

**130 000 km**  
Backbone DWDM Networks

# DWDM VOLGA

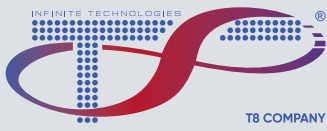
telecommunications equipment  
for fiber optic networks

200 Gbit/s | 400 Gbit/s | 600 Gbit/s

**800 Gbit/s**

maximum speed  
per one wavelength





## T8 is a Russian developer and manufacturer of DWDM telecommunications equipment and innovative solutions for fiber-optic communication lines

Since 2016 T8 has been taking part of the National Champions Project of the Russian Ministry of Economic Development (Support for private high-tech leading companies). In 2020, T8 took 1st place in the main TechUspech rating among large companies.

In 2021, the Company became a member of the first Vertically Integrated DWDM Project in Russia. The signed agreement between T8 LLC and Rostelecom PJSC is aimed at developing products of the radio-electronic industry based on Russian electronic components.

The company is a member of the TELMI alliance of Russian manufacturers of modern telecommunications equipment. All production processes of the company are certified according to the international quality control system ISO 9001.

T8 offers customers comprehensive solutions for building DWDM networks such as design, supply, installation of equipment and service maintenance.

### T8 DWDM equipment is designed to build:



backbone networks



regional and metro networks



data center interconnects



5G transport networks

### T8 customers:

- telecom operators
- IT companies
- financial institutions
- fuel and energy companies
- data centers
- state structures
- industrial enterprises

### Major projects:

- Sberbank Data Center
- DWDM network for Sochi 2014 Olympic Games project
- DWDM networks for Macro-Regional Branch of Rostelecom PJSC
- DWDM networks in Kazakhstan
- DWDM networks for Gazprom PJSC – Moscow – St. Petersburg
- DWDM network for Transammiak PJSC
- DWDM networks for Rosseti PJSC

## DWDM

## Dense Wavelength Division Multiplexing

Wavelength channel multiplexing technology



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## About company



### Development and production of DWDM equipment

The company has implemented a full cycle of production of telecommunications equipment – from the stage of designing the circuitry of the future device to the final assembly and configuration. Volga multiservice platform is used for building communication channels from 155 Mbit/s to 800 Gbit/s at one wavelength. According to a number of indicators, T8 DWDM equipment has the best characteristics in the world. The manufactured products have been assigned the status of telecommunications equipment of Russian origin (Decree of the Government of the Russian Federation of July 10, 2019 N 878, as amended on March 27, 2023).

According to the Localization Criteria of Rostelecom PJSC, equipment manufactured by T8 scored the highest score among all participants in the register (94,6 points). DWDM-platform Volga has declarations of conformity in accordance with the requirements of the European Union.

### Calculation and design of optical networks

The company's design department calculates DWDM networks of any complexity and topology using proprietary software. T8 specialists analyze the performance of customers' optical network infrastructure and calculate the necessary equipment for organizing high-speed signal transmission on various networks. The design department annually calculates more than 300 projects, of which dozens reach the stage of implementation into existing DWDM systems. The high quality of project implementation was noted by positive feedback and recommendations from customers.

### Equipment installation

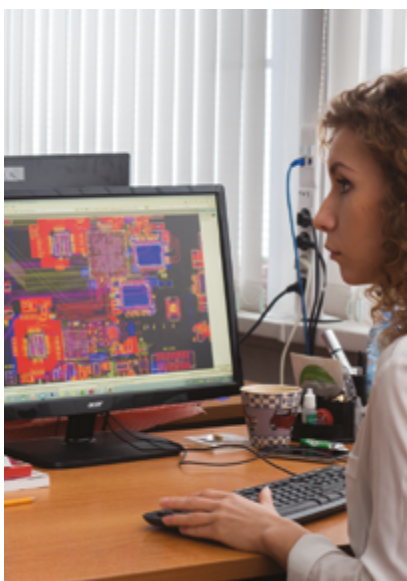
The company employs mobile teams of engineers who independently install equipment at customer sites. T8 specialists have extensive practical experience in installing systems in the most non-standard situations in a short time and with high quality. The company has experience in implementing DWDM systems from Turkmenistan to the Arctic. Over the years of its operation, T8 has put into operation over 130.000 km of DWDM networks, of which more than 37.000 km are high-speed systems of 100-800 Gbit/s per channel. The company has 30% Russian market share of DWDM systems, about 10.000 units of high-tech equipment are installed on customer networks annually.

### Service maintenance of equipment

T8 service begins with the first contact with the customer and continues after the equipment is installed on the network. The unique laboratory, which includes more than 2000 devices, allows us to offer the best conditions for FOCL servicing in Russia. For customers, there is a round-the-clock support service. Technical specialists promptly respond to requests and, if necessary, use their own storage of replacement equipment for uninterrupted and reliable network operation. Currently more than 3.300 chassis are in the commercial mode and assigned to support and maintenance services. Incidents are handled through an automated management system. Customers are provided with access to the technical support information portal.

### R&D in the field of optoelectronics and laser physics

T8 has a strong focus on R&D in optoelectronics and laser physics, which has led to the company's world-class DWDM products. Every year, T8 receives patents for new scientific developments. STC conducts scientific research in the field of data transmission in optical networks in its own interests and takes an order for R&D.





## Development and production of radio-photonic and radio-electronic component base

T8 is a participant in the state program for the development of the electronic and radio-electronic industry. Under this state program, the department of optoelectronic components develops and manufactures components for optoelectronic systems. In 2018, the company presented test samples of its own element base: 40 Gbit/s modulator, MUX/DEMUX AAWG, SFP/SFP+ and QSFP28 modules, radio photonic circuits/solutions based on modulators. Using solutions developed at the research center, Volga platform has set several records in the field of data transmission.

## Competence Center for Fiber Optics

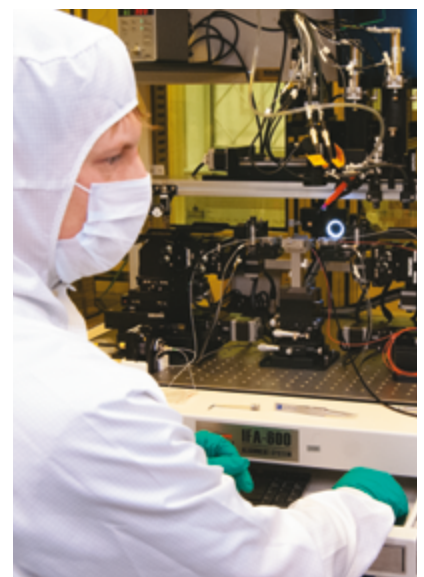
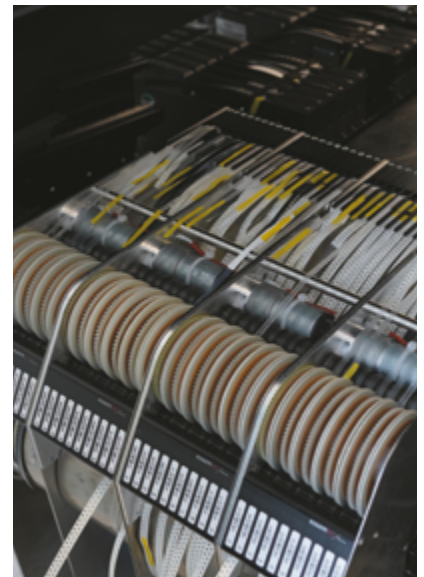
The company employs more than 500 people, including more than 250 developers, five professors and more than 30 PhDs. They are world-class experts and graduates of the best technical universities in the country. T8 selects and promotes the growth of the best graduates of the Moscow Institute of Physics and Technology, Moscow State University, Bauman Moscow State Technical University and other universities.

## The educational center

Comprehensive training resources and programs of the company provide the knowledge and skills necessary to operate T8 solutions:

- «Operation of DWDM Equipment», «Fractal Network Management System» and «Operation of DWDM Equipment» (CNE Axon). Titan Network Management System» offline courses are trainings for partners and customers of T8. They are held in an open laboratory and include lectures and practical exercises.
- «DWDM Technology Basics» online course is a series of online lessons in which T8 experts step by step analyze DWDM technology
- Corporate training for T8 engineers and scientists aimed at continuous improvement of professional skills and staff efficiency

In 2021, T8 established the first Backbone High-speed Transport DWDM Systems (HTS DWDM) basic department at SPbSUT University (Bonch-Bruevich Saint Petersburg State University of Telecommunications). This project will grow a new generation of technical specialists in the field of DWDM and modern innovative solutions in the field of optical communications.



# Backbone DWDM Networks

Digital transformation requires telecom operators to be able to flexibly increase the capacity of backbone channels in a short time and with minimal capital investment.

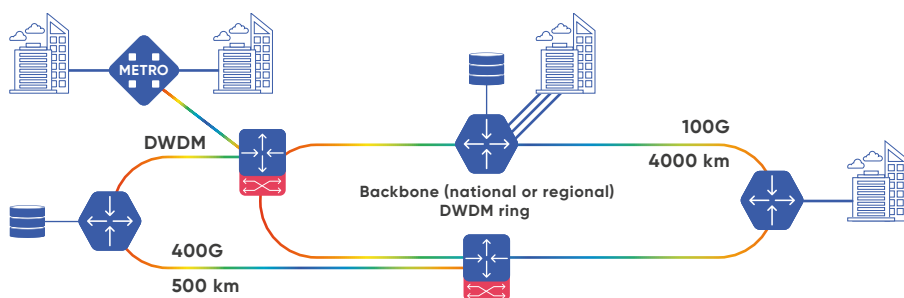
For backbone telecom operators, T8 offers high-speed equipment with a channel rate of up to 800 Gbit/s, which provides up to 38.4 Tbit/s over one pair of optical fiber. Volga DWDM platform has proven itself well both at short distances and at extra-long spans, up to 4.000 km without regeneration.

DWDM transponders of the latest generation is ideal for building the most balanced solution between the bandwidth and transmission range of the system. The platform has a wide range of elements for organizing DWDM networks of any length. The implementation of various protection schemes ensures the reliability of connections. In addition to redundancy of information and optical channels, redundancy of communication nodes is available.

Many opportunities for managing and monitoring all network nodes are carried out through the Fractal NMS or a new one with extended functionality of the Titan NMS class.

Practical experience in building backbone networks allows us to foresee important features of projects and quickly resolve complex issues. To build the optimal network topology, the company uses its own network design center. Experience and expertise offers great opportunities to launch complex networks with minimal capital costs.

- up to 38.4 Tbit/s over one pair of optical fiber high throughput for backbone channels on extended communication lines
- wide choice of line interfaces
- a wide range of equipment for building networks with complex topology and high fault tolerance requirements
- flexible management and monitoring of networks by the Fractal management system or the new NMS Titan with extended functionality



In 2021, using Volga DWDM equipment, T8 built a technological network for the longest ammonia pipeline in the world, Transammiak PJSC, with a total line length of more than 1.500 km

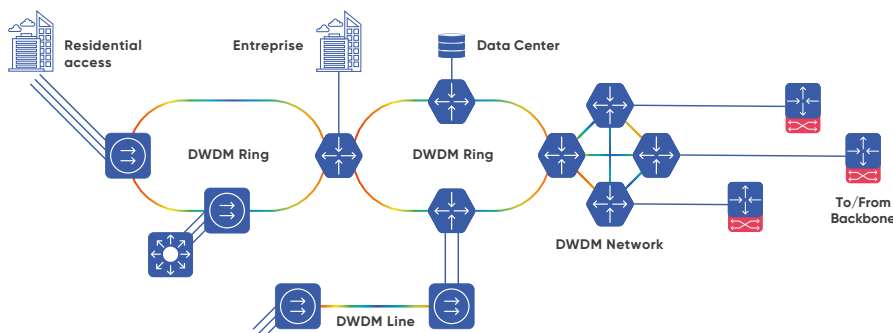
# Regional and City Optical Networks

T8 offers modern telecommunications equipment for urban and regional networks (metro networks), represented by a wide variety of technologies and, as a result, client interfaces. Volga multiservice line makes it possible to combine systems from PDH and SDH to high-speed Ethernet data transmission systems into a single modern transport infrastructure. Client service flows from E1 to 400GE are efficiently aggregated and transmitted over optical channels (wavelengths) with bandwidths from 155 Mbps to 800 Gbit/s.

A feature of the Metro segment is complex topologies. Circuit switching at the optical or electrical layers provides the flexibility of the optical infrastructure. For this purpose, in Volga equipment line, multi-connected ROADMs are implemented at the optical DWDM level in a promising configuration CDC-F (Colorless, Directionless, Contentionless, FlexGrid), and at the electrical OTN level nodes with a centralized matrix OTN-XC connect channels are implemented.

Volga provides a possibility to gradually scale throughput, reduce capital costs for the construction and further development of networks of telecom operators. Units of different generations of the system are compatible with each other, which provides customers with a seamless transition to new solutions.

- high throughput: from 155 Mbit/s to 800 Gbit/s per wavelength
- multiservice – transparent transfer of any client services: E1 (PDH), STM-1...64 (SDH), 1GE...400GE (Ethernet data network traffic), OTU1...OTUCn (OTN), CPRI mobile traffic / eCPRI, FC800...FC3200 (SAN traffic)
- support for optical (ROADM) and electrical (OTN-XC switching)
- coherent and non-coherent systems up to 80 DWDM channels

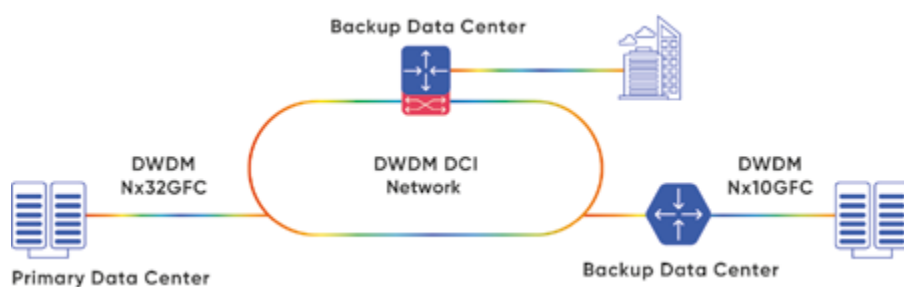


On Volga DWDM-equipment regional networks are built in the Macro-Regional Branch of Rostelecom PJSC: Center, Siberia, North-West, South, Volga Region and others

# Data Center Solutions

Cloud computing, the Internet of Things (IoT) and virtualization (VR) reach the potential of a modern data center and increase the load on communications channels. T8 offers a specialized solution for scaling a telecommunications network. It is Volga DCI chassis. The developed equipment for data centers increases the bandwidth of communication channels as needed without significant capital costs. The solution has a high port density and energy efficiency.

The DCI chassis can be equipped with both interface cards, transponder and aggregator units, as well as optical units that provide traffic transmission over the required distance. The maximum chassis capacity can be 8.4 Tbit/s with a capacity of 1.2 Tbit/s per slot. The equipment is Brocade<sup>1</sup> certified and supports Fiber Channel options.



