

CORIANT IS NOW PART OF INFINERA

Coriant® Pluggable Optical Layer

Reducing Cost, Space, and Power with Compact Optical Layer Pluggables

By shrinking optical layer functions to compact pluggables, the Coriant® Pluggable Optical Layer enables network operators to avoid choosing between the low start-up cost of fixed WDM or the flexibility and low operational costs of ROADMs, and between the flexibility of a DWDM system with separate modules for each function or the compact footprint and installation simplicity of a systems-on-a-blade architecture. In addition to compact pluggables, the second element of the Pluggable Optical Layer comprises a range of carrier modules that enable these pluggables to be supported across the Coriant packet optical portfolio, including the Coriant® 7100 Packet Optical Transport Platform, Coriant Groove™ G30 Network Disaggregation Platform, Coriant® mTera® Universal Transport Platform (UTP), and Coriant® hiT 7300 Multi-Haul Transport Platform. The third and final component of the Pluggable Optical Layer is a range of passive equipment including DWDM and CWDM filters, splitters/combiners, Dispersion Compensation Modules (DCMs), and baffles. This passive equipment can also be used with the Coriant® 8600 Smart Router Series, when equipped with CWDM or DWDM interfaces, with active pluggables housed in the 7100 Series or Groove G30 if required.

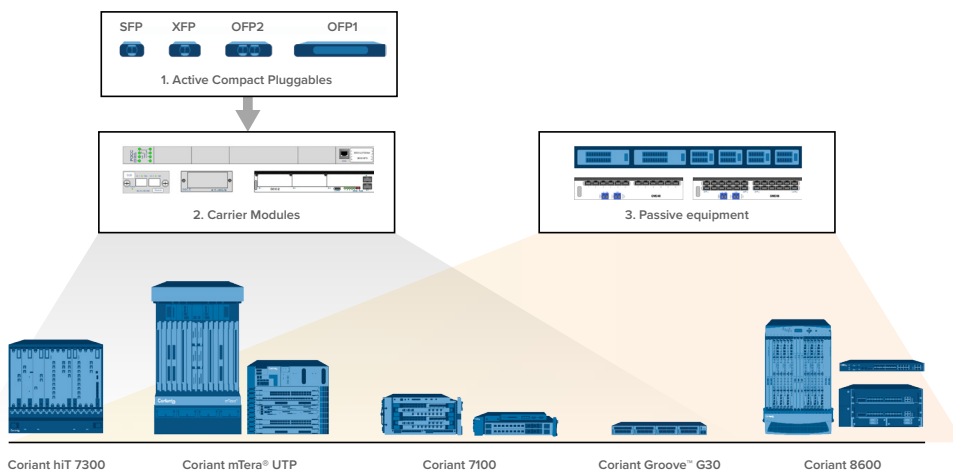


Figure 1 - The Three Elements of the Coriant® Pluggable Optical Layer

ADDRESSING A WIDE RANGE OF APPLICATIONS

The Pluggable Optical Layer is able to address a wide range of metro applications for data center interconnect, mobile backhaul, fixed broadband backhaul, and business services. As shown in Figure 2, the Pluggable Optical Layer can be deployed by itself for point-to-point, chain, ring, or more complex topologies, or as a cost-effective extension of the ROADM network with spurs and arcs. It can address extended reach single channel, CWDM, passive DWDM, and amplified DWDM applications. It can also be used to enhance Coriant packet optical platforms including the 7100 Series, mTera UTP, and hiT 7300 with functionality such as OTDR and 1+1 protection, and by boosting alien wavelength power levels above the required minimums.

BENEFITS OF THE CORIANT® PLUGGABLE OPTICAL LAYER

- **Reduces** CapEx by up to 30% relative to traditional approaches with the ability to select only the needed functionality and avoid paying for unwanted functionality
- **Future-proofs** your investments with the ability to add functionality with new pluggables as your needs evolve
- **Minimizes** OpEx by cutting footprint up to 70% and by reducing power consumption up to 50% relative to traditional approaches, and by automating the amplifier gain setting
- **Addresses** a wide range of metro and DCI applications from single channel and CWDM to 96 channels of DWDM, including point-to-point, chain, and ring topologies
- **Enhances** Coriant packet optical platforms enabling functions such as OTDR and 1+1 protection

