

# Optical Sampling Modules

- ▶ 80C01 • 80C02 • 80C05 • 80C06 • 80C07B • 80C08C • 80C10 • 80C11



## CSA/TDS8000 Series Sampling Oscilloscope Optical Modules

The CSA/TDS8000 Series Sampling Oscilloscopes, when configured with one or more optical sampling modules, provide complete optical test solutions for Telecom (155 Mbps to 43.018 Gbps) or Datacom (Fibre Channel, Gigabit Ethernet, 10 GbE and InfiniBand) applications, as well as general purpose optical component testing.

Each optical module includes all the elements necessary for optical testing:

- ▶ Optical to electrical converter
- ▶ Average power monitor
- ▶ One or more reference receiver filters\*<sup>1</sup>
- ▶ A full bandwidth optical path
- ▶ A low-noise electrical sampler\*<sup>2</sup>
- ▶ Optional clock recovery
- ▶ Universal optical input connector

\*<sup>1</sup>Excluding 80C05 and 80C06, which do not include reference receiver filter rates except for 9.953 Gbps rate provided by 80C05.

\*<sup>2</sup>Excluding 80C06.

### 80C01 Multi-rate Telecom Sampling Module

– The 80C01 module supports waveform conformance testing of long-wavelength (1100 to 1650 nm) signals at 622, 2488 Mbps and 9.953 Gbps as well as general-purpose testing with up to 20 GHz optical bandwidth. With its clock recovery option, the 80C01 provides testing solutions for 622 and 2488 Mbps telecom applications.

### 80C02 High-performance Telecom Sampling Module

– The 80C02 module is optimized for testing of long-wavelength (1100 to 1650 nm) signals at 9.953 Gbps (SONET OC-192/SDH STM-64). With its high optical bandwidth of 30 GHz (typical), it is also well-suited for general purpose, high-performance optical component testing. The 80C02 can be optionally configured with clock recovery that supports 9.953 Gbps telecom standards.

## ▶ Features & Benefits

- 10 Gbps Telecom and Datacom
  - 80C08C Low-noise, High Optical Sensitivity and Broad Wavelength Conformance Testing for 10 GbE LAN, WAN and FEC, 10G Fibre Channel and 10 Gbps Telecom Rates
  - 80C11 30 GHz Optical Bandwidth Conformance Testing and Characterization for 10 Gbps Telecom and Datacom Standards
  - 80C08C and 80C11 Integrated Clock Recovery Supports Standard or User Defined Rate from 9.8 to 12.6 Gbps

- 40 Gbps Telecom
  - 80C10, 80C05 and 80C06 Provide Highest Optical Bandwidth Capability for Performance Testing and Signal Characterization of 40 Gbps RZ or NRZ Data Formats
  - 80C10 Provides 65 GHz Optical Bandwidth and Reference Receivers for Conformance Testing of 39.813 Gbps (OC-768/STM-256) and 43.018 Gbps (ITU-T G.709 FEC)

### Tributary Telecom and Datacom

- 80C07B Provides Excellent Optical Sensitivity and Broad Wavelength Test Capability
- 80C01 and 80C07B Multi-rate Telecom Conformance Testing Solutions from 155 Mbps (OC-3/STM-4) through 9.953 Gbps (OC-192/STM-64) and Multi-rate Datacom Conformance Testing Solutions for Fibre Channel, Gigabit Ethernet, and InfiniBand Standards

## ▶ Applications

- High-speed Optical Communications Testing
- Eye-pattern and Pulse Shape Analysis
- Conformance Testing

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### 80C05 40 GHz Optical Sampling

**Module** – The 80C05 module is optimized for testing long-wavelength (1520 to 1580 nm) telecom signals at 40 Gbps and with reference receiver filtering provided for 9.953 Gbps. The 80C05, with its selectable bandwidth, lets the user choose optimal noise vs. bandwidth performance to accurately characterize the signal. With its high optical bandwidth (40 GHz), it is also well-suited for general purpose, high-performance optical component testing.

