Semi-Active WDM System for 5G Fronthaul Transmission Facilitates Rapid Deployment of 5G by Operators

Product Introduction

1 Product Introduction

1.1. Product Overview

After deploying 5G networks, the density of base stations will be 2 to 4 times that of 4G networks, and fiber constraints will be the main issue faced in 5G fronthaul deployment. To meet the rapid deployment of base stations and effectively save fiber resources in 4G and 5G network deployments, operators have adopted a solution combining WDM multiplexer and colored light modules to achieve low-cost, rapid coverage. However, there are also shortcomings and pain points in practical applications:

◆ Passive WDM + colored light module mode has the following issues:

➢ Passive WDM lacks management and protection；

➢ Lack of management means；

➢ Weak ability to detect faults in fiber links；

➢ No protection for intermediate transmission fiber cores, requiring external OLP for implementation；

➢ Maintenance of optical modules heavily relies on manual intervention；

◆ Solutions using active WDM or OTN technologies can solve the difficulties of network management and primary/backup route selection in optical paths, but they also face challenges such as high costs and difficulties in remote power supply.

Based on previous technical accumulations and research on active and passive WDM, and continuous in-depth understanding combined with customer pain points regarding fronthaul equipment carrying demands, Guangzhou Rui Dong has introduced a semi-active WDM as a solution for base station fronthaul.

The semi-active WDM solution uses active equipment on the local end and passive equipment on the remote end, facilitating deployment and maintenance. Through local

equipment, it supports network management, line protection, and fast OTDR fault location functions. The maintenance methods are convenient and flexible, meeting high reliability requirements. This solution significantly alleviates the pressure on fiber resources, while also balancing cost, management, and protection advantages, thereby assisting operators in low-cost, high-bandwidth, and rapid deployment of 5G fronthaul networks.

This solution is suitable for scenarios with tight fiber resources at extended base stations, simple dual-star or bus-type network configurations (covering scenarios such as highways, high-speed railways, tunnels, bridges, etc.). It features colored light modules located on AAU and DU equipment, using WDM technology for transmission to save fiber resources and support OADM up/down wave functions. It can also utilize dual-route fiber cables for fronthaul service protection, while supporting legacy 4G fronthaul fibers, achieving unified fronthaul for 4G/5G.
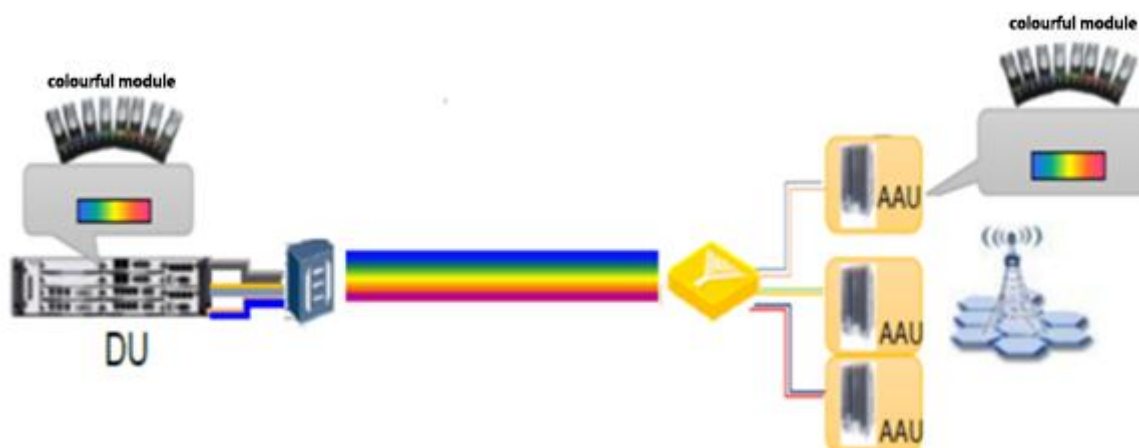