- frontal blowing of the chassis
- highly integrated solution: DCI includes interface cards (transponder and aggregator units) and optical units (multiplexers and amplifiers)
- compact and large capacity in a single chassis, configurable single wave rate from 100 to 600 Gbit/s
- high interface density and power efficiency
- support for SAN protocols: Fiber Channel 8/10/16/32GC, Brocade<sup>1</sup> certified

In 2018, the largest data center of Sberbank was equipped with the latest generation of Volga 400 Gbit/s channel-forming DWDM equipment. On the multiservice platform, a high-speed network was built between several data centers with redundant channels.

<sup>1</sup>An up-to-date list of certified equipment is available upon request



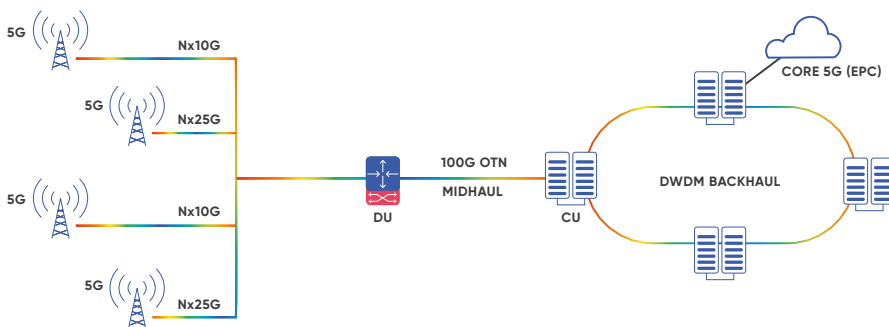


5G mobile networks are an integral part of digital transformation and the digital economy. 5G networks must provide speeds 20 times faster than the 4G generation and, therefore, place increased demands on the transport infrastructure.

Volga DWDM-equipment shows a high degree of readiness for new technological solutions. Low signal transmission delays, high-energy efficiency and the ability to organize a high density of channels in the fiber make it possible to use the platform in building 5G network infrastructure.

The equipment can be used to organize a transport layer on any of the 5G mobile network segments: Fronthaul, Midhaul and Backhaul. It provides the reliable delivery of mobile traffic (including CPRI/eCPRI) with a minimum deterministic delay, and a network synchronization, supporting such protocols as SyncE (clock synchronization) and 1588v2 (phase / time synchronization).

- a universal solution for transferring 4G and 5G client traffic to Fronthaul, Midhaul and Backhaul
- optimized, deterministic delays
- support for various Fronthaul 4G and 5G protocols with CPRI options (CPRI7, 8, 10), eCPRI (10GE, 25GE), network synchronization protocols SyncE and 1588v2



Volga DWDM platform has been tested in the 5G. T8 tested equipment on the Fronthaul, the most difficult segment. The eCPRI traffic was aggregated into a 200G link and passed between the base station DU and the remote RRUs. DWDM equipment has demonstrated error-free transmission and minimal delays due to parameter optimization.



# Alien Wavelength Technology

Expansion of existing OTN/DWDM networks and the need to increase channel capacity are some of the most common issues that T8 specialists have to solve. It is not always possible to expand the bandwidth of already installed equipment, so T8 suggests using «alien wavelength» technology. To increase the capacity of the system using this technology, it is enough to install the minimum set of channel-forming equipment (transponder or aggregator) and configure it to work together with the equipment of the linear path of another vendor. Alien Wavelength Technology enables companies to upgrade networks in cost-optimization way and reduce dependence on current equipment vendors.

Volga platform provides the transmission of any client signals supported by Volga units in an «alien» frequency grid without interrupting third-party traffic. A wide range of transceiver equipment and several types of chassis make it possible to find an effective solution for increasing network throughput. The use of the «alien wavelength» technology requires a preliminary study of the optical path. Therefore, to implement this task, the employees of the scientific department of the T8 company conduct additional measurements of the line parameters.

- transmission of client signals to any distance in a «alien grid» of wavelengths
- optimization of the cost of modernization of communication networks
- rapid capacity expansion within existing infrastructure



In 2020, a new backbone high-speed network of 100 Gbit/s was built on Volga DWDM platform, which united 13 communication nodes of the National Sports TV Channel LLC in the largest cities of Russia using the technology of «alien wavelength»

# Volga Multiservice DWDM Platform

| Telecom

| DCI

| OTN X Connect



# Volga DWDM System | Telecom

Telecommunication equipment for high-speed optical communication networks

Volga DWDM platform is an effective solution implemented using DWDM/OTN technology for organizing high-speed communication networks. The equipment supports channel speeds up to 800 Gbit/s, with a total system throughput of up to 38 Tbit/s per fiber pair. The platform chassis is available in 11316110U and is installed (mounted) in standard 19/21" telecommunication cabinets. DWDM Volga | Telecom is optimized to work with high-speed transponders: 100, 200, 400, 600 and 800 Gbit/s.

## Platform for any topology

A wide selection of channel-forming equipment with flexible line interface parameters meets the needs of operators when building metro, regional and backbone optical networks. A wide range of amplifiers (EDFA, RAMAN, EAM, ROPA, hybrid EDFA+RAMAN) makes it possible to build long and extra-long single-span lines. The presence of units with electrical and optical cross-connection opens up the possibility of creating complex network topologies. To ensure the reliability of connections, software and hardware mechanisms are provided to support 1+1 redundancy at the optical and electrical levels. Support for forward error correction FEC, including Super-FEC, HD-FEC and SD-FEC, provides a significant operating margin and increases the length of the regeneration section.

## Network scalability and upgrade

The platform provides the possibility accomplish an increase the network bandwidth quickly by adding units to the free slots of the chassis or increasing the linear speed of optical channels on transponders. Network reconfiguration and expansion can be done without interrupting communication. A wide range of client interfaces helps to seamlessly upgrade legacy communication lines with the transition to modern high-speed equipment of the new generation.

## A new level of network management and infrastructure monitoring

The carrier grade management system is designed for centralized control of DWDM equipment and integration with external IT systems (OSS/BSS). NMS provides information about the network structure, the general state of the communication channels between them at different levels of network organization.

The use of an OTDR unit built into the platform from Volga DWDM equipment line allows operators to monitor the state of the optical infrastructure in real time, prevent network failures and reduce downtime.

## Specifications

- Form factor from 1 to 10U
- A wide range of equipment for speeds from 155 Mbps to 800 Gbit/s
- ROADM: WSS 1x1, 1x2, 1x4, 1x9
- Optical amplifiers: EDFA, RAMAN, EAM, ROPA and hybrid EDFA+RAMAN
- Carrier grade management system

## Efficiency

- High density of client interfaces
- Up to 1.2 Tbit/s per slot
- Quick installation on current communication lines
- Alien Wavelength technology support

## Reliability

- 1+1 redundancy of control and power units
- Integration with OTDR system for fiber health monitoring

## Certification

- Status of telecommunications equipment of Russian origin (TORP)
- Departmental certification
- Equipment in the register of innovative products recommended for purchase



## V1



possible execution on request

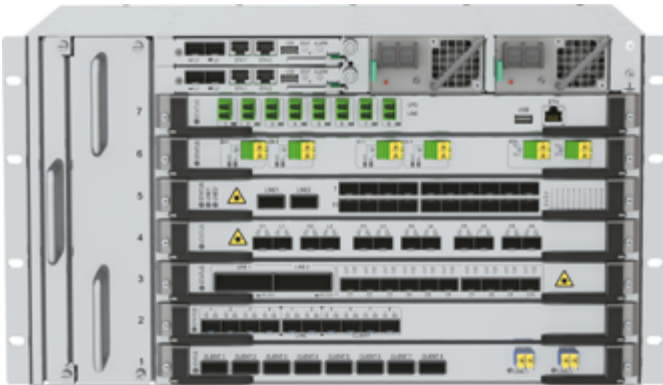
## V3



## V10



## V6



Chassis use	V10R2	V6R2	V3R2	V1
Slots in chassis	13	7	3	monoblock
Control unit redundancy	1+1 (variant with no redundancy is available)			no
Power supply redundancy	1+1			
Management system	EMS and NMS Fractal/Titan			
Air flow direction	lateral (left to right)			
Power supply modules	AC 220 B 50 Hz / DC 36-72 V			
Dimensions (W x H x D)	482 x 441 x 340 mm	482 x 258.2 x 340 mm	482 x 136.2 x 340 mm	482 x 44 x 378 mm
Working temperature	from +5 to +40 °C			
Mounting depth of the chassis	300 mm			
Maximum humidity	80 % (at +25 °C)			
Chassis power consumption (without equipment)	160 W	113 W	63 W	–
Chassis weight (without equipment)	12 kg	8.6 kg	7.4 kg	–

# Volga DWDM System | DCI

High-speed equipment for data center interconnections

A feature of the data center infrastructure is the presence of cold and hot aisles and the corresponding equipment cooling scheme in the data center. An important requirement for telecom equipment is the support of high-speed clients, their efficient aggregation in a high bandwidth channel.

DCI chassis allow operators to set up high-capacity DWDM links to connect data centers within a city or over longer distances. Through the compact platform it is possible both effectively accommodate up to 2 (V3 DCI) or 6 (V6 DCI) high-speed aggregators, and an optical line system in one chassis.

With the help of line cards of the M1200 line in the DCI version, it is possible to organize information transfer up to 2.4 Tbit/s in one V3 DCI chassis, and up to 7.2 Tbit/s in the V6 DCI chassis.

Responding to the needs of data center clients, within the framework of the DCI line, T8 has developed cards with a wide range of multi-service client interfaces. For example, the M400-2C2-20P2Q-DCI Aggregator supports high-speed FibreChannel storage protocol options along with Ethernet clients up to 400GE.

## Specifications

- Form factor from 1 to 6U
- A wide range of equipment for speeds from 155 Mb/s to 800 Gbit/s
- Carrier grade management system

## Efficiency

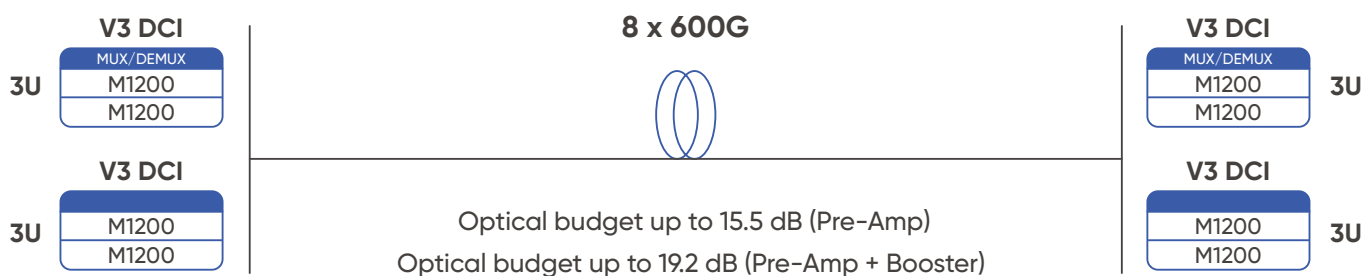
- High density of client interfaces
- Up to 1.2 Tbit/s per slot
- Support for Alien Wavelength technology

## Reliability

- 1+1, 2+1 redundancy of control and power units
- Advanced cooling system with data center design

## Certification

- Status of telecommunications equipment of Russian origin (TORP)
- Departmental certification
- Equipment in the register of innovative products recommended for purchase



## Compact monoblock solutions

The transceiver units and optical equipment of Volga line can be implemented in a compact 1U package. Such a monoblock design is an independent system with integrated control units. Monoblocks can be implemented both with the classic «left to right» blowing option, and in the data center version, with «front to back» blowing.

A distinctive feature of 1U solutions is the ability to organize networks with personalized data processing algorithms.

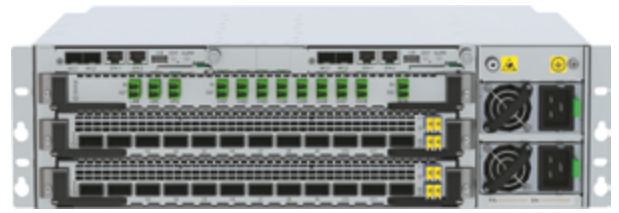
Such compact solutions are in demand in the banking sector, where security issues are in the first place.



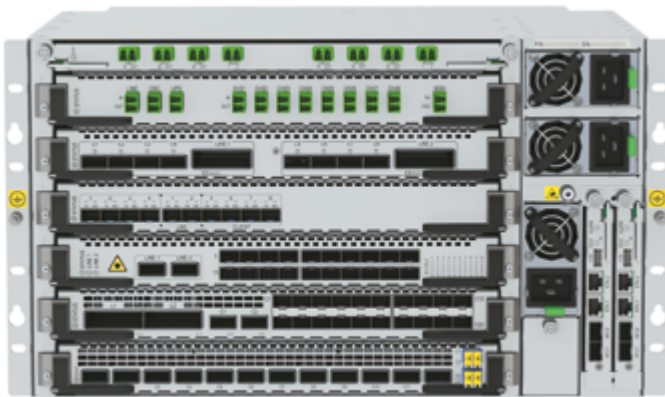
## V1 DCI



## V3 DCI



## V6 DCI



Chassis use	V6 DCI	V3 DCI	V1 DCI
Slots in chassis	7	3	monoblock
Control unit redundancy	1+1 (version without redundancy is available)		no
PSU redundancy	1+1 or 2+1	1+1	
Control system	EMS and NMS Fractal/Titan		
Air flow direction	frontal		
Power supply	modules AC 220 V 50 Hz / DC 36-72 V		
Dimensions (W x H x D)	482 x 264 x 470 mm	482 x 133 x 470 mm	482 x 44 x 470 mm
Working temperature	from +5 to +40 °C		
Maximum humidity	80 % (at +25 °C)		
Chassis power consumption (without equipment)	120 W	60 W	–
Chassis weight (without equipment)	10 kg	7 kg	–

# Volga DWDM System | OTN X-Connect

## Backbone OTN cross-connect for DWDM networks

Volga OTN cross-connect switches ODU streams at ODU1/2/3/4 levels in a non-blocking mode. The XC2T model has a bandwidth of up to 2 Tbit/s. A centralized OTN cross-connect fabric (OTN XC) system with a capacity of 4 Tbit/s is under development. The cross-connect matrix provides the possibility to place a variety of client signals in the payload of OTN containers ODU-k ( $k = 0/1/2/3/4$ ), and then programmatically redistribute them between different OTN optical channels OTU-k ( $k = 1/2/3/4$ ), i.e. between line ports tuned to different wavelengths.

This allows the operator to manage the distribution of client port traffic across transport channels more efficiently. Each client port is no longer rigidly associated with a specific transport channel (as in a muxponder). Traffic can be switched to any transport interface through the NMS or automatic traffic redistribution can be configured depending on the channel load.

OTN technology is the successor to SDH circuit switching technology, with VC-x cross-connect as a key element. OTN cross-connect ODU-k channels includes the best SDH features such as:

- Add-Drop & Continue: copy the same service channel, for example, in two independent directions (line outputs) and at different wavelengths
- SNCP protection switches at the ODU-k level organization

The hardware architecture of the WDM/OTN cross-switch implies the presence in the chassis of separate line cards (DWDM side) and tributary cards (client interface side), interconnected by an OTN cross-connect matrix. Along with this, for example, in the new XC900 chassis it will be possible to use two slots for conventional transponders.

