



## PRODUCT DOCUMENTATION

### *BTI 7000 Series Product Guide*

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# Preface

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This preface explains who should read this guide, related documentation, and documentation conventions.

## Audience

This guide is primarily intended for product planners, network planners and those involved in the design, installation, and maintenance of optical links and networks.

## Features of the BTI 7000 Series

For detailed information about this release, see the *BTI 7000 Series Release Notes* for this release.

## BTI 7000 Series common equipment

The following table lists the shelves and other common equipment introduced as part of the BTI 7000 Series. For detailed information, see the *BTI 7000 Series Product Guide* and the *BTI 7000 Series Common Equipment Installation Guide*.

### BTI 7000 Series common equipment

Equipment	PEC
BTI 7060	BT7A50AA
BTI 7060 with rear access -48V	BT7A50AR
BTI 7060 Cooling Unit (CU)	BT7A52DA, BT7A52EA
BTI 7060 Main Shelf Interface (MSI)	BT7A53BA, BT7A53BB
BTI 7060 Expansion Shelf Interface (ESI)	BT7A54BA
BTI 7060/BTI 7200 System Control Processor (SCP)	BT7A20CA
BTI 7060 AC Power Assembly Kit	BT7A50BA
BTI 7060 AC Power Module	BT7A58AA
BTI 7060 Filler Panel Kit	BT7A55EA
2U Cover – ANSI	BT7A5070
2U Cover – ETSI	BT7A5071
BTI 7030	BT7A56AA
BTI 7030 Cooling Unit (CU)	BT7A57BA
BTI 7030 Main Shelf Interface (MSI)	BT7A53CA, BT7153CB, BT7A53BB
BTI 7030 System Control Processor (SCP)	BT7A21BA
BTI 7030 AC Power Assembly Kit	BT7A56CA
BTI 7030 AC Power Module	BT7A58BA
1U Cover – ANSI	BT7A5670
1U Cover – ETSI	BT7A5671
BTI 7020	BT7A56BA

**BTI 7000 Series common equipment (Continued)**

<b>Equipment</b>	<b>PEC</b>
BTI 7200	BT7A51AA
BTI 7200 with rear access -48V	BT7A51AR
BTI 7200 Cooling Unit (CU)	BT7A52EA
BTI 7200 Main Shelf Interface (MSI)	BT7A53EA
BTI 7200 Common Communication Module (CCM)	BT7A54EA
BTI 7200 ANSI shelf cover	BT7A5180
BTI 7200 ETSI shelf cover	BT7A5181
BTI 7200 Air Deflector	BT7A59EA
BTI 7200 Installation kit	BT7A5034
BTI 7200 Pack of 5 Mounting Bracket Pairs (7200)	BT7A5035
BTI 7200 Pack of 5 Center Guides	BT7A5036
Single Expansion Shelf Kit (2x 1310 SFP, 1x Dual SM Patch Cord 1.5m)	BP1A58LA-01.5
Single Expansion Shelf Kit (2x 1310 SFP, 1x Dual SM Patch Cord 2m)	BP1A58LA-02

The BTI 7000 Series shelves support a wide range of modules. For the list of modules supported, see the *BTI 7000 Series Product Guide*.

The following table lists the BTI graphical user interface management software suite. For detailed information about each application, refer to the documentation set for the application.

**Management software suite**

<b>proNX Management Suite</b>
proNX Service Manager (PSM)
proNX 900 Node Controller (proNX 900)

**Equipment compliance**

The following table provides agency-compliance information for BTI 7000 Series equipment.



<b>Agency</b>	<b>Compliance information</b>
<b>FDA</b>	This equipment is classified by the FDA under IEC 60825, parts 1 and 2, as a Class 1 laser product with a Class 1 hazard rating.
<b>FCC</b>	This equipment complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.
<b>Industry Canada</b>	This Class A digital apparatus complies with Canadian ICES-003.

