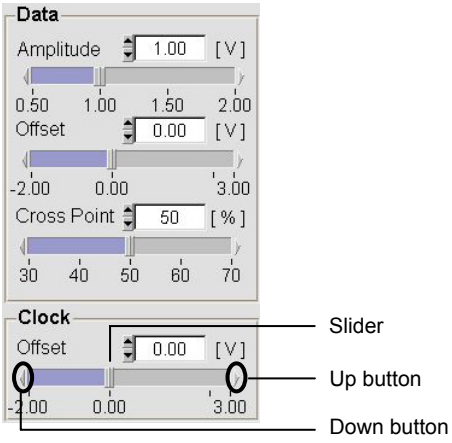
Measurement items cannot be changed during measurement.

# 4.5 Setting Data/Clock Items

= For details about the function, see section 2.3 =

With the Data/Clock items, you can set the data amplitude, offset, cross point, and the clock offset of the PPG interface.

## Procedure




- Data Amplitude
  1. Set the amplitude by entering a number in the Amplitude box, or by selecting a number in the spin box.

- Data Offset
  2. Set the offset by entering a number in the Offset box, or by selecting a number in the spin box.

- Data Cross Point (Enabled When the PPG Pattern Setting is PRBS)
  3. Set the data cross point by entering a number in the Cross Point box, or by selecting a number in the spin box.

- Clock Offset
  4. Set the clock offset by entering a number in the Offset box, or by selecting a number in the spin box.

## Explanation

- The Data/Clock items can be set by clicking a slider's Up and Down buttons, or by dragging the slider.

- Data Cross Point is enabled when the PPG Pattern setting is PRBS. When Program is selected, the Data Cross Point is fixed at 50%.

- The setting ranges for the Data/Clock items are as follows.

  • Data Amplitude: 0.50 to 2.00 [V], in steps of 0.01 [V]

  • Data Offset: -2.00 to 2.00 [V], in steps of 0.01 [V]

  • Data Cross Point: 30 to 70 [%], in steps of 1 [%]

  • Clock Offset: -2.00 to 2.00 [V], in steps of 0.01 [V]

# 4.6 Turning Output ON and OFF

Procedure

### Things to Check before Turning Output ON

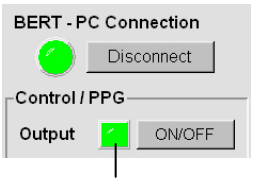
- Is the output terminal connected to the DUT correctly? And are the terminators attached?
- Are appropriate values set for the Data Amplitude, Data Offset, and Clock Offset?

**CAUTION**

- To protect the output circuit, do not open the output terminals, and terminate them with a 50 Ω-load.
- To protect the DUT when connecting the instrument and DUT, adjust the output level so that it does not exceed its absolute maximum rating, or insert an attenuator or similar device.

### Turning ON the Output

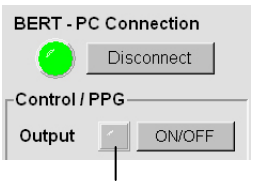
1. When the Output indicator is dimmed, click the Output **ON/OFF** button under Control/PPG. The indicator display turns green, and output is ON.




Green: Outut ON

### Turning OFF the Output

2. When the Output indicator is green, click the Output **ON/OFF** button under Control/PPG. The indicator display turns gray, and output is OFF.




Gray: Output OFF

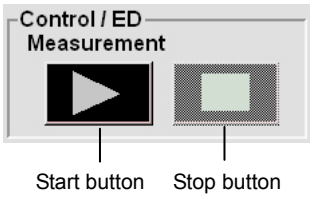
Explanation

Output ON/OFF is enabled when the AP9945 is connected to the PC (the BERT-PC Connection indicator is green).

You can perform the same operation using the OUTPUT ON/OFF switch on the front panel of the main unit.
The Output ON/OFF button and OUTPUT ON/OFF switch are interlocked.

# 4.7 Starting and Stopping Measurement

## Procedure




### Starting Measurement

Click the **Start** button to start measuring.

### Restarting Measurement

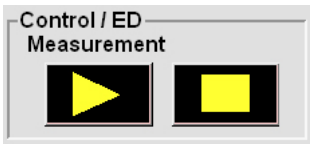
Click the **Start** button during measurement to clear the measured results and restart measurement.

### Stopping Measurement

Click the **Stop** button during measurement to stop measuring.

## Explanation

During measurement, the Start and Stop buttons turn yellow.



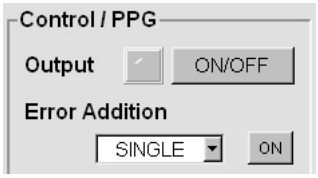

When the measurement mode is Single, click the Start button to start measurement. After the measurement time specified under Period elapses, measurement automatically stops. When the measurement mode is Manual, click the Start button to start measurement. Measurement continues until the Stop button is clicked.

# 4.8 Adding Errors

## Procedure

### Setting Error Types

Select the type of error to add (Single, 1E-3 to 1E-12) from the Error Addition list under Control/PPG.



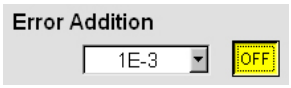

### Adding the Error or Stopping the Error Addition

- When Error Addition is Single

1. When the **ON** button is clicked, one bit error is added.

- When Error Addition is 1E-3 to 1E-12

1. When you click the **ON** button the display changes to OFF, the color changes to yellow, and bit error is added according to the selected error rate.




2. When you click the **OFF** button the display changes to ON, the color changes to gray, and bit error adding stops.

## Explanation

Added Error Types
Single, 1E-3, 1E-4, 1E-5, 1E-6, 1E-7, 1E-8, 1E-9, 1E-10, 1E-11, 1E-12

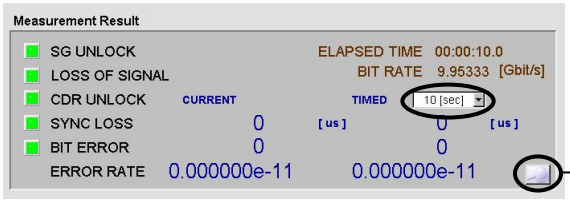
# 4.9 Measurement Result

Measured results are displayed under Measurement Result. Also, you can set the time for display updating of the measured results, and zoom the results.