OTN technology is used in conjunction with DWDM technology, where several OTN ODU-k channels of different levels at different wavelengths can be transmitted simultaneously on one fiber. Today, a combination of OTN and DWDM technologies is the most common solution for building modern fiber-optic telecommunication networks.

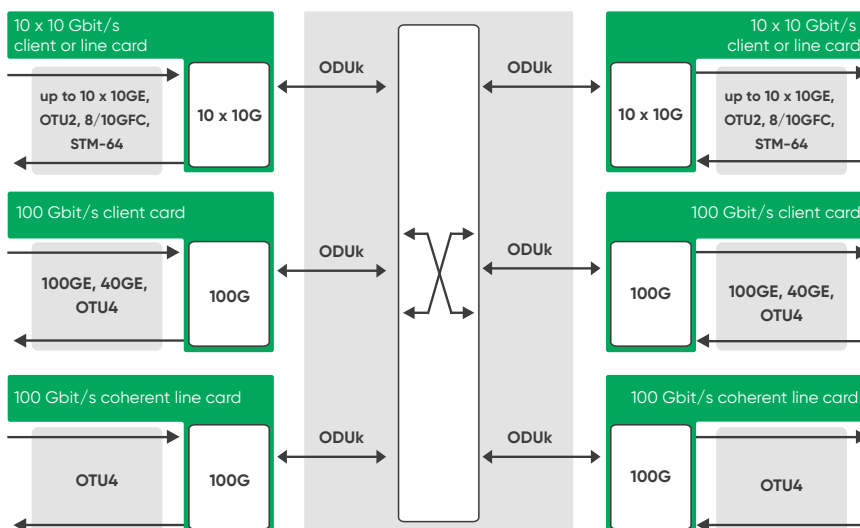


Volga cross-connect



Units for Volga series chassis with OTN-switching

- transmission of up to two 100/200G channels from one line card
- pluggable CFP/CFP2 modules on line cards
- a wide variety of pluggable client interfaces and the number of ports (up to 20) on client boards
- replaceable SFP+/SFP28/QSFP28 modules on client boards



Parameters / Chassis	XC9R2	V10R2-X2	
Chassis switching capacity	900 Gbit/s (factory X04F-X2-01)	2 Tbit (factory X04F-X2-01)	5 Tbit (factory X04F-X3-01)
Number of cards Volga - XC	9	10	
Number of cards Volga	2	-	
Cross Connect Card	2 (X04F-X2-01)	3 (2T - X04F-X2-01/ 5T - X04F-X3-01)	
Line cards	100 Gbit/s	1 x 200G, 2 x 100G, 2 x 200G (only X04F-X3-01)	
Types of client cards	10 x 10 Gbit/s (10GE, STM-64, OTU2, FC1000, 100GE)	2 x 100G, 20 x 10G (10GE, STM-64, OTU2), 10GFC, 100GE, 40G, STM-256	
Cross connect card redundancy	1+1	2+1 (capacity/slot 200G c X04F-X2-01; 500G c X04F-X3-01)	
		2+1 (capacity/slot 200G c X04F-X3-01)	
Control units redundancy	1+1		
Synchronization units redundancy	1+1		
Power supply redundancy	1+1		

Line boards	L400-2C2-X2	L200-1C2-X2	L100-1C-X2	L200-2C2-X2
Number of interfaces	2	1	1	2
Interface type	CFP2 (100G/200G)		CFP (100G)	CFP2 (100G)
Modulation format	DP-8QAM/DP-16QAM		DP-QPSK	
Frequency grid	50/100 GHz			
Automatic dispersion correction	up to $\pm 20$ ns/nm		up to $\pm 50$ ns/nm	up to $\pm 40$ ns/nm
Wavelength range	1528.7 – 1567.1 nm			
OSNRT (0.1 nm, BER = 10 <sup>-12</sup> )	18.1 dB /19.2 dB		12.5 dB	11.4 dB
FEC	SD-FEC 15 %			
Output power (BER = 10 <sup>-12</sup> )	-15...+1 dBm		-5...0 dBm	-15...+1 dBm
Receiver sensitivity	-22 dBm		-18 dBm	-22 dBm
Receiver overload	0 dBm			
Power consumption	up to 150 W	up to 130 W	up to 110 W	up to 130 W

Client boards	C100-10P-X1	C200-20P-X2	C200-2Q-X2	C100-2Q1P-X1
Number and type of interfaces	10 (SFP+)	20 (SFP+/SFP28)	2 x (QSFP+/QSFP28)	2 x (QSFP+/QSFP28) + 1 x SFP+/SFP28
Interface standard	10GE/OTU2/ STM-64/FC	10GE, 25GE, OTU2, STM-64, 8/10/16/32GFC, CPRI 4.9G/6.1G/9.8G	40GE/OTU3/ STM-256/100GE/OTU4	10GE, OTU2, STM-64, CPRI 4.9G/6.1G/9.8G, 8/10/16/32GFC, 25GE OTU3/ STM-256/100GE/OTU4
Power consumption	up to 100 W	up to 150 W	up to 110 W	up to 130 W



# 800 Gbit/s

## Aggregating Transponders

The M800 series units provide aggregation of up to 8 high-speed Ethernet (400GE/100GE), OTN (OTU4) client signals and their transmission over a WDM line in a linear signal up to 800 Gbit/s.

Implemented several versions of the unit for different configurations.

### Key points about the M800 muxponder line

- the ability to gradually scale the network as traffic grows
- flexible configuration of the line interface
- high speed clients
- best optical performance at the line interface

### Modifications:

M800-1-8Q

8 x 100 Gbit/s - client  
1 x 800 Gbit/s - line

M800-1-4Q/1QD

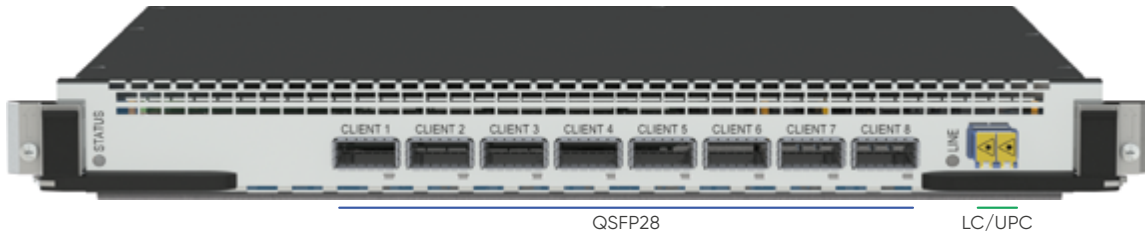
4 x 100 Gbit/s + 400 Gbit/s - client  
1 x 800 Gbit/s - line

M800-1-2QD

2 x 400 Gbit/s - client  
1 x 800 Gbit/s - line

# Aggregator M800-1-8Q

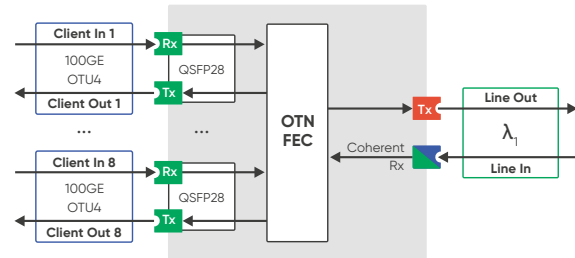
Aggregates up to 8 x 100G clients and transmits up to 800 Gbit/s over a single wavelength



The world's highest data rate per wavelength

## Available versions:

Data Center | Telecom



Line interfaces	1 x LC/UPC DWDM			
	Line Mode Examples			
Line interface speed	200G	400G	600G	800G
Modulation formats	DP-P-16QAM (95 GBaud)	DP-P-16QAM (95/85 GBaud)	DP-P-64QAM (95/85 GBaud)	DP-P-64QAM (95/91.6 GBaud)
FEC	SD-FEC			
Redundancy support	no			
Frequency grid (multiplexing technology)	91.6 GBaud: 100 GHz Flattop AWG   95 GBaud: 125 GHz / FlexGrid   85 GBaud: 100 GHz Flattop AWG			
Frequency range	191.25 – 196.1 THz			
Transmitter output power	the ability to adjust the output power in the range -9 ... + 4 dBm			
OSNR <sub>T</sub>	12.2 dB	17.3 dB / 17.9 dB * 95/85 GBaud	22.2 dB / 23.7 dB * 95/85 GBaud	27.4 dB / 28.4 dB * 95/91.6 GBaud
Receiver sensitivity	-25 dBm	-25 dBm	-21.5 / -20.5 dBm * 95 GBaud / 85 GBaud	-16.5 / -15.5 dBm * 95 GBaud / 91.6 GBaud
Receiver overload	5 dBm			
Automatic dispersion correction	- 45 300 ... + 468 200 ns/nm			- 39 600 ... + 39 600 ns/nm

### Aggregation up to 8 x 100GE (QSFP28) → 800G or up to 6 x 100GE/OTU4 (QSFP28) → 600G

Client interfaces	8 x QSFP28	
Transfer protocols	100GE/OTU4	100GE

### Aggregation up to 4 x 100GE (QSFP28) and 1 x 400GE (QSFP-DD) → 800G

Client interfaces	4 x QSFP28, 1 x QSFP-DD	
Transfer protocols	2 x 100GE/OTU4 (QSFP-28) 1 x 400GE (QSFP-DD)	4 x 100GE (QSFP-28) 1 x 400GE (QSFP-DD)

### Aggregation up to 2 x 400GE (QSFP-DD) → 800G

Client interfaces	2 x QSFP-DD			
Transmitting protocols	–	1 x 400GE (QSFP-DD)	–	2 x 400GE (QSFP-DD)

Power consumption for all versions	up to 120 W	up to 130 W	up to 140 W	up to 160 W
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# 1200 Gbit/s

## Aggregating Transponders

The M1200 series units provide aggregation of multi-service client signals Ethernet (100GE), OTN (OTU4) or Ethernet (400GE) and their transmission over a WDM line in two linear streams up to 600 Gbit/s. Implemented modifications M1200-2-12Q and M1200-2-3QD to support various client configurations.

The line of muxponders implements the ability to fine-tune the parameters of the linear interface at transmission and reception to improve the characteristics of the linear signal and optimize digital processing algorithms for coherent reception. Intermediate modulation formats (Fractional QAM) with a non-integer value of symbol efficiency SE [bps] are supported, which provides the possibility to improve OSNR for particular scenarios.

### Key points about the M1200 muxponder line

- maximum throughput per slot in the line
- the possibility of scaling the communication channel on the existing infrastructure
- advanced options for setting the line interface
- multiservice clients
- redundancy support
- lightning protection (increased resistance to rapid change in the SOP-signal)
- optimal balance between bandwidth and distance

### Modifications:

M1200-2-12Q

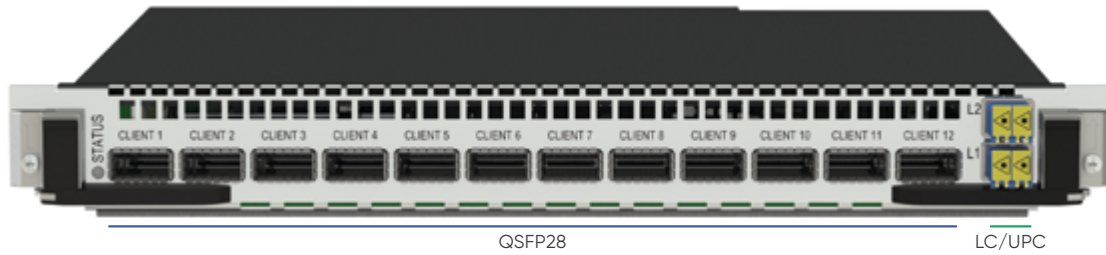
12 x 100 Gbit/s - client  
2 x 600 Gbit/s - line

M1200-2-3QD

3 x 400 Gbit/s - client  
2 x 600 Gbit/s - line

# Aggregator M1200-2-12Q

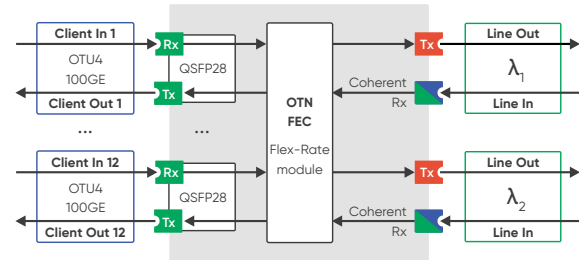
Aggregates up to 12 x 100G clients and transmits up to 1200 Gbit/s on two wavelengths



Maximum speed in one slot, speed scalability, unlimited line settings

## Available versions:

Data Center



Line interfaces	2 x LC/UPC DWDM					
	Line mode examples					
Line interface speed	2 x 100G	2 x 200G	2 x 300G	2 x 400G	2 x 500G	2 x 600G
Modulation formats	DP-P-QPSK DP-QPSK	DP-QPSK DP-P-16QAM DP-16QAM DP-32QAM	DP-P-16QAM DP-16QAM DP-32QAM DP-64QAM	DP-16QAM DP-32QAM DP-64QAM	DP-32QAM DP-64QAM	DP-32QAM DP-64QAM
	* intermediate modulation formats available for all modes (Fractional QAM)					
FEC	HD-FEC 7 %, SD-FEC 15 % / 27 %					
Redundancy support	yes					
Frequency grid	50 GHz / 100 GHz / FlexGrid (in increments of 6.25 GHz)			100 GHz / FlexGrid (in increments of 6.25 GHz)		
Frequency range	191.25 – 196.1 THz					
Transmitter output power	the ability to adjust the output power in the range -10 ... +3 dBm					
OSNR <sub>T</sub>	9.91 dB *69.435 GBaud, DP-P-QPSK, SD-FEC 27 %	12.98 dB *71.675 GBaud, Fractional QAM, SD-FEC 27 %	16.98 dB *71.868 GBaud, Fractional QAM, SD- FEC 27 %	20.19 dB *69.435 GBaud, DP-16QAM, SD-FEC 27 %	24.74 dB *69.435 GBaud, DP-32QAM, SD-FEC 27 %	29.75 dB *71.955 GBaud, Fractional QAM, SD-FEC 15 %
Receiver sensitivity	-25 dBm	-25 dBm	-25 dBm	-17 dBm	-15 dBm	-15 dBm
Receiver overload	5 dBm					
Automatic dispersion correction	up to ± 320 ns/nm	up to ± 320 ns/nm	up to ± 100 ns/nm	up to ± 50 ns/nm	up to ± 20 ns/nm	up to ± 10 ns/nm
Lightning protection (resistance to rapid SOP changes)	4 Mrad/s	10 Mrad/s	3 Mrad/s	1 Mrad/s	50 Krad/s	50 Krad/s

## Aggregator M1200-2-12Q

Client interfaces	12 x QSFP28					
Transmitting protocols	100GE, OTU4, OTUC1					
Power consumption	up to 170 W	up to 195 W	up to 220 W	up to 240 W	up to 265 W	up to 280 W

## Aggregator M1200-2-3QD

Client interfaces	up to 3 x QSFP-DD					
Transmitting protocols	400GE					
Power consumption	up to 230 W					