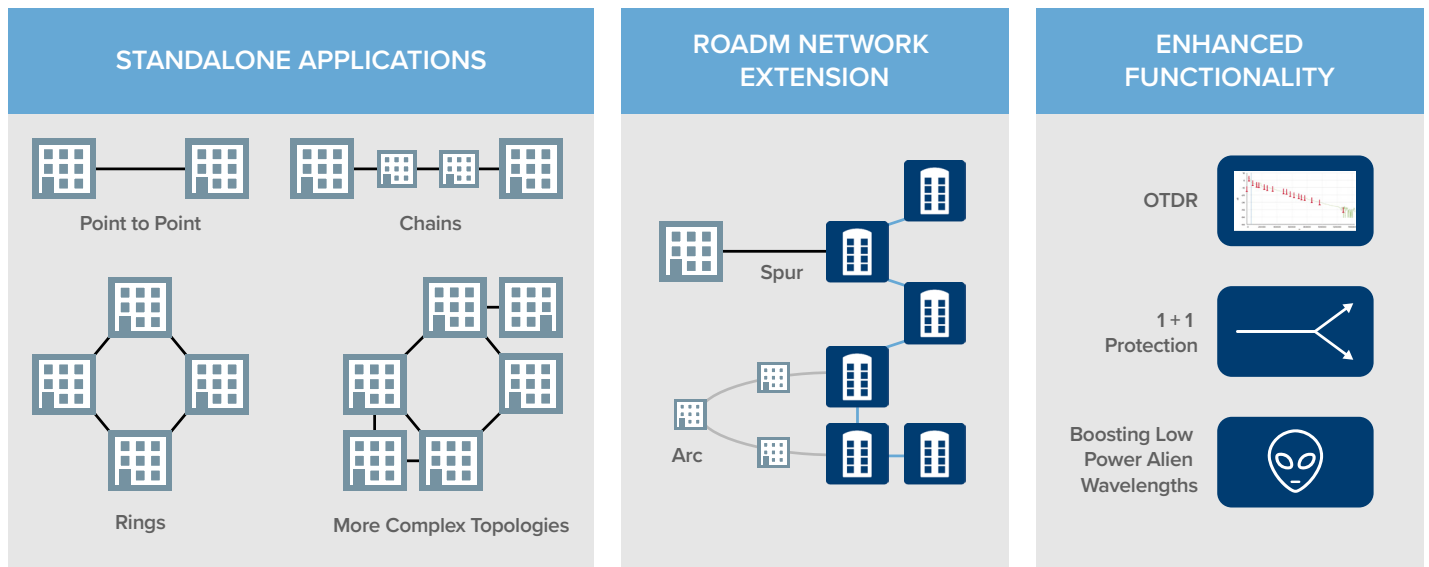


Figure 2 - Coriant® Pluggable Optical Layer Applications

ACTIVE COMPACT PLUGGABLES (SFP, XFP, OFP2, OFP1)

The Pluggable Optical Layer enables a wide range of optical layer functions to be deployed in the form of active compact pluggables, as shown in Figure 3.

