GIGALIGHT Marketing Report Special Issue on Coherent Optical Communication

2022 Q3 Vol .5

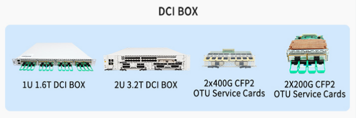
Solutions

Coherent DCI Box Series

Gigalight
GIGALIGHT Launched DCI BOX for Ultra-long Distance DCI Interconnection
High capacity
Low energy consumption
Small size
Simple operation and maintenance
1U 1.6T DCI BOX
2U 3.2T DCI BOX

To meet the needs of the DCI market, GIGALIGHT has launched an ultra-high-speed and large-capacity coherent transmission solution - DCI BOX series. With outstanding features of high capacity, small size, low power consumption, and easy operation and maintenance, this series system is a friendly choice for global small and medium-sized data center interconnection (DCI) applications.

The GIGALIGHT coherent solution is a platform-based system that can be configured with different function boards according to different needs, to achieve customers' personalization requirements. The solution includes following extensive range of coherent transmission subsystems and coherent optical modules:


DCI BOX
1U 1.6T DCI BOX
2U 3.2T DCI BOX
2x400G CFP2 OTU Service Cards
2X200G CFP2 OTU Service Cards

DWDM Passive Systems

48CH DWDM 100GHz
1U RACK

64CH DWDM 75GHz
2U RACK

96CH DWDM 50GHz
2U RACK

Optical Layer Systems (selected products)

RFA Amplifier Card

OLP Card

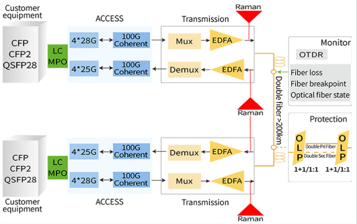
Network Management
Unit(NMU) Card

OTDR Monitoring Card

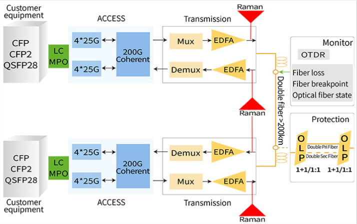
EDFA Amplifier Card

GIGALIGHT Coherent Subsystem Ultra-High-Speed Large-Capacity Coherent Transmission Solution

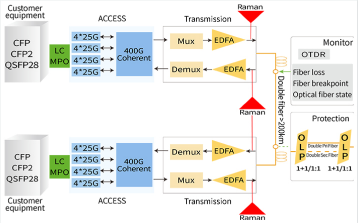
Scheme Architecture Figure 1: 100G Lambda Single Span 200km


Customer equipment
CFP
CFP2
QSFP28
LC
MPO
ACCESS
4*28G
100G Coherent
4*25G
100G Coherent
Transmission
Mux
EDFA
Demux
EDFA
Raman
Raman
Double fiber >200km
Monitor
OTDR
Fiber loss
Fiber breakpoint
Optical fiber state
Protection
OLP
Double Pri Fiber
Double Sec Fiber
OLP
1+1/1:1
1+1/1:1
CFP
CFP2
QSFP28
LC
MPO
4*25G
100G Coherent
4*28G
100G Coherent
Demux
EDFA
Mux
EDFA
Customer equipment
ACCESS
Transmission
Raman

Scheme Architecture Figure 2: 200G Lambda Single Span 200km


Customer equipment
CFP
CFP2
QSFP28
LC
MPO
ACCESS
4*25G
4*25G
200G Coherent
Transmission
Mux
EDFA
Demux
EDFA
Raman
Raman
Double fiber >200km
Monitor
OTDR
Fiber loss
Fiber breakpoint
Optical fiber state
Protection
OLP
Double Pri Fiber
Double Sec Fiber
OLP
1+1/1:1
1+1/1:1
CFP
CFP2
QSFP28
LC
MPO
4*25G
4*25G
200G Coherent
Demux
EDFA
Mux
EDFA
Customer equipment
ACCESS
Transmission
Raman

Scheme Architecture Figure 3: 400G Lambda Single Span 200km


Customer equipment
CFP
CFP2
QSFP28
LC
MPO
ACCESS
4*25G
4*25G
4*25G
4*25G
400G Coherent
Transmission
Mux
EDFA
Demux
EDFA
Raman
Raman
Monitor
OTDR
Fiber loss
Fiber breakpoint
Optical fiber state
Double fiber >200km
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CFP
CFP2
QSFP28
LC
MPO
4*25G
4*25G
4*25G
4*25G
400G Coherent
Demux
EDFA
Mux
EDFA
Customer equipment
ACCESS
Transmission
Raman

The DCI BOX series come from GIGALIGHT's Open Optical Network Laboratory. The Laboratory mainly carries out various practical activities of open optical network products, which is laying a solid foundation for GIGALIGHT to deliver system integration products worldwide.

