T-BERD®/MTS-8000 I-PMD™

In-Service PMD Test Solution for DWDM/ROADM Networks

The innovative JDSU in-service PMD test solution (I-PMD) for the T-BERD/MTS-8000 V2 uses dense wavelength division multiplexing (DWDM) traffic wavelengths to efficiently measure polarization mode dispersion (PMD) (using effective DGD) without inserting a test signal.

Based on the coherent detection technique, the I-PMD provides high-resolution optical channel analysis (for power level and frequency) and in-band optical signal-to-noise ratio (OSNR) testing capability, enabling long-term monitoring for signal variations.

The I-PMD is the industry's first solution dedicated for network maintenance and troubleshooting of high-speed DWDM and reconfigurable optical add-drop multiplexers (ROADMs).

Key Benefits

- Qualifies link PMD, without turning off DWDM transmission, and monitors PMD fluctuations on DWDM channels using remote access for long-term analysis
- Prequalifies running 2.5 or 10 G DWDM systems with upgradability to 10 or 40 G
- Identifies PMD or spectral issues on faulty DWDM channels from any test access point
- Offers simultaneous in-band OSNR measurements for advanced analysis

Key Features

- Single-ended test solution combines the capabilities of three instruments into one (PMD, OSA, and I-OSNR)
- Use traffic wavelength to test 2.5/10/40 G, regardless of single polarity or modulation format
- Out-of-service PMD measurements when combined with a polarized broadband source at the far end
- Automated, in-service I-OSNR for any single polarization format from 2.5 to 40 G
- In-service I-OSNR measurements on 40 G PM NRZ-QPSK signals in ROADM DWDM networks
- Out-of-band OSNR measurements on pol-mux signals using the JDSU ON/OFF method

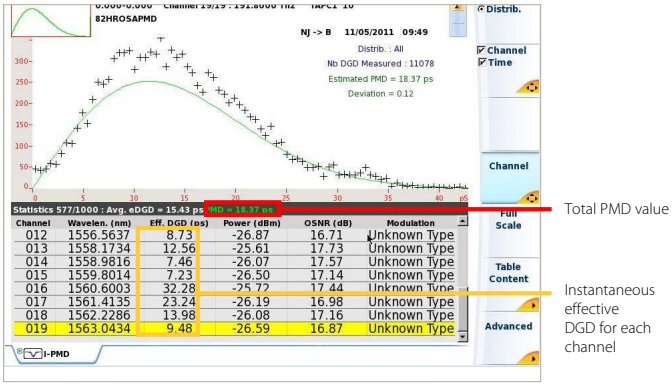
Applications

- Test for in-service PMD on DWDM and ROADM networks
- Monitor live DWDM channels for PMD
- Troubleshoot high-speed DWDM networks
- Perform live characterization for future upgrade paths from 2.5 to 40 G

Measuring PMD In-Service on Live Traffic

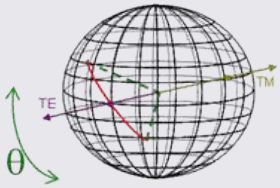
DWDM channels running at 2.5, 10, and 40 G are used as test signals to measure effective DGD and link PMD. Technicians can now qualify link PMD for live DWDM traffic.

- Perform measurements on a live DWDM system with fixed or ROADM network configurations
- Use high sensitivity to enable testing from any access point in the network
- Repeat effective DGD measurements to obtain PMD link values for a given test point
- Identify live channels or define channel test grid per ITU-T G.693
- Map DGDEff variations over time channel per channel to determine fluctuations in link PMD



Channel	Wavelen. (nm)	Eff. DGD (ps)	Power (dBm)	OSNR (dB)	Modulation
012	1556.5637	8.73	-26.87	16.71	Unknown Type
013	1558.1734	12.56	-25.61	17.73	Unknown Type
014	1558.9816	7.46	-26.07	17.57	Unknown Type
015	1559.8014	7.23	-26.50	17.14	Unknown Type
016	1560.6003	32.28	-25.72	17.44	Unknown Type
017	1561.4135	23.24	-26.19	16.98	Unknown Type
018	1562.2286	13.98	-26.08	17.16	Unknown Type
019	1563.0434	9.48	-26.59	16.87	Unknown Type

Effective DGD and PMD measurement of 10 G DWDM channels



$$DGD_{Effective}(\nu)=\frac{\Delta\theta(\nu)}{2\pi.\Delta\nu}$$

What is Effective DGD?

Effective DGD [ΔτEff] is a quantity that represents the perturbation a channel undergoes due to PMD. Mathematically, it is defined as:

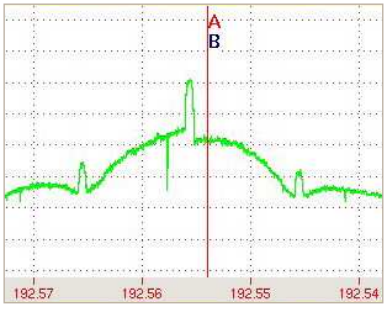
ΔτEff = Δτ sinφ, where Δτ is the instantaneous DGD in the channel, and φ is the angle (in Stokes space) between the actual signal polarization state and the principal polarization states in the WDM channel.

For intermediate polarization states, effective DGD may be any intermediate value, following a Rayleigh distribution. Therefore, the effective DGD always represents the impact of PMD on the channel.