### 80C06 55 GHz Optical Sampling

**Module** – The 80C06 module is optimized for testing long-wavelength (1520 to 1580 nm), high-power, high-bandwidth optical signals that are typical of transmission tests for 40 Gbps NRZ and RZ systems. With its high optical bandwidth, 55 GHz (typical), it is also well-suited for general-purpose, high-performance optical component testing.

### 80C07B Multi-rate, Datacom and Telecom Optical Sampling Module –

The 80C07B module is a broad wavelength (700 to 1650 nm) multi-rate optical sampling module optimized for testing datacom/telecom signals from 155 to 2500 Mbps. With its amplified O/E converter design, this module provides excellent signal-to-noise performance, allowing users to examine low-power optical signals. The 80C07B can be optionally configured with clock recovery that supports 155, 622, 1063, 1250, 2125, 2488, 2500 and 2666 Mbps rates.

### 80C08C Multi-rate, Datacom and Telecom Optical Sampling Module with 10 GbE Forward Error Correction -

The 80C08C module is a broad wavelength (700 to 1650 nm) multi-rate optical sampling module providing datacom rate testing for 10GbE applications at 9.953, 10.3125, 11.0957 Gbps and 10G Fibre Channel applications at 10.51875 Gbps. The 80C08C also provides telecom rate testing at 9.953, 10.664, and 10.709 Gbps. With its amplified O/E converter design, this module provides excellent signal-to-noise performance and high optical sensitivity, allowing users to examine low-power level optical signals. The 80C08C can be optionally configured with clock recovery options that can support any standard or user defined rate in the continuous range from 9.8 to 12.6 Gbps.

### 80C10 65 GHz 40 Gbps Optical Sampling Module with 43 Gbps ITU-T G.709

**Forward Error Correction** – The 80C10 module provides integrated and selectable reference receiver filtering, enabling conformance testing at either 1310 nm or 1550 nm for 39.813 Gbps (OC-768/STM-256) and 43.018 Gbps (43 Gbps ITU-T G.709 FEC) rates. In addition to the filter rates, the user may also choose selectable bandwidths of 30 GHz or 65 GHz for optimal noise vs. bandwidth performance for accurate signal characterization.

### 80C11 Multi-rate, Datacom and Telecom Optical Sampling Module –

The 80C11 module is a long wavelength (1100 to 1650 nm) multi-rate optical sampling module optimized for testing 10 Gbps datacom and telecom standard rates at 9.953, 10.3125, 10.51875, 10.664, 10.709, and 11.0957 Gbps. With its high optical bandwidth of up to 30 GHz (typical) it is well-suited for general purpose high-performance 10 Gbps optical component testing. The 80C11 can be optionally configured with clock recovery options that can support any standard or user defined rate in the continuous range from 9.8 to 12.6 Gbps.

## Optical Sampling Modules

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### ► Characteristics

#### ► Optical Sampling Module Characteristics (Refer to Optical Sampling Module User Manual for more detailed information)