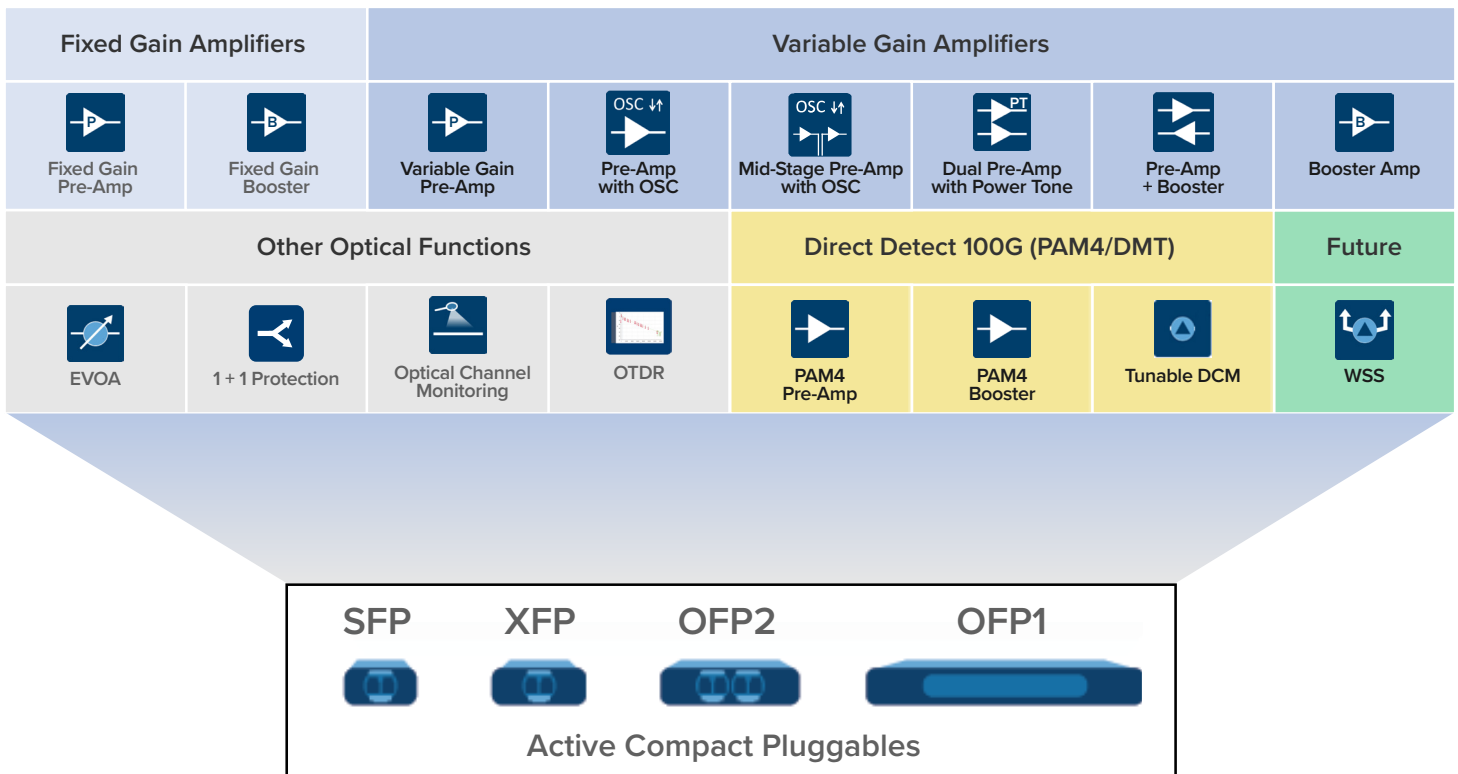


Figure 3 - Active Compact Pluggables

These pluggables are available in four form factors: SFP, XFP, OFP2, similar in size to CFP2s, and OFP1, similar in size to CFPs, as shown in Table 1.





	SFP	XFP	OPF2	OPF1
				
Height	8.5 mm	8.5 mm	19.5 mm	19.5 mm
Width	13.4 mm	18.35 mm	50.5 mm	110 mm
Depth	56.5 mm	78.00 mm	154.4 mm	200 mm

Table 1 – SFP, XFP, OPF2, and OPF1 Pluggables

XFP Fixed Gain Amplifiers

Three fixed gain amplifiers are available in the XFP form factor: a -4 dBm pre-amplifier, a +2 dBm pre-amplifier, and a +5 dBm booster, as shown in Table 2.

Equipment	Pre-amplifier	Booster	Target Output Power	Maximum Channels	Applications
PAXFP4N	✓		-4 dBm	8	Point-to-Point, Spurs
PAXFP2	✓		+2 dBm	1	Spur Express
BAXFP5		✓	+5 dBm	1	100G OCh 1+1

Table 2 - XFP Fixed Gain Amplifiers

Consuming a maximum of only 4.5 W, these XFPs are supported in both the Coriant® 7100 Pico™ Packet Optical Transport Platform aux slot with the XCC carrier module and in the Coriant® 7100 Nano™ Packet Optical Transport Platform in an empty XFP slot of the High Density 10G Transponder (HDTG) module. Applications include point-to-point DWDM for up to 8 channels and span losses of up to 21 dB, and spur express applications where a single DWDM channel is expressed optically onto the 7100 ROADM network without the need for OEO regeneration. Additional uses include 100G OCh 1+1 protection with the OPSM module in the 7100 Series, and boosting the power of alien wavelengths that are below the minimum power threshold required by the 7100 ROADM.