**Organization of the BTI 7000 Series documentation**


The following guides are contained in the BTI 7000 Series documentation suite.

- *BTI 7000 Series Alarm and Troubleshooting Guide*
- *BTI 7000 Series Command Line Interface Reference Guide*
- *BTI 7000 Series Common Equipment Installation Guide*
- *BTI 7000 Series Dynamic Optical Layer Engineering Guideline*
- *BTI 7000 Series Management Communications Channel Solutions Guide*
- *BTI 7000 Series Multiplexing Solutions Guide*
- *BTI 7000 Series Muxponder Solutions Guide*
- *BTI 7000 Series Operations Solutions Guide*
- *BTI 7000 Series Optical Amplifier and DCM Solutions Guide*
- *BTI 7000 Series packetVX Solutions Guide*
- *BTI 7000 Series Product Guide*
- *BTI 7000 Series SNMP Overview Guide*
- *BTI 7000 Series Test and Turn-up Guide*
- *BTI 7000 Series TL1 Reference Guide*
- *BTI 7000 Series Transceiver InformationGuide*
- *BTI 7000 Series Transponder Solutions Guide*
- *BTI 7000 Series Upgrade Guide*
- *BTI 7000 Series Release Notes*
- BTI 7000 Series Quick Installation Notes (various)

**Documentation conventions**

Convention	Description
<b>Note</b>	Means reader take note. Notes contain helpful suggestions or background information.
 <b>Caution</b>	Means reader be careful. Equipment damage or loss of data can result from your actions.
 <b>Warning</b>	Means reader be careful. Harm to yourself or others can result from your actions.



Convention	Description
 <b>Laser Warning</b>	Invisible laser radiation can be emitted from the aperture ports of amplifier circuit packs when no fiber cable is connected. Avoid exposure and do not stare into open apertures to avoid permanent eye damage.

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# 1.0 Introduction to the BTI 7000 Series

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This section provides a brief overview of the BTI 7000 Series.

- 1.1, “BTI 7000 Series — Intelligent Services Edge Solution”
- 1.2, “Management interfaces”
- 1.3, “Remote management capabilities”
- 1.4, “Security and users”
- 1.5, “Performance monitoring”
- 1.6, “Alarm, event, and state management”
- 1.7, “Logs”
- 1.8, “Power monitoring”
- 1.9, “In-Service software upgrade”
- 1.10, “High temperature automatic shutdown”
- 1.11, “Operational support systems”

## 1.1 BTI 7000 Series — Intelligent Services Edge Solution

---

The BTI 7000 Series addresses the increasing demand for multiple services, greater transport capacity, dynamic networking, and management simplicity right to the network optical edge. Integrating both advanced wavelength and packet-oriented functionality, the BTI 7000 Series delivers all the capabilities of large core network platforms in the industry's most compact, low-power consumption, easy-to-use packet optical network system.

The BTI 7000 Series provides operational simplicity with industry-standard interfaces, monitoring and management tools, and support services. The system's management features lower the cost of optical network operation, administration, maintenance and provisioning, and also provide fault, performance and security management.

The BTI 7000 Series is designed to be easily integrated into existing networks and managed by third-party element management systems (EMS), network management systems (NMS) and operation support systems (OSS). Configuration is typically accomplished while the system remains in service.

### Integrated packet and optical solutions

The BTI 7000 Series merges Ethernet and optical networking with a fully-featured WDM infrastructure, including performance monitoring and protection for carrier-grade service delivery. With a complete portfolio of client service modules, CWDM and DWDM networking capabilities, reach extension, and fiber adaptation for any application, the system delivers end-to-end network efficient multiprotocol gigabit services and high capacity for smarter and faster campus, metropolitan, and regional networks.