	Application Type	Standards and Supported Filter Rates	Number of Input Channels	Effective Wavelength Range	Calibrated Wavelengths
80C01	Tributary Telecom	OC-12/STM-4 (622 Mbps), OC-48/STM-16 (2.488 Gbps), OC-192/STM-64 (9.953 Gbps)	1	1100 nm to 1650 nm	1310 nm and 1550 nm (±20 nm)
80C02	10 Gbps Telecom	OC-192/STM-64 (9.953 Gbps) 10GBASE-W (9.953 Gbps)	1	1100 nm to 1650 nm	1310 nm and 1550 nm (±20 nm)
80C05	40 Gbps Telecom	OC-192/STM-64 (9.953 Gbps)	1	1520 nm to 1580 nm	1550 nm (±20 nm)
80C06	40 Gbps Telecom	—	1	1520 nm to 1580 nm	1550 nm (±20 nm)
80C07B	Tributary Datacom/Telecom	Standard Included: OC-48/STM-16 (2.488 Gbps), InfiniBand, 2 GbE (2.500 Gbps); Optional (choose any two): OC-3/STM-1 (155 Mbps), OC-12/STM-4 (622 Mbps) Fibre Channel (1.063 Gbps), GbE (1.250 Gbps), 2G Fibre Channel (2.125 Gbps)	1	700 nm to 1650 nm	780 nm, 850 nm, 1310 nm, 1550 nm (±20 nm)
80C08C	10 Gbps Datacom/Telecom	OC-192/STM-64 (9.953 Gbps), 10GBASE-W (9.95328 Gbps), 10GBASE-R (10.31 Gbps), 10G Fibre Channel (10.52 Gbps) ITU-T G.975 FEC (10.664 Gbps), ITU-T G.709 (10.709 Gbps), 10 GbE FEC (11.1 Gbps)	1	700 nm to 1650 nm	780 nm, 850 nm, 1310 nm, 1550 nm (±20 nm)
80C10	40 Gbps Telecom	OC-768/STM-256 (39.813 Gbps), ITU-T G.709 FEC (43.018 Gbps)	1	1310 nm and 1550 nm	1310 nm and 1550 nm (±20 nm)
80C11	10 Gbps Datacom/Telecom	OC-192/STM-64 (9.953 Gbps), 10GBASE-W (9.95328 Gbps), 10GBASE-R (10.31 Gbps), 10G Fibre Channel (10.52 Gbps) ITU-T G.975 FEC (10.664 Gbps), ITU-T G.709 (10.709 Gbps), 10 GbE FEC (11.1 Gbps)	1	1100 nm and 1650 nm	1310 nm and 1550 nm (±20 nm)

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### ► Optical Sampling Module Characteristics (continued)

	<b>Clock Recovery (optional)</b>	<b>Clock Recovery Outputs</b>	<b>Unfiltered Optical Bandwidth*1</b>	<b>Absolute Maximum Nondestructive Optical Input</b>	<b>Internal Fiber Diameter</b>
80C01	Option CR: 622 Mbps, 2.488 Gbps	±Clock, ±Data	20 GHz	5 mW average; 10 mW peak power at wavelength of highest relative responsivity	9 μm/125 μm single-mode
80C02	Option CR: 9.953 Gbps	Clock, Clock/16, Data	28 GHz	5 mW average; 10 mW peak power at wavelength of highest relative responsivity	9 μm/125 μm single-mode
80C05	Not Available	Not Available	40 GHz	20 mW average; 60 mW peak power at wavelength of highest relative responsivity	9 μm/125 μm single-mode
80C06	Not Available	Not Available	<i>55 GHz</i>	20 mW average; 60 mW peak power at wavelength of highest relative responsivity	9 μm/125 μm single-mode
80C07B	Option CR1: 155 Mbps, 622 Mbps, 1.063 Gbps, 1.250 Gbps, 2.125 Gbps, 2.488 Gbps, 2.500 Gbps, 2.66 Gbps	±Clock, ±Data	<i>2.5 GHz</i>	5 mW average; 10 mW peak power at wavelength of highest responsivity	62.5 μm/125 μm multi-mode
80C08C	Option CR1: 9.953 Gbps, 10.31 Gbps; Option CR2: 10.31 Gbps, 10.52 Gbps; Option CR4: Continuous from 9.8 Gbps to 12.6 Gbps	Clock, Clock/16	<i>10 GHz</i>	1 mW average; 10 mW peak power at wavelength of highest responsivity	Single-mode and multi-mode fibers up to core diameter of 62.5 μm
80C10	Future Upgradeable	Future	<i>65 GHz</i>	20 mW average; 60 mW peak power at wavelength of highest relative responsivity	9 μm/125 μm single-mode
80C11	Option CR1: 9.953 Gbps; Option CR2: 9.953 Gbps, 10.664 Gbps; Option CR3: 9.953 Gbps, 10.709 Gbps; Option CR4: Continuous between 9.8 Gbps to 12.6 Gbps	CR1: Clock, Clock/16, Data; CR2, CR3, CR4: Clock, Clock/16	28 GHz	5 mW average; 10 mW peak power at wavelength of highest responsivity	9 μm/125 μm single-mode

\*1 Values shown are warranted unless printed in an italic typeface which represents a typical value.