Procedure

### Setting TIMED

1. Select the time at which the measured results are updated (100 ms, 1 sec, 10 sec, 100 sec, or 150 sec) from the TIMED list.



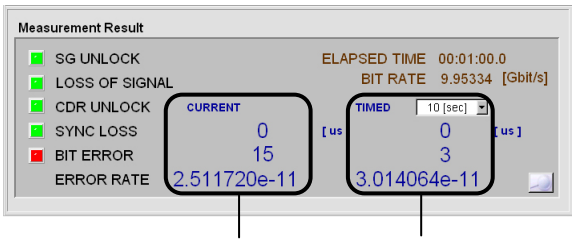

### Zooming the Measured Results

1. Click the **Zoom In/Out** button to zoom the measured results in or out.


2. Click the **Zoom In/Out** button again to return the measured results to normal display.

Explanation

| Item | Description |
|---|---|
| ELAPSED TIME | Shows the time elapsed since measurement started. |
| BIT RATE | Shows the bit rate of the receive clock of the ED. [Gbit/s] |
| SG UNLOCK | Shows an indicator of the synchronization status. Enabled with the SG type and when Clock Source is set to Internal.<br>Green: SG normal status (synchronization established)<br>Red: SG unsynchronized<br>Gray: Invalid status |
| LOSS OF SIGNAL | Shows an indicator of the status of the input signal of the ED.<br>Green: Normal status<br>Red: Signal disconnected<br>Gray: Invalid status |
| CDR UNLOCK | Shows an indicator of the status of the CDR function of the ED. Enabled when Port Select is set to DATA IN (CDR).<br>Green: Normal status<br>Red: Error status<br>Gray: Invalid status |
| SYNC LOSS | Shows the pattern sync loss status of the ED using an indicator, and shows the pattern sync loss time using a numeric value.<br>• Pattern sync loss status<br>Green: Normal status<br>Red: Error status<br>Gray: Invalid status<br>• Pattern sync loss time<br>Display range: 0 to 3.564000E+11 [us] |
| BIT ERROR | Shows the bit error status of the ED using an indicator, and shows the bit error number using a numeric value.<br>• Bit error status<br>Green: Normal status<br>Red: Bit error detection status<br>Gray: Invalid status<br>• Number of bit errors<br>Display range: 0 to 1.008120E+15 [bit] |
| ERROR RATE | Shows the bit error rate of the ED using a numerical display.<br>Display range:<br>0.000000E-10 to 0.000000E-16 (errors: none)<br>2.478654E-16 to 2.498779E-01 (errors: occurs) |



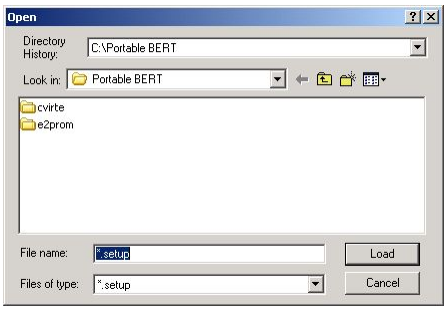

SYN CLOSS, BIT ERROR, and ERROR RATE are displayed under CURRENT and TIMED. CURRENT displays the total number of measured results since measurement started. TIMED displays the measured results at each update time. TIMED is useful when investigating increases and decreases in errors. Even if TIMED switches during measurement, only the display switches and this does not affect the measured values.

# 4.10 Loading and Saving Setting Values

## Procedure

### Loading Setting Values

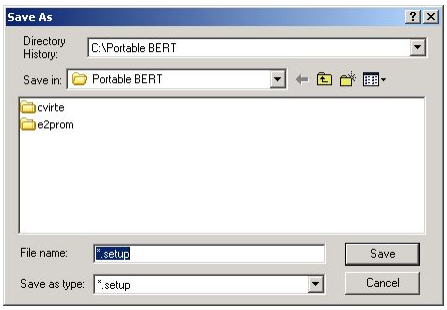
1. Choose **File** > **Load** from the menu. The Open dialog box opens.




2. Select a file to load, then click the **Load** button. The setting values are loaded.

### Saving Settings

1. Choose **File** > **Save** from the menu. The Save as dialog box opens.




2. Select a file to save, then click the **Save** button. The set value is saved.

## Explanation

The extension for setup files is .setup.

OUTPUT ON/OFF and Logging Setup information is not saved in settings files.
The OUTPUT ON/OFF and Logging Setup information from before the load is held.

# 4.11 Displaying the Version

Displays version information for the AP9945.

## Procedure

1. Choose **Help** > **About** from the menu. The About dialog box opens.


2. Click the **Close** button. The About dialog box closes.

# 5.1 When Trouble Occurs

## Troubleshooting

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

| Symptoms and Corrective Actions | | Related Section |
|---|---|---|
| The power is not turned ON. | | |
| | Securely connect the accessory power cord plug to the power connector on the rear panel. | 3.3 |
| | Check that the main power switch on the rear panel is ON. | 3.4 |
| | Check that the power switch on the front panel is ON. | 3.4 |
| | Check whether the fuse is blown out. | 5.4 |
| Synchronization could not be established. | | |
| | Check cable connections. | 1.2, 3.9 |
| | Check the port selection (DATA IN (CDR), DATA IN) and connection of the ED, and if the settings are different from the connections, make the settings match. | 4.3 |
| | Check that the OUTPUT of the PPG is ON. | 4.6 |
| | Check the DATA setting of the PPG and ED. If the setting of the PPG is different from that of the ED, make these settings match with each other. | 4.2 |
| | Check the value of the Data Amplitude. If the amplitude is small, correct it. | 4.5 |
| | Check the value of the Threshold Level. If the value is inappropriate, change it. | 4.3 |
| | When using DATA IN, adjust the phase of the data and clock. | 1.2, 3.9 |
| The sync loss error occurs. | | |
| | Check the data settings of the PPG and ED. If the setting of the PPG is different from that of the ED, make these settings match with each other. | 4.2 |
| | Check Error Addition, and if the setting is ON, turn it OFF. | 4.8 |
| | Check the value of the Data Amplitude. If the amplitude is small, correct it. | 4.5 |
| | Check the value of the Threshold Level. If the value is inappropriate, change it. | 4.3 |
| Output waveform is noisy. | | |
| | Check cable connections. | 1.2, 3.9 |
| | Check the output terminal. If there are unused terminals, connect the accessory terminators. | 1.2, 3.9 |
| | Use cables and connectors that support the frequency characteristics. | - |
| The fan stopped. | | |
| | 1. Hold down the power switch on the front panel for one second or longer. The power is OFF.<br>2. Turn OFF the main power switch on the rear panel.<br>3. Contact your nearest YOKOGAWA dealer for repairs. | 3.4 |