OPF2 Variable Gain Amplifiers

Variable gain amplifiers are available in the OPF2 form factor. Available options include a pre-amplifier (O2PA), pre-amplifiers with OSC (O2PAOSC, O2PAOHIR, O2PAOHLR, O2PAOHER), a dual pre-amp with power tone (O2DPAPT), a booster amplifier (O2BAH), and pre-amps plus boosters (O2PABA, O2PABAS). The four pre-amplifiers with OSC are optimized for different span losses and channel counts while the two pre-amps plus boosters are optimized for different applications with the O2PABAS for ROADM spur applications. These amplifiers support a wide range of applications including point-to-point, chain, ring, spur, and arc topologies. Up to 96 channels and span losses of up to 51 dB are supported. The OPF2 amplifiers have a maximum power consumption of between 8 W and 11 W.

Equipment	Pre-amplifier	Mid-stage Access	Booster	Automatic Gain Control	Max Channels			Max Span Loss
					P2P	Cascade	Spur	
O2PA	1				96	-	-	20 dB
O2PAOSC	1			OSC	96	40	-	18 dB
O2PAOHIR	1	✓		OSC	96	96	-	18 dB
O2PAOHLR	1	✓		OSC	96	96	-	26 dB
O2PAOHER	1	✓		OSC	96	96	-	35 dB
O2DPAPT	2			Power Tone	96	40	-	15 dB
O2BAH			1	OSC	96	96	-	51 dB ¹
O2PABA	1		1		96	-	-	30 dB
O2PABAS	1		1	OSC	-	-	16	10 dB

1. Point-to-point with O2PAOHER, excluding the insertion loss of filters

Table 3 - OPF2 Variable Gain Amplifiers

All of these amplifiers support gain flattening filters (GFF), transient suppression control (TSC), and automatic power shutdown (APS). GFF ensures a flat gain response across the specified operating band and input power range, while TSC prevents dramatic changes in optical power from propagating. APS automatically shuts down the amplifier when the aggregate input power falls below a specified threshold. OFP2 amplifiers are available with an OSC for in-band management and automatic gain control (AGC) and with power tone, which provides a cost-effective solution for automatic gain control but without the in-band management capability. The O2PAOHIR, O2PAOHLR, and O2PAOHER all provide mid-stage access, enabling a DCM to be supported without reducing the maximum span loss.

OFP2 Amplifiers and Tunable DCM for Direct Detect 100G (PAM4/DMT)

Beyond the variable gain amplifiers described previously, two additional OFP2 amplifiers are supported in the Groove G30: the O2PAOUIR high power pre-amplifier with dual OSCs and the O2BAU high power booster amplifier. Together with the O2TDCM Tunable Dispersion Compensation, they enable support for cost-effective direct detect 100G based on PAM4 or DMT. Up to 96 channels are supported with spans of up to 15 dB.

EVOA SFP

While improved filter and transceiver technology enables extended network designs without the need for per channel equalization and balancing, more complex network designs can require Electronically Variable Optical Attenuators (EVOAs). The Pluggable Optical Layer includes SFP-based EVOAs with integrated photodiodes that simplify operations with automatic attenuation.

OTDRs (OFP1 and OFP2)

The Pluggable Optical Layer supports Optical Time Domain Reflectometer (OTDR) in both OFP1 (O1OTDR) and OFP2 (O2OTDR) form factors. Compatible with the 7100 Series, mTera UTP, and hiT 7300, the O1OTDR OFP1 supports both in-service and out-of-service OTDR on up to 16 fibers (i.e., 8 bi-directional degrees) and can be used on EDFA-only spans as well as hybrid EDFA/Raman spans. It supports measurements with resolution down to as little as 1 meter and distances of approximately 100 km. In order to support in-service operation, it operates at 1625 nm in the L-band and therefore requires a filter to separate this from the C-band, which is used for the DWDM channels. Supported in the Groove G30, the O2OTDR provides the same functionality in an OFP2 form factor but with 4 ports instead of 16.

OFP2 Optical Protection Switch

The O2OPS OFP2 provides a cost-effective option for supporting a variety of protection schemes including 1+1 OCh, 1+1 OMS, and 1+1 OTS. It provides a single protection switch in an OFP2 form factor with protection switching triggered by Loss of Signal (LOS).