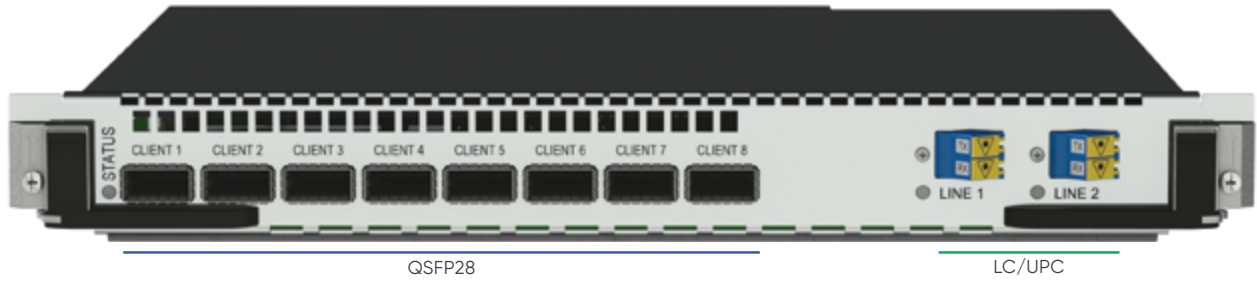


# Units of equipment



# Aggregator M800-2-8Q

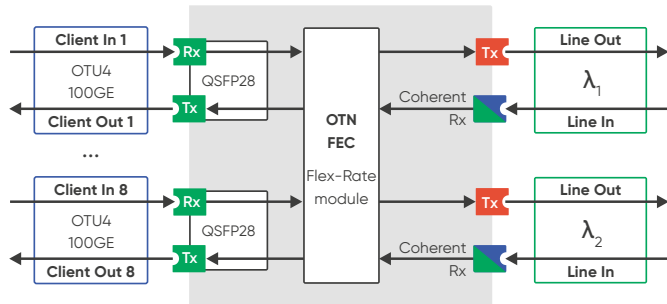
Aggregate up to 8 x 100G clients and transmit up to 800 Gbit/s x 2 wavelengths



Efficient and economical transmission of high-speed clients, unlimited line configuration options, redundancy support

### Available versions:

Telecom | Data Center

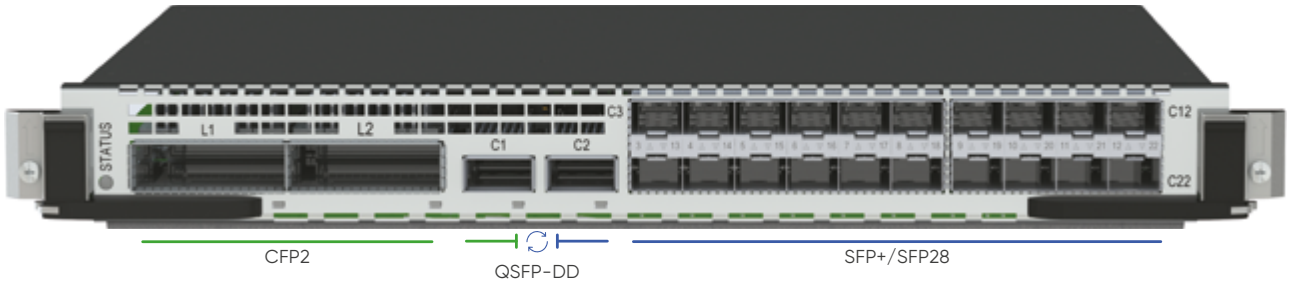


Line interfaces	2 x LC/UPC DWDM, 2 x LC/UPC DWDM			
	Line mode examples			
Line interface speed	2 x 100G	2 x 200G	2 x 300G	2 x 400G
Modulation formats	DP-P-QPSK DP-QPSK	DP-QPSK DP-P-16QAM DP-16QAM DP-32QAM	DP-P-16QAM DP-16QAM DP-32QAM DP-64QAM	DP-16QAM DP-32QAM DP-64QAM
	* intermediate modulation formats available for all modes (Fractional QAM)			
FEC	HD-FEC 7 %, SD-FEC 15 % / 27 %			
Redundancy support	yes			
Frequency grid	50 GHz/100 GHz / FlexGrid (increment 6.25 GHz)			
Frequency range	191.25 – 196.1 THz			
Transmitter output power	-10...+3 dBm (transmitter output power setting)			
OSNR <sub>T</sub>	9.91 dB * 69.435 GBaud, DP-P-QPSK, SD-FEC 27 %	12.98 dB * 71.675 GBaud, Fractional QAM, SD-FEC 27 %	16.98 dB * 71.868 GBaud, Fractional QAM, SD-FEC 27 %	20.19 dB * 69.435 GBaud, DP-16QAM, SD-FEC 27 %
Receiver sensitivity	-25 dBm	-25 dBm	-25 dBm	-17 dBm
Receiver overload	5 dBm			
Automatic dispersion correction	up to ± 320 ns/nm	up to ± 320 ns/nm	up to ± 100 ns/nm	up to ± 50 ns/nm
Lightning protection (resistance to rapid SOP changes)	up to 4 Mrad/s	up to 10 Mrad/s	up to 3 Mrad/s	up to 1 Mrad/s
Client interfaces	8 x QSFP28			
Transmitting protocols	100GE, OTU4, OTUC1			
Power consumption	up to 170 W	up to 195 W	up to 220 W	up to 240 W



# Aggregator M400-2C2-20P2Q (in development)

Client aggregation up to 600 Gbit/s total capacity and 300G dual wavelength transmission (or up to 400G single wavelength)

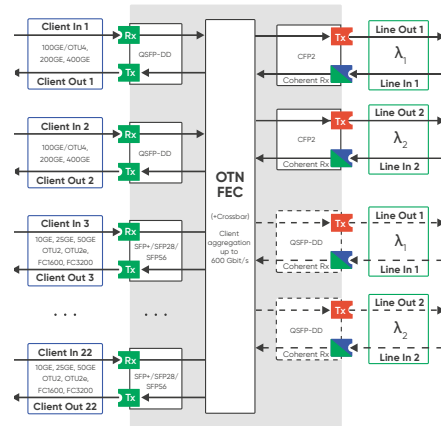


Support for multi-service multi-rate clients and efficient transmission with selectable line interface

Ports can be client or line (QSFP-DD coherent)

## Available versions:

Data Center

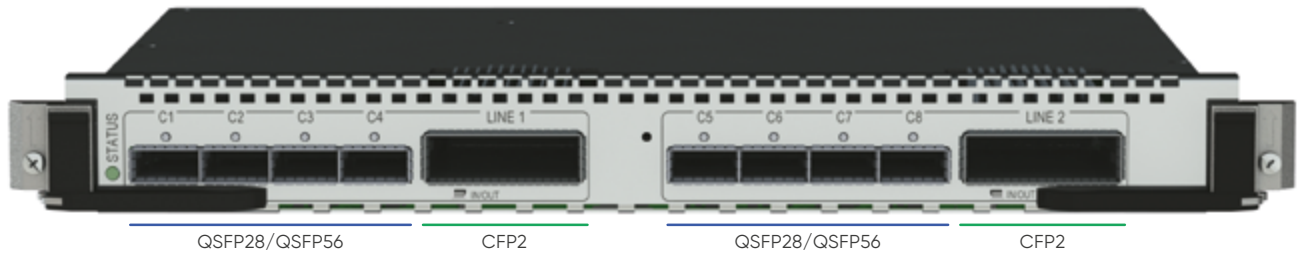


Line interfaces	2 x CFP2			
	Examples of linear modes (characteristics are determined by plug-in modules)			
Line interface speed	2 x 100 G	2 x 200 G	2 x 300 G	1 x 400G * additional transmission is available on the second line interface 200 G
Modulation formats	DP-QPSK DP-DQPSK	DP-QPSK/DP-8QAM/ DP-16QAM	DP-8QAM	DP-16QAM
FEC	HD-FEC 7 % / O-FEC 15 %	O-FEC 15 %		
Redundancy support	yes			no
Frequency grid	50 GHz / 100 GHz / FlexGrid (in increments of 6.25 GHz)		100 GHz / FlexGrid (in increments of 6.25 GHz)	
Frequency range	191.275 – 196.125 THz			
Transmitter output power	- 4 dBm	-8.5 dBm / -9 dBm / -8 dBm	- 10 dBm	-11 dBm
OSNR <sub>T</sub>	12.9 dB 11.5 dB	15.7 dB / 17.5 dB / 20 dB	20.5 dB	24 dB
Receiver sensitivity	-32 dBm -31 dBm	-28 dBm / -28 dBm / -23 dBm	-23 dBm	-20 dBm
Receiver overload	6 dBm			
Automatic dispersion correction	up to ± 77 ns/nm	up to ± 48 ns/nm up to ± 48 ns/nm up to ± 25 ns/nm	up to ± 48 ns/nm	up to ± 24 ns/nm
Lightning protection (resistance to rapid SOP changes)	up to 3 Mrad/s	up to 6 Mrad/s	up to 500 Krad/s	up to 500 Krad/s
Client interfaces	20 x SFP+/SFP28, 2 x QSFP-DD			
Transmitting protocols	<b>Aggregating of 2 x 300G (or 1 x 400G + 1 x 200G) clients with a total capacity up to 600G:</b> <ul style="list-style-type: none"> <li>• up to 20: 10GE, FC1600 (SFP+)</li> <li>• up to 16 x 25GE (SFP28)</li> <li>• up to 12 OTU2, OTU2e (SFP+), FC3200 (SFP28), 50GE (SFP56)</li> <li>• up to 6: FlexO (SFP+/QSFP28)</li> <li>• up to 2 x 100GE/OTU4 (QSFP28)</li> <li>• up to 2 x 200GE (QSFP-DD/QSFP56)</li> <li>• up to 1 x 400GE (QSFP-DD)</li> </ul>			
Power consumption	up to 170 W			



# Aggregator MD400-2C2-8Q

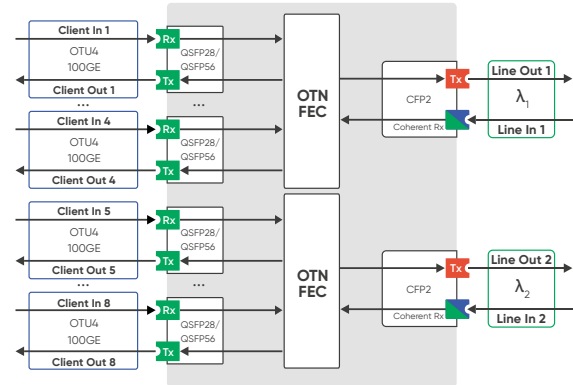
Aggregation of up to 2 x (4 x 100G) clients and independent transmission of 400G per wavelength



Cost-effective solution for transferring high-speed clients with redundancy

## Available versions:

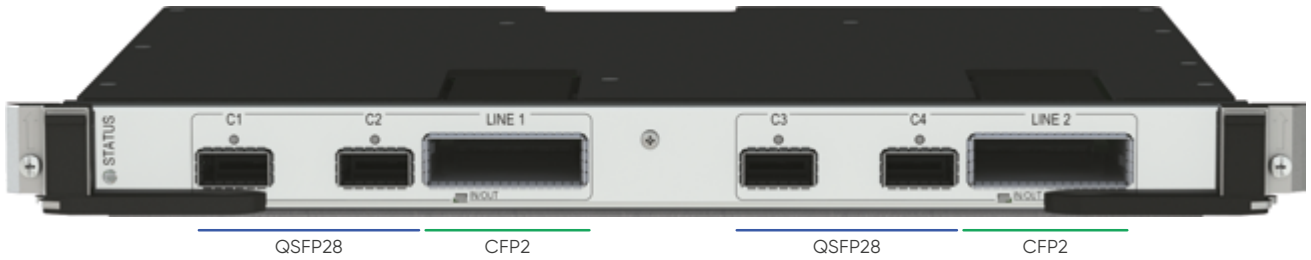
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Line interfaces	2 x CFP2			
	Line Mode Examples (characteristics are determined by plug-in modules)			
Line interface speed	2 x 100G	2 x 200G	2 x 300G	2 x 400G
Modulation formats	DP-QPSK DP-DQPSK	DP-QPSK DP-8QAM DP-16QAM	DP-8QAM	DP-16QAM
FEC	HD-FEC 7 % / O-FEC 15 %	O-FEC 15 %		
Redundancy support	yes		—	
Frequency grid	50 GHz / 100 GHz / FlexGrid (in increments of 6.25 GHz)		100 GHz / FlexGrid (in increments of 6.25 GHz)	
Frequency range	191.275 – 196.125 THz			
Transmitter output power	-4 dBm	-8.5 dBm -9 dBm -8 dBm	-10 dBm	-11 dBm
OSNR <sub>T</sub>	12.9 dB 11.5 dB	15.7 dB 17.5 dB 20 dB	20.5 dB	24 dB
Receiver sensitivity	-32 dBm -31 dBm	-28 dBm -28 dBm -23 dBm	-23 dBm	-20 dBm
Receiver overload	6 dBm			
Automatic dispersion correction	up to ± 77 ns/nm	up to ± 48 ns/nm up to ± 48 ns/nm up to ± 25 ns/nm	up to ± 48 ns/nm	up to ± 24 ns/nm
Lightning protection (resistance to rapid SOP changes)	up to 3 Mrad/s	up to 6 Mrad/s	up to 500 Krad/s	up to 500 Krad/s
Client interfaces	8 x QSFP28/QSFP56 (4 x QSFP28 in 1 x CFP2)			
Transmitting protocols	up to 2 x [4 x 100GE/OTU4] (QSFP28) up to 2 x [2 x 200GE] (QSFP-28)			
Power consumption	up to 140 W			

# Aggregator MD200-2C2-4Q

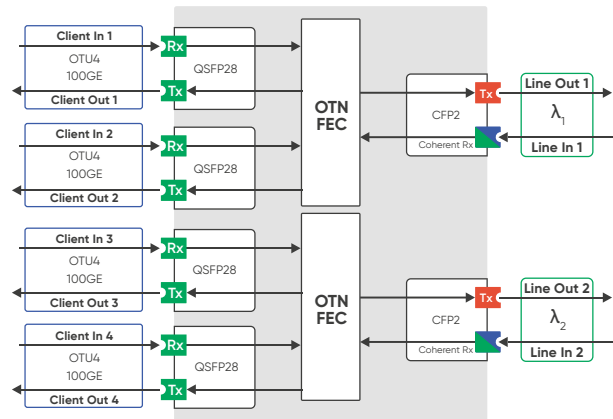
Aggregation of up to 2 x (2 x 100G) clients and independent transmission of 200G per wavelength



