AP9945
PORTABLE BERT

Compact Bit Error Rate Tester Dedicated to High-speed 10 Gbit/s Band

- PPG/ED integrated design
- Variable source option provides bit-rates from 9.95 Gbit/s to 11.32 Gbit/s
- Adjust output amplitude, offset and crosspoint
- Clock and Data Recovery (CDR) function included
- Compact and lightweight (5 kg)
- Low bit rate pattern generator

The AP9945 integrates a pulse pattern generator (PPG) and error detector (ED) in a compact, lightweight (5 kg) package, so a single unit can handle bit error rate (BER) measurements. In addition, the small size and light weight of the unit provides the following advantages:

- *Optimize the use of lab bench space*
- *Take measurements in close proximity to the system/device being measured*
- *Easily portable*

The AP9945 is controlled through a USB connection to a personal computer (*1) running Microsoft Windows (not included). The USB driver and control software are provided as standard features with the AP9945. (*1) Windows is a registered trademark of Microsoft Corporation.
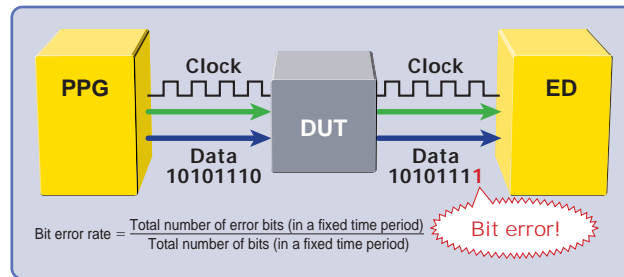
10G Bit/s Bit Error Rate

●PPG Function

- **Optional variable output supports multiple bit rates:**
  9.95 Gbit/s to 11.32 Gbit/s, variable in steps of 1 kHz
- **Output amplitude:**
  0.5 Vp-p to 2.0 Vp-p, variable in steps of 10 mV
- **Offset:**
  2.0 V to +3 V, variable in steps of 10 mV
- **Crosspoint:**
  30% to 70%, variable in steps of 1%
- **Data and data bar:**
  2 outputs
- **Trigger output for oscilloscope synchronization**
- **Port for external 10 G clock synchronization input and 1/16 or 1/64 synchronization input**
  It is possible to perform an error rate test with jitter deliberately added to the data pattern by inputting a synchronization signal with added jitter to this port.

●Bit Error Rate Test (BERT)

A BERT is a type of code error measurement made through digital communication using a PPG as the signal source and an ED as the error detector.

$$\text{Bit error rate} = \frac{\text{Total number of error bits (in a fixed time period)}}{\text{Total number of bits (in a fixed time period)}}$$

●ED Function

- **CDR function included as standard feature**
  The CDR signal extracts the clock from the data signal and performs synchronization when a data signal is the only input. In optical communications, the CDR function is a useful tool because the data signal is often transmitted alone.
- **In addition to the CDR input port, there are ports for inputting separate data and clock signals. When this ports are used, the phases of the data and clock must be matched externally.**
- **Input ranges:**
  0.1 Vp-p to 0.7 Vp-p (with CDR), 0.1 Vp-p to 0.6 Vp-p (without CDR)

●Test Patterns

- There are two types of test patterns: pseudo-random (PRBS) patterns and program patterns.
- The PRBS patterns range from PRBS7 to PRBS31.
- In the standard configuration, the AP9945 program pattern consists of 128 bytes. In addition to signal generation in the 10 Gbit/s band, the AP9945 can generate signals at divide rates of 1/2 (5 Gbit/s band), 1/4 (2.5 Gbit/s band), and 1/8 (1.25 Gbit/s band). Please note that the ED function only works with the 10 Gbit/s band.

●Supported Bit Rates

(Note: If a fixed bit rate is specified for the clock, then only the specified bit rate is supported.)

| Network name	Standard	Standard bit rate	FEC
SDH/SONET	STM-64/OC-192	9.953280 Gbit/s	10.664228 Gbit/s
	STM-16/OC-48		10.796778 Gbit/s
10G Ethernet	10GBASE-R	10.312500 Gbit/s	11.095728 Gbit/s
Fibre Channel	10G-FC	10.518750 Gbit/s	11.317642 Gbit/s
OTN	OTU2	10.709225 Gbit/s	

Example Applications

●Optical Device Characteristics Evaluation Test
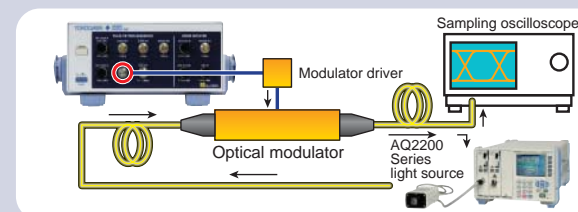
The AP9945 can be used to test and evaluate the characteristics of optical devices such as optical modulators and transmitter optical subassemblies (TOSA). Waveform characteristics can be observed using instruments such as an oscilloscope, optical spectrum analyzer, and optical power meter while varying the amplitude, offset, and crosspoint of the data input signal being input to the modulator driver.

