Tektronix®

DPO7OE1 33 GHz Optical Probe

The DPO7OE1 is a 33 GHz, low noise, broad wavelength optical probe with optical reference receiver (ORR) performance for 28Gbaud PAM4 and PAM2 (NRZ). The DPO7OE1 can be used as a conventional Optical-to-Electrical (O/E) converter for wide-bandwidth optical signal acquisition. The DPO7OE1 provides an FC/PC or FC/APC optical connection for Tektronix DPO/MSO70000 C/DX/SX model oscilloscopes for high-speed optical signal verification.

Features and benefits

- Accurate Optical Reference Receiver (ORR) filters for 25 GBd, 26 GBd, and 28 GBd optical networking standards ensure highest measurement accuracy and correlation
- Versatile design delivers Bessel-Thompson ORR specified bandwidths or unfiltered response up to 33 GHz on multiple channels
- Broad wavelength (750 nm to 1650 nm), single-mode/multi-mode input with FC/PC or FC/APC connector options
- High sensitivity and low noise provide best SNR for high-speed signal analysis
- Enables deep analysis of PAM4 and PAM2 (NRZ) signaling, equalization and error detection/isolation
- Compatible with ATI and TekConnect® channels for maximum performance or channel density

Applications

- Datacenter Networking equipment design validation
- Research - Characterization of laser-based velocity measurement system (e.g. PDV, BLR) and other optical phenomena
- System debug of optical interfaces using a real time oscilloscope's unique debug features

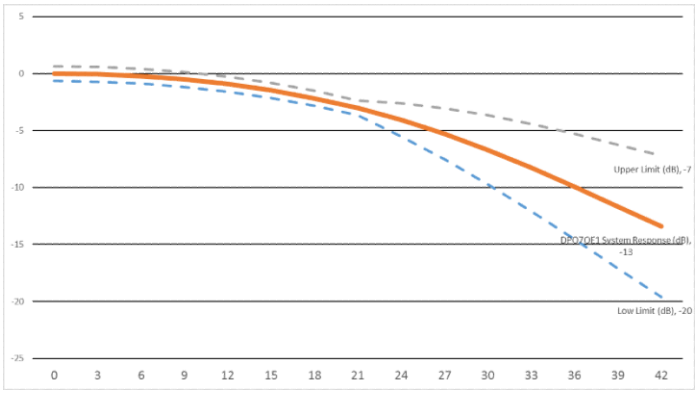
Optical reference receiver performance

Achieving Optical Reference Receiver (ORR) response requires sufficient instrument bandwidth to ensure smooth frequency roll-off characteristics beyond the data rate. For design of Datacenter Networking equipment, an ORR with a fourth-order Bessel-Thomson (BT4) frequency response is generally used. For NRZ (PAM2), the reference receiver's −3 dB electrical bandwidth is set to a frequency of 75% of the optical symbol rate and its bandwidth limit guard bands are specified to a frequency of 150% of the optical symbol rate. Using these values for a 28 GBd optical signal yields the following frequency response requirements:

Optical reference receiver attenuation	Frequency
-3 dB	0.75 * 28 G = 21 GHz
Nominal: -10 dB Range: -7 to -20 dB	1.50 * 28 G = 42 GHz

For PAM4 signals the BT4 filter is tuned lower. The electrical bandwidth is set to a frequency corresponding to 50% of the symbol rate. The ORR BT4 filters for the important symbol rates of PAM4 standards, such as 26.5625 GBd, are also available in the DPO7OE1.

The DPO7OE1 can be used in conjunction with 50 GHz and higher ATI channels on the DPO70000SX instruments, providing ample bandwidth for a smooth BT response for up to 28 GBd data. The graph below shows a typical frequency response of the DPO7OE1 on a DPO77002SX real-time oscilloscope.



Fourth order Bessel-Thompson frequency response of the DPO7OE1 Optical Probe and DPO70000SX ATI channel

The smooth, controlled system response with the DPO7OE1 and DPO70000SX oscilloscope is possible because the oscilloscope's system software calculates the BT4 filters using the S-parameters unique to the optical probe and the oscilloscope channel. Most real-time oscilloscopes today have a rather sharp roll-off (e.g. "brick wall") at or just above the rated channel bandwidth. This response limits the ability to replicate a true BT4 response, which has a much more gradual roll-off characteristic. Without a true BT4 response, the signal's eye opening will be reduced, adversely impacting the accuracy of the measurement.