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### ▶ Optical Sampling Module Characteristics (continued)

	Optical Return Loss	Fiber Input Accepted	RMS Optical Noise (typical)	RMS Optical Noise (maximum)	Independent Channel Deskew
80C01	>30 dB	single-mode	8.0 $\mu$ W at 622.08 Mbps, 2.488 Gbps, 9.953 Gbps, 12.5 GHz; 15.0 $\mu$ W at 20 GHz	12.0 $\mu$ W at 622 Mbps, 2.488 Gbps, 9.953 Gbps 12.5 GHz; 25 $\mu$ W at 20 GHz	Standard
80C02	>30 dB	single-mode	6.0 $\mu$ W at 9.953 Gbps, 12.5 GHz; 10.0 $\mu$ W at 20 GHz; 15.0 $\mu$ W at 30 GHz	10.0 $\mu$ W at 9.953 Gbps, 12.5 GHz mode; 15 $\mu$ W at 20 GHz; 30 $\mu$ W at 30 GHz	Standard
80C05	>30 dB	single-mode	10.0 $\mu$ W at 9.953 Gbps; 15 $\mu$ W at 20 GHz; 25 $\mu$ W at 30 GHz; 70 $\mu$ W at 40 GHz	15 $\mu$ W at 9.953 Gbps; 25 $\mu$ W at 20 GHz; 35 $\mu$ W at 30 GHz; 70 $\mu$ W at 40 GHz	Standard
80C06	>30 dB	single-mode	150 $\mu$ W at 55 GHz	192 $\mu$ W at 55 GHz mode	Standard
80C07B	>14 dB (multi-mode) >24 dB (single-mode)	single- or multi-mode	0.50 $\mu$ W at 155 Mbps, 622 Mbps; 1063 Mbps, 1250 Mbps; 0.70 $\mu$ W at 2.488/2.500 Gbps	1.0 $\mu$ W at 155 Mbps, 622 Mbps, 1063 Mbps, 1250 Mbps; 1.5 $\mu$ W at 2.488/2.500 Gbps	Standard
80C08C	>14 dB (multi-mode) >24 dB (single-mode)	single- or multi-mode	1.7 $\mu$ W at all filter rates	3.0 $\mu$ W at all filter rates	Standard
80C10	>30 dB	single-mode	40 $\mu$ W at 39.813 Gbps, 43.018 Gbps (1550 nm); 75 $\mu$ W at 39.813 Gbps, 43.018 Gbps (1310 nm); 30 $\mu$ W at 30 GHz mode (1550 nm); 55 $\mu$ W at 30 GHz mode (1310 nm); 85 $\mu$ W at 65 GHz mode (1550 nm); 150 $\mu$ W at 65 GHz mode (1310 nm)	60 $\mu$ W at 39.813 Gbps, 43.018 Gbps (1550 nm); 110 $\mu$ W at 39.813 Gbps, 43.018 Gbps (1310 nm); 50 $\mu$ W at 30 GHz mode (1550 nm); 90 $\mu$ W at 30 GHz mode (1310 nm); 120 $\mu$ W at 65 GHz mode (1550 nm); 220 $\mu$ W at 65 GHz mode (1310 nm)	Standard
80C11	>30 dB	single-mode	5.5 $\mu$ W at all filter rates; 10.0 $\mu$ W at 20 GHz 20.0 $\mu$ W at 30 GHz	3.0 $\mu$ W at all filter rates; 14.0 $\mu$ W at 20 GHz 30.0 $\mu$ W at 30 GHz	Standard

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### ► Optical Sampling Module Characteristics (continued)