Cost-effective solution for transferring high-speed clients with redundancy

## Available versions:

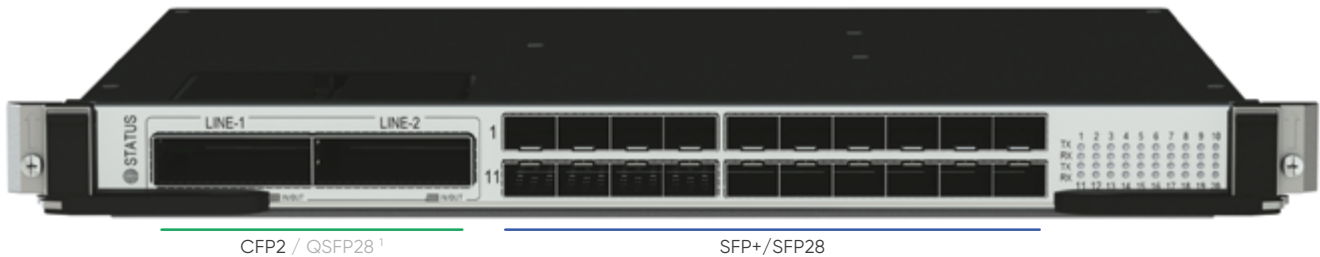
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Line interfaces	2 x CFP2	
	Line Mode Examples (characteristics are determined by plug-in modules)	
Line interface speed	2 x 100G	2 x 200G
Modulation formats	DP-QPSK DP-DQPSK	DP-8QAM DP-16QAM
FEC	HD FEC 7 %, SD FEC 15 %	SD FEC 15 %
Redundancy support	yes	
Frequency grid	50 GHz / 100 GHz / FlexGrid (in increments of 6.25 GHz)	
Frequency range	191.25 – 196.1 THz	
Transmitter output power	-15...1 dBm	
OSNR <sub>T</sub>	11.4 dB * DP-QPSK, SD FEC 15 %	18.1 dB * DP-8QAM, SD FEC 15 %
Receiver sensitivity	-22 dB	-21 dB
Receiver overload	6 dBm	
Automatic dispersion correction	up to ± 40 ns/nm	up to ± 20 ns/nm
Lightning protection (resistance to rapid SOP changes)	up to 5 Mrad/s	up to 1.6 Mrad/s
Client interfaces	4 x QSF28 (2 x QSF28 in 1 x CFP2)	
Transmitting protocols	100GE/OTU4	
Power consumption	up to 90 W	

# Aggregator MS-D100EC2-DT10

Aggregation of up to 20 multi-service signals with a total capacity of up to 200 Gbit/s and transmission over 100G at two wavelengths (or up to 200G at a single wavelength)



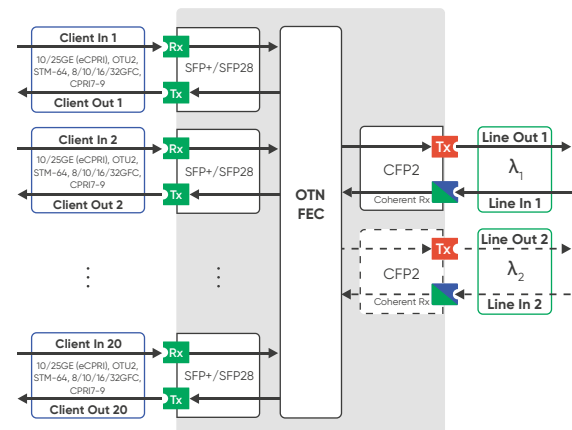
Support for an extended set of clients in a single redundant slot

## Available versions:

Telecom | Data Center

<sup>1</sup> MS-D100EC2-DT10 is unit for aggregating multiservice signals and transmitting in a coherent high-speed signal through the CFP2 line interface

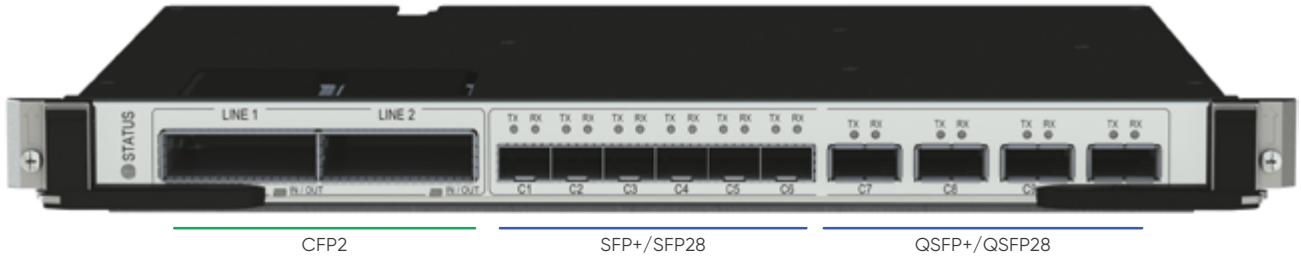
MS-D100EQ-DT10 is unit for aggregating low-speed signals via the QSFP28 interface into high-speed transponders M800-1-8Q and M1200-2-12Q for efficient use of optical line resources



Line interfaces	2 x CFP2	
	Line Mode Examples (characteristics are determined by plug-in modules)	
Line interface speed	2 x 100G (redundancy)	1 x 200G
Modulation formats	DP-DQPSK / DP-QPSK	DP-8QAM / DP-16QAM
FEC	HD FEC 7 %, SD FEC 15 %	SD FEC 15 %
Redundancy support	yes	no
Frequency grid	50 GHz / 100 GHz / FlexGrid (in increments of 6.25 GHz)	
Frequency range	191.25 – 196.1 THz	
Transmitter output power	-15...+1 dBm	
OSNR <sub>T</sub>	11.4 dB * DP-QPSK, SD FEC 15 %	18.1 dB * DP-8QAM, SD FEC 15 %
Receiver sensitivity	-22 dB	-21 dB
Receiver overload	6 dBm	
Automatic dispersion correction	up to ± 40 ns/nm	up to ± 20 ns/nm
Lightning protection (resistance to rapid SOP changes)	up to 5 Mrad/s	up to 1.6 Mrad/s
Client interfaces	20 x SFP+/SFP28	
	Total client capacity up to 100G	Total client capacity up to 200G
Transmitting protocols	<b>Aggregating 100G (CFP2):</b> • up to 10 x 10GE, CPRI7-9, OTU2/OTU2e, STM-64, FC800/1200 (SFP+) • up to 6 x FC1600 (SFP+) • up to 3 x 25GE (eCPRI), FC3200 (SFP28)	<b>Aggregating 2 x 100G (or 1 x 200G, CFP2):</b> • up to 20 x 10GE, CPRI7-9, OTU2/OTU2e, STM-64, FC800/1200 (SFP+) • up to 12 x FC1600 (SFP+) • up to 6 x FC3200, 25GE (eCPRI) (SFP28)
Power consumption	up to 140 W	up to 125 W

# Aggregator MS-D100EC2-SX10/Q40Q

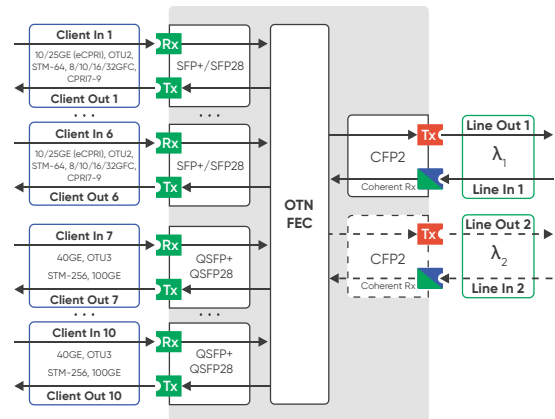
Aggregation of up to 10 multi-service signals with a total capacity of up to 200 Gbit/s and transmission over 100G at two wavelengths (or up to 200G at a single wavelength)



Support for an extended set of clients in a single redundant slot

### Available versions:

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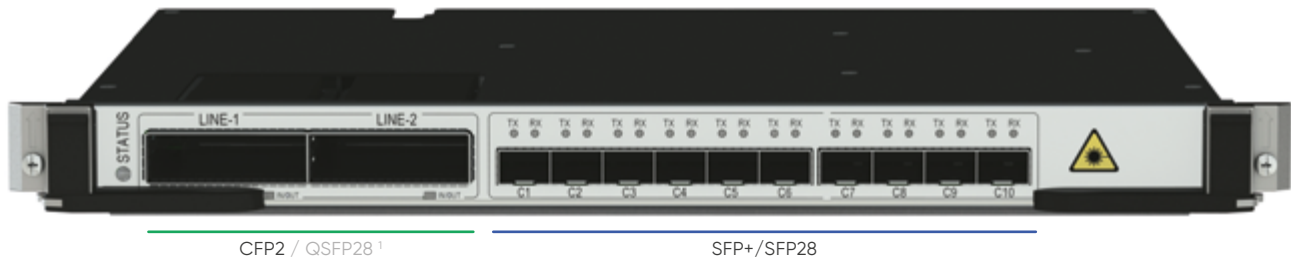


Line interfaces	2 x CFP2	
	Line Mode Examples (characteristics are determined by plug-in modules)	
Line interface speed	2 x 100G (redundancy)	1 x 200G
Modulation formats	DP-DQPSK DP-QPSK	DP-8QAM DP-16QAM
FEC	HD FEC 7 %, SD FEC 15 %	SD FEC 15 %
Redundancy support	yes	no
Frequency grid	50 GHz / 100 GHz / FlexGrid (in increments of 6.25 GHz)	
Frequency range	191.25 – 196.1 THz	
Transmitter output power	-15...+1 dBm	
OSNR <sub>T</sub>	11.4 dB * DP-QPSK, SD FEC 15 %	18.1 dB * DP-8QAM, SD FEC 15 %
Receiver sensitivity	-22 dB	
Receiver overload	6 dBm	
Automatic dispersion correction	up to ± 40 ns/nm	up to ± 20 ns/nm
Lightning protection (resistance to rapid SOP changes)	up to 5 Mrad/s	up to 1.6 Mrad/s
Client interfaces	6 x SFP+/SFP28, 4 x QSFP+/QSFP28	
	Total client capacity up to 100G	Total client capacity up to 200G
Transmitting protocols	<ul style="list-style-type: none"> <li>• up to 6 x 10GE, CPRI7-9, OTU2/OTU2e, STM-64, FC800/1200/1600 (SFP+)</li> <li>• up to 3 x 25GE (eCPRI), FC3200 (SFP28)</li> <li>• up to 2 x 40GE/OTU3 (QSFP+)</li> <li>• up to 1 x 100GE/OTU4 (QSFP28)</li> </ul>	<ul style="list-style-type: none"> <li>• up to 6 x 10GE (eCPRI), CPRI7-9, OTU2/OTU2e, STM-64, FC800/1200/1600 (SFP+)</li> <li>• up to 6 x 25GE (eCPRI), FC3200 (SFP28)</li> <li>• up to 4 x 40GE/OTU3 (QSFP+)</li> <li>• up to 2 x 100GE/OTU4 (QSFP28)</li> </ul>
Power consumption	up to 140 W	up to 125 W



# Aggregator MS-D100EC2-T10

Aggregation up to 10 x 10G / 6 x 25G clients and transmits up to 100/200 Gbit/s over a single wavelength. 1+1 redundancy in 100 Gbps mode



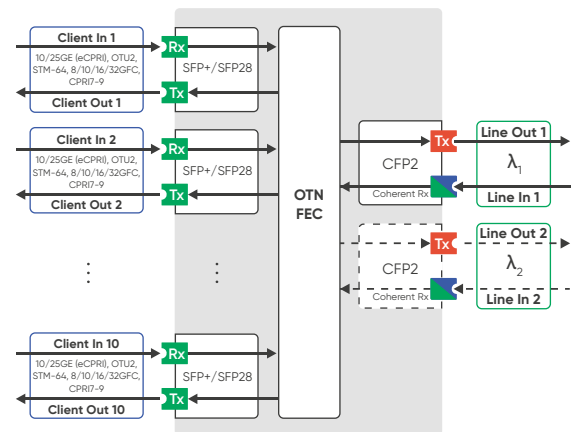
Support for multi-service clients in one redundant slot

## Available versions:

Telecom | Data Center

<sup>1</sup>MS-D100EC2-T10 is unit for aggregating multiservice signals and transmitting in a coherent high-speed signal through the CFP2 line interface

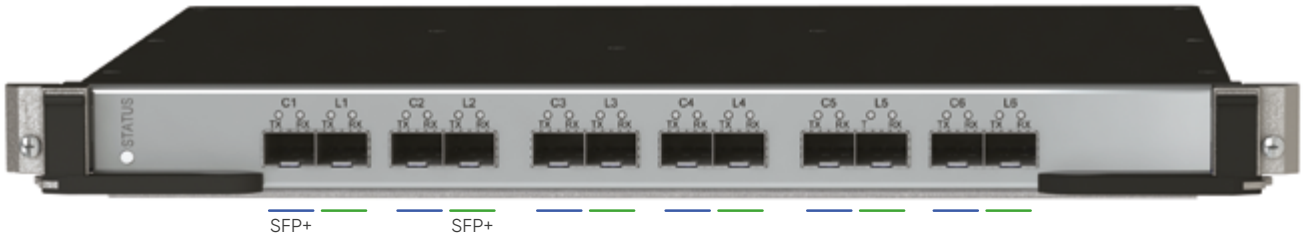
MS-D100EQ-T10 is unit for aggregating low-speed signals via the QSFP28 interface into high-speed transponders M800-1-8Q and M1200-2-12Q for efficient use of optical line resources



Line interfaces	2 x CFP2	
	Line Mode Examples (characteristics are determined by plug-in modules)	
Line interface speed	2 x 100G (redundancy)	200G
Modulation formats	DP-DQPSK DP-QPSK	DP-8QAM DP-16QAM
FEC	HD FEC 7 %, SD FEC 15 %	SD FEC 15 %
Redundancy support	yes (100G)	no
Frequency grid	50 GHz / 100 GHz / FlexGrid (in increments of 6.25 GHz)	
Frequency range	191.25 – 196.1 THz	
Transmitter output power	-15...+1 dBm	
OSNR <sub>T</sub>	11.4 dB * DP-QPSK, SD FEC 15 %	18.1 dB * DP-8QAM, SD FEC 15 %
Receiver sensitivity	-22 dB	
Receiver overload	6 dBm	
Automatic dispersion correction	up to ± 40 ns/nm	up to ± 20 ns/nm
Lightning protection (resistance to rapid SOP changes)	up to 5 Mrad/s	up to 1.6 Mrad/s
Client interfaces	10 x SFP+/SFP28	
	Total client capacity up to 100G	Total client capacity up to 200G
Transmitting protocols	<b>Aggregating 100G (CFP2):</b> • up to 10 x 10GE, CPRI7-9, OTU2/OTU2e, STM-64, FC800/1200 (SFP+) • up to 6 x FC1600 (SFP+) • up to 3 x 25GE (eCPRI), FC3200 (SFP28)	<b>Aggregating 200G (CFP2):</b> • up to 10 x 10GE, CPRI7-9, OTU2/OTU2e, STM-64, FC800/1200 (SFP+) • up to 10 x FC1600 (SFP+) • up to 6 x 25GE (eCPRI), FC3200 (SFP28)
Power consumption	up to 125 W	up to 140 W

# Aggregator TS-10EP/TD-10EP/TSX-10EP

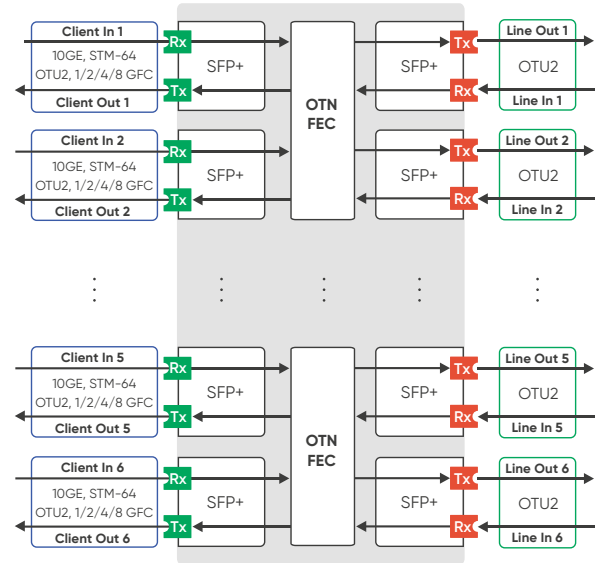
1/2/6 transponders unit for transmission of one/two/six independent 10G signals



