

# 400G WaveLogic Ai FOTR Modules

For the 6500 Packet-Optical Platform

Optimized for multiservice clients and leveraging the best-in-class performance and low power consumption of Ciena's WaveLogic Ai coherent modem, the WaveLogic Ai FOTR modules are highly dense optical transponder and service channel interfaces that enable a more programmable infrastructure

The WaveLogic Ai (WLAi) FOTR combines up to 34 clients (four QSFP28/QSFP+, sixteen SFP28/SFP+ and fourteen SFP+ pluggable modules) and one programmable 400G coherent line interface in a double slot form factor. With its flexible range of supported pluggable client ports, operators can accommodate Ethernet, SONET/SDH, OTN, and 16G/32G Fiber Channel services with pay-as-you-grow benefits. One variant of the module includes an Optical Protection Switch (OPS) port directly on the card for integrated optical layer protection without the need to deploy additional hardware. The WLAi FOTR operates flexibly in any of the existing 6500 D-Series and S-Series shelf configurations, from the compact 6500-D2 (2RU height) to the half-rack 6500-S32 configuration, so network providers can select the appropriate form factor to match specific capacity and power/space requirements.

The WLAi FOTR module integrates Ciena's programmable WLAi coherent modem technology, which allows users to tune capacity from single wave 100 Gb/s to 400 Gb/s to maximize capacity for any distance. Users can transport twice the capacity per wavelength versus leading solutions today, or extend signals over three times the distance at equivalent capacities to gain significant economic savings. Specifically, 400G can be deployed in metro and DCI applications, 300 Gb/s for regional applications, 200 Gb/s for long-haul terrestrial, and 100G for >10,000 km compensated submarine links.



## Features and Benefits

- Provides a flexible range of multi-protocol services to address various applications
- Addresses all application requirements with a single module that leverages a pay-as-you-grow operating model
- Maximizes channel capacity for all applications, with tunability from 100G to 400G in 50G steps
- Increases service availability with a variant that integrates an Optical Protection Switch on the card
- Offers unprecedented, real-time optical networking performance data with the programmability required to make networks more adaptable

### Flexible Services

- ✓ 10GE/100GE
- ✓ 16G FC/32G FC
- ✓ 16G FICON
- ✓ 10G CE LR
- ✓ OC-192/STM-64
- ✓ OTU2/OTU2e

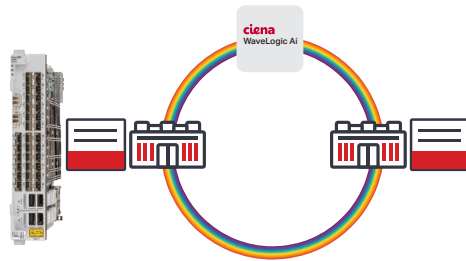


Figure 1. Flexible services across high-capacity wavelengths scaling up to 400G with WLAi FOTR

Each WLAi FOTR module cost-efficiently addresses all application requirements and supports a pay-as-you-grow operating model. The user simply selects the maximum reach required and enables client capacity in 100G increments by selecting the appropriate software license. As bandwidth requirements increase, additional capacity licenses can be purchased. Using this approach, operators not only realize lowest cost/bit per kilometer advantages, but also benefit from simpler forecasting, shorter certification cycles, and reductions in sparing costs.

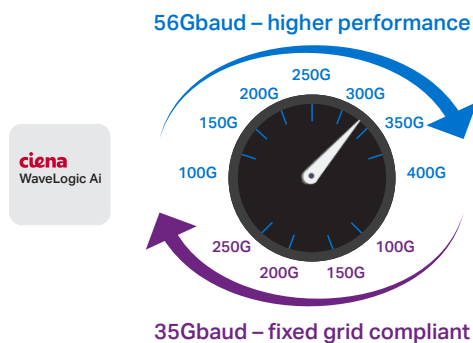


Figure 2. Trade channel throughput for optical performance and spectrum usage

WLAi FOTR operates at a selectable symbol rate of 35GBaud or 56GBaud, giving users the ability to trade channel throughput for optical performance and spectrum usage while delivering power and space efficiency benefits over both fixed and flexible grid photonic line systems. The full range of capacities are available at 56GBaud, with 100G to 250G channel capacities available at 35GBaud.

To provide previously unattainable network monitoring and efficiencies, WLAi FOTR offers unique, real-time link monitoring capabilities, enabling operators to extract the most efficiency out of their network at any point in the network's life. With these embedded link measurement capabilities, operators can determine exactly how much margin is currently present in the network, as well as the optimal capacity they can deploy. Combined with Software-Defined Networking (SDN) analytics, applications such as predictive link failure now become possible, allowing operators to pre-empt outages with scheduled maintenance activities. Users can access the following critical real-time link measurements:

- Pre-FEC BER, Pre-FEC Q (average, max)
- Tx power level
- Rx total power and channel power
- Maximum, average, and real-time DGD
- PDL (average, max)
- Total Rx and total Tx link dispersion
- Estimated fiber length
- Estimated unidirectional latency
- Effective Signal-to-Noise Ratio (ESNR)

In addition to these new levels of intelligence and programmability, the WLAi FOTR provides features that facilitate and accelerate operational tasks—including topology discovery, facility/terminal loopbacks, an independent integrated test set per client port, and 15-min interval line performance monitoring data—providing users with quick visibility into data and signal integrity. Various client and line protection options offer users the ability to implement the level of resiliency needed for their network.