Fig.1 Diagram of a semi-active WDM scheme

The networking architecture of semi-active wavelength division multiplexing (WDM) can be divided into star and bus topologies according to specific scenarios。
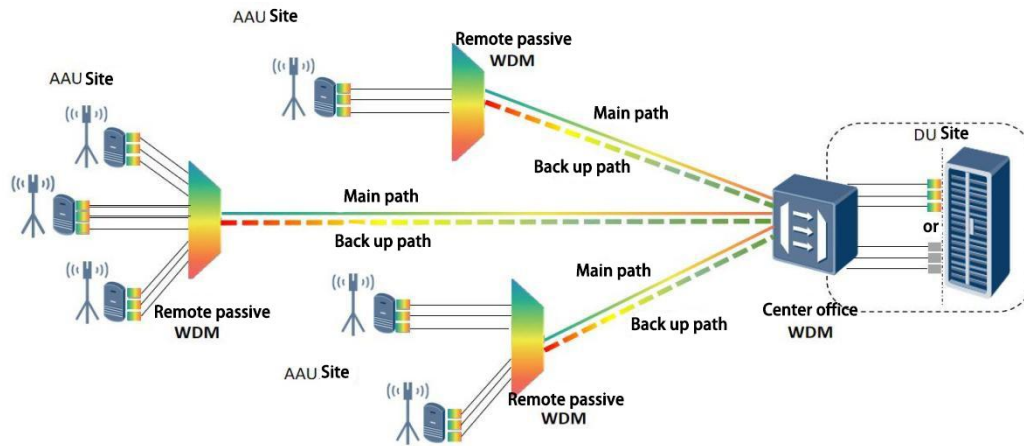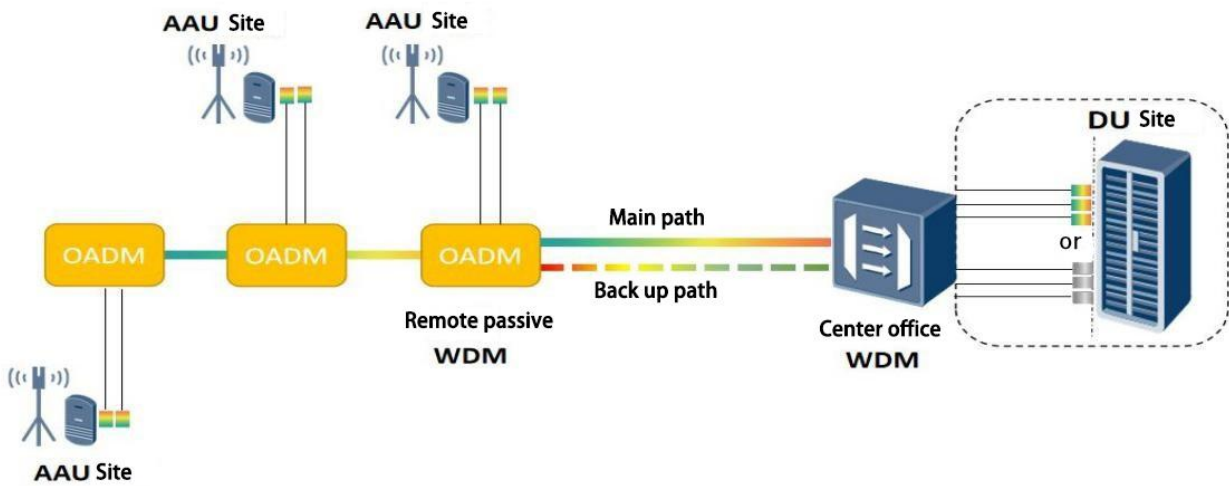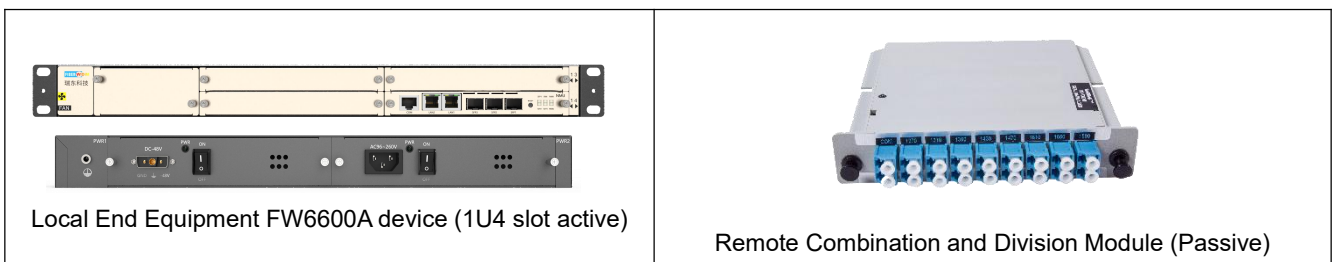
Figure 2 Semi-active WWD-star networking
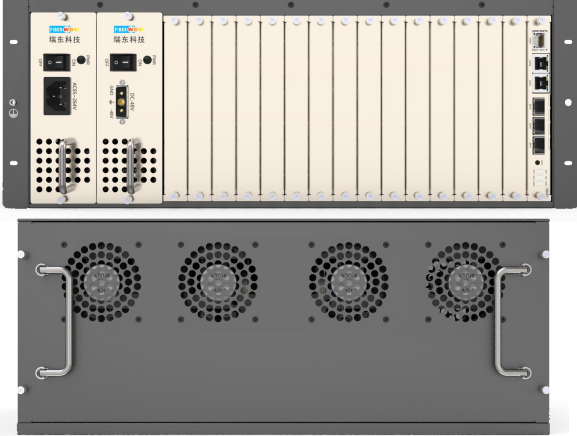
Figure 3 Semi-active WDM bus networking

Device view

Local End Equipment FW6600A device (1U4 slot active)

Remote Combination and Division Module (Passive)

Local End Equipment FW6600B   (2U8 slot active)

19-inch rack (remote cabinet mounting)

Local End Equipment FW6600C (4U16 slot active)

Outdoor waterproof and dustproof box (remote wall/pole)

Features

◆ It supports comprehensive access to wireless fronthaul and other services, taking into account wireless fronthaul, private line, and home broadband services, and maximizes the value of fronthaul networks；

◆ Maximize optical fiber saving, one fiber can carry 9 channels of 4G & 5G fronthaul CPRI/eCPRI services；

◆ The local side is active and the remote end is passive, and WDM technology is used to extend the physical channel of pure transparent transmission, without delay and jitter introduction；

◆ It supports the monitoring function of the luminous power of each channel, which is easy to maintain and locate faults；

◆ It supports 1:1 protection at the optical layer, and the protection switching time is less than 20 ms, improving network reliability；

◆ The optical-layer protection function card can be selected according to the application scenario, and supports hot-swap and power-off/power-on-hold functions to ensure that the device does not affect service operation in the event of a power-off；

◆ It supports SNMP, Web and other graphical interface network management；

◆ Local end equipment active supports AC 220V, DC -48V power supply optional, and 1+1 power input protection；

◆ The installation method is flexible, the central office equipment supports rack-mounted installation

and wall-mounted installation, and the remote equipment supports rack-mounted, pole-mounted and wall-mounted installation, which is easy to install and plug-and-play；

◆ The remote outdoor device meets the requirements of the IP67 standard and supports pole and wall mounting.