- **Converged Ethernet and optical networking** — carrier-grade availability with 16 $\lambda$  CWDM, 32 $\lambda$  DWDM or hybrid WDM options, and up to 40 DWDM channels with DOL.
- **Multiprotocol services** — featuring a variety of Transponder, Muxponder, and integrated packetVX™ modules with built-in WAN protection for high availability.
- **Rapid service provisioning** — with client service modules that can be remotely configured to address any service, protocol, or interface speed.
- **Network interoperability** — integrating third-party devices with SONET, SDH, and ITU G. 709 OTN WDM wavelength encapsulation options.
- **Comprehensive performance monitoring and network management** — with real-time and historical monitoring of physical, L1, and L2 parameters and intelligent in-band management software with General Communications Channel (GCC) support.
- **Fiber networking** — with single-fiber, bidirectional networking, 1310nm network integration, optical amplification, and dispersion compensation for reach extension.
- **Environmentally friendly** — using state-of-the-art technology the BTI 7000 Series is engineered for very low power consumption reducing carbon footprint for central offices and data centers.

## 1.2 Management interfaces

The BTI 7000 Series supports standard communication interfaces over serial and IP connections, including Telcordia Transaction Language One (TL1), Command Line Interface (CLI), SNMP and GCC0.

For an overview of GCC0, see [12.3, “Management Communication Channels”](#). For detailed information, see the *Management Communications Channel Solutions Guide*.

In addition, the system provides the following graphical user interface (GUI) software to manage the system:

**Table 1-1 GUI System Management Software**

Interface	Description
proNX Service Manager (PSM)	Provides proactive, service-centric management of network resources using tools closely aligned with service providers' own business processes.  PSM was introduced in Release 9.1, and replaces the proNX 9000 Network Manager.
proNX 900 Node Controller (proNX 900)	A craft management interface to manage individual network elements (NEs).
proNX 9000 Network Manager (proNX 9000)	A network management interface to manage network elements.  proNX 9000 was replaced by PSM starting with Release 9.1.

The TL1 and proNX 900 interfaces allow you to manage the following functions on the BTI 7000 Series:

- Provisioning
- Alarm and Event Management
- Performance Monitoring
- Security Management
- System Administration
- Log Management

The CLI allows you to configure, monitor and maintain packetVX modules. For detailed information, see the *BTI 7000 Series Command Line Interface Reference Guide*.

The SNMP interface enables:

- Retrieval of system inventory information.
- Provisioning of equipment, facilities and services.
- Monitoring of faults through trap-based alarm notification and retrieval of active alarms and conditions.

- Retrieval of performance monitoring data and trap-based PM threshold crossing alerts.

Administration management functions including software upgrades and database backup and restore.

This section covers the following topics:

- [1.2.1, “proNX Management Suite”](#)
- [1.2.2, “TL1 interface”](#)
- [1.2.3, “SNMP interface”](#)

## 1.2.1 proNX Management Suite

The proNX™ Management Suite delivers a powerful, modular, carrier-grade element, network, and service management solution. The portfolio delivers seamless end-to-end monitoring, control, provisioning, and planning of infrastructure and services across BTI networks.

### proNX Service Manager

proNX Service Manager (PSM) provides proactive, service-centric management of network resource using tools closely aligned with service providers’ own business processes. It is designed to simplify network operations from visualization and activation of services to troubleshooting and supporting end customers. proNX SM can be installed in a standalone configuration for new installations, or in a co-resident configuration, when installed with an existing proNX 9000.

PSM is Java-based, and uses a client/server architecture. For more information about PSM refer to the *proNX Service Manager User Guide*.

<b>Note</b>	PSM replaces the proNX 9000 Network Manager starting with Release 9.1.
-------------	--

### proNX 900 Node Controller

proNX 900 Node Controller (proNX 900) provides comprehensive nodal management and can be deployed as a local craft terminal for on-site or remote element access. The easy-to-use graphical user interface (GUI) provides system provisioning, configuration, fault management, and performance monitoring of BTI network elements, as well as, systems software upgrades, and database backups and restoration.

proNX 900 can be connected directly to a network element or set up to access a network element remotely through DCN. Also, it can be started from third-party management systems.

