Application Brief
TI DLP® Innovative Technology for Optical Networking

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Optical Networking

Optical networking is a high-speed communication technology that transmits data as light signals through fiber-optic cables, enabling ultra-high bandwidth and long-distance connectivity. To fully use this capacity, programmable wavelength control is essential, enabling critical network functions including Dynamic Gain Equalization (DGE), Optical Channel Monitoring (OCM), Wavelength Selective Switching (WSS), and Optical Circuit Switching (OCS) to be performed with optimal precision and speed. Filtering and signal processing algorithms then enable fine grained control over each channel's power and routing path, which can be leveraged directly for network performance optimization or scaled to meet the demands of AI workloads and next generation data centers.

TI DLP® technology, built around the Digital Micromirror Device (DMD) and Phase Light Modulator (PLM), is uniquely positioned to meet these demands. By leveraging reliable MEMS micromirrors, DLP® technology delivers a multi-application optical platform on a single chip, incorporating WSS, DGE, OCM, and OCS systems with the switching speed, signal integrity, and scalability required for modern fiber optic infrastructure.

Features and Benefits

- Ultra Fast, Software Defined Wavelength Control
  - Switching speeds of <10 µs for DMD and <75 µs for PLM — significantly faster than current competing technologies
- Reliable Digital MEMS Operation
  - Purely digital micromirror design ensures no analog drift over time or temperature, outperforming competing technologies
- Multiple Applications on a Single Chip
  - DGE and OCM
  - WSS and OCM
  - DGE and WSS and OCS
- Compact and Scalable Design
  - Scales across Metro, Long-Haul, and Data Center deployments with 30%-50% smaller optical module sizes versus current market-based design

TI DLP Designs for Optical Networking

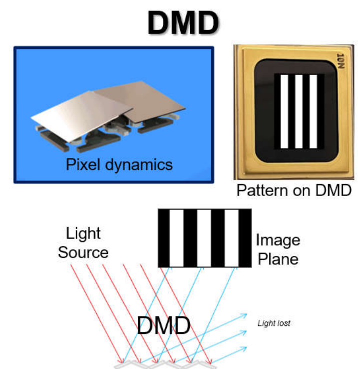

Figure 1. DMD Informational Diagram

The DMD (Amplitude Modulation) employs an array of individually addressable mirrors to modulate light, toggling between an *on* state reflecting light toward the optical path and an *off* state deflecting it away. This binary control enables high-precision wavelength attenuation and channel monitoring for DGE and OCM applications, with limited compatibility with WSS and OCS systems.

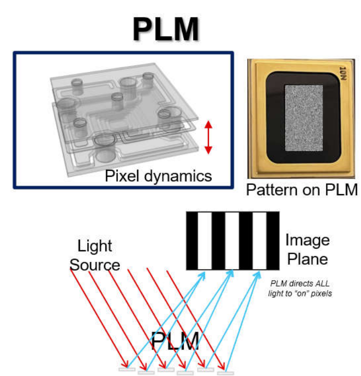

Figure 2. PLM Informational Diagram

The PLM (Phase Light Modulation) takes a different approach by spatially retarding the wavefront to create a programmable diffraction pattern, directing all light toward *on* pixels. This efficient light steering significantly minimizes insertion loss, making the PLM particularly advantageous for wavelength switching and routing in WSS and OCS applications, while remaining compatible with all systems, including OCM and DGE.

Dynamic Gain Equalization (DGE)

DGE corrects signal power variations across wavelength channels, verifying consistent optical performance throughout the network. In a DGE system, a diffraction grating separates the Wavelength Division Multiplexing (WDM) signal into individual wavelength channels, each directed onto a corresponding region of the DMD or PLM. The DMD independently attenuates each channel through precise mirror modulation, while the PLM achieves attenuation via programmable phase modulation. The equalized channels are then recombined and fed into an Erbium-Doped Fiber Amplifier (EDFA) for amplification, delivering balanced signals ready for transmission across long-haul, metro, and data center network segments.

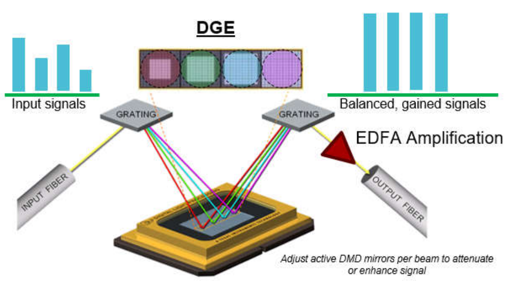

Figure 3. Pre-EFDA Amplification DGE Process Visual

Optical Channel Monitoring (OCM)

OCM acts as the feedback loop for DGE, continuously measuring channel signal strength and supplying real time attenuation requirements. A diffraction grating separates the incoming WDM signal by wavelength, with the DLP device sequentially steering each channel onto a single point detector to measure the power level. TI DLP DMD technology dominates the OCM space today, with <10 µs switching speeds enabling onboard integration with DGE, eliminating the need for a separate InGaAs linear array detector and reducing system cost and complexity. Looking ahead, TI's PLM further extends OCM capability, significantly reducing overall system complexity.

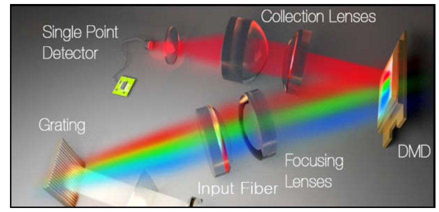

Figure 4. OCM Configuration Visual

Wavelength Selective Switch (WSS)

WSS routes individual wavelength channels from a single input fiber to multiple output ports, enabling dynamic software defined reconfiguration of the optical network. A diffraction grating separates the incoming WDM signal by wavelength, with the PLM steering each channel to its designated output port through programmable phase modulation. The PLM delivers <75 µs switching speeds with <2 dB insertion loss, >30 dB port isolation, and full polarization independence, eliminating phase flicker and crosstalk that degrade competing WSS technologies. Deployed primarily in Reconfigurable Optical Add-Drop Multiplexers (ROADMs) across long-haul and metro networks, TI's PLM based WSS supports seamless integration with OCM and DGE functionalities.

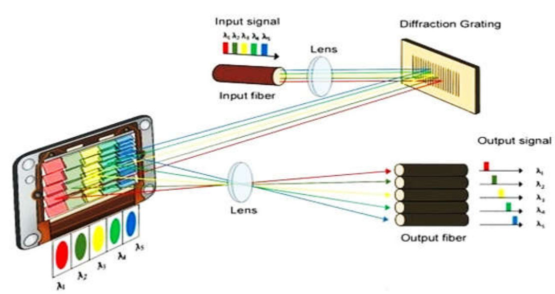

Figure 5. WSS Configuration Visual

Optical Circuit Switching (OCS)

OCS enables high-capacity connectivity by simultaneously switching all wavelengths across multiple fiber ports, making it preferred for dynamic optical networking applications. Unlike WSS, which routes individual channels, OCS uses PLM architecture to steer all wavelength channels between input and output ports in a single operation, eliminating individual channel switching and reducing overall system complexity. OCS shares the same PLM performance and reliability characteristics as WSS, including switching speed, insertion loss, port isolation, and long term operational stability.

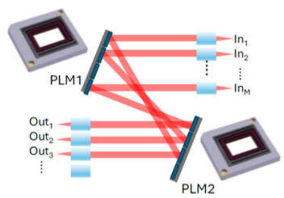

Figure 6. OCS Configuration Visual

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