100G Long-distance Optical Module Series

GIGALIGHT 100G Long-distance
Optical Module
Transmission Solution

GIGALIGHT provides a variety of solutions to meet the 100G long-distance transmission requirement, including 4x25G NRZ series, 100G PAM4 series and coherent series. All GIGALIGHT 100G long-distance transmission optical modules can be applied to metro DCI, to achieve mutual communication, data & content sharing, and provide redundant backup for two or more data centers.

In the data centers field, due to the high-density and low-power connection requirements of data centers, QSFP28 optical modules with smaller packaging and power consumption can be mostly used, and then selected according to the needs of transmission distance.

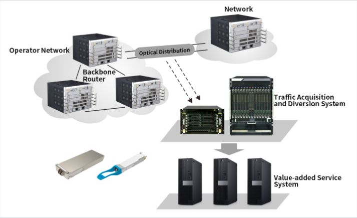
Data Center
Data Center

100G QSFP28	Transmission Distance	Service Speed	Optical Ports Speed	Electrical Ports Speed	Power Consumption
LR4	10/20km	100GE OTU4	4x25G 28G NRZ	4x25G 28G NRZ	<3.5W
ER4 Lite	30/40km	100GE OTU4	4x25G 28G NRZ	4x25G 28G NRZ	<3.8W
ER4	40km	100GE OTU4	4x25G 28G NRZ	4x25G 28G NRZ	<6W
eER4	60km	100GE OTU4	4x25G 28G NRZ	4x25G 28G NRZ	<6W
ZR4	90km	100GE OTU4	4x25G 28G NRZ	4x25G 28G NRZ	<6W
LR1	10/20km	100GE	1x100G PAM4	4x25G NRZ	<4W
ER1	30/40km	100GE	1x100G PAM4	4x25G NRZ	<4W

The 4x25G adopts the NRZ solution, with more mature technology, lower cost per device, and can be directly interconnected with 25G optical modules. The 100G single-wave optical module uses 100G PAM4 modulation, which reduces optical complexity and cost compared to the 4x25G solution by reducing the number of optical transmitters and receivers from 4 to 1. At the same time, the advent of single-wave 100G transmission technology has laid the foundation for the development of 400G (4x100G) Ethernet. When making selections, the 4x25G solution can be used in 25G/100G data center, and the 100G PAM4 solution can be used in 100G/400G data center.

GIGALIGHT's 4x25G series 100G optical modules meet the dual-rate requirements of Ethernet and optical transport networks for more demanding telecom application environments. When 100G is adapted to OTU, it can be mapped to OTU4 (optical density unit), or inversely multiplexed into OTU2/3. According to the specific implementation of the 100G interface, there are multiple pairs of packaging mapping paths.

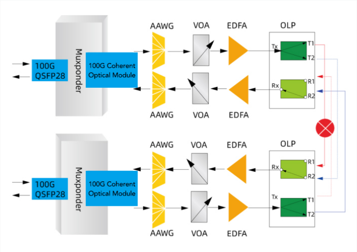
- 100G serial signal mapping to ODU4 (at 112Gbps)
- 100G serial signal reverse multiplexing to ODU2e, ODU2,ODU3
- 100G signal reverse multiplexing to 10x10G or 4×25G


Network
Operator Network
Optical Distribution
Backbone Router
Traffic Acquisition and Diversion System
Value-added Service System

100G	Transmission Distance	Service Speed	Optical Ports Speed	Electrical Ports Speed	Power Consumption
CFP LR4	10km	100GE OTU4	4x25G 28G NRZ	10x10G 11G NRZ	<9W
CFP2 LR4	10km	100GE OTU4	4x25G 28G NRZ	4x25G 28G NRZ	<6W
CFP2 ER4	40km	100GE OTU4	4x25G 28G NRZ	4x25G 28G NRZ	<9W
CFP4 LR4	10km	100GE OTU4	4x25G 28G NRZ	4x25G 28G NRZ	<4W

Among them, the CFP/CFP2/CFP4/QSFP28 form factor are in decreased order, and the power consumption is getting lower under the same transmission distance, so customers can choose the product with the best power consumption according to the required form factors and transmission distance of the equipment.