# 5.2 Error Messages and Corrective Actions

### Error Messages

When using the AP9945, messages may be displayed on the screen of the controller PC. The meanings of the messages and their corrective actions are explained below. If “service is required” is indicated under corrective actions, contact your nearest YOKOGAWA dealer for repairs.

| Message | Trouble | Corrective Action | Related Section |
|---|---|---|---|
| It failed in open of the COM port. | Failed to open the COM port | Check the COM port of the instrument and controller PC. If they are different, make them the same. | 3.8 |
| | | Check the connection between the instrument and the controller PC. Connect the accessory USB cable between the instrument and the controller PC. | 3.6 |
| | | Check that the power to the instrument is ON. | 3.4 |
| Initialize was end in failure. error number:100 | EEPROM Read time out | The accessory USB cable between the instrument and the controller PC may be disconnected. Connect the cable then try the connection again. | 3.7 |
| | | The power to the instrument may be OFF. Turn the power ON, then try the connection again. | 3.4 |
| Initialize was end in failure. error number:110 | Data file open error | Reinstall the software. | 3.5 |
| Initialize was end in failure. error number:111 | Data file size error | Reinstall the software. | 3.5 |
| Initialize was end in failure. error number:112 | Data file version error | Reinstall the software. | 3.5 |
| Initialize was end in failure. error number:113 | Data file error | Reinstall the software. | 3.5 |
| Sorry, can not change while measuring. | Error during measurement | Settings cannot be changed during measurement. Stop measurement before changing settings. | 4.4, 4.7 |
| Format error : invalid character(****). | File format Illegal character error | The loaded program pattern file may contain illegal characters, or the file may be corrupt. Check the contents of the file. | 4.2, 4.10 |
| Format error: pattern length is wrong. | File format Program pattern length error | The loaded program pattern length may be illegal, or the file may be corrupt. Check the contents of the file. | 4.2, 4.10 |
| Please input [FileName]. | File name not entered | A file name was not entered. Enter a file name. | 4.2, 4.10 |

# 5.3 Maintenance and Inspection

To ensure normal operation of the instrument, it is recommended to perform regular maintenance and inspection.

### Calibration Cycle

It is recommended to carry out the performance test described below once per year.

### Performance Test

After an inspection has been completed, the performance results are recorded in the performance test record sheet. The performance test record sheet is a list stating all tested specifications and allowable limits. The test result records can be used to compare the data after completion of the periodic maintenance, troubleshooting, repair, and adjustment.

### Recommended Test Instruments

The following list shows the measuring instruments necessary to carry out the performance test. Use a measuring instrument with the recommended level of performance and functions or higher.

| Accessory Name | Performance Requirements | Recommended Instruments |
|---|---|---|
| Digital oscilloscope | Digital Communications Analyzer<br>Dual Channel 50 GHz Electrical Plug-In Module | Agilent 86100A<br>Agilent 83484A |
| Phase shifter | 3.5 mm-connector type | HLS-JJ-13 manufactured by Hirose Electric |
| Attenuator | 10 dB (3.5 mm-connector type)<br>20 dB (3.5 mm-connector type) | INMET 41KC-10<br>INMET 41KC-20 |
| Coaxial cable | 3.5 mm-connector type<br>SMA connector type | |

## (1) BER Measurement (CDR)

### Description

Correct functioning of the PPG-ED (CDR) is verified with BER measurement using PPG-ED loop back.

### Specifications

No error occurs after measurement for five minutes.

### Procedures

1. Insert a 10 dB-attenuator into the DATA IN (CDR) terminal of the ED of the AP9945 and connect to the DATA OUT terminal of the PPG with a coaxial cable.

2. Set up the AP9945 as follows.

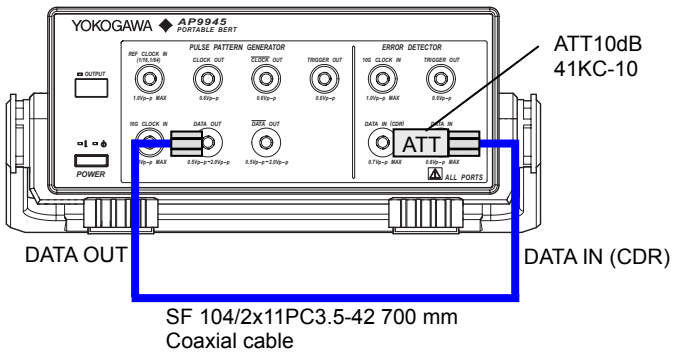
| | | | |
|---|---|---|---|
| Data Offset: | 0.00 V | Polarity: | Normal |
| Data Cross Point: | 50% | Coupling to PPG: | Select |
| Clock Source: | Internal | Divide Ratio: | 1/1 |
| Bit Rate*: | 11.32 Gbit/s | Pattern: | PRBS |
| Clock Offset: | 0.00 V | Data: | PRBS31 |
| Port Select: | DATA IN(CDR) | Measure Mode: | Single |
| Threshold Level: | 0 V | Period: | 5 Min |

*:In case of oscillator type, the highest possible frequency setting

3. Set the AP9945's data amplitude to 0.5 V and start the BER measurement.

4. In the same manner, set the data amplitude to 2.0 V and start the BER measurement.

### Connection Diagram



## (2) BER Measurement (No CDR)

### Description

Correct functioning of the PPG-ED (no CDR) is verified with BER measurement using PPG-ED loop back.

### Specifications

No error occurs after measurement for five minutes.

### Procedures

1. Insert a 10 dB-attenuator into the DATA IN terminal of the ED of the AP9945 and connect to the DATA OUT terminal of the PPG with a coaxial cable.

2. Insert a phase shifter into the 10G CLOCK IN terminal of the ED of the AP9945 and connect to the CLOCK OUT terminal of the PPG with a coaxial cable.