	Offset Capability	Power Meter	Power Meter Range	Power Meter Accuracy	Mask Test Optical Sensitivity*2
80C01	Standard	Standard	+4 dBm to -30 dBm	5% of reading	-8 dBm at 622 Mbps, 2.488 Gbps, 9.953 Gbps; -5.0 dBm at 20 GHz
80C02	Standard	Standard	+4 dBm to -30 dBm	5% of reading	-9 dBm at 9.953 Gbps; -7 dBm at 20 GHz; -4 dBm at 30 GHz
80C05	Standard	Standard	+13 dBm to -21 dBm	5% of reading	-7 dBm at 9.953 Gbps; -5 dBm at 20 GHz; -3 dBm at 30 GHz; 0 dBm at 40 GHz
80C06	Standard	Standard	+13 dBm to -21 dBm	5% of reading	+5 dBm at 55 GHz mode
80C07B	Standard	Standard	+4 dBm to -30 dBm	5% of reading	-22 dBm at 155 Mbps, 622 Mbps; -20 dBm at 2488/2500 Mbps
80C08C	Standard	Standard	0 dBm to -30 dBm	5% of reading	-15 dBm at all filter rates
80C10	Standard	Standard	+13 dBm to -21 dBm	5% of reading	0 dBm at 39.813 Gbps, 43.018 Gbps; 0 dBm at 30 GHz; +3 dBm at 65 GHz
80C11	Standard	Standard	+4 dBm to -30 dBm	8% of reading	-10 dBm at all filters rates, -7 dBm at 20 GHz; -4 dBm at 30 GHz mode

\*2Smallest power level for mask test. Values represent theoretical typical sensitivity of NRZ eyes for competitive comparison purposes. Assumes instrument peak-peak noise consumes most of the mask margin.

### Physical Characteristics for Optical Sampling Modules

	Dimensions (mm/inches)			Weight (kg/lb)
	Width	Height	Depth	Net
80C01	165/6.5	25/1.0	305/12.0	<2.61/<5.75
80C02	165/6.5	25/1.0	305/12.0	<2.61/<5.75
80C05	165/6.5	25/1.0	305/12.0	>2.61/>5.75
80C06	165/6.5	25/1.0	305/12.0	>2.61/>5.75
80C07B	165/6.5	25/1.0	305/12.0	<1.36/<3.0
80C08C	165/6.5	25/1.0	305/12.0	<1.22/<2.7
80C10	165/6.5	25/1.0	305/12.0	>2.61/>5.75
80C11	165/6.5	25/1.0	305/12.0	<1.22/<2.7

### ► Optical Module Application Summary

Filter Rate	Optical Sampling Module
<b>SONET/SDH</b>	
155 Mbps (OC-3/STM-1)	80C07B
622 Mbps (OC-12/STM-4)	80C01, 80C07B
2.488 Gbps (OC-48/STM-16)	80C01, 80C07B
9.953 Gbps (OC-192/STM-64)	80C01, 80C02, 80C05, 80C08C, 80C11
10.66423 Gbps (ITU-T G.975 FEC)	80C08C, 80C11
10.709225 Gbps (ITU-T G.709 FEC)	80C08C, 80C11
39.813 Gbps (OC-768/STM-256)	80C05*3, 80C06*3, 80C10
43.018 Gbps (ITU-T G.709 FEC 43.02 Gbps)	80C05*3, 80C06*3, 80C10
<b>Gigabit Ethernet</b>	
1.250 Gbps (GbE)	80C07B
2.500 Gbps (2 GbE)	80C07B
9.95328 Gbps (10GBASE-W)	80C08C, 80C11, 80C02
10.3125 Gbps (10GBASE-R)	80C08C, 80C11
11.0957 Gbps (10 GbE FEC)	80C08C, 80C11
<b>Fibre Channel</b>	
1.063 Gbps (FC)	80C07B
2.125 Gbps (2G FC)	80C07B
10.51875 Gbps (10G FC)	80C08C, 80C11
<b>InfiniBand</b>	
2.500 Gbps (InfiniBand)	80C07B

\*3Filter for this rate not provided by this module.

## ► Ordering Information

### 80C01

**Includes:** User manual, FC/PC optical connector.

Frequency response curves for 622, 2488 and 9953 Mbps filter rates.

**Opt. CR** – 622 and 2488 Mbps clock recovery.

### 80C02

**Optical Sampling Module.**

**Includes:** User manual, FC/PC optical connector.

Frequency response curves for 9.953 Gbps filter rates.