OFP2 Optical Channel Monitoring

The O2OCM provides per channel power monitoring on four ports (i.e., two degrees in two directions), and can be used to provide optical layer visibility enabling proactive troubleshooting. It can also be used with EVOAs, or in the future, WSS pluggables to enable automatic power balancing.

CARRIER CARDS FOR ACTIVE PLUGGABLES

Coriant provides a number of options for deploying active pluggables across the Coriant packet optical portfolio, as shown in Table 4.

Product	Module	SFP	XFP	OFP2	OFP1
7100 Series (OTS/Nano/Pico)	POCC			3	1
	O1SFP	8			
7100 Pico (Aux Slot)	XCC		2		
	O2CC			1	
Groove G30	OCC-2	2		3	
mTera UTP	OFP1CC				3
	CD-20				1
hiT 7300	CCB-1				1

Table 4 - Pluggable Optical Layer Carrier Modules/Units

The Pluggable Optical Carrier Card (POCC) is a 1-slot module that supports up to three OFP2s and one OFP1, with support for up to six POCCs in the 7100 Nano, up to four POCCs in the 7100 OTS (slots 7-10), and up to two POCCs in the 7100 Pico. The O1SFP, which is an OFP1 form factor pluggable, is supported in the POCC and provides eight SFP ports for housing the SFP EVOAs. In addition, the 7100 Pico can support one XFP Carrier Card (XCC) or one OFP2 Carrier Card (O2CC) in its aux slot, leaving its two full size slots available for port cards. The OCC-2 provides three OFP2s and two SFPs. Up to two OCC-2s can be supported in the 1RU Groove G30. Up to three OFP1s are supported in the mTera UTP with the OFP1CC, while the hiT 7300 Controller Carrier Board (CCB-1) can support one O1OTDR plus OTDR filters.

PASSIVE EQUIPMENT

The Pluggable Optical Layer supports diverse passive equipment components.

DWDM Filters

With support for a wide range of compact, low loss passive filters, the Pluggable Optical Layer includes high channel count mux/demux options such as the 96 channel OMD96 and the 48 channel OMD48, which both occupy two of the four slots in the Groove G30. The OMD44 provides a 1RU standalone 44 channel mux/demux.

Equipment	WDM	Channels	Parts	Applications	Maximum Insertion Loss		Form Factor	Housing
					Add/Drop	B2B Express		
OMD96	DWDM	96	1	Mux/Demux	8.2 dB	N/A	Groove Sled	Groove G30 (Maximum 2)
OMD48	DWDM	48	2	Mux/Demux	6 dB	N/A	Groove Sled	Groove G30 (Maximum 2)
OMD44	DWDM	44	1	Mux/Demux	5.5 dB	N/A	1RU Standalone	
OMD8	DWDM	8	5	Mux/Demux, Add/Drop	3.6 dB	1.2 dB	Cartridge	Passive Shelf (Maximum 4) 7100 Nano AC (Maximum 2)
OMD8	DWDM	8	2	Mux/Demux, Add/Drop	3.6 dB	1.2 dB	OFF2	OCC-2 in Groove G30
OMD4	DWDM	4	10	Mux/Demux, Add/Drop	2.9 dB	1.2 dB	Cartridge	Passive Shelf (Maximum 8)
OMD2 Cable	DWDM	2	20	Mux/Demux, Add/Drop	1.9 dB	1.4 dB	Cable	N/A
OMD1 Cable	DWDM	1	16	Add/Drop	1.9 dB	1.4 dB	Cable	N/A
BMD5	DWDM	5x8 channels	1	Band Mux	2.6 dB	3.6 dB	Cartridge	Passive Shelf (Maximum 8)

Table 5 - Passive DWDM Filters

The OMD8 cartridge occupies 2 slots in the 8-slot Passive WDM Shelf (PWS) and can be used for mux/demux or paired for add/drop. It has a maximum insertion loss of 3.6 dB for add/drop and 1.2 dB for back-to-back (B2B) express (i.e., across two OMD8s). The OMD8 is also available in an OFF2 form factor and is supported in the OCC-2 in the Groove G30, with two parts enabling 16 channels for point-to-point DCI applications.