3. Set up the AP9945 as follows.

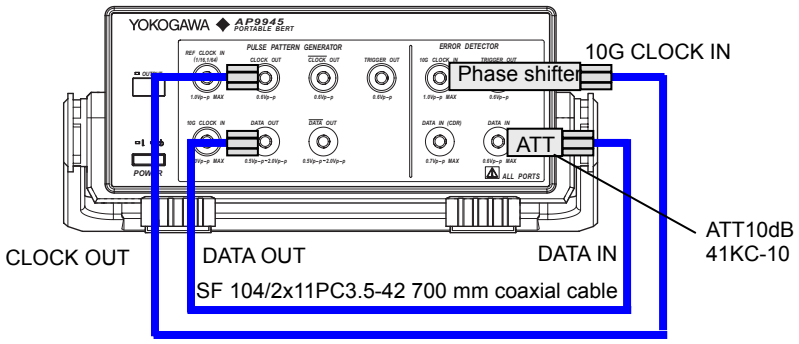
| | | | |
|---|---|---|---|
| Data Offset: | 0.00 V | Polarity: | Normal |
| Data Cross Point: | 50% | Coupling to PPG: | Select |
| Clock Source: | Internal | Divide Ratio: | 1/1 |
| Bit Rate*: | 10.71 Gbit/s | Pattern: | PRBS |
| Clock Offset: | 0.00 V | Data: | PRBS31 |
| Port Select: | DATA IN | Measure Mode: | Single |
| Threshold Level: | 0 V | Period: | 5 Min |

*:In case of oscillator type, the highest possible frequency setting

4. Set the AP9945's data amplitude to 0.5 V and start the BER measurement.

5. In the same manner, set the data amplitude to 2.0 V and start the BER measurement.

### Connection Diagram



## (3) Output Waveform Test

### Description

Check that the output waveform of the DATA OUT of the PPG is within the specification range.

### Specifications

The output waveform must be within the specification range.
Eye Amp: Data amplitude ± 5% ± 0.1 V
Eye SN: Reference value is 15 or more (phase is 40 to 60%).

### Procedures

1. Insert a 20 dB attenuator into the input terminal of the oscilloscope and connect to the DATA OUT terminal of the PPG of the AP9945 with a coaxial cable.

2. Connect the TRIGGER OUT terminal of the PPG of the AP9945 and trigger input terminal of the oscilloscope with a coaxial cable.

3. Set up the AP9945 as follows.

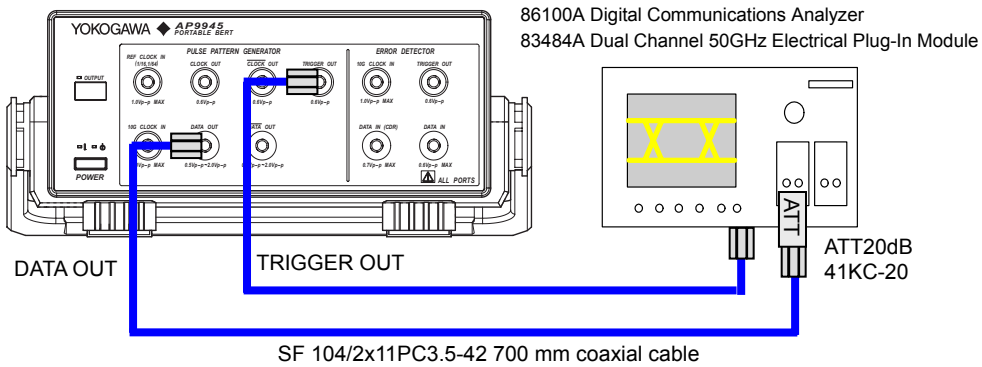
| | | | |
|---|---|---|---|
| Data Offset: | 0.00 V | Polarity: | Normal |
| Data Cross Point: | 50% | Divide Ratio: | 1/1 |
| Clock Source: | Internal | Pattern: | PRBS |
| Bit Rate*: | 11.32 Gbit/s | Data: | PRBS31 |
| Clock Offset: | 0.00 V | PPG Trigger: | 1/16 |

*:In case of oscillator type, the highest possible frequency setting

4. With the data amplitude, data offset, and data cross point settings of the AP9945 combined as shown below, check the waveform with the oscilloscope.

| Combination | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Data Amplitude | 0.5 V | 2.0 V | 2.0 V | 2.0 V | 2.0 V | 2.0 V |
| Data Offset | 0 V | 0 V | -2 V | +3 V | 0 V | 0 V |
| Data Cross Point | 50% | 50% | 50% | 50% | 30% | 70% |

### Connection Diagram



## (4) Input Sensitivity Test

### Description

Check that the input sensitivity of the DATA IN of the ED is within the specification range.

### Specifications

The input sensitivity performance must be 0.1 V or more.
(Since the 20 dB-ATT is inserted into the input, no error must occur for five minutes when the Data amplitude is set at 1.0 V or less.)

### Procedures

1. Insert a 20 dB-attenuator into the DATA IN (CDR) terminal of the ED of the AP9945 and connect to the DATA OUT terminal of the PPG with a coaxial cable.

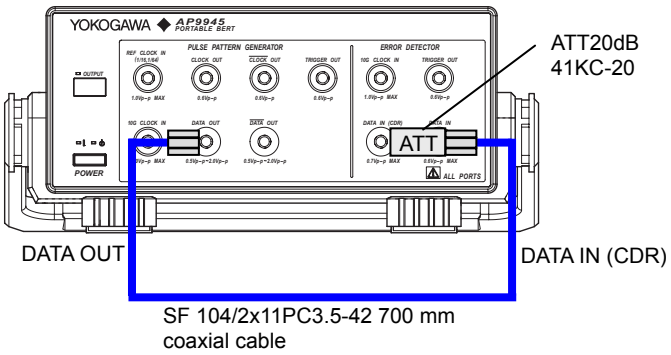
2. Set up the AP9945 as follows.

| | | | |
|---|---|---|---|
| Data Offset: | 0.00 V | Polarity: | Normal |
| Data Cross Point: | 50% | Coupling to PPG: | Select |
| Clock Source: | Internal | Divide Ratio: | 1/1 |
| Bit Rate*: | 11.32 Gbit/s | Pattern: | PRBS |
| Clock Offset: | 0.00 V | Data: | PRBS31 |
| Port Select: | DATA IN(CDR) | Measure Mode: | Single |
| Threshold Level: | 0 V | Period: | 5 Min |