2 Hardware Introduction

2.1. Local End Equipment

FW6600A - 1U Chassis

1U Chassis Front View

1U Chassis Back View

2.1.1.

FW6600A is designed with a 1U standard 19-inch rack-mounted plug-in card structure, providing 4 business slots, 1 main control card slot, 1 fan slot, and 2 power slots (at the rear). It uses a front panel outlet method, with all optical interfaces and network management interfaces designed on the front；

The FW6600A-type 1U chassis has four service slots, and the NMS card occupies one slot, and can be inserted into a maximum of three service cards, which can support convergence in three optical directions

■ **Technical Specifications of FW6600A 1U Chassis**

The name of the metric		metrics
Dimensions:		482(W)×44(H)×320(D)(mm)
Weight (fully loaded)		7.5kg
TypicalPowerConsumption		<30W
Protection Features		Hot-swappable NE management card without affecting existing services when failing
StandardOperating Voltage:	DC	-36 V-72V
	AC	90V -260V

2.1.2 FW6600B - 2U Chassis

2U Chassis Front View
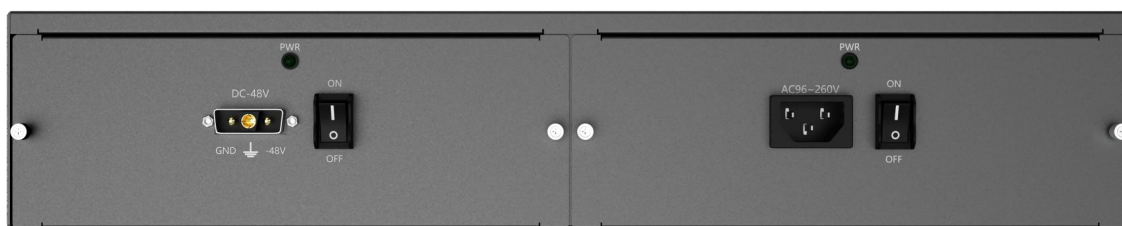
2U Chassis Back View

FW6600B is designed with a 2U standard 19-inch rack-mounted plug-in card structure, providing 8 business slots, 1 main control card slot, 1 fan slot, and 2 power slots (at the rear). It uses a front panel outlet method, with all optical interfaces and network management interfaces designed on the front；

The FW6600B-type 2U chassis has 8 service slots, and the NMS card occupies 1 slot, and can be inserted into a maximum of 7 service cards, which can support convergence in 7 optical directions
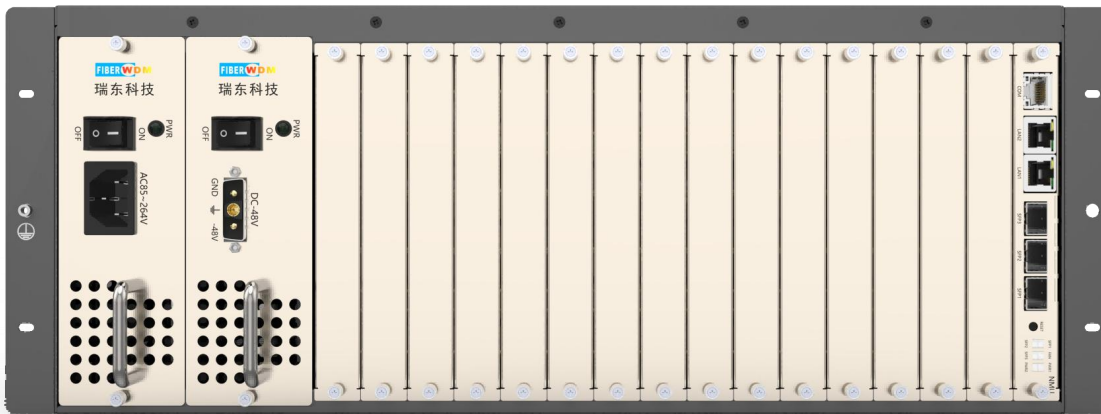
■ **Technical Specifications of FW6600B 2U Chassis**

The name of the metric		metrics
Dimensions		486(W)×86(H)×352(D)(mm)
Weight (fully loaded)		13.5kg
TypicalPowerConsumption		<50W
Protection Features		Hot-swappable NE management card without affecting existing services when failing
StandardOperating Voltage:	DC	-36 V-72V
	AC	90V -260V