**Opt. CR** – 9.953 Gbps clock recovery.

### 80C05

**Optical Sampling Module.**

**Includes:** User manual, FC/PC optical connector.

Frequency response curves for 9.953 Gbps filter rates.

**80C05E1** – Bundled ordering configuration includes 80C05 plus one 80E01 single-channel 50 GHz electrical module.

### 80C06

**Optical Sampling Module.**

**Includes:** User manual, FC/PC optical connector.

**80C06E1** – Bundled ordering configuration includes 80C06 plus one 80E06 single-channel 70+ GHz electrical module.

### 80C07B

**Multi-rate Datacom and Telecom Optical Sampling Module.**

**Includes:** User Manual, FC/PC Optical Connector.

Frequency response curves for 2.488, 2.500 Gbps data rates plus selected filter option data rates.

**Opt. CR1** – 155/622/1063/1250/2125/2488/2500/2666 Mbps clock/data recovery.

User must select any one (1) of the following filter options:

**Opt. F1** – 155, 622 Mbps.

**Opt. F2** – 155, 1063 Mbps.

**Opt. F3** – 155, 1250 Mbps.

**Opt. F4** – 155, 2125 Mbps.

**Opt. F5** – 622, 1063 Mbps.

**Opt. F6** – 622, 1250 Mbps.

**Opt. F7** – 622, 2125 Mbps.

**Opt. F8** – 1063, 1250 Mbps.

**Opt. F9** – 1063, 2125 Mbps.

**Opt. F10** – 1250, 2125 Mbps.

### 80C08C

**Multi-rate Datacom and Telecom Optical Sampling Module.**

**Includes:** User Manual, FC/PC optical connector.

Frequency response curves for 9.953, 10.31, 10.52, 10.66, 10.71, 11.1 Gbps filter rates.

**Opt. CR1** – 9.953, 10.31 Gbps clock recovery.

**Opt. CR2** – 10.31, 10.52 Gbps clock recovery.

**Opt. CR4** – Continuous rate clock recovery supporting any standard or user-definable rate in the range from 9.8 to 12.6 Gbps.

### 80C10

**Multi-rate Optical Sampling Module.**

**Includes:** User manual, FC/PC optical connector.

Frequency response curves for 39.813 and 43.108 Gbps filter rates.

**80C10E1** – Bundled ordering configuration includes 80C10 plus one 80E06 single-channel 70+ GHz electrical module.

### 80C11

**Multi-rate Datacom and Telecom Optical Sampling Module.**

**Includes:** User Manual, FC/PC optical connector.

Frequency response curves for 9.953, 10.31, 10.52, 10.66, 10.71, 11.1 Gbps filter rates.

**Opt. CR1** – 9.953 Gbps clock recovery.

**Opt. CR2** – 9.953, 10.66 Gbps clock recovery.

**Opt. CR3** – 9.953, 10.71 Gbps clock recovery.

**Opt. CR4** – Continuous rate clock recovery supporting any standard or user-definable rate in the range from 9.8 to 12.6 Gbps.

## Service

**Opt. C3** – Three years of Calibration Service.

**Opt. C5** – Five years of Calibration Service.

**Opt. D1** – Calibration data report.

**Opt. D3** – Three years of calibration data reports (requires Opt. C3).

**Opt. D5** – Five years of calibration data reports (requires Opt. C5).

**Opt. R3** – Extended repair warranty to three years.

**Opt. R5** – Extended repair warranty to five years.

## Optical Connector Accessories

While the FC/PC connector is standard with the 8000 Series optical sampling modules, the input connector type can be interchanged with any of the following standard adapters:

**ST/PC** – Order 119-4513-00.

**D4/PC** – Order 119-4514-00.

**Biconic** – Order 119-4515-00.

**FC/APC** – Order 119-5115-00.

**SMA 2.5** – Order 119-4517-00.

**SC/APC** – Order 119-5116-00.

**DIN/PC 47256** – Order 119-4546-00.

**HP/PC** – Order 119-4556-00.

**SMA** – Order 119-4557-00.

**DIAMOND 3.5** – Order 119-4558-00.

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