*:In case of oscillator type, the highest possible frequency setting

3. Set the AP9945's data amplitude to a 2.0 V to 0.5 V variable setting and start the BER measurement.

### Connection Diagram



# Performance Test Record Sheet

| AP9945 Portable BERT | |
|---|---|
| Place: | Manufacture No.: |
| | Tested by: |
| Temperature: | Approved by: |
| Humidity: | Date: |

| Description of Test | | Results | | |
|---|---|---|---|---|
| | | Min. | Actual | Max. |
| (1) BER measurement (CDR) | Data Amplitude=0.5 V | | BER<$0*10^{-12}$ | |
| | Data Amplitude=2.0 V | | BER<$0*10^{-12}$ | |
| (2) BER measurement (no CDR) | Data Amplitude=0.5 V | | BER<$0*10^{-12}$ | |
| | Data Amplitude=2.0 V | | BER<$0*10^{-12}$ | |
| (4) Input sensitivity test | | | | |
| | | | | |

| Description of Test | Eye Amp | Eye SN |
|---|---|---|
| (3) Output waveform test | | |
| A) Data Amplitude=0.5 V, Data Offset=0 V, Data Cross Point=50% | | |
| B) Data Amplitude=2.0 V, Data Offset=0 V, Data Cross Point=50% | | |
| C) Data Amplitude=2.0 V, Data Offset=-2 V, Data Cross Point=50% | | |
| D) Data Amplitude=2.0 V, Data Offset=+3 V, Data Cross Point=50% | | |
| E) Data Amplitude=2.0 V, Data Offset=0 V, Data Cross Point=30% | | |
| F) Data Amplitude=2.0 V, Data Offset=0 V, Data Cross Point=70% | | |
| | | |

| Test Conditions | |
|---|---|
| AP9945 Setting | |
| Bit rate | Gbit/s |
| Test coding (number of PRBS steps) | PRBS31 |
| | |
| | |
| | |
| | |
| | |
| | |

# 5.4 Replacing the Power Fuse

**WARNING**

- To prevent fire, use a fuse of the specified rating (for voltage, current, and type).
- Be sure to turn OFF the power switch and disconnect the power cord before replacing the fuse.
- Do not short the fuse holder.

### Fuse Rating

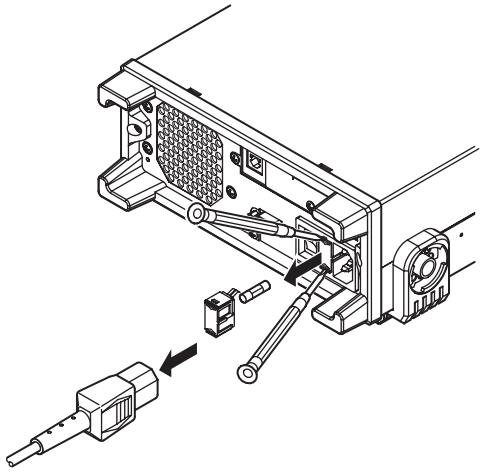
The power fuse used by the instrument is as follows.

- Maximum rated voltage: 250 V
- Maximum rated current: 4 A
- Type: time lag
- Standard: UL/VDE compliant

### Replacing the Fuse

Perform the following procedure to replace the fuse.

1. Turn OFF the power switch on the front panel and the main power switch on the rear panel.
2. Remove the power cord from the power connector.
3. Insert the tips of flathead screw drivers into the indentations on both sides of the fuse holder on the rear panel, then push in and pull up to remove the fuse holder.
4. Remove the blown fuse from the fuse holder.
5. Insert a new fuse into the fuse holder, then replace the fuse holder into its original location.



# 5.5 Recommended Replacement Parts

Yokogawa guarantees this product according to the terms and conditions of the warranty. As stated in the warranty, the following wearable parts are not covered under warranty. The period of replacement varies according to the conditions of use. The periods in the table below are approximate. Contact your nearest YOKOGAWA dealer for replacement of parts.

| Part Name | Recommended Replacement Period |
|---|---|
| Cooling fan | 6 years |

# 6.1 PPG Section

### Interface

| Item | | Specifications |
|---|---|---|
| Data output (DATA OUT $\overline{\text{DATA OUT}}$) | Bit rate | 9.95 to 11.32 Gbit/s |
| | Data format | NRZ |
| | Output level | 0.50 to 2.00 Vp-p (in steps of 10 mV) |
| | TR/TF(20 to 80%) | <25ps |
| | Offset voltage | -2 to +3 V (in steps of 10 mv) |
| | Cross point variation | 30 to 70% (in steps of 1%) |
| | Number of outputs | 2 (Non-invert and Invert) |
| | Connector | 3.5 mm-Female |
| | Output terminating conditions | Either 50 Ω AC-termination or DC-termination can be used. |
| | Invert function | Positive/negative logic invert |
| | Output control | ON/OFF function (GND level at OFF) |
| Clock output (CLOCK OUT $\overline{\text{CLOCK OUT}}$) | Output level | 0.6 Vp-p (AC coupling) Typ. |
| | Duty | 50% ±10% |
| | TR/TF(20 to 80 %) | <25ps |
| | Offset voltage | -2 to +3 V (in steps of 10 mv) |
| | Number of outputs | 2 (Non-invert and Invert) |
| | Connector | SMA-Female |
| | Output terminating conditions | Either 50 Ω AC-termination or DC-termination can be used. |
| | Output control | ON/OFF function (GND level at OFF) |
| Trigger output (TRIGGER OUT) | Clock trigger | 1/16 or 1/64 of the clock frequency |
| | Pattern trigger | PRBS: Outputs a high pulse (128 bit) every 128 cycles of the pulse PRBS pattern.<br>PROGRAM: Repeatedly outputs Low and High of 1024 bit width |
| | Low bit rate trigger | Clock frequency corresponding to the bit rate pattern |
| | Output level | 0.6 Vp-p ±0.3 V |
| | Connector | SMA-Female |
| | Output terminating conditions | Either 50 Ω AC-termination or DC-termination can be used. |