2.1.3 FW6600C -4U chassis

4U chassis front
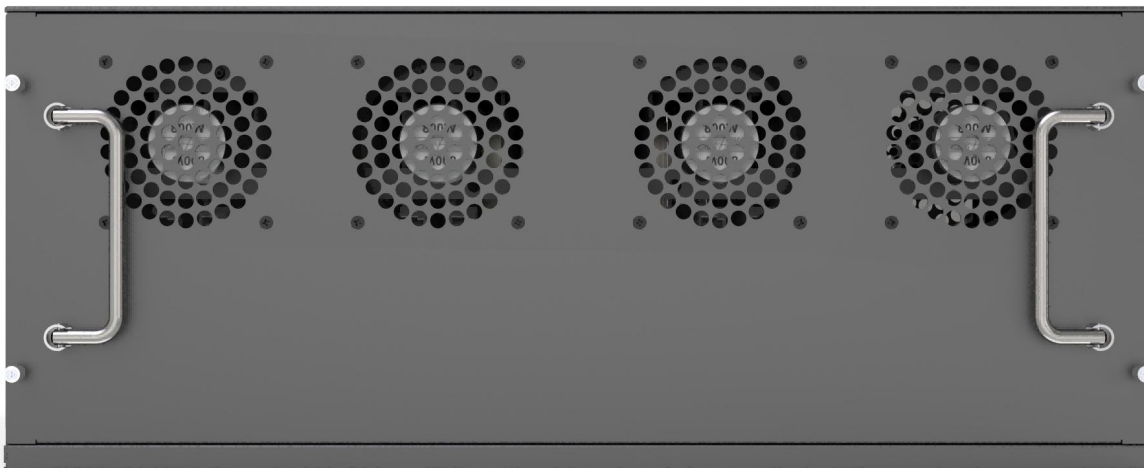
4U chassis back

The FW6600C chassis adopts a 4U standard 19-inch rack-mount and plug-in card structure, and provides 16 service slots, 1 main control board slot, 1 fan slot, and 2 power supply slots in a single chassis. The front panel cable outlet mode is adopted, and all optical interfaces, power supply and network management interfaces are designed on the front；

The FW6600C-type 4U chassis has 16 service slots, and the NMS card occupies 1 slot, and can insert up to 15 service boards, which can support the convergence of 15 optical directions

■ **FW6600C 4U Chassis specifications**

The name of the metric	metrics
Dimensions	483(W)×178(H)×280(D)(mm)

Weight (fully loaded)		15.5kg
TypicalPowerConsumption		<80W
Protection Features		Hot-swappable NE management card without affecting existing services when failing
StandardOperating Voltage:	DC	-36 V -72V
	AC	90V -260V

2.1.4 6 waves of Local End Equipment Mux&DeMux

■ **Functional structure：**
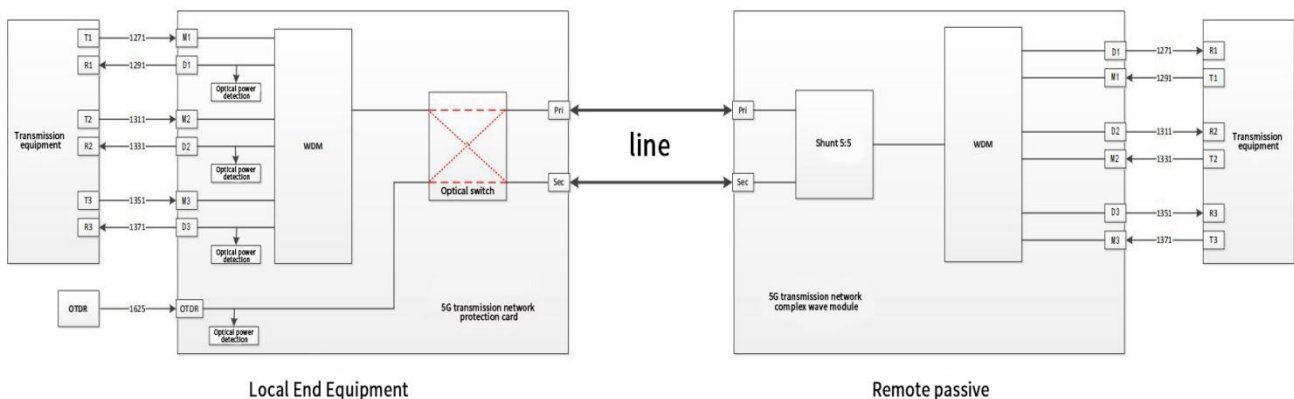
6 waves of Local End Equipment Mux&DeMux Functional structure (with optical power monitoring and optical protection)

■ **Optical performance indicators**

parameter	unit	index
Number of channels		6
Center wavelength	nm	1271、 1291、 1311、 1331、 1351、 1371
Center wavelength deviation	nm	±1.5
-1dB channel bandwith	nm	>14
Banding flatness	dB	<0.5
Mux&DeMux Channel insertion loss （without Optical Protection）	dB	<1.8
Mux&DeMux Channel insertion	dB	<3.5

parameter	unit	index
loss（with Optical Protection）		
Mux&DeMux Channel insertion loss uniformity	dB	<1.0
Adjacent channel isolation	dB	>25
Non-adjacent channel isolation	dB	>35
Wavelength Heat stability	nm/℃	<0.002
Insertion loss heat stability	dB/℃	<0.007
Polarization-related losses	dB	<0.2
Return loss	dB	≥45
Working temperature	℃	-40～+85
Storage temperature	℃	-40～+85
Working humidity		5%～95% RH， No condensation
The number of slots in the chassis		1slot
OTDR monitoring port		With OTDR monitoring port (wavelength 1625/1650nm) optional
Optical protection		It can provide single-fiber main and standby optical path protection
Optical protection switching time		＜20ms
Optical power detection range		-50 dBm ~+25dBm
Optical interface		LC/UPC