Analyzing Live Transmission Signals

The JDSU I-PMD is much more than an in-service PMD analyzer. It can precisely characterize and pinpoint all detailed spectral information for optical signals.

- Precisely characterize laser frequencies and power levels
- Identify laser (incorrect tuning, chirp) or ROADM component (bandpass window) failures
- Analyze 2.5/10/40 G and next-generation modulation format signals
- Compare the passband shape against the ITU grid (using dedicated probe signal)

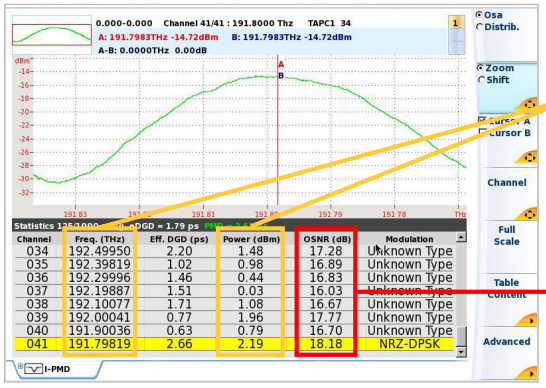


Laser chirp identification with I-PMD high-resolution spectrum analysis

Qualify DWDM with In-Band OSNR Testing

OSNR measurements complete full DWDM system qualification. The JDSU optical polarization splitting (OPS) method suppresses the transmission signal to access the noise value inside the optical channel. The I-PMD is the only viable test solution for any scenario regardless of the filter type, data rate, or direct modulation format.

- Perform I-OSNR tests simultaneously with PMD and spectral analysis
- Measure PMD and I-OSNR to correlate with BER to identify the root causes of failures
- Perform long-term I-OSNR analysis



Channel	Freq. (THz)	Eff. DGD (ps)	Power (dBm)	OSNR (dB)	Modulation
034	192.49950	2.20	1.48	17.28	Unknown Type
035	192.39819	1.02	0.98	16.89	Unknown Type
036	192.29996	1.46	0.44	16.83	Unknown Type
037	192.19887	1.51	0.03	16.03	Unknown Type
038	192.10077	1.71	1.08	16.67	Unknown Type
039	192.00041	0.77	1.96	17.77	Unknown Type
040	191.90036	0.63	0.79	16.70	Unknown Type
041	191.79819	2.66	2.19	18.18	NRZ-DPSK

Spectrum analysis of a 40 G channel

Specifications

In-Band DWDM Spectral Analyzer Module	
Optical Interfaces	
Applicable fiber	SMF 9/125 µm
Interchangeable optical connectors	FC, SC, DIN, LC
General	
Weight	600 g (1.2 lb)
Dimensions (w × h × d)	213 x 124 x 32 mm (8.38 x 4.88 x 1.26 in)
Operating temperature range	0°C to +40°C (32°F to 104°F)
Storage temperature range	–20°C to +60°C (–4°F to 140°F)
Humidity	95% without condensing
Frequency	
Optical frequency (wavelength) range	196.05–191.35 THz (1529.16–1566.72 nm)
Absolute uncertainty of frequency (wavelength)[1]	±370 MHz (±3 pm)
Frequency (wavelength) resolution	300 MHz (2.4 pm)
Minimum signal separation	2 GHz (16 pm)
Power level	
Input power range (in 300 MHz bandwidth)[2]	–60 dBm to +10 dBm
Max. safe total input power[3]	+17 dBm
Absolute uncertainty[1,4]	±0.5 dB
linearity[5]	±0.4 dB
Polarization dependence	±0.2 dB
PMD	
Test conditions	2.5/10/40 G DWDM channel
DWDM channel spacing	Min. 50 GHz as per ITU-T G.694.1
Input power level[6]	–45 dBm to +10 dBm
Measurement range	0 to 50 ps
Uncertainty[7]	200 fs ±2% x PMD
Acquisition time[8]	<5 s
I-OSNR	
Test conditions	Up to 40 G (single-polarization signal)
Test Method	Polarization nulling
Measurement range[9]	5 to 35 dB
Absolute uncertainty[10]	±0.5 dB

1. Over entire frequency range.
2. Power of unmodulated single-frequency laser or peak power of modulated signal in 300 MHz optical bandwidth.
3. Total power of all input signals.
4. At –20 dBm input power.
5. For input powers between –10 and –40 dBm.
6. Per DWDM channel.
7. From 1 to 20 ps PMD with strong coupling. Power level from –35 to –10 dBm. Averaging over 1000 independant effective DGD values. 10 G NRZ signal. OSNR >15dB.
8. Effective differential group delay, power level, frequency, and I-OSNR measurements per channel performed simultaneously.
9. Optical noise level >–55 dBm in 0.1 nm bandwidth.
10. At 1550 nm from 10 to 25 dB OSNR with PMD <50 ps.

Ordering Information

Description	Part Number
In-service PMD test solution with instantaneous effective DGD measurement, long-term PMD monitoring, high-resolution spectrum analysis, and in-band OSNR measurement. Contains a T-BERD 8000 V2 mainframe with I-PMD and polarization scrambler modules, accessories, and a transport case.	TB8000-IBDT-P1
In-service PMD analyzer with instantaneous effective DGD measurement, long-term PMD monitoring, high-resolution spectrum analysis, and in-band OSNR measurement. Contains an MTS 8000 V2 mainframe with I-PMD and polarization scrambler modules, accessories, and a transport case.	MTS8000-IBDT-P1

JDSU

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