Solutions for independent transmission of 10G services over long distances

## Available versions:

Telecom | Data Center

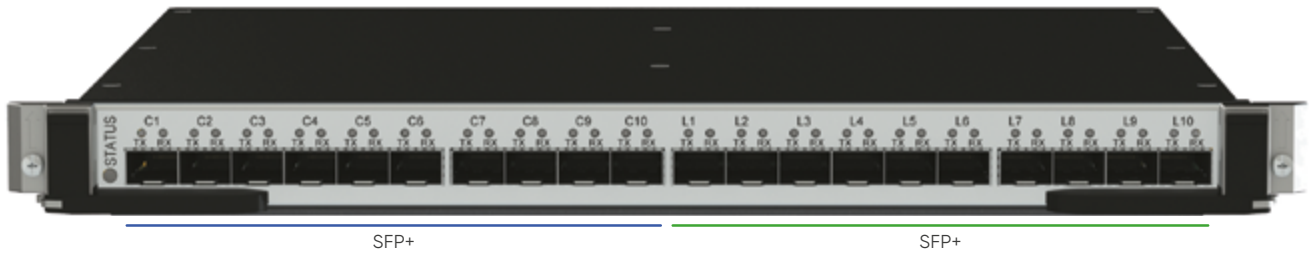


Versions TSX-10EP

Transponder	TS-10EP	TD-10EP	TSX-10EP
Line interfaces	1 x SFP+	2 x SFP+	6 x SFP+
Line interface speed	10G (OTU2)		
FEC	EFEC G.709, G.975.1 1.7%, 12%, 13%		
Redundancy support	no	yes (1+1)	yes (1+1)
Switching support	no		
Frequency grid	determined by installed module		
Wavelength range			
Transmitter output power			
OSNR <sub>r</sub>			
Receiver sensitivity			
Receiver overload			
Client interfaces	1 x SFP+	2 x SFP+	6 x SFP+
Transmitting protocols	FC100, FC200, FC400, FC800, OTU2, 10GE, STM-64		
Power consumption	up to 18 W	up to 20 W	up to 60 W

# Transponder TT-10EP

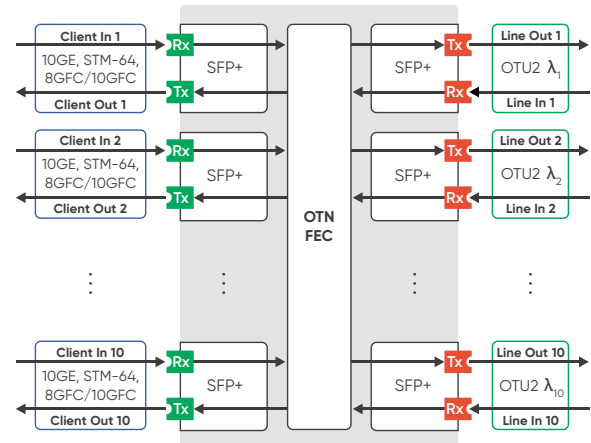
10 transponders unit for transmission of 10 independent 10G signals



Solution for independent transmission of 10 x 10G services over long distances with redundancy support

## Available versions:

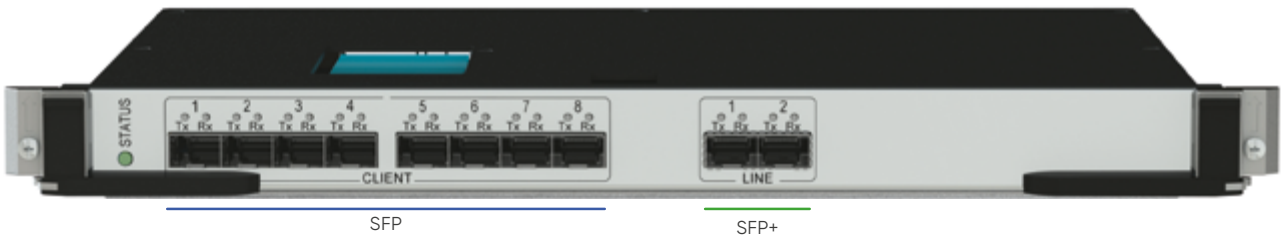
Telecom | Data Center



<b>Line interfaces</b>	<b>10 x SFP+</b>
Line interface speed	10G (OTU2/OTU2e*) * supports OTU2e on 4 line ports
FEC	FEC G.709, G.975.11.3 / on special request: G.975.1 1.7%
Redundancy support	no
Switching support	yes
Frequency grid	determined by installed module
Wavelength range	
Transmitter output power	
OSNR <sub>r</sub>	
Receiver sensitivity	
Receiver overload	
<b>Client interfaces</b>	<b>10 x SFP+</b>
Transmitting protocols	10GE, OTN OTU2/OTU2e (without FEC), SDH STM-64 * OTU2/OTU2e support on 4 client ports
Power consumption	up to 100 W

# Aggregator MS-DC10EP-Q3F/O1

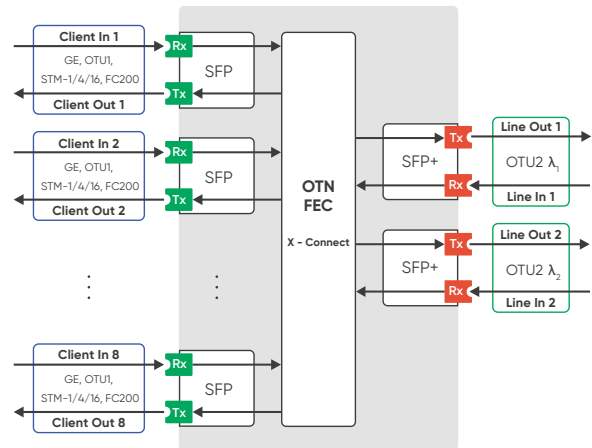
Aggregation of up to 8 multi-service low-speed clients with a total capacity of 10 Gbit/s and switching to two 10G OTN line interfaces (supporting 1+1 redundancy)



Solution for aggregation, switching and transmission of low-speed clients over long distances. Redundancy support

## Available versions:

Telecom | Data Center

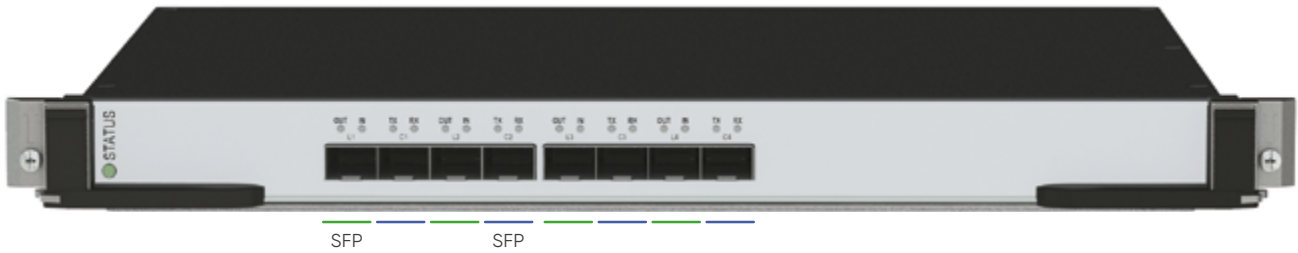


<b>Line interfaces</b>	<b>2 x SFP</b>
Line interface speed	10G (OTU2)
FEC	FEC G.709 / G.975.11.3 / G.975.11.7 7%
Redundancy support	yes (1+1)
Switching support	yes
Frequency grid	determined by installed module
Wavelength range	
Transmitter output power	
OSNR <sub>r</sub>	
Receiver sensitivity	
Receiver overload	
<b>Client interfaces</b>	<b>8 x SFP</b>
Transmitting protocols	up to 8 x STM-16, OTU1 (FEC G.709), FC200, GE, STM-1/STM-4
Power consumption	up to 50 W



# Transponder TQ-3FS

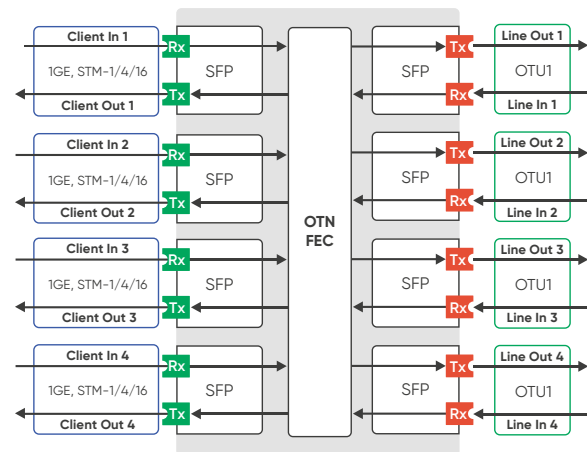
4 transponders unit for the transmission of 4 independent low-capacity signals (up to 2.5 Gbit/s)



Solution for independent transmission of 4 low-speed clients over long distances

## Available versions:

Telecom | Data Center



<b>Line interfaces</b>	<b>4 x SFP</b>
Line interface speed	2.5G (OTU1)
FEC	FEC G.709 / G.975.11.3
Redundancy support	no
Switching support	no
Frequency grid	determined by installed module
Wavelength range	
Transmitter output power	
OSNR <sub>r</sub>	
Receiver sensitivity	
Receiver overload	
<b>Client interfaces</b>	<b>4 x SFP</b>
Transmitting protocols	1GE, STM-1/4/16
Power consumption	up to 50 W

# Aggregator MD-D3ES-S3/D1

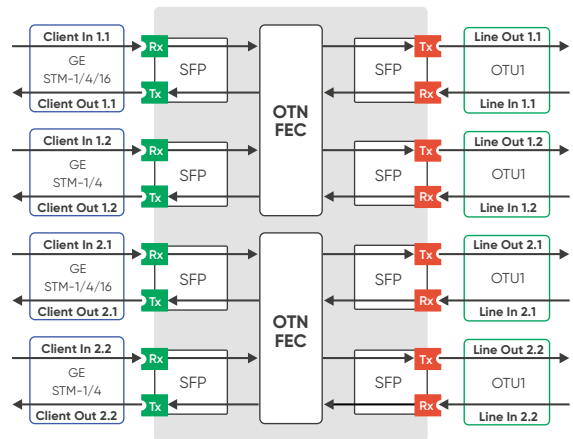
2 independent aggregators unit. There are aggregation of up to two low-capacity clients in one of the linear interfaces up to 2.5G (1+1 redundancy) in each



Two independent devices in one slot for aggregation and transmission of low-speed clients over long distances

### Available versions:

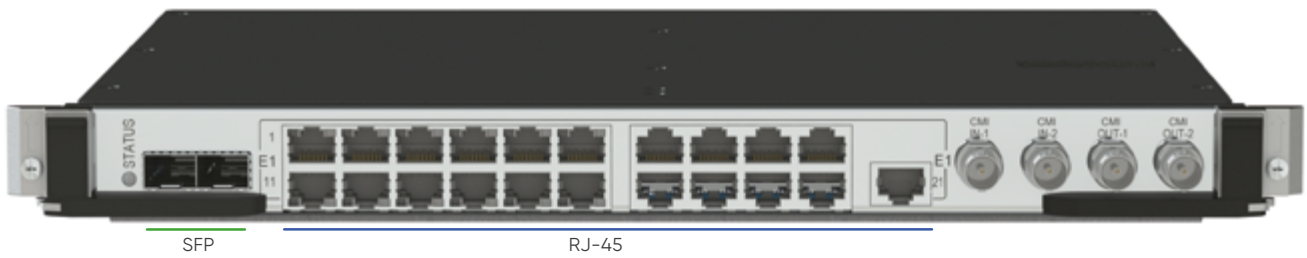
Telecom | Data Center



Line interfaces	2 x 2 x SFP
Line interface speed	2.5G (OTU1)
FEC	FEC G.709 / G.975.11.3
Redundancy support	yes (in each aggregator)
Switching support	no
Frequency grid	determined by installed module
Wavelength range	
Transmitter output power	
OSNR <sub>r</sub>	
Receiver sensitivity	
Receiver overload	
Client interfaces	2 x 2 x SFP
Transmitting protocols	2 x (2 x GE or STM-1/STM-4) 2 x (STM-16, FC200)
Power consumption	up to 42 W

# Aggregator MS-2S-21E

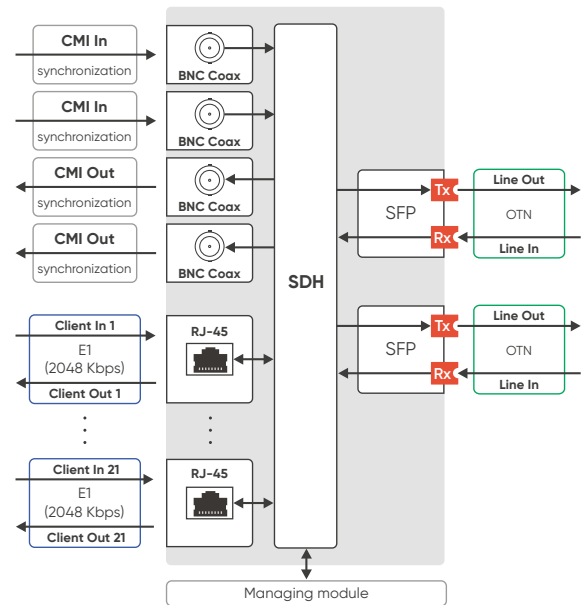
Aggregation of 21 E1 streams and transmission in two line signals 155 Mbps (STM-1)



A solution for seamless migration to OTN and network infrastructure upgrades. Low-speed streams, support for internal or external synchronization

## Available versions:

Telecom



Line interfaces	2 x SFP
Line interface speed	155 Mbit/s (STM1)
Modulation formats	NRZ
Redundancy support	yes
Switching support	yes
Wavelength range	determined by installed module
Transmitter output power	
OSNR <sub>r</sub>	
Receiver sensitivity	
Receiver overload	
Automatic dispersion correction	no
Client interfaces	21 x RJ45
Transmitting protocols	E1
Power consumption	up to 20 W

# Hybrid amplifier EDFA + RAMAN

Combination of distributed counter Raman amplifier and erbium amplifier in one slot device



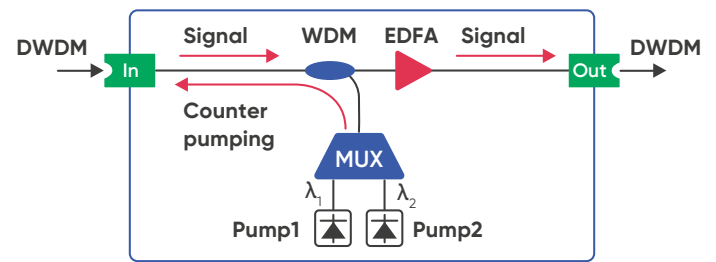
- reduction of the effective noise factor of the amplifier
- increase in signal transmission rate due to less impact of low noise factor on more complex modulation forms
- increasing the distance between amplifying nodes and lower network operating costs

The hybrid amplifier consists of a counter-pumped Raman stage and an erbium amplifier.