2.1.5　12 waves remote passive WDM Mux&DeMux

■ **Product illustration：**

12 waves remote passive WDM Mux&DeMux（optical protection）

■ **Optical performance indicators**

parameter	unit	index
Number of channels		12
Center wavelength	nm	1271、1291、1311、1331、1351、1371、1471、1491、1511、1531、1551、1571
Center wavelength deviation	nm	±1.5
-1dB channel bandwith	nm	>14
Banding flatness	dB	<0.5
Mux&DeMux Channel insertion loss（without Optical Protection）	dB	<2.2
Mux&DeMux Channel insertion loss（with Optical Protection）	dB	<3.5
Mux&DeMux Channel insertion loss uniformity	dB	<1.2
Adjacent channel isolation	dB	>25
Non-adjacent channel isolation	dB	>35
Wavelength Heat stability	nm/℃	<0.002
Insertion loss heat stability	dB/℃	<0.007
Polarization-related losses	dB	<0.2
Return loss	dB	≥45
Working temperature	℃	-40～+85
Storage temperature	℃	-40～+85
Working humidity		5%～95% RH， No condensation
The number of slots in the chassis		1slot
OTDR monitoring port		With OTDR monitoring port (wavelength 1625/1650nm) optional
Optical protection		It can provide single-fiber main and standby optical path protection

Optical protection switching time		＜20ms
Optical power detection range		-50 dBm ~+25dBm
Optical interface		LC/UPC

2.2. Remote passive WDM

2.2.1. Remote 1U rack

The remote 1U rack is a 3-slot, 1U-high passive rack, which is suitable for inserting 3 remote combiner splitters, which can realize the compact installation of the remote combiner and splitter and save space in the equipment room. The 1U rack can be installed in a 19-inch cabinet.。

■ **Size: 1U, 44 mm (H)× 438 mm (W), × 132 mm (D)**

Figure 2.2.1 View of a remote 1U rack

2.2.2. Remote 3U rack

The 3U rack is a 16-slot, 3U-high passive rack, which is suitable for vertically inserting 16 remote combiners and splitters, which can realize the compact installation of remote combiners and save space in the computer room. The 3U rack can fit in a 19-inch cabinet.。

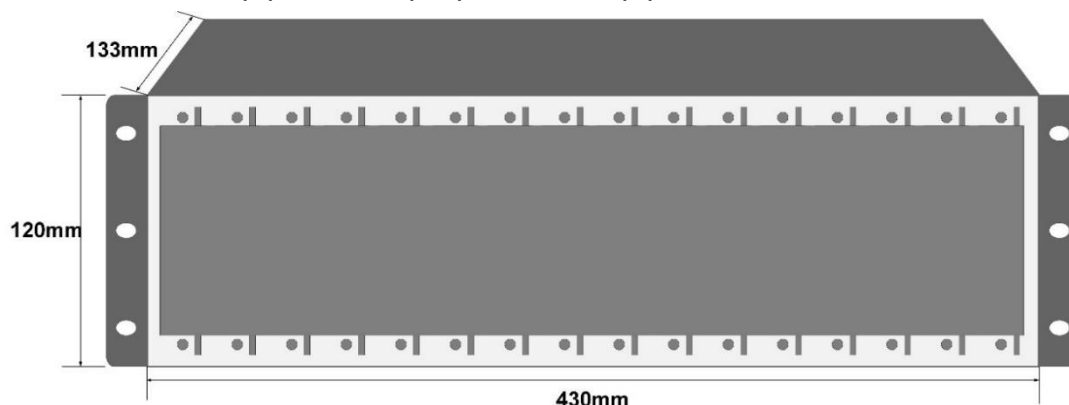■ **Size: 3U, 120 mm (H), 430 mm (W×), × 133 mm (D)**

Figure 2.2.2 Rack view of the remote OPC1000-16

2.2.3. Remote outdoor boxes

The outdoor dust-proof box is a special box for outdoor wall-mounted or pole-mounted remote WDM system, which supports 1 or 2 built-in remote combination splitters, meets the requirements of IP67 standards, has a lightweight structure and is easy to install。