For detailed information about installing and using proNX 900, see the *Common Equipment Installation Guide* and the *proNX 900 Node Controller Online Help*.

### proNX 9000 Network Manager

proNX 9000 Network Manager™ (proNX 9000) delivers secure and flexible end-to-end management of BTI networks built on Intelligent Services Edge Solutions platform elements. A client-server based solution that delivers topology views, inventory control, fault management, service provisioning and security management through a GUI, proNX 9000 provides the following capabilities:



- View of the entire network
- Topology management
- Multiple concurrent users
- Access proNX 900 to configure and provision individual network elements
- Multilayer service discovery and display
- Network level FCAPS, such as network-wide alarm collection, PM collection, database backup, and software upgrade
- Northbound SNMP interface for integration into a third-party OSS

For detailed information about installing and using proNX 9000, see the *proNX 9000 Network Manager Installation Guide* and the *proNX 9000 Network Manager User Guide*.

### proNX 9010 Network Designer

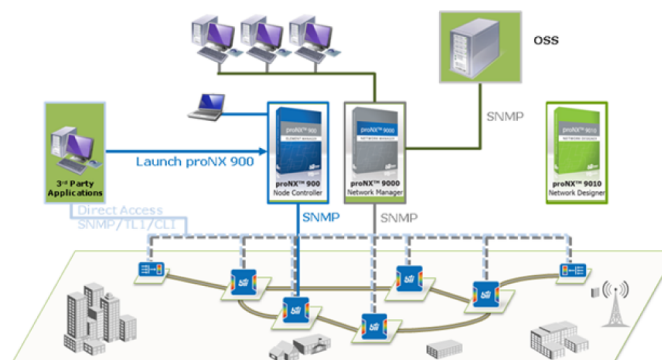
proNX 9010 Network Designer™ (proNX 9010) is a standalone Windows-based application for designing BTI networks. This GUI-based network designer features an automated Service wizard to simplify and automate network planning, and provides an optical verification tool to ensure that each network is designed within acceptable specifications. A comprehensive library includes all supported BTI components. Link engineering functionality includes power OSNR and dispersion calculations across the network.

proNX 9010 also features a reporting tools that provides the following:

- Bill of Material (BOM) information, both in total and per site
- Per-site details, such as shelf layout, and power and space requirements
- Wavelength diagrams that show end-to-end results of optical validation

For information about installing and using proNX 9010, see the *proNX 9010 Network Designer User Guide*.

The following figure provides an overview of how the proNX Management Suite can be deployed.



## 1.2.2 TL1 interface

The BTI 7000 Series supports a comprehensive and interactive TL1 interface based on Telcordia standards, including TR-NWT-831, GR-199-CORE and GR-833-CORE. This interface supports up to 24 concurrent user sessions.

For a complete list of commands and user authorization levels, see the *TL1 Reference Guide*.

The TL1 interface is accessible through the craft serial port, using a VT-100 terminal (or terminal emulator), as well as from either the craft or management LAN ports on the BTI 7000 Series.

## 1.2.3 SNMP interface

Simple Network Management Protocol (SNMP) is an application-layer protocol designed to facilitate the exchange of management information between network devices. SNMP enables trap-directed notification of events on a device.

For the BTI 7000 Series, the SNMP implementation supports SNMP Version 1 (SNMPv1) as defined in RFCs 1155, 1157, 1212, 1213, and 1215, and SNMPv2c as defined in RFCs 1901 through 1907. SNMPv3 is not supported in this release.

The enterprise MIBs, as provided on the Customer Documentation CD, define BTI 7000 Series-specific MIB objects and notifications. These MIBs are available in both SNMPv1 and SNMPv2c versions. In addition, the SNMP agent supports both SNMPv1 and SNMPv2c Protocol Data Unit (PDU) messages.

The system and SNMP group objects in MIB-II, as defined in RFC 1213, are supported for both read and write access. In addition, the MIB includes a group of system-related objects under the network Element branch.