Raman amplification of the signal occurs in the fiber line before entering the erbium amplifier. This achieves a reduction in the noise level in the receiver and an increase in the quality of the received signal.

Reducing the noise level makes possible to increase the distance between the amplifying nodes, the range of non-regeneration transmission, as well as reduce the cost of network operation and increase the throughput of the operated communication lines through the use of multi-level formats with high spectral efficiency.

A configuration with intersectional access is possible for the connection of dispersion compensators.



Functional diagram of a hybrid amplifier

# ROPA Remote Optical Pump Amplifier

Extended spans between two nodes with remote signal amplification



- used in long single-span lines to increase the distance between two communication nodes
- configurations with counter and forward pumping are possible

The Remote Optical Pumping Amplifier (ROPA) consists of two functional units such as a passive part (sealed sleeve with erbium fiber) and an active part (pumping unit near the 1480 nm wavelength). The passive part is located far from the service nodes in the optical cable system itself.

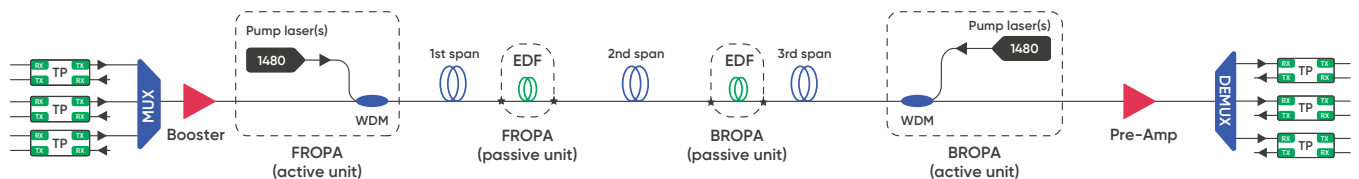
The pumping of such amplifiers is carried out remotely via a telecommunications or additional fiber. Configurations of ROPA amplifiers are possible with counter (pump radiation is delivered from the receiving part) and forward pumping (pump delivery from the transmitting part).

ROPA increases the distance between two communication nodes.

Number of pump laser diodes = 4.

Maximum total pump power = 30.5 dBm.

The mode is to control the power of each of the pump laser diodes.

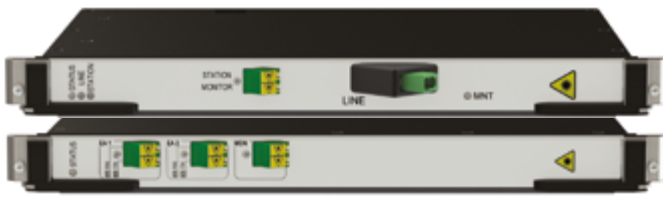


Variant of ROPA application scheme



# EDFA and RAMAN Optical Fiber Amplifiers

Series of erbium amplifiers (EA) and Raman amplifiers (RA) up to 1 W for building extended communication lines in the C-band (1529–1561 nm)



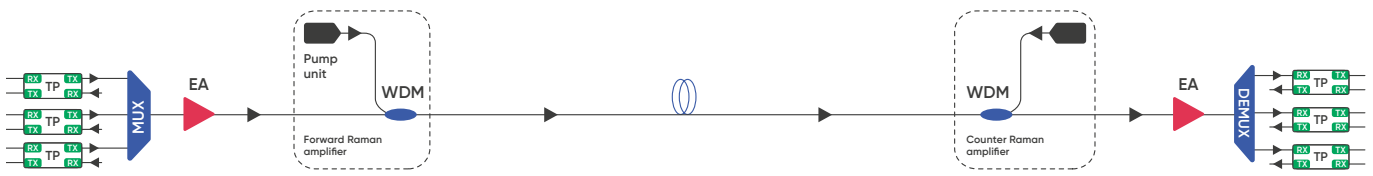
- configurations in the form of a one-section or two-section amplifier
- preservation of channel gain when changing the number of channels
- low noise factor
- low non-uniformity of the amplification spectrum in the C-band
- output power and gain stabilization modes for EA and gain stabilization for RA with counter-pumping

## Characteristics of the erbium amplifier:

- has a flexible and fast adjustment to changes in the configuration of fiber-optic communication lines and is widely used in backbone, regional and metro networks
- works in a wide range of input and output powers and has the ability to adjust the gain
- has a low noise factor and low spectral non-uniformity

## Characteristics of the Raman amplifier:

- has 4 laser pump diodes with a total power of 1 W, which makes it possible to achieve low spectral gain non-uniformity and effective noise factor
- has configurations with back and forth pumping and is used in lines with long spans
- used to increase the length of the span between erbium amplifiers



Scheme of a single-span line with erbium and Raman amplifiers

Parameter	EA	RA	HA
Spectral range	1529–1561 nm		
Output signal power	+10 ... +26 dBm	–	+16 ... +23 dBm
Raman pump power at the line input, max.	–	30 dBm	26 dBm
Number of Raman pumping laser diodes	–	4	2
Amplification range	11–18, 14–24, 25–36, 20–35	10–20 (for Backward, ***)	4–7 for RA * **** 11–18, 14–24 for EA *
Irregularity, max.	1.5 dB	1.2 dB	1.6 dB
Noise factor	+6...+9 dB	–3 ... –1 dB	+1 ... +2.5 dB
Operating Mode			
Control Pump Power	–	yes	–
Control Output Signal Power	yes	–	yes
Control Gain	yes	yes (for Backward)	yes
Additional Functions			
Single- or two-sections amplifier's configurations	yes	–	yes
APR	yes	yes	yes

EA – erbium amplifier

RA – raman amplifier

HA – hybrid amplifier

\* managing by the general (total) coefficient of amplification HA parameter

\*\* depends on coefficient of amplification

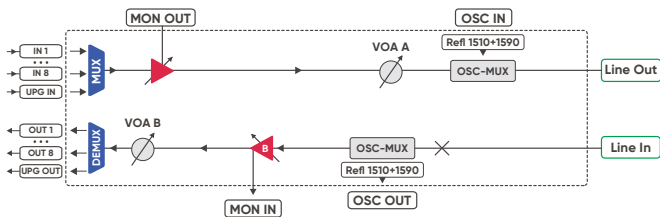
\*\*\* SMF-28 Fiber, Loss 0.2 dB/km

# Combined Line Card

Link aggregation and amplification in one unit

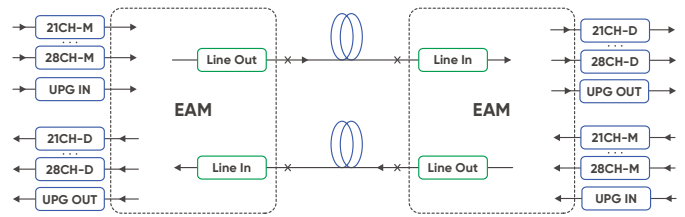


- built-in DWDM multiplexer/demultiplexer for 8 channels
- built-in single-stage erbium amplifier (PreAMP), optional two-stage (PreAMP + Booster mode)
- built-in CWDM multiplexer/demultiplexer of service channel



EAM Application Diagram

The board is designed for customers who need small-channel, cost-effective and compact line systems. The unit combines amplifiers for receiving and transmitting, multiplexers and demultiplexers for add/drop of the service channel. To launch a full-fledged optical communication line, it is enough to install one EAM board on each of the nodes. By default, the board supports up to 8 channels in the 100 GHz network. An external 40-channel multiplexer/demultiplexer is available to further increase throughput.



# Multiplexers and Demultiplexers

Controlled optical units for channels add and drop



- a multiplexer is used to combine signals received at the line input at different wavelengths
- when the light propagation changes, the multiplexer becomes a demultiplexer
- support 40 or 48 channels
- passive multiplexers without power meters and tunable attenuators have lower attenuation and are cost-effective

The unit are designed to combine separate DWDM channels into one WDM linear optical signal (performed by a multiplexer), or separate channels from it (performed by a demultiplexer). The signal level in each optical channel is controlled by the built-in optical attenuator. The optical signal of the DWDM channel is fed to one of the input connectors, and then to a variable optical attenuator. The power attenuation value for each channel is set by software in the NMS interface. The optical signal enters the waveguide, where the individual DWDM channels are combined into a single spectrally multiplexed linear optical signal. Units support 40 or 48 channels.

Parameter	OM-48-AV-PM	OM-40-AV-PM	OADM-8/8-AV-PM	OADM-4/4-AV-PM	OADM-2/2-AV-PM	OADM-1/1-AV-PM
Interval between channels	100 GHz					
Number of add/drop channels	48/0	40/0	8/8	4/4	2/2	1/1
Power meter	yes	yes	yes	yes	yes	yes
Attenuator adjustment range	0-15 dB					
Attenuator step	0.1 dB					
Power consumption	45 W		15 W			

## OTDR Reflectometer

Real-time monitoring of optical infrastructure status



- constant and continuous monitoring of the state of the line
- the ability to prevent alarms on the network
- reduction of downtime in the event of a network failure due to the synchronous operation of data transmission equipment and monitoring of the state of the infrastructure

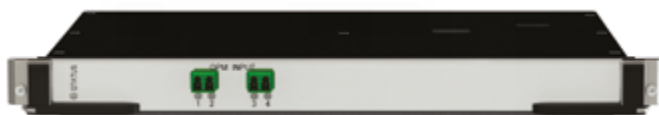
The reflectometer unit is used to determine the distance to welded joints, macrobends, connectors, breaks. It has two scanning modes – automatic and manual. In automatic mode, it is possible to configure the frequency of line polling. The reflectometer unit has the ability to record and store a reference reflectogram for each line.

Each new received reflectogram is compared with the reference one to detect new events. The unit is controlled by external software. The unit is intended for use in Volga chassis.

Parameter	OTDR
Central wavelength	1626±3 nm
Number of fibers tested	up to 12
Pulse width	10 ns, 30 ns, 100 ns, 300 ns, 1 μs, 3 μs, 10 μs, 20 μs
Dynamic range	40 dB (1 port), 36 dB (12 ports)
Distance accuracy	from 0.3 m up to 20 m
Loss contributed to 1528–1563 nm	≤1.5 dB
Loss contributed to 1510 nm	≤1.5 dB
Loss contributed to 1310 nm	≤2 dB

## Spectral channel monitoring unit

Line spectrum control



- work in the C-band 1528–1558 nm
- channel grid with a step of 50 GHz
- optical switch for four lines

The range of measured channel power is from –40 to –10 dBm. Spectral noise measurement error goes from –55 dBm. Spectrum measurement for modulation formats 2.5 Gbit/s (direct and external), 10G, limited to 40G and 100G. The unit is controlled via a web interface.

The interface displays the spectrum of the group optical signal and a table of channel powers for various types of modulation.

Parameter	OPM-4-10	OPM-4-100-50-CL	OPM-8-100-50-CL
Number of optical inputs (directions)	4	4	8
Optical switch number of channels	4	4	8
Switching time of optical switch, ms	10	10	10
Operating wavelength range, nm	1529–1561	1528–1568	1528–1568
Interval between channels, GHz	50	50/100	50/100
Nominal channel power range, dBm	–40...–10	–40...–10	–40...–10
Power consumption, W	≤15	≤10	≤10

# Classic Reconfigurable ROADM Multiplexer

Flexible add/drop channels in a standard 50 GHz channel grid for network upgrades and redundancy

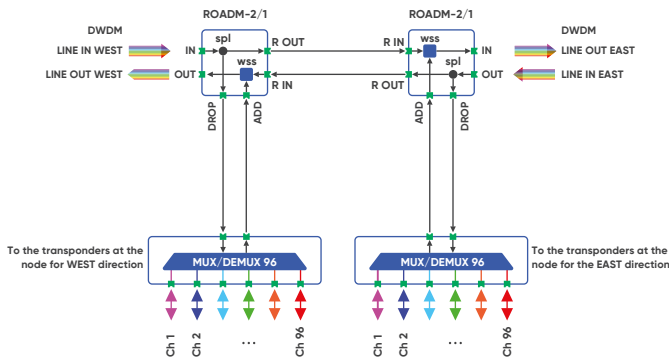


- redirection of optical channels on large network nodes of termination and cross-switching
- channel power equalization
- selective combining of channels into one input DWDM signal

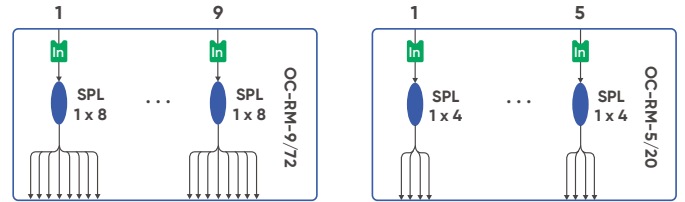
Reconfigurable multiplexers/demultiplexers ROADM-x/1 (x = 2, 4) are designed for flexible redirection of optical channels at large termination and cross-switching network nodes.

Multiplexers ROADM-x/1 are designed for selective combination of channels from two, four and nine input DWDM signals, respectively, into one output group DWDM signal.

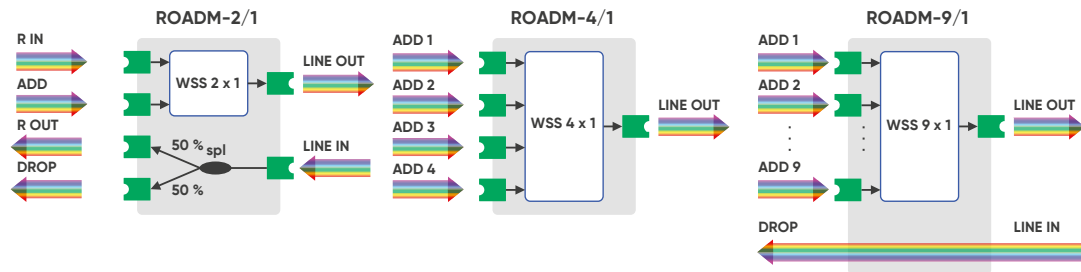
Auxiliary devices OC-RM-x/y are used to switch ROADM-x/1 boards in multi-link nodes. Modifications: OC-RM 5/20-5 splitters for 4 connections each, OC-RM 9/72-9 splitters for 8 connections each.