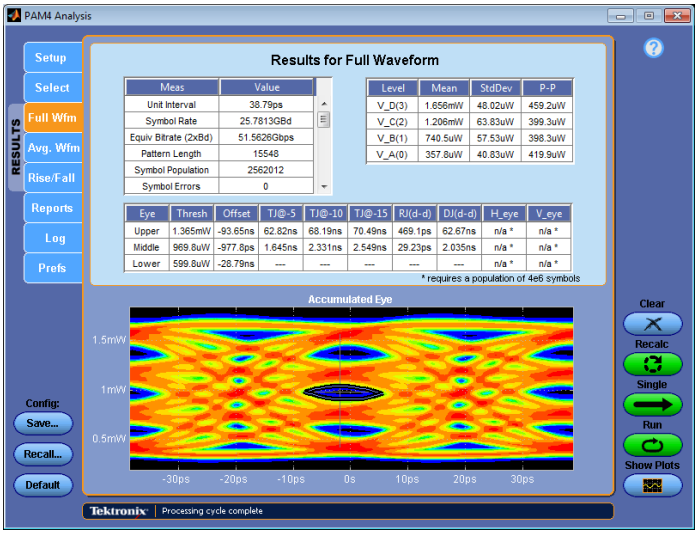
Optical signal analysis

The DPO7OE1 optical probe enables deep analysis of PAM4 and PAM2 (NRZ) signaling using Tektronix' industry leading DPOJET Jitter and Eye Analysis and PAM4 Analysis software.

DPOJET supports the traditional optical measurements. These measurements include extinction ratio, eye high, eye low, eye crossing, average optical power, and optical modulation amplitude.

Industry-leading PAM4 signaling analysis

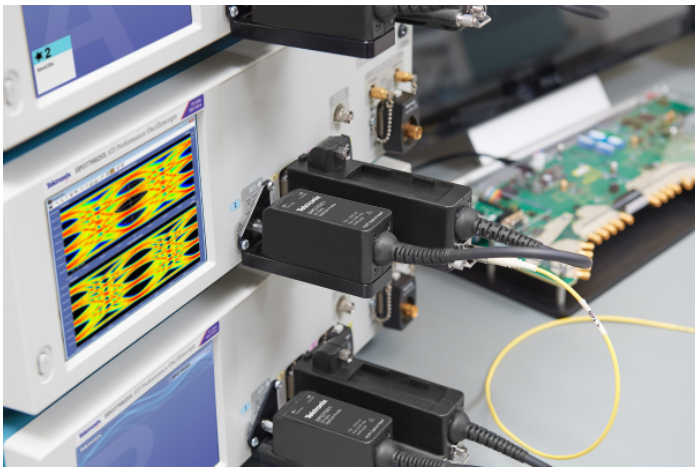
The PAM4 software supports analysis of PAM4 optical signals with clock recovery, error detection, and IEEE and OIF-CEI standard specific measurements, e.g. TDECQ.



PAM4 Analysis Software with Eye Diagram and Example measurement Results

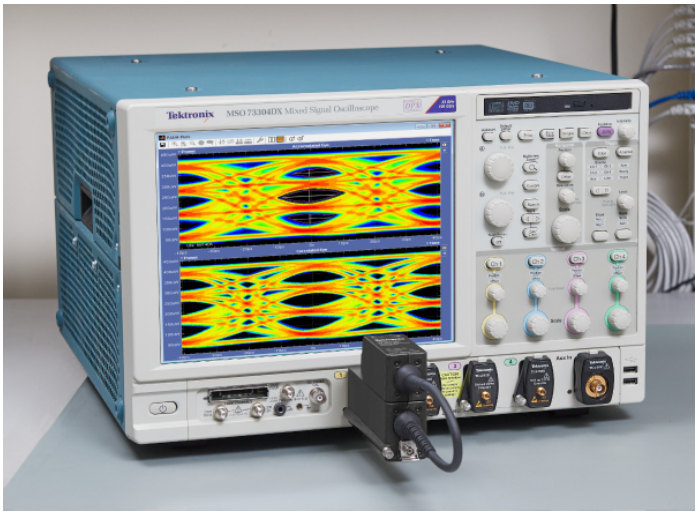
Versatile configurations

The versatile design of the DPO7OE1 optical probe is compatible with either a DPO70000SX oscilloscope's ATI channel or channels with the TekConnect interface. This versatility makes the DPO7OE1 optical probe suitable for use with all DPO70000SX, MSO/DPO70000DX, and MSO/DPO70000C series oscilloscopes.