- Rise and fall times: Tr/Tf, Crosspoint position
- Overshoot percentage
- Jitter measurements: Peak to peak and RMS
- Extinction ratio
- Pulse mask test
- Output power (peak, average), light wavelength

### ●XFP Module Characteristics Evaluation Test
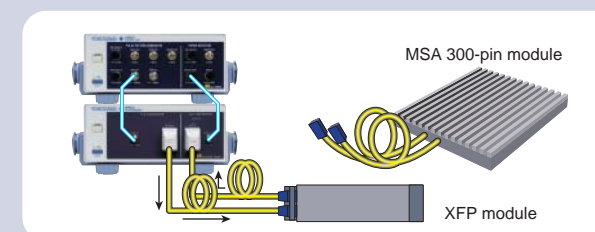
The XFP module is an MSA which is an optical transceiver containing an optical transmitter and an optical receiver. XFP technology is very flexible, with support for STM-64/OC-192, 10G Fibre Channel, and 10G Ethernet. The XFP module requires the following tests:

- Jitter test
- Optical reception sensitivity test
- Optical output eye mask test

With AQ2200 Series modules (sold separately), it is possible to install the BERT, optical modulator, optical receiver, optical ATTN, and other equipment in a 19-inch rack to form an extremely compact test system. The AQ2200 Series can also handle optical receiver sensitivity tests.

AP9945 Standard Software Screen
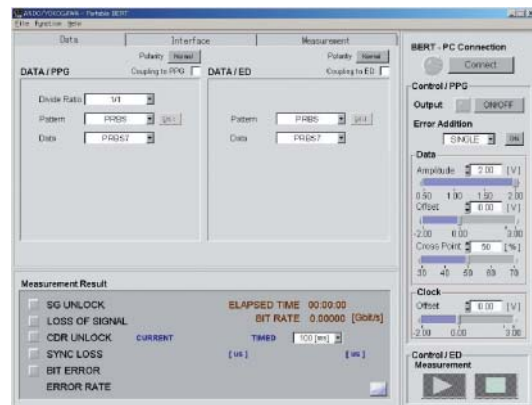
① **PPG**
  ①-1 Divide Rate
    : Bit rate divide rate setting (1/1, 1/2, 1/4, 1/8)
  ①-2 Pattern
    : PRBS or PROGRAM
  ①-3 DATA
    : When PRBS is set, select PRBS7, PRBS15, PRBS23, or PRBS31.
      When PROGRAM is set, a separate data input window is displayed

② **ED**
  ②-1 Pattern
    : PRBS or PROGRAM
  ②-2 DATA
    : When PRBS is set, select PRBS7, PRBS15, PRBS23, or PRBS31.
      When PROGRAM is set, a separate data input window is displayed.

③ **Measurement Result**: Measurement result display area
④ **Connection**: Button for connecting/disconnecting AP9945 and PC
⑤ **PPG Output**: PPG output ON/OFF button
⑥ **Error Addition**: Error addition setting
⑦ **Output Waveform Setting**: The slidebar waveform, which changes each of the settings for the PPG output waveform, can be changed while it is being output.
⑧ **Measurement Start/Stop**: ED measurement start/stop button

Specifications

PPG and ED

Item	Product specifications
When clock is specified	Select up to two of the following frequencies: 9.95328 GHz, 10.3125 GHz, 10.6642 GHz, 10.709 GHz, 11.095 GHz.
When built-in signal generation is specified	
Variable frequency range	9.95 to 11.32 GHz
Minimum setting increment	1 kHz
External reference	
Frequency	1/64 or 1/16 of bit rate
Input level	0.4 to 1.0 Vp-p: 50 Ω AC
External clock input	
Frequency	1/1 bit rate
Input level	0.4 to 1.0 Vp-p: 50 Ω AC
Trigger output	
Clock trigger	1/64 or 1/16 of clock output frequency
Pattern trigger	PRBS, PROGRAM
Output level	0.6Vp-p ± 0.3V