An example of a doubly connected add/drop node



Auxiliary device OC-RM-5/20, OC-RM-9/72 diagrams



ROADM-x/1 (x = 2, 4) Reconfigurable add/drop multiplexer schemes

ROADM parameter	2/1	4/1
Interval between channels	50 GHz	
Number of channels	96	
Frequency range	191.30...196.05 THz	
Line Loss Line In – R Out/Drop	4 dB	–
Line Loss R In/ Add - Line Out	6.5 dB	7.5 dB
Channel loss, "blocked" state	40 dB	
Attenuator adjustment range	0...15 dB	
Attenuator step	0.1 dB	
Attenuator switching time	≤ 250 ms	
Channel switching time	≤ 850 ms	
Power consumption no more	10 W	

# C-F/CD-F ROADM Reconfigurable Multiplexer

## Multi-degree C-F/ CD-F ROADM nodes

- support for up to 9 (20) directions per node
- support for C-F/CD-F functionality
- add/drop up to 96 channels in the current terminal connection
- monitoring and equalization of the channel spectrum



COMD-2-8



COMD-3-4



FROADM-9/1

Reconfigurable Add/Drop Multiplexers FROADM-9/1 help to build multi-degree nodes that support the following functionality: flexible channel grid (F – FlexGrid), connection of any wavelength to any port with the possibility of remote wavelength reconfiguration (C – Colorless), channel add/drop from any port to any direction with the possibility of remote change of direction (D – Directionless). It is possible to monitor and equalize the channel spectrum at the Line Out output.

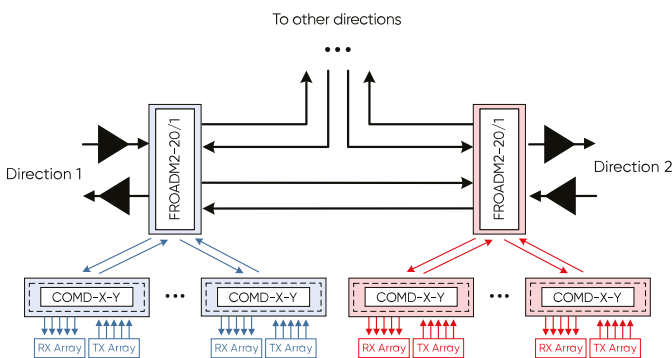
FROADM-1/9 Reconfigurable Multiplexers. Used to organize terminal CD-F connections. They have nine bidirectional add/drop ports.

Reconfigurable Multiplexers FROADM2-20/1 help to build multi-degree nodes that support C-F/CD-F functionality. There are 20 add/drop ports. It is possible to monitor and equalize the channel spectrum at the Line In input and the Line Out output.

"Colorless" multiplexers COMD-x-y are used to increase connected channels in C-F/CD-F termination. Modifications: COMD-3-4 – three pairs of passive optical splitters for four connections each, COMD-2-8 – two pairs of splitters for 8 connections each.

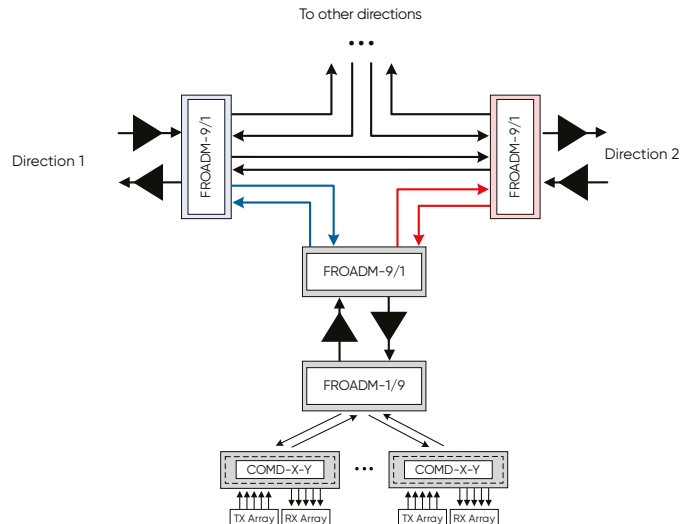
### Colorless Flexgrid

design of the multi-degree node



### Colorless Directionless Flexgrid

design of the multi-degree node



Parameter	FROADM-9/1	FROADM-1/9	FROADM2-20/1 (in development)
Channel spectrum width tuning step	12.5 GHz (6.25 GHz on request)		
Frequency range	191.250 ... 196.075 THz		
Maximum node connectivity	9	9	20
Maximum channels	96		



# Network Management Systems

- | Fractal NMS
- | Titan NMS



# Fractal Network Management System

## Configuration management

- setting the parameters of network elements, including the add of passive network elements (NE) that do not have electronic identification elements
- synchronization of NMS and NE databases for all supported types and versions of NEs
- collection of information about network elements
- graphical representation of sections (bay face layout), installed boards and devices, their technical condition, color indication of the emergency state of connections, both OTN optical levels (channels, multiplex sections, etc.) and OTN electrical levels (OTU1-4, ODU0-4)
- server interface for integration with other EMS or NMS via SNMP protocol
- support for monitoring equipment from other vendors via SNMP protocol

## Security management

- identification and authentication of the user, differentiation of access rights based on the role model
- domain organization of network elements
- logging and passive audit
- control of the integrity and security of stored and transmitted information

## Quality control

- activation/deactivation of measurement of quality indicators on network elements and sections
- keeping a log of registration of quality indicators by VC, MS, RS, OTU (FEC) levels, with the ability to print information available to the operator and save it on external media

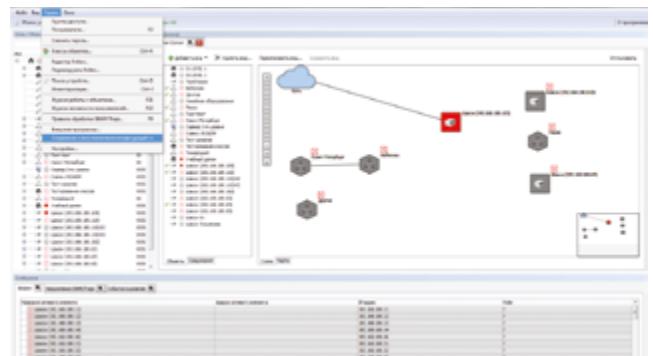
## Troubleshooting control and management

- provision of information about malfunctions and changes in the state of monitored network elements (less than 1 min)
- maintaining fault logs
- management of efficiency monitoring modes and receipt of alarm and other messages from network elements, add/drop units ports («masking» and changing the category of alarm messages)
- support for sensors for monitoring and managing external alarms at the facility
- e-mail notification, as well as an audible notification of the operator when an error occurs

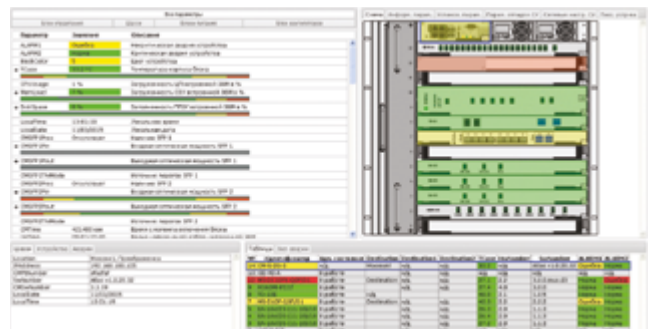
Fractal is a multifunctional management and monitoring system that supports a wide range of equipment



The main window of the Fractal client application



Channel configuration



Integrated Element Manager (EMS)



# Titan Network Management System

## System topology

NMS provides information about the network structure, the general state of communication channels between them at different levels of network organization.

The following topology views are available:

- by type of communication channels (physical/OTS/OMS)
- Domains/Nodes
- levels of network organization (Main, etc.)

## Fault Management

The NMS aggregates data on the occurrence of abnormal situations on the equipment of network elements of the DWDM network received from element management system (EMS) and controls the entire life cycle of emergency messages.

The function provides:

- prompt detection and localization of alarms
- determining their severity and possible causes
- notification of service personnel
- processing and storage of accident records, taking into account changes in their state

## Performance Management

The function collects performance statistics, identifying and resolving problems before they affect the availability of communication channels or lead to equipment damage.

Performance indicators include:

- operating parameters (voltage, current, temperature, output power, gain, etc.)
- performance indicators (duration of operation since power on/reboot, BER, etc.)
- notifications about the output of the values of the observed parameters from the range of acceptable values (TCA – Threshold Crossing Alert)

## Configuration Management

The function provides the following operations:

- backup in automatic and manual modes
- restoring the configuration from the created copies
- multiplexing and cross-connection
- channel settings
- time synchronization

## Events

The NMS collects and stores the following data registered on the EMS and received from all network elements:

- control system start event
- managed object database change events: (standalone object state change events/configuration change (user-initiated) / user actions (RPC).

The event log is stored in permanent storage (on the server), the storage depth is not limited.

Titan is a Network Management System (NMS class) for centralized DWDM equipment managing and integration with external IT systems (OSS/BSS)

- support for a distributed mode of operation based on a cluster
- synchronization with equipment in real time
- use of SDN protocols Netconf/YANG



Topology



NE Management

Event ID	Severity	Category	Message	Time	Source
1001	Warning	Configuration	Configuration change detected on node net2	2023-10-27 10:15:30	net2
1002	Warning	Performance	Temperature threshold crossing on node net3	2023-10-27 10:16:45	net3
1003	Warning	Configuration	Configuration change detected on node net4	2023-10-27 10:17:15	net4
1004	Warning	Performance	Power output threshold crossing on node net5	2023-10-27 10:18:00	net5
1005	Warning	Configuration	Configuration change detected on node net6	2023-10-27 10:19:30	net6
1006	Warning	Performance	Temperature threshold crossing on node net7	2023-10-27 10:20:15	net7

Fault Management

## Inventory

The NMS provides information about the current composition of the equipment of the DWDM-system network elements.

The user has access to a graphical representation of the chassis of the network element selected in the Topology and the units installed in it with the corresponding list of AID components, as well as the inventory section with tabular equipment data.

## Software Management

The NE software management function provides the following operations:

- loading/deleting package and bundle files with NE software updates
- storage of downloaded packages and bundles in the appropriate repositories
- launching the installation of updates
- update status control

## Security

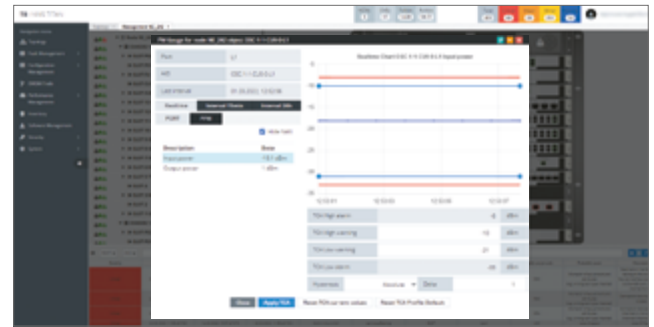
- control of connections to NMS
- security logging
- creating/editing/deleting user accounts
- assignment of user access rights

## System

Provides control of the state of network elements and the status of their synchronization (NE Control), viewing the list of IP addresses of network elements and their testing (IP Addresses), viewing system messages (Task Queue, Syslog)

## Export table

Report management provides the ability to export data from NMS partition tables to files on the user's local computer



PM Gauge



OTDR



OPM



DWDM Trails



# T8 Services





# Technical support

## 24/7 help from T8 specialists

T8 provides full service support for telecommunication DWDM and CWDM equipment. Specialists provide services 24/7 to all customers who have a valid service contract. The scope of technical support services depends on the program chosen by the customer. Response time to requests from 15 minutes, depending on the terms of the contract. The company has a large fund of replacement equipment for prompt replacement at communication centers throughout Russia and the CIS countries. Technical support services are located in Moscow and St. Petersburg. Incidents are managed in an automated management system. T8 provides customers with access to a technical support information portal.

### Services provided by technical support

- remote diagnostics of equipment faults (by phone, e-mail or remote connection provided by the customer)
- diagnostics of malfunctions at the communication facility
- installation and connection of replacement equipment to replace the faulty one, restoration of configurations
- preventive software update
- providing access to the technical support information portal
- conducting a preventive audit of the network
- repair of faulty equipment
- drawing up recommendations and methods for equipment installation and commissioning

## Fiber Optics Research Center

The largest Center of competence in the field of fiber optics in Russia

In 2013, a research Center was established and separated into Scientific and Technocal Center – T8 STC LLC. The team of the Center includes Doctors and PhDs, post-graduate students and graduates of the country's leading technical universities.

The Center conducts most of the research in the interests of T8, creating innovative solutions for the telecommunications industry. The main activity of the Center is the development of modern coherent systems with a channel rate of up to 800 Gbit/s, which are not inferior in their characteristics to foreign solutions. Taking into account the geography of our country, extensive research is carried out by the staff of the Center in the field of data transmission over long distances. Selected foreign manufacturers of telecommunication equipment perform such complex work, and only T8 does this in Russia.

T8 STC is a participant of the «Development of the electronic and radio-electronic industry for 2013-2025», the State project of the Russian Federation. The T8 STC laboratory is equipped with the latest equipment. There are more than 400 instruments from leading manufacturers: Anritsu, Keysight, HP, Tektronix, Ando, Yokogawa, Digital Lightwave, JDSU, Agilent, Accelink, Wandell&Goldermann, TSH, ROHDE&SCHWARZ and others. This allows the staff of the Center to conduct complex experiments, study subtle optical effects, and perform advanced scientific research in the field of fiber optics.

The Center has high-tech devices and equipment for pilot and small-scale production of optical components and units of telecommunication equipment. In 2018, a high-class «clean room» was created for high-tech operations.

The tasks of the Center include work on increasing the degree of localization and the transition to the domestic component base. Optical units based on discrete elements and transponders based on FPGAs have been developed, and solutions based on Russian integrated circuits are being created. To modernize communication systems and reduce dependence on individual suppliers of electronic components, employees of T8 STC conduct a constant analysis of the modern component base in the Russian and world markets.

T8 STC specialists have successfully developed optoelectronic components:

- modulator based on LiNbO<sub>3</sub> fiber Mach-Zehnder interferometer
- radio photonic schemes/solutions based on modulators
- AAWG module for multiplexing and demultiplexing of optical signal

The components are mass-produced. They can be used both with Volga DWDM platform and with other optoelectronic systems, primarily telecommunications. The components are available for order by manufacturers of telecommunications systems and optical sensors, educational institutions and laboratories.

Employees of T8 STC participate in specialized scientific conferences in Russia and abroad, publish articles in leading domestic and foreign publications. Scientific publications of the company's specialists could be found on the website [t8.ru](http://t8.ru).



# Training Center

## Competence Center for Fiber Optics

T8 offers professional training on working with DWDM systems. The company has developed three training courses:

### **Operation of Volga DWDM equipment**

Duration – 3 days.

The course helps to gain practical knowledge on the operation of Volga DWDM platform in an intensive format and at minimal cost. The course program is designed for those who operate Volga DWDM equipment in optical communication networks or plan to work with this platform. Training takes place in an open laboratory in the format of lectures and practical exercises under the guidance of qualified practitioners.

### **Fractal Network Management System**

Duration – 1 day.

The course is devoted to the operation of DWDM-equipment Volga, the practice of setting up a network and working with the management system NMS Fractal.

To improve the efficiency of assimilation of new material and the use of the acquired knowledge in their activities, T8 employees published methodological manuals and a «DWDM Technology Basics» brochure. At the end of the training, certificates on the successful completion of the courses are issued.

### **Operation of DWDM Equipment (CNE Axon) Titan Network Management System**

Duration – 5 days.

The course is designed for engineers and technical specialists who manages and monitors DWDM-equipment Volga working with the management system NMS Titan.

## T8 | DWDM SYSTEMS

T8 is a Russian developer and manufacturer of DWDM telecommunications equipment and innovative solutions for fiber-optic communication lines.

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