### Data

| Item | | Specifications |
|---|---|---|
| Communication pattern | PRBS | $2^n$-1(n=7,15,23,31) |
| | PROGRAM | Select from 2, 4, 8, 16, 32, 64, 128 byte length |
| | Low bit rate pattern | A pattern of 1/2, 1/4, or 1/8 of the corresponding bit rate (9.95 to 11.1 Gbit/s) |
| Error add is activated. | SINGLE | Adds one bit error each time the button is pressed |
| | RATE | 1.0E-n (n = 3 to 12, in steps of 1) |

# 6.2 ED Section

### Interface

| Item | | Specifications |
|---|---|---|
| Data input*3 (DATA IN (CDR)) | Bit rate | 9.95 to 11.32 Gbit/s |
| | Bit rate allowable range | Operation bit rate ±100 ppm of the PPG |
| | Data format | NRZ |
| | Input level | 0.1 to 0.7 Vp-p |
| | Minimum input sensitivity | 100 mV or less (for Eye Height)*1 |
| | Input threshold variable | ±0.35 V (in steps of 1 mv) |
| | Connector | 3.5 mm-Female |
| | Input terminating conditions | 50 Ω AC coupling |
| | Invert function | Positive/negative logic invert |
| Data input*3 (DATA IN) | Bit rate | 9.95 to 10.71 Gbit/s |
| | Data format | NRZ |
| | Input level | 0.1 to 0.6 Vp-p |
| | Minimum input sensitivity | 100 mV or less (for Eye Height)*1 |
| | Input threshold variable | ± 0.3 V (in steps of 1 mv) |
| | Connector | 3.5 mm-Female |
| | Input terminating conditions | 50 Ω AC coupling |
| | Invert function | Positive/negative logic invert |
| Clock input*3 (10G CLOCK IN) | Frequency | Frequency having the same rate synchronized with the data input |
| | Input level | 0.2 to 0.6 Vp-p |
| | Connector | SMA-Female |
| | Input terminating conditions | 50 Ω AC coupling |
| Trigger output (TRIGGER OUT) | Clock trigger | 1/16 or 1/64 of the clock frequency |
| | Pattern trigger | PRBS: Outputs a high pulse (128 bit) every 128 cycles of the pulse PRBS pattern.<br>PROGRAM: Repeatedly outputs Low and High of 1024 bit width |
| | Output level | 0.6 Vp-p ±0.3 V |
| | Connector | SMA-Female |
| | Output terminating conditions | Either 50 Ω AC-termination or DC-termination can be used. |

### Data

| Item | | Specifications |
|---|---|---|
| Receive pattern | PRBS | $2^n$-1(n=7,15,23,31) |
| | PROGRAM | Select from 2, 4, 8, 16, 32, 64, 128 byte length |
| Measurement function | Manual | Measured between pressing of MEASUREMENT START button and pressing of STOP button. |
| | Single | Measured once at the time specified by the user |
| | Measurement time | 99 hours maximum |
| | Measured results | CURRENT, TIMED, BIT ERROR COUNT, ERROR RATE, SYNC LOSS |
| | Error log | Yes |

# 6.3 Common Items

| Item | | Specifications |
|---|---|---|
| Operation clock mode | | Internal clock, external reference clock, external clock |
| Internal clock | Internal fixed frequency (when oscillator specified) | Select 1 or 2 frequencies from 9.95328 GHz, 10.3125 GHz, 10.6642 GHz, 10.709 GHz, 11.095 GHz. |
| | Internal variable frequency (when SG specified) | Variable frequency range: 9.95 to 11.32 GHz<br>Set resolution: 1 kHz<br>Frequency accuracy: ± 3 ppm |
| External reference clock*3 (REF CLOCK IN) | Frequency | 1/16 or 1/64 of bit rate |
| | Input level | 0.4 to 1.0 Vp-p |
| | Duty | 50%-square waveform (nominal value) |
| | Connector | SMA-Female |
| | Input terminating conditions | 50 Ω AC coupling |
| External clock input*3 (10 G CLOCK IN) | Frequency | 1/1 of bit rate |
| | Input level | 0.4 to 1.0 Vp-p |
| | Duty | 50% (nominal value) |
| | Connector | SMA-Female |
| | Input terminating conditions | 50 Ω AC coupling |
| Main unit control IF (USB) | USB | USB1.1, USB2.0 |
| | Port setting | Communication speed: 9600 bps, data bit: 8, parity: none, stop bit: 1, flow control: none<br>(connect the USB IF of the PC) |

# 6.4 General Specifications

| Item | | Specifications |
|---|---|---|
| Power supply | Rated supply voltage | 100 to 240 VAC |
| | Allowed supply voltage fluctuation range | 90 to 264 VAC |
| | Rated supply voltage frequency | 50/60 Hz |
| | Power supply frequency variation range | 48 to 63 Hz |
| | Maximum power consumption | 100 VA or less |
| Dimensions and weight | Dimensions | W 213 × H 88 × D 429 [mm] (not including protrusions) |
| | Weight | 5 kg or less |
| Operating Environment | Temperature range | 5 to 40°C |
| | Humidity range | 20 to 80% |
| Safety standard | Supported standards | EN61010-1<br>• Overvoltage category (Installation category) CAT II*2<br>• Measurement category CAT I*3<br>• Pollution degree 2*4 |
| Emission | Supported standards | EN61326 Class A<br>EN55011 Class A |
| | Cable conditions | • USB<br>Use a shielded cable.<br>Use a cable of three meters or less in length.<br>• DATA OUT/DATA IN (CDR)<br>Use a coaxial cable of three meters in length or less.<br>• CLOCK OUT, DATA IN, 10G CLOCK IN, TRIGGER OUT<br>Use a coaxial cable of three meters in length or less. |
| Immunity | Complying standard | EN61326 Annex A |
| | Cable conditions | Same as emission cable conditions |

*1: Specified by making loop back measurements in the PPG and ED with PRBS31 and data cross point of 50%.