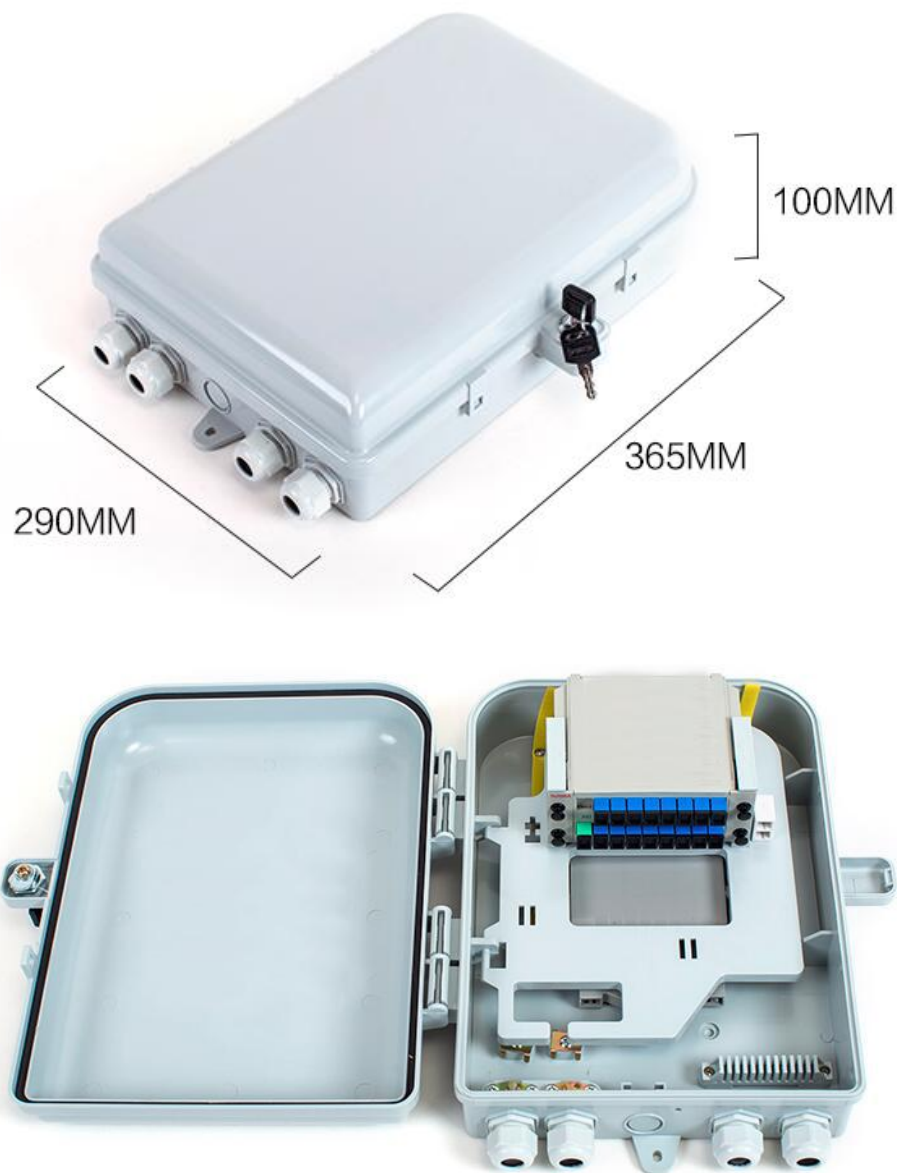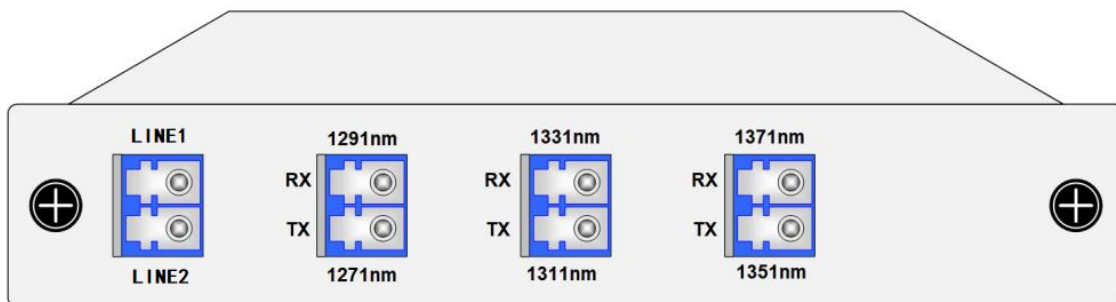■ **Size:365 mm (length)×290mm (width)×100 mm (height)**
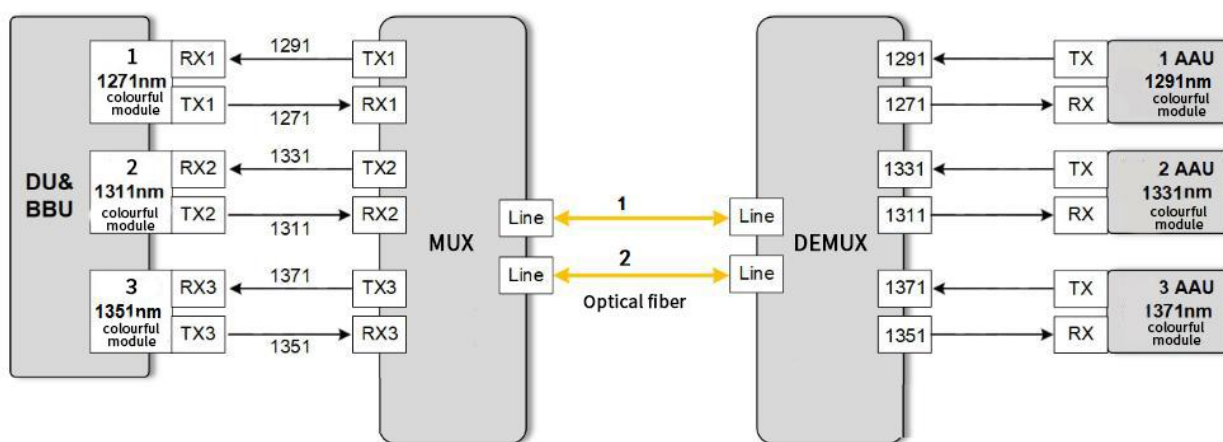