100G coherent optical modules are mainly used for line-side optical transmission in 100G wavelength division systems, which have good OSNR performance, sensitivity, dispersion tolerance, and DGD tolerance compared with various other forms of line-side optical modules. Coherent module using DWDM technology is widely used in 100G metropolitan area networks to meet high-capacity and long-distance requirements.


100G
QSFP28
Muxponder
100G Coherent
Optical Module
AAWG
VOA
EDFA
OLP
Tx
T1
T2
Rx
R1
R2
AAWG
VOA
EDFA
AAWG
VOA
EDFA
OLP
Rx
R1
R2
Tx
T1
T2
100G
QSFP28
Muxponder
100G Coherent
Optical Module
AAWG
VOA
EDFA

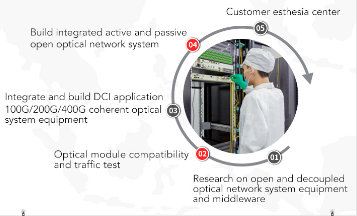
Coherent Optical Series	Category	100G CFP DCO	100G CFP2 DCO
Line Modulation		32G Baud DP-QPSK	32G Baud DP-QPSK
ZR 80km 120km	OSNR Tolerance	17.0dB/ BER 4E-3	17.0dB/ BER 4E-3
	Typical Power Consumption	23W	18W
	FEC Configuration	HD-FEC	HD-FEC
MR 600km	OSNR Tolerance	15.5dB/ BER 3E-3	15.5dB/ BER 3E-3
	Typical Power Consumption	24W	19W
	FEC Configuration	HD-FEC	HD-FEC
LH 1200km	OSNR Tolerance	13.0dB/ BER 2E-2	13.0dB/ BER 2E-2
	Typical Power Consumption	31W	24W
	FEC Configuration	SD-FEC	SD-FEC

The size of CFP2 is almost half of CFP. It has more advantages in power consumption and higher cost. Customers can choose according to the budget and package required for the device. At the same time, it can be used in conjunction with GIGALIGHT's economical coherent subsystem. The system has outstanding features such as large capacity, small size, low energy consumption, and easy operation and maintenance. It is believed that it can bring more choices to small and medium-sized data centers globally.

The technology of 100G network is becoming more and more mature. GIGALIGHT has a complete range of 100G long-distance optical modules. Customers can make choices according to application requirements, transmission distance, network deployment situation, etc. At the same time, GIGALIGHT's research and development of 100G optical modules will not stop here. GIGALIGHT will take cost control as the basic subject of product design and development at the same time. With the advantages of scale accumulated over time and strong bargaining power in the supply chain, GIGALIGHT will continue to optimize its technology and management to provide customers with low-cost, high-quality, full-coverage products and solutions!

GIGALIGHT Open Optical Network Lab Snapshot

The GIGALIGHT Open Optical Network Laboratory focuses on implementing various researches around the middleware and subsystems of the open optical society.


Customer esthesia center
05
Build integrated active and passive open optical network system
04
Integrate and build DCI application 100G/200G/400G coherent optical system equipment
03
Optical module compatibility and traffic test
02
01
Research on open and decoupled optical network system equipment and middleware

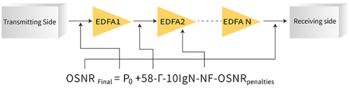
Lab
Snapshot

Extended Reading

How to understand the complex relationship between optical signal-to-noise ratio, dispersion and transmission distance in coherent optical communication.

The longest transmission distance of the coherent system is mainly limited by the OSNR tolerance value of the RX side (under the condition of non-OEO solution, the OEO solution will increase the delay and cost). It requires that the OSNR of the last RX received is greater than the RX OSNR tolerance value, which usually requires the system to leave a margin. Taking the 100G coherent system as an example, in different FEC configuration modes, the difference in the OSNR tolerance value of the 100G coherent system directly determines the number of EDFAs that can be cascaded and also limits the farthest transmission distance of the coherent system.