Optical Reference Receiver on a DPO70000SX oscilloscope's ATI Channel

DPO7OE1 supports multiple optical inputs with 33 GHz maximum bandwidth



DPO7OE1 is compatible with MSO/DPO70000DX models

Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Nominal characteristics

Optical bandwidth (-6 dB)	33 GHz
Optical reference receiver filters	28GB-FC: 28.05 GHz OTU4: 27.95 GHz 200GBASE-LR: 26.56 GHz 100GBASE-SR: 25.78 GHz
Rise time (10% to 90%)	13.5 ps
Coupling	DC
Wavelength range (Opt. FC/PC)	750 nm to 1650 nm 850 nm, 1310 nm, 1550 nm (calibrated)
Wavelength range (Opt. FC/APC)	1260 nm to 1650 nm 1310 nm, 1550 nm (calibrated) [1]
Maximum input power (linear response)	4 mW
Maximum non-destruct input signal	8 mW
Optical power meter range	-38 to +6 dBm
Input return loss	19 dB
Aberrations	3% pk-pk
Output zero (dark level)	<10 µW ± 4% (vertical offset)
Optical connector types	FC/PC (Opt. FC/PC) FC/APC (Opt. FC/APC)
Input fiber core diameter (maximum)	9 µm to 50 µm (SMF and MMF)
Oscilloscope interfaces	ATI (1.85 mm RF connector), TekConnect
Compatible Tektronix oscilloscopes	DPO70000SX, DSA/DPO70000D, MSO/DPO70000DX, MSO/DSA/DPO70000C
Optical noise	1310 nm with filters

Characteristic	TekConnect	ATI
28GB-FC	7.0 µWrms	7.1 µWrms
OTU4	6.9 µWrms	7.0 µWrms
200GBASE-LR	6.7 µWrms	6.7 µWrms
100GBASE-SR	6.6 µWrms	6.6 µWrms
33 GHz Flat-top	9.9 µWrms	9.6 µWrms

1 The DPO7OE1 supports a calibrated amplitude response at custom wavelengths after a user calibration procedure is run.

Temperature

Operating	10 °C to +40 °C
Non-operating	-22 °C to +60 °C

Ordering information

Models

DPO7OE1	33 GHz bandwidth, single/multi-mode, 750 nm to 1650 nm, optical probe for MSO/DPO70000 Real Time Oscilloscopes

Standard accessories

Hard case, Instruction manual, Certificate of Traceable Calibration, One year warranty, Optical fiber cleaning tool, ATI input support accessory

Recommended oscilloscope application software

PAM4-O	Optical Measurements for PAM4
DJA	DPOJET Jitter and Eye Diagram Analysis with Optical Measurements
DJAN	DPOJET Jitter and Eye Diagram Analysis with Vertical Noise Separation
SDLA	Serial Data Link Analysis

Recommended accessories

006-8327-xx	Optical connector cleaner

Options

Product options

Note: Select an optical input connector type from the following mandatory, mutually exclusive options.

FC/APC	FC/APC optical input connector (typically used in research applications)
FC/PC	FC/PC optical input connector (typically used in networking/data center network applications)

Service options

Opt. C3	Calibration Service 3 Years
Opt. C5	Calibration Service 5 Years
Opt. D3	Calibration Data Report 3 Years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. G3	Complete Care 3 Years (includes loaner, scheduled calibration, and more)
Opt. G5	Complete Care 5 Years (includes loaner, scheduled calibration, and more)
Opt. R3	Repair Service 3 Years (including warranty)
Opt. R5	Repair Service 5 Years (including warranty)

Probes and accessories are not covered by the oscilloscope warranty and service offerings.

CE

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

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