Figure 2.2.3 View of the remote outdoor dust box

6 waves remote passive WDM Mux&DeMux

■ **Product illustration：**

6 waves remote passive WDM Mux&DeMux（optical protection）

■ **Functional structure：**

Functional structure of the remote passive WDM

■ **Optical performance indicators**

parameter	unit	index
Number of channels		6
Center wavelength	nm	1271、 1291、 1311、 1331、 1351、 1371
Center wavelength deviation	nm	±1.5
-1dB channel bandwith	nm	>14
Banding flatness	dB	<0.5
Mux&DeMux Channel insertion loss(without optical protection)	dB	<1.8
Mux&DeMux Channel insertion loss (with Optical Protection)	dB	<4.5
Mux&DeMux Channel insertion loss uniformity	dB	<1.0
Exp interface loss uniformity	dB	<1.2
Adjacent channel isolation	dB	>25
Non-adjacent channel isolation	dB	>35
Wavelength Heat stability	nm/℃	<0.002
Insertion loss heat stability	dB/℃	<0.007

parameter	unit	index
Polarization-related losses	dB	<0.2
Return loss	dB	≥45
Working temperature	℃	-40～+85
Storage temperature	℃	-40～+85
Working humidity		5%～95% RH， no condensation

2.2.4. 12waves remote passive WDM Mux&DeMux

■ **Product illustration**：
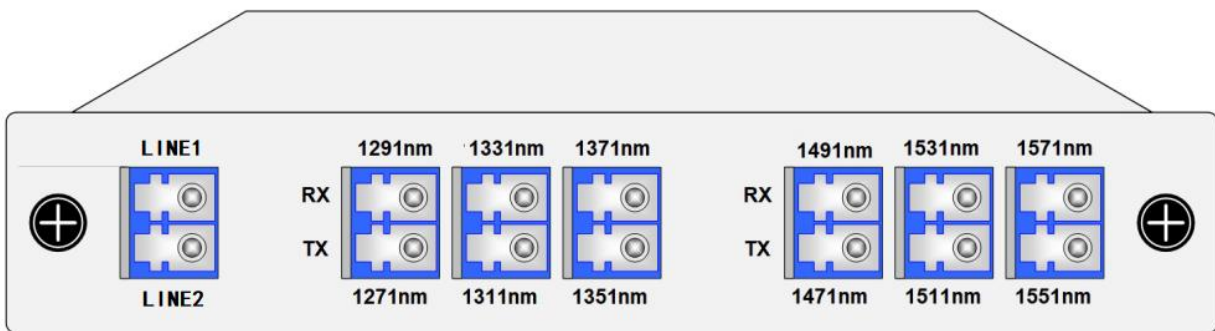
12 waves remote passive WDM Mux&DeMux（optical protection）
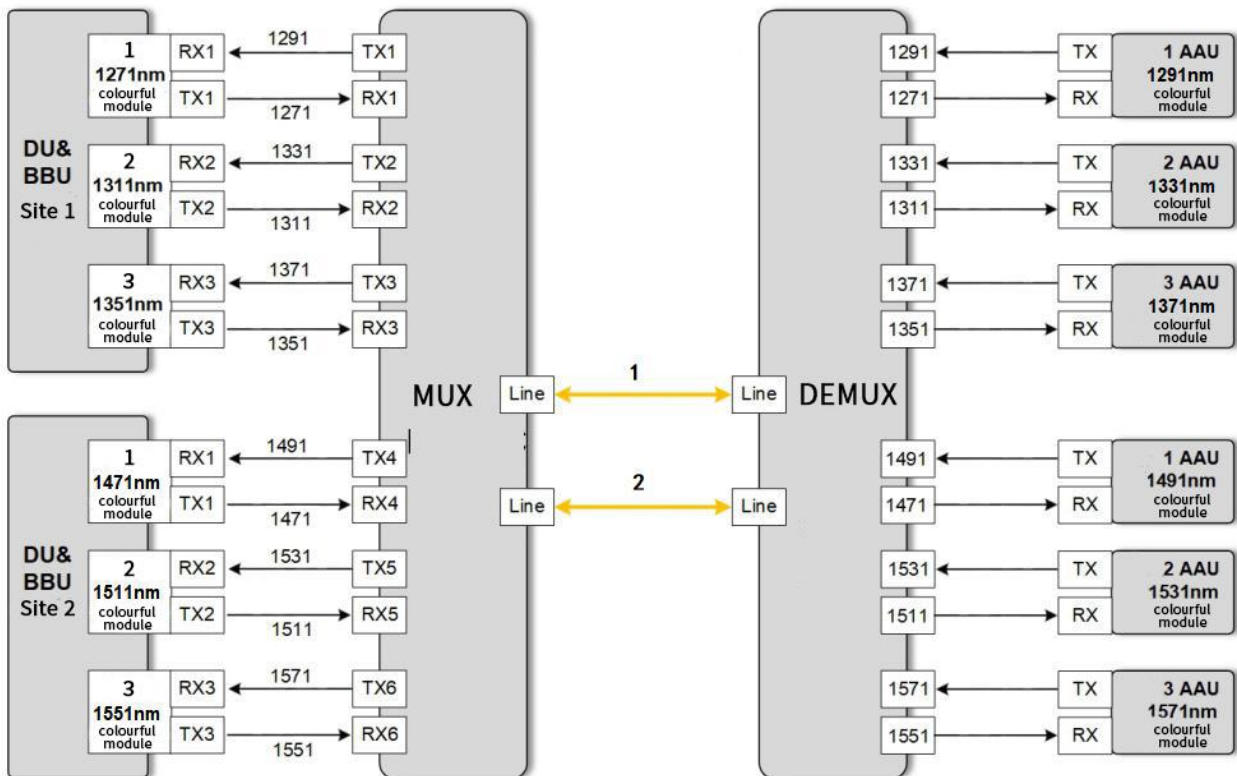
■ **Functional structure**：