We calculate the final OSNR performance after EDFA cascade using the following common industry formula


Transmitting Side
EDFA1
EDFA2
EDFA N
Receiving side

$$OSNR_{Final} = P_0 + 58 - \Gamma - 10\lg N - NF - OSNR_{penalties}$$

Among them,

- P_0 is the single-wave optical power into the fiber. (In order to reduce non-linear effects, it usually requires TX optical power into the fiber P_0 is 1dbm)
- Γ is the optical power attenuation of each span, an

EDFA span is usually 100km in engineering, then $\Gamma= 0.25\mathrm{dB/km}\times 100\mathrm{km}=25\mathrm{dB}$

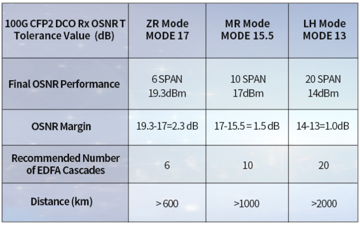
- N is the number of spans
- NF is the EDFA noise index, NF is usually 6dB
- $\mathrm{OSNR}_{\mathrm{penalties}}$ are the transmission cost caused by CD, PMD, PDL, etc., usually default 1dB
- 58 is the physical constant

We can calculate the final value of OSNR by applying the theoretical formula to the number of N span segments
$\mathrm{OSNR}_{\mathrm{Final}} = P_0+58-\Gamma-10\lg N-NF-\mathrm{OSNR}_{\mathrm{penalties}}$

1、When EDFA span N=6, the total distance is 6X100= 600KM
$\mathrm{OSNR}_{\mathrm{Final}} = 1 + 58 -25 - 10\mathrm{X}0.77-6-1 = 19.3$

2、When EDFA span N=10, the total distance is 10X100= 1000KM
$\mathrm{OSNR}_{\mathrm{Final}} = 1 + 58 -25 - 10\mathrm{X}\ 1-6-1 = 17$

3、When EDFA span N=20, the total distance is 20X100= 2000KM
$\mathrm{OSNR}_{\mathrm{Final}} = 1 + 58 -25 - 10\mathrm{X}1.3-6-1 = 14$

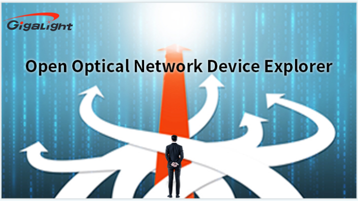


100G CFP2 DCO Rx OSNR T Tolerance Value (dB)	ZR Mode MODE 17	MR Mode MODE 15.5	LH Mode MODE 13
Final OSNR Performance	6 SPAN 19.3dBm	10 SPAN 17dBm	20 SPAN 14dBm
OSNR Margin	19.3-17=2.3 dB	17-15.5 = 1.5 dB	14-13=1.0dB
Recommended Number of EDFA Cascades	6	10	20
Distance (km)	> 600	>1000	>2000

The EDFA cascade will lead to more and more noise (the noise of the cascaded EDFA can be derived from the formula). The RX OSNR tolerance is related to the modulation rate, modulation format, type of FEC, and complex compensation algorithm. For a good quality coherent DCO module, the RX tolerance value shows good result. Regarding the RX dispersion tolerance, the current DSP algorithms have already well compensated the RX dispersion tolerance. Usually, in the coherent link, it does not need to consider additional dispersion compensation. The main issue that needs to be considered at present is the RX OSNR.

Enterprise Perspective

The Guardian of Open Optical Networks and Coherent Subsidence Technology


Gigalight
Open Optical Network Device Explorer

GIGALIGHT
Coherence Milestones

100G Coherent Optical Module

2017
|
2019

Following the first launch of 100G CFP DCO coherent optical module in China in 2017, GIGALIGHT launched a lower power consumption 100G CFP2 DCO digital coherent optical module in 2019, and demonstrated it at the CIOE2019 Optical Expo in September of the same year.

OpenZR+ MSA

2020

In November 2020, GIGALIGHT was invited to become the first contributor member of OpenZR + MSA due to the excellent achievements in the field of coherent optical communication, and participated in the discussion and formulation of the open coherent optical communication network protocol.

1U 800G DCI BOX

2021

In March 2021, GIGALIGHT 100G CFP2 DCO conducted mass production. In June of the same year, GIGALIGHT launched the economical 1U 800G DCI BOX coherent transport subsystem that can carry four 200G coherent service boards.

1U 1.6T DCI BOX

2022

In June 2022, GIGALIGHT expanded the coherent equipment product line again and launched a 1U 1.6T DCI BOX coherent transmission subsystem that can be loaded with four 400G (2x200G) coherent service boards. In the same month, GIGALIGHT ushered in a good news - the Supreme Court finally ruled that Finisa's patent was invalid, and the five-year patent case ended with GIGALIGHT's complete victory.

*If you are interested in our products or solutions, please reply to the email directly to explain your needs, and our sales manager will get in touch with you as soon as possible!

Gigalight

Open Optical Network Device Explorer