PPG only

Item	Product specifications
Data output	
Bit rate	9.95 Gbit/s to 11.32 Gbit/s
Output level	0.50 to 2.00 Vp-p (in steps of 10 mV)
Offset voltage	−2 V to +3 V (in steps of 10 mV)
Crosspoint variation	30% to 70% (in steps of 1%)
Connector	3.5 mm female 50 Ω AC termination or DC termination
Clock output	
Output level	0.6 Vp-p (AC coupled)
Offset	−2 V to +3 V (in steps of 10 mV)
Connector	SMA female 50 Ω AC termination or DC termination
Transmit patterns	
PRBS	7, 15, 23, or 31
PROGRAM	128 Byte
Low Bit Rate	Patterns equal to 1/2, 1/4, and 1/8 the supported Bit Rates (9.95 Gbit/s to 11.1 Gbit/s)

ED only

Item	Product specifications
DATA IN (CDR)	
Bit rate	9.95 Gbit/s to 11.32 Gbit/s
Input level range	0.1 to 0.7 Vp-p
Input threshold value variation	±0.35 V (in steps of 1 mV)
Connector	3.5 mm female: 50 Ω AC coupling
DATA IN	
Bit rate	9.95 Gbit/s to 10.71 Gbit/s
Input level range	0.1 to 0.6 Vp-p
Input threshold value variation	±0.3 V (in steps of 1mV)
Connector	3.5 mm female: 50 Ω AC coupling
Clock input	
Frequency	Frequency with same bit rate synchronized to data input
Input level	0.2 to 0.6 Vp-p
Connector	SMA female: 50 Ω AC coupling
Receiving patterns	Same as PRBS and PROGRAM sending patterns (Low Bit Rate does not supported)

PORTABLE BERT AP 9945

Model

Product	Model		Remarks
AP9945 Portable BERT	734001	-□ -□ -□ -□	
		-SG0: No SG	F1□ required
		-SG1: Built-in SG	Cannot be combined with F1□
		-F10 : No generator 1	SG1 required
		-F11 : Generator 1	9.95328 GHz
		-F12 : Generator 1	10.3125 GHz
		-F13 : Generator 1	10.6642 GHz
		-F14 : Generator 1	10.709 GHz
		-F15 : Generator 1	11.095 GHz
		-F20 : No generator 2	F1□ required
		-F22 : Generator 2	10.3125 GHz
		-F23 : Generator 2	10.6642 GHz
		-F24 : Generator 2	10.709 GHz
		-F25 : Generator 2	11.095 GHz
		-E : VDE AC250V straight	
		-G : AS AC250V straight	
		-J : BS AC250V straight	
		-T : UL/CSA AC125V straight,3 to 2pin Converter	
		-U : UL/CSA AC125V straight	
		/PA : Clock Phase Adjuster	

Note 1: The frequency for the standard product is 9.95328 GHz.

7340 01-SG0-F11-F20-□

Example 1: Setting the oscillator to 10.3125 GHz only

7340 01-SG0-F12-F20-□

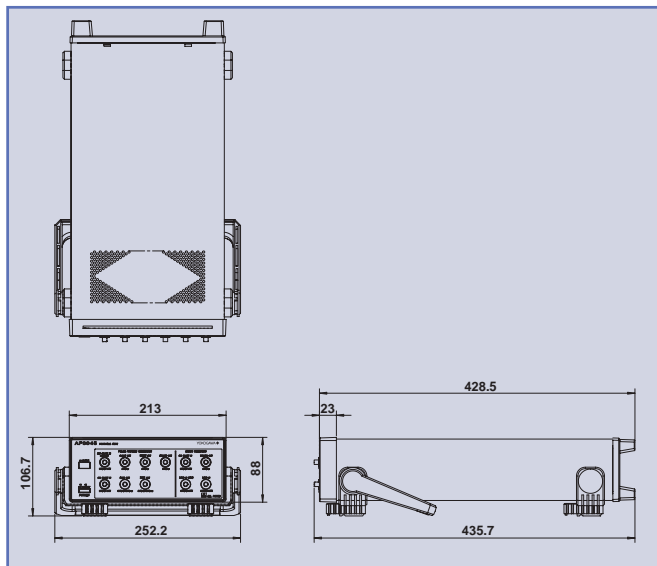Example 2: Setting the oscilloscope to both 10.3125 GHz and 11.095 GHz

7340 01-SG0-F12-F25-□

Example 3: Specifying the built-in SG type

7340 01-SG1-F10-F20-□

Note: The bit rate cannot be changed in internal clock mode except with the built-in SG type. However, the bit rate can be changed using an external clock.

External Dimensions

213
106.7
88
252.2
AP9945
428.5
23
435.7