■ **Optical performance indicators**

parameter	unit	index
Number of channels		12
Center wavelength	nm	1271、1291、1311、1331、1351、1371、1471、1491、1511、1531、1551、1571
Center wavelength deviation	nm	±1.5
-1dB channel bandwith	nm	>14
Banding flatness	dB	<0.5
Mux&DeMux Channel insertion loss(without optical protection)	dB	<2.2
Mux&DeMux Channel insertion loss (with Optical Protection)	dB	<6.0
Mux&DeMux Channel insertion loss uniformity	dB	<1.5
Adjacent channel isolation	dB	>25
Non-adjacent channel isolation	dB	>35
Wavelength Heat stability	nm/℃	<0.002
Insertion loss heat stability	dB/℃	<0.007
Polarization-related losses	dB	<0.2
Return loss	dB	≥45
Working temperature	℃	-40～+85
Storage temperature	℃	-40～+85
Working humidity		5%～95% RH，no condensation

2.3. colourful module

2.3.1. colourful module 25G/10km CWDM colourful module

Based on the wireless fronthaul passive wavelength division multiplexing system, the 25Gb/s SFP28 CWDM colourful module conforms to the MSA protocol, has the characteristics of low power consumption, small size, multi-rate, etc., is compatible with eCPRI (25G), CPRI 10, 25GE and other network applications, with a maximum transmission distance of up to 10 kilometers, RoHS compliant, and supports digital diagnostic functions。

■ Working temperature
  Commercial grade：0°C-+70°C
  Industrial grade：-40°C-+85°C

■ Storage temperature
  Temperature：-40°C-+85°C
  Humidity：5%~95%no condensation

■ **Optical performance indicators**

Product model	Tx wavelength (nm)	Rx wavelength (nm)	Distance (km)	Tx optical power range (dBm)	Overload Optical Power (dBm)	Ext (dB)	Receiver Sensitivity (dBm)
RSPD-25GC10--27	1271	1260~1620	10km	0~+6	>+2	>3.5	<-13.8
RSPD-25GC10--29	1291						
RSPD-25GC10--31	1311						
RSPD-25GC10--33	1331						
RSPD-25GC10--35	1351						
RSPD-25GC10--37	1371						

2.3.1. 10G/10km CWDM colourful module

The 10Gb/s SFP+ CWDM colourful module based on the wireless fronthaul passive wavelength division multiplexing system conforms to the MSA protocol, has the characteristics of low power consumption, small size, multi-rate, etc., is compatible with CPRI 7/8, 10GE, STM-64 and other network applications, with a maximum transmission distance of up to 10 kilometers, RoHS compliant, and supports digital diagnostic functions。

- ■ Working temperature
  Commercial grade：0°C-+70°C
  Industrial grade：-40°C-+85°C

- ■ Storage temperature
  Temperature：-40°C-+85°C
  Humidity：5%~95%no condensation

- ■ **Optical performance indicators**

Product model	Tx wavelength (nm)	Rx wavelength (nm)	Distance (km)	Tx optical power range (dBm)	Overload Optical Power (dBm)	Ext (dB)	Receiver Sensitivity (dBm)
RSPD-10GC10-27	1271	1260~1620	10km	0~+3	>+1	>4	<-14.4
RSPD-10GC10-29	1291						
RSPD-10GC10-31	1311						
RSPD-10GC10-33	1331						
RSPD-10GC10-35	1351						
RSPD-10GC10-37	1371						
RSPD-10GC10-47	1471						
RSPD-10GC10-49	1491						

RSPD-10GC10-51	1511						
RSPD-10GC10-53	1531						
RSPD-10GC10-55	1551						
RSPD-10GC10-57	1571						
RSPD-10GC10-59	1591						

2.4 NMS function

The semi-active wavelength division multiplexing system has the management function of central and remote devices, and supports configuration management, fault management, performance management, network topology management and other major functions. The network management function ensures that the requirements of monitoring, management, and production convenience in the overall principles of 5G fronthaul are met。

The basic functions are as follows：

1) User and user group management

2) User rights management

3) System data backup and recovery

4) The system has log management function

5) The system supports the creation, query, deletion, modification and other management functions of network elements (central office equipment, remote equipment) and other 。

> ➤ NE name；

> ➤ Device classification (local, remote)；

> ➤ Latitude and longitude；

> ➤ Location information, i.e. detailed address (city, station, floor, rack location, etc.)；

> ➤ Software version (central office device)；

> ➤ Remote device information includes device classification (remote end), NE name, latitude and longitude (longitude, latitude), location information, local office device, SN serial number, device model (or PN), device capacity, channel number (start channel number, end channel number), occupied channel number, and manufacturer name. The above field information can be manually entered

by OMC or by handheld terminal APP。

6) The system supports the statistics and query capabilities of the slots, units, service ports, channels and other parameters of the central office equipment。

7) The system supports the configuration management of the central office equipment：

   ➢ Unit card configuration management: You can query and configure service interface disk information, device exit information, software version, board alarms, performance, and running status。

   ➢ Port configuration management: supports setting and querying port parameters。

8) The system supports the query and configuration of protection management：

   ➢ Support setting basic information for line protection, including: protection mode (automatic/manual), automatic recovery waiting time for main and backup channels, etc;

   ➢ Support querying basic information on line protection, including: working channel/protection channel status (primary, backup), switching events, etc。

9) The system supports functions such as alarm query and statistics, alarm confirmation, alarm clearing, alarm shielding, and alarm filtering query.

10) The system allows users to specify and query network element performance monitoring;

11) The system supports network topology management;

   Optional SMS alarm function；