The OMD4 cartridge occupies 1 slot in the passive shelf and can also be used for mux/demux or paired for add/drop. It has a maximum insertion loss of 2.9 dB for add/drop and 1.2 dB for back-to-back express. Cable-based filters with 1 or 2 channels of add/drop provide a cost-effective and footprint-efficient solution for low channel count sites.

The BMD5 provides a band mux with 5 bands of 8 channels. Each band can be dropped to OMD8s for individual channel breakout or expressed between degrees, providing a cost-effective solution for ring and multi-degree applications. These filters are all 100 GHz and follow an 8 skip 1 channel structure (i.e., channels 1-8, 10-17, 19-26, 28-35, 37-44) with support for up to 40 channels.

CWDM Filters

The COMD8 cartridge provides an 8-channel CWDM Mux/Demux and occupies 2 slots in the PWS while the COMD4 is a 4-channel CWDM Mux/Demux and occupies 1 slot in the PWS. A cable-based version of the OMD4 is also available.

Equipment	Channels (nm)	Parts	CWDM Upgrade Port	Monitoring/Test Port	DWDM Port	Maximum Insertion Loss	Form Factor	Housing
COMD8	8 (1471-1611)	1	x	x	x	3.6 dB	Cartridge	PWS (Maximum 4) 7100 Nano AC (Maximum 2)
COMD4	4 (1271-1331)	1	x	x	x	2.9 dB	Cartridge	PWS (Maximum 8)
COMD4 Cable	4 (1471-1531 or 1551-1611)	2	x	x	x	2.9 dB	Cable	N/A
COMD8U Indoor	8 (1471-1611 or 1271-1451)	2	✓	✓	x	3.6 dB (5 dB B2B)	LGX	LGXS-14 (4RU Shelf) LGXS-3 (1RU Shelf)
COMD4U Indoor	4 (1471, 1491, 1591, 1611)	1	✓	✓	✓	3.6 dB (5 dB B2B)	LGX	LGXP-3 (1RU Panel) LGXW-2 (Wall Mount)
COMD8U Outdoor	8 (1471-1611)	1	✓	✓	x	3.6 dB (5 dB B2B)	LGX with IP 66 Hardened Enclosure	
COMD4U Outdoor	4 (1471, 1491, 1591, 1611)	1	✓	✓	✓	3.6 dB (5 dB B2B)	LGX with IP 66 Hardened Enclosure	

Table 6 - Passive CWDM Filters

LGX provides an industry standard form factor for passive optical equipment. The COMD8U and COMD4U provide 8 and 4 channels of CWDM respectively, based on the LGX form factor. They both have an expansion port for the lower CWDM band and a monitoring/test port. The COMD4U also has a port for the DWDM C-band. The COMD8U and COMD4U are available with IP 66 dust and waterproof enclosures for pole or outdoor wall mounting. All the CWDM filters have an operating temperature range of -40°C to +85°C.

Other Filters: High/Low, OTDR

A high/low filter is also available that muxes/demuxes 1271-1451 nm and 1471-1611 nm. Applications for this filter include muxing/demuxing the low CWDM channels and the high CWDM channels, muxing/demuxing the low CWDM channels and the DWDM C-band, and muxing/demuxing a 1310 nm channel and the CWDM high band or DWDM C-band. This filter is cartridge-based and occupies one slot in the PWS. Finally an OTDR filter cable is available for use with the OFF1 and OFF2 OTDR pluggables, which separates the C-band and the 1625 nm channel used for OTDR.

Part	Band A	Band B	Form Factor	Housing
High/Low Filter	1271-1451 nm	1471-1611 nm	Cartridge	PWS (Maximum 8)
OTDR Cable	C-band (1530-1565 nm)	1625 nm	Cable	N/A

Table 7 - Additional Filters

Colorless Add/Drop

The CAD8 is an OFF2 form factor pluggable splitter/combiner that enables 8 colorless, flexi-grid add/drop ports in the Groove G30. The CAD8E can be deployed with the CAD8 to expand the number of colorless add/drop ports per fiber to 16.