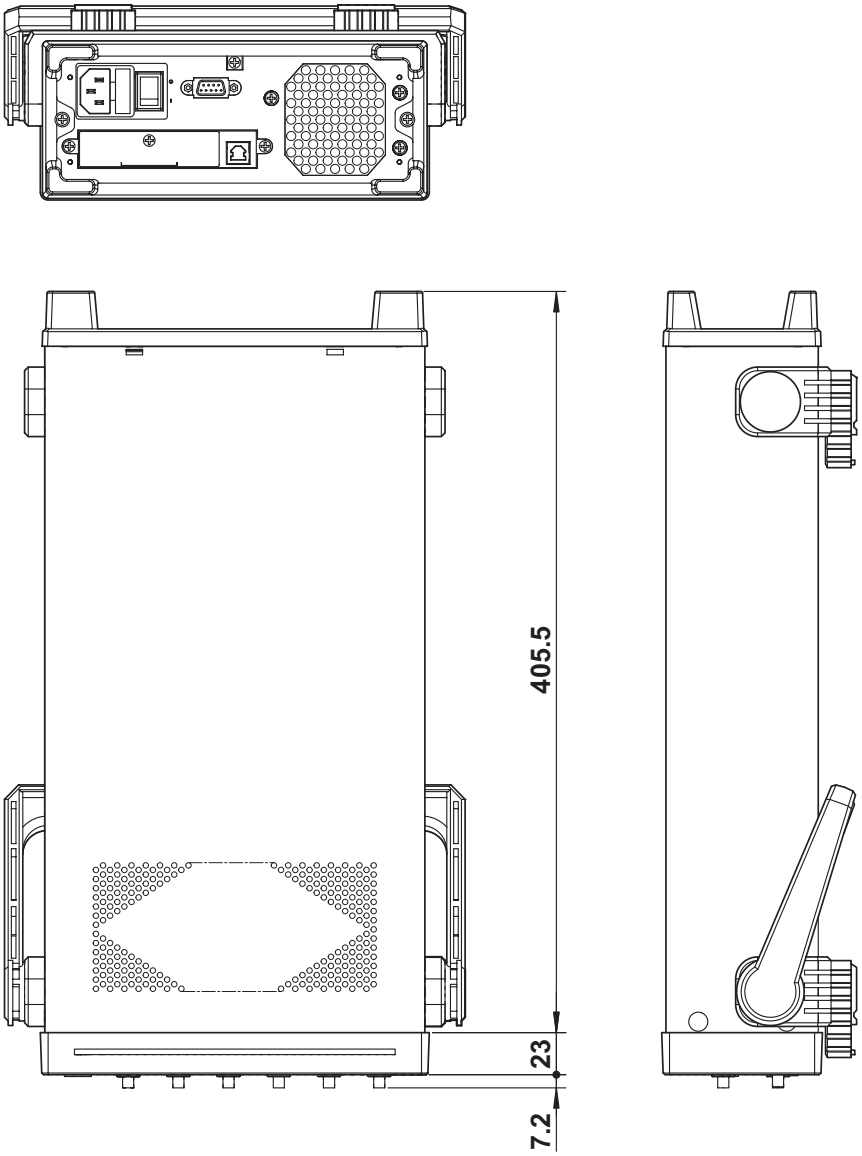
*2: The Overvoltage Category is a value used to define the transient overvoltage condition and includes the impulse withstand voltage regulation. CAT II applies to electrical equipment that is powered through a fixed installation such as a wall outlet wired to a distribution board.

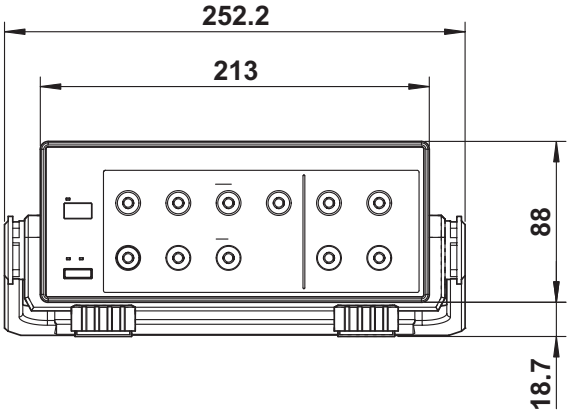
*3: This equipment is for Measurement Category I (CAT I). Do not use it with Measurement Category II (CAT II),Measurement Category III (CAT III), nor Measurement Category IV (CAT IV).
CAT I applies to electrical equipment on a circuit that is not connected directly to the power source and measurement performed on such wiring. CAT II applies to electrical equipment that is powered through a fixed installation such as a wall outlet wired to a distribution board and measurement performed on such wiring. CAT III applies to measurement of the distribution level, that is, building wiring, fixed installations. CAT IV applies to measurement of the primary supply level, that is, overhead lines, cable systems, and so on.

*4: Pollution Degree applies to the degree of adhesion of a solid, liquid, or gas which deteriorates withstand voltage or surface resistivity. Pollution Degree 2 applies to normal indoor atmospheres (with only non-conductive pollution).

# 6.5 External Dimensions

UNIT: mm




Actual dimensions may vary by +/-3%

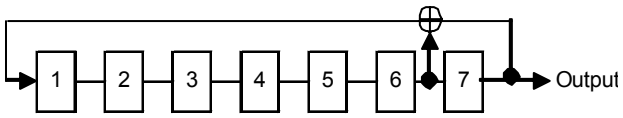
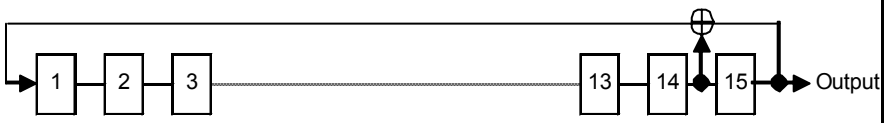
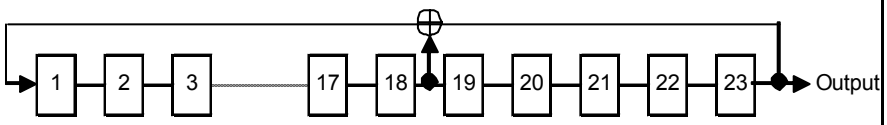
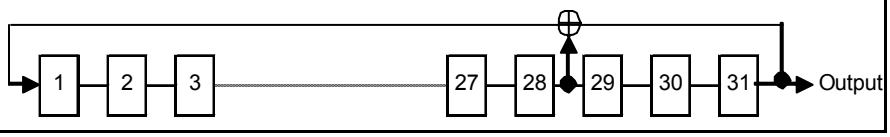
# Appendix 1 Pseudo Random Pattern (PRBS Pattern)

### Principles of Pseudo Random Pattern Generation

The pseudo random pattern is expressed by the N-th generating polynomial expression shown in the Table below. The cycle is “2N-1”. In the PRBS pattern having a cycle of “2N-1”, the pattern in which “1” is continued N bits is generated only once.