With Ciena's 400G WaveLogic Ai FOTR modules, operators can evolve to a more programmable network and reduce transport costs for a wide range of 10G - 100G services across any distance, leveraging industry-leading multi-rate coherent optics.

## WaveLogic Ai FOTR Modules Specifications

Module Description	WaveLogic Ai FOTR 34 Port (4xQSFP28/16xSFP28/14xSFP+)	WaveLogic Ai FOTR w/OPS 34 Port (4xQSFP28/16xSFP28/14xSFP+)
Number of line ports	Line: 1 x WLAi line port (up to 400 Gb/s)	
Number of client ports	Clients (34 Ports Total): 4 x QSFP28/QSFP+, 16 x SFP28/SFP+, 14 x SFP+	
Integrated Optical Protection	N/A	1+1 Line Protection
Weight	2.5 kg (5.5 lb)	
Tunable frequency	191.3425 to 196.1075 THz, 0.0001THz tuning precision	
Tx output power	-9 to +4 dBm	-9 to -0.3 dBm
Rx back-back sensitivity	-20 dBm (per channel)	-18.2 dBm (per channel)
Rx overload	+5 dBm (per channel) +11 dBm (total power)	+5.7 dBm (per channel) +11.7dBm (total power)
Rx damage level	+14 dBm (total power)	+14.7 dBm (total power)
PMD tolerance	For 35Gbaud: 80 ps mean, 240 ps peak For 56Gbaud: 50 ps mean, 150 ps peak	
PDL tolerance	For 35Gbaud, all line rates: 2.5 dB For 56Gbaud, line rate dependent: <ul style="list-style-type: none"> <li>• 100G line rate: 3.0 dB</li> <li>• 150G line rate: 2.8 dB</li> <li>• 200G line rate: 2.5 dB</li> <li>• 250G line rate: 2.5 dB</li> <li>• 300G line rate: 2.0 dB</li> <li>• 400G line rate: 1.5 dB</li> </ul>	
Chromatic Dispersion Tolerance	<ul style="list-style-type: none"> <li>• For 35Gbaud: -89000 to +579000 ps/nm</li> <li>• For 56Gbaud, 100G, 150G, 200G, 250G line rate: -35000 to +435500 ps/nm for both terrestrial and submarine applications</li> <li>• For 56Gbaud, 300G line rate: -35000 ps/nm to +35000 ps/nm for terrestrial applications and -35000 to +435500 ps/nm for submarine applications</li> <li>• For 56Gbaud, 400G line rate: -17500 ps/nm to +17500 ps/nm for both terrestrial and submarine applications</li> </ul>	
WaveLogic Ai link performance monitoring	<ul style="list-style-type: none"> <li>• Pre-FEC BER, Pre-FEC Q (average, max)</li> <li>• Tx power level</li> <li>• Rx total power and channel power</li> <li>• Maximum, average, and real-time DGD</li> <li>• PDL (average, max)</li> <li>• Total Rx and total Tx link dispersion</li> <li>• Estimated fiber length</li> <li>• Estimated unidirectional latency</li> <li>• Effective Signal-to-Noise Ratio (ESNR)</li> </ul>	
Client Protocols (Mappings)	<ul style="list-style-type: none"> <li>• 100GbE (GMP)</li> <li>• 10GbE (BMP)</li> <li>• OTU2, OTU2e (None)</li> <li>• 16G FC / 16G FICON (BMP)</li> <li>• 32G FC (BMP)</li> <li>• OC-192 / STM-64 (BMP/AMP)</li> </ul>	

## WaveLogic Ai FOTR Modules Specifications continued

<b>Certifications</b>	<ul style="list-style-type: none"> <li>• IBM GDPS</li> <li>• SAN environments: Brocade (including multi-link trunking support) and Cisco switches</li> </ul>
<b>Topology Discovery</b>	<ul style="list-style-type: none"> <li>• 10GE and 100GE LLDP Ingress Monitoring (LLDP snooping)</li> <li>• Network Discovery Protocol (NDP) Adjacencies for photonic layer discovery</li> </ul>
<b>Loopback support</b>	<ul style="list-style-type: none"> <li>• Line: facility and terminal loopbacks supported</li> <li>• Client: facility and terminal loopbacks supported</li> </ul>
<b>Integrated test set (ITS)</b>	<ul style="list-style-type: none"> <li>• 34 independent ITS per card, 1 per client port</li> <li>• Ability to test full traffic path across the DWDM line, as well as subtending equipment</li> </ul>
<b>Protection</b>	<ul style="list-style-type: none"> <li>• 1+1 OPS client-layer optical path protection</li> <li>• 1+1 OPS optical channel path protection</li> <li>• 1+1 OPS optical trunk protection</li> <li>• Layer 0 Control Plane restoration</li> </ul>
<b>Shelf capacity</b>	<ul style="list-style-type: none"> <li>• 6500-D2: 400 Gb/s</li> <li>• 6500-D7/S8: 1.2 Tb/s</li> <li>• 6500-S14: 2.8 Tb/s</li> <li>• 6500-S32: 6.4 Tb/s</li> </ul>
<b>ROADM Support</b>	<ul style="list-style-type: none"> <li>• Up to 16 cascaded ROADMs</li> </ul>
<b>Channel plan support</b>	<ul style="list-style-type: none"> <li>• 35Gbaud: 50GHz fixed, 75GHz fixed, 100GHz fixed, flexible grid</li> <li>• 56Gbaud: 75GHz fixed, 100GHz fixed, flexible grid</li> </ul>

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