Part	Technology	Colorless	Directionless	Form Factor	Compatible Product	Housing
CAD8	Splitter/Combiner	8 ports	x	OFF2	Groove G30	OCC-2 in Groove G30
CAD8E	Splitter/Combiner	8 ports	x	OFF2	Groove G30	OCC-2 in Groove G30
CX-12C	Splitter/Combiner	12 ports	x	OFF1	mTera UTP	OFF1CC or CD20 in mTera UTP

Table 8 - Passive Colorless/Directionless Equipment

The CX-12C is a splitter/combiner that provides 12 colorless/directionless expansion ports for the mTera UTP's CD-20 high port count colorless/directionless module. It can be deployed in the mTera UTP's OFF1CC module or in the CD-20, which has one OFF1 slot.

Dispersion Compensation Modules and Air Baffles

The Pluggable Optical Layer also supports DCMs from 10 km to 100 km in 10 km increments. With a 2-slot cartridge form factor, up to 4 DCMs can be housed in the PWS and up to 2 in the 7100 Nano AC. In addition to compact size, they benefit from low insertion loss between 2 dB (10 km) and 7.2 dB (100 km). Additional features include a flat C-band amplitude response, minimal phase and group delay ripple, and PMD of less than 1 ps. The PWS also supports 2-slot air baffles enabling front-to-back airflow and reduced footprint for 7100 Pico deployments with passive equipment, with the PWS replacing a 7100 Pico baffle.

Housing for Passive Equipment

Part	Height	Width	Depth	Houses
PWS ¹	1RU (43.18 mm)	442 mm	238.6 mm	Passive Cartridges (8 x 1 slot cartridges, 4 x 2 slot cartridges)
7100 Nano AC	N/A	N/A	N/A	Passive Cartridges (two double slots at the center bottom of shelf)
Groove G30	1RU (44 mm)	440 mm	510 mm	OMD96, OMD48 (Maximum 2)
OCC-2 in Groove G30	N/A	N/A	N/A	OMD8 OFF2, CAD8 OFF2, CAD8E OFF2
OFF1CC in mTera UTP	N/A	N/A	N/A	CX-12C & OTDR OFF1s (Maximum 3)
CD-20 in mTera UTP	N/A	N/A	N/A	CX-12C OFF1 (Maximum 1)
LGXS-14 (4RU Shelf)	4RU (177 mm)	435 mm	285 mm	14x LGX CWDM Filters
LGXS-3 (1RU Shelf)	1RU (43.6 mm)	482 mm	279 mm	3x LGX CWDM Filters
LGXP-3 (1RU Panel)	1RU (43.6 mm)	482 mm	2 mm	3x LGX CWDM Filters

1. Passive cartridges can also be attached directly to the rack frame

Table 9 - Housing Options for Passive Equipment

The PWS has 8 slots and supports up to eight 1-slot cartridges or up to four double slot cartridges. It has a height of 1RU and is supported in 19-inch, ETSI, and 23-inch racks. The PWS has an operating temperature range of -40°C to +85°C. And while not requiring power, it does have two RJ45 ports to communicate inventory information. The AC version of the 7100 Nano also has space at the front bottom of the shelf for two double slot passive cartridges, as shown in Figure 4.