For the output level of the PRBS pattern, “1” and “0” correspond to the Low level and High level respectively when Polarity and Invert are set.

The mark ratio of the PRBS pattern of this instrument is fixed at “1/2”.

| Cycle | Generating Polynomial Expression | Pattern Generation Block |
|---|---|---|
| $2^7 - 1$ | $1 + X^6 + X^7$ |  |
| $2^{15} - 1$ | $1 + X^{14} + X^{15}$ |  |
| $2^{23} - 1$ | $1 + X^{18} + X^{23}$ |  |
| $2^{31} - 1$ | $1 + X^{28} + X^{31}$ |  |



N: Shift register, ⊕: Exclusive OR

# Appendix 2 Auto Sync Function

## Auto Sync Function

In this instrument, the pattern is synchronized by the PRBS pattern or program pattern. This instrument provides an auto sync function that compares the input pattern with the reference pattern to automatically establish the pattern synchronization.

## Synchronization Establishment/Sync Loss Conditions

Whether or not the synchronization is established is judged based on the threshold value conditions for the pattern synchronization.

If the error rate exceeds the threshold value of the sync loss conditions, it is judged as sync loss status. Additionally, if the error rate equals the threshold value of the synchronization establishment conditions or less, synchronization is judged to be established.

Furthermore, when the error rate always exceeds the threshold value of the sync loss conditions, the pattern cannot be synchronized.

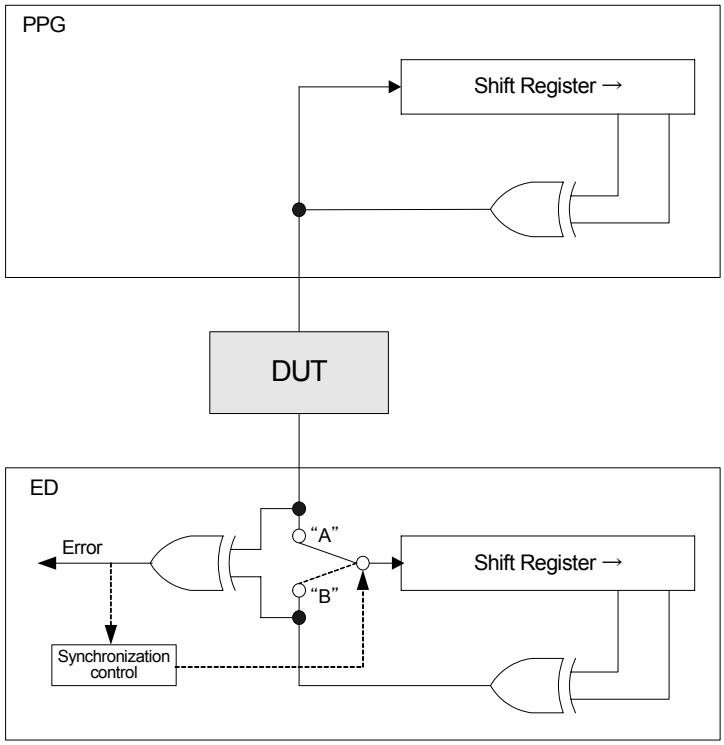
The pattern synchronization threshold value conditions for this instrument are as follows.

| Pattern | Sync loss conditions | | | Synchronization establishment conditions | | |
|---|---|---|---|---|---|---|
| | Measure Bit | Error Bit | Error Rate | Measure Bit | Error Bit | Error Rate |
| PRBS | 8,192 | 2,048 | 2.50E-01 | 128 | 2 | 1.56E-02 |
| PROGRAM | 16,384 | 128 | 7.81E-03 | 16,384 | 32 | 1.95E-03 |

# Appendix 3 PRBS Pattern Synchronization Method

### Block Diagram

The following shows the block diagram of the PRBS pattern synchronization method for this instrument.

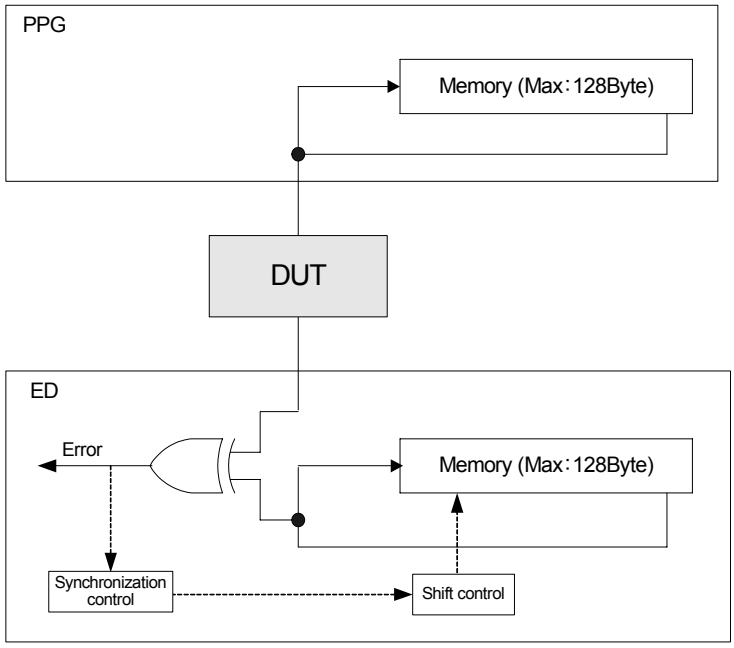



A side / B side auto switching

# Appendix 4 Program Pattern Synchronization Method

### Block Diagram

The following shows the block diagram of the Program pattern synchronization method for this instrument.




### Synchronization Method

The reference pattern is compared with the received pattern. If these patterns do not match, the pattern is shifted one bit and it is compared with the reference pattern again. This bit shift is performed repeatedly until the receive pattern matches the reference pattern in order to establish the synchronization.