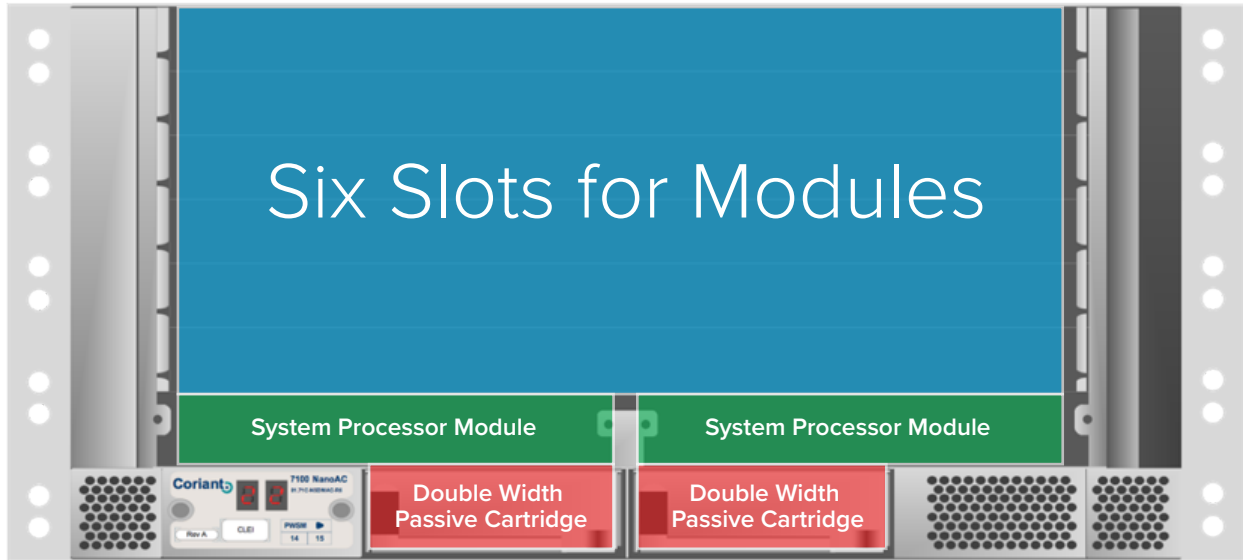


Figure 4 - Coriant® 7100 Nano AC: Slots for Passive Cartridges

The OMD96 and OMD48 can be housed in the Groove G30 with each module occupying two of the four Groove G30 slots. OFP2 passive equipment can be housed in the Groove G30's OCC-2. The mTera UTP's OFP1CC can house up to three CX-12C OFP1s, while its CD-20 colorless/directionless module can house one.

Four options are available for housing the LGX CWDM passive filters. A 4RU shelf provides 14 slots for LGX filters. A 1RU shelf provides three slots, while a 1RU panel also provides three slots but without the full enclosure. A wall mounting unit with two slots is also available. All four options have an operating temperature range of -40°C to +85°C.

SFP, XFP, OFP2, AND OFP1 COMPATIBILITY MATRIX

Equipment	Acronym	Description	Form Factor	7100 Series	Groove G30	mTera UTP	hiT 7300
Fixed Gain Amplifiers	PAXFP4N	Pre-amp, -4 dBm Output	XFP	✓			
	PAXFP2	Pre-amp, XFP, +2 dBm Output	XFP	✓			
	BAXFP5	Booster Amplifier XFP, +5 dBm Output	XFP	✓			
Variable Gain Amplifiers	O2PA	Variable Gain Pre-amp	OFP2	✓	✓		
	O2PAOSC	Variable Gain Pre-amp with OSC	OFP2	✓	✓		
	O2PAOHIR	Intermediate Reach High Channel Count Pre-amp with OSC	OFP2	✓	✓		
	O2PAOHLR	Long Reach High Channel Count Pre-amp with OSC	OFP2	✓	✓		
	O2PAOHER	Extended Reach High Channel Count Pre-amp with OSC	OFP2	✓	✓		
	O2DPAPT	Dual Pre-amp with Power Tone	OFP2	✓			
	O2BAH	Booster Amp High Channel Count	OFP2	✓	✓		
	O2PABA	IR Pre-amp + Booster	OFP2	✓	✓		
	O2PABAS	Spur Pre-amp + Booster	OFP2	✓			
PAM4	O2PAOUIR	High Power Pre-amplifier with two OSCs	OFP2		✓		
	O2BAU	High Power Booster Amplifier	OFP2		✓		
	O2TDCM	Tunable Dispersion Compensation	OFP2		✓		
Other	SEVOA	SFP EVOA	SFP	✓			
	O1SFPC	OFP1 8xSFP Carrier Card (SFPCC OFP1)	OFP1	✓			
	O2OTDR	OTDR	OFP2		✓		
	O1OTDR	OTDR	OFP1	✓		✓	✓
	O2OPS	1+1 Optical Protection	OFP2	✓	✓		
	O2OCM	Per Channel Optical Power Monitoring	OFP2		✓		
Passive ¹	CAD8	8 Channel Colorless Add/Drop	OFP2		✓		
	CAD8E	8 Channel Colorless Add/Drop	OFP2		✓		
	OMD8-1	8 Channel Mux/Demux (channels 1-8)	OFP2		✓		
	OMD8-2	8 Channel Mux/Demux (channels 9-16)	OFP2		✓		
	CX-12C	12-Port Colorless Fan Out	OFP1			✓	

1. Passive equipment can be housed in any appropriate slot, though it will only be visible to the systems listed in the table.

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