Enterprise-specific fault management trap messages for all alarms and non-alarmed conditions reported by the system are supported.

For each alarm, a raise and clear trap is defined. A read-only table is defined, which provides a listing of active conditions and alarms.

Performance monitoring of current and historical PM values for optical amplifiers and optical transceivers can be also retrieved.

Additionally supported is full provisioning, configuration, and status monitoring support for optical amplifiers and optical transceivers.

Inventory retrieval is available with this latest release.

Support is provided for the General Communications Channel (GCC), optical supervisory channel (OSC) and network management interfaces.

For details about setting up and using SNMP, refer to the *BTI 7000 Series SNMP Overview Guide*.

## 1.3 Remote management capabilities

---

The Optical Supervisory Channel (OSC) modules provide remote management of a BTI 7000 Series Network Element. The OSC module can use the OSPF routing protocol to support network topology discovery and link failure.

The OSC coupler/splitter tray provides in-service splitting and coupling of the OSC from live, traffic-carrying fibers. The coupler/splitter tray is separated from the electronic components of the OSC circuit pack. As a result, failure of the electronic components on the OSC circuit pack will not impact service on the traffic-carrying fibers.

For more information on the OSC, see [Chapter 12, “Remote management”](#).

## 1.4 Security and users

---

The BTI 7000 Series employs a master set of user profiles to administer access whether it is from an NMS or a local operator. User profiles can be created and managed via the management interfaces that the BTI 7000 Series supports.

The BTI 7000 Series supports a maximum of 500 user profiles, which can be created using the TL1, CLI, or proNX 900 interface, or any combination of these interfaces. Each user profile is associated with a user ID and password for authentication purposes. In addition, each profile is associated with a security authorization level that determines access rights available to the user once they have logged into the system.

The BTI 7000 Series supports the security authorization levels defined in the Telcordia TR-NWT-835 standard—Superuser, Provisioning, Maintenance and Surveillance.

For more information on security and user profiles, see the *Operations Solutions Guide*.

## 1.5 Performance monitoring

---

The BTI 7000 Series supports the collecting and reporting of statistical information that can be used to assess system performance and network health. The operator can retrieve current and historical performance metrics.

Historical PMs (also known as bins) for various entities in the shelf can be stored at 15-minute, 24-hour, and untimed intervals. The data collected in 15-minute bins for the most recent 24 hours, one 24-hour bin, and one untimed bin might be available for retrieval. Configurable alarm thresholds are also available for particular PMs.

For an overview of PM montypes supported by a particular BTI 7000 Series module, see the chapter for the module's portfolio in this guide. For detailed information about performance monitoring support in the BTI 7000 Series see the solutions guide for each BTI 7000 Series module portfolio.

## 1.6 Alarm, event, and state management

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The BTI 7000 Series performs fault detection and reports fault conditions autonomously through the management interfaces—TL1, CLI, proNX 900, and SNMP. The system also manages and reports on the state of various system components.

### Alarms

The BTI 7000 Series has several methods for reporting possible problems with the system.

- LEDs on the faceplate of each module, including common equipment, alert the user to failures on the system.
- The office alarm interface on the BTI 7000 Series provides audible and visual office alarms.
- The environmental alarm interface on the BTI 7000 Series receives notifications of external conditions, such as, equipment failures and warnings.

For information about the alarm connectors on the MSI (Main Shelf Interface) module refer to the *BTI 7000 Series Common Equipment and Installation Guide*.

The proNX 900 displays alarms at the system, module, and port level. Embedded online help for each alarm provides alarm clearing procedures. TL1 can also be used to retrieve the same alarms that appear on the proNX 900.

Alarm reports are useful diagnostic tools that provide detailed information on the category of the alarm, severity, type of condition, source of condition and the time an alarm was raised or cleared. A view of the active alarms on the system is always available from the TL1, proNX 900 Node Controller, or SNMP interfaces. BTI 7000 Series logs also keep track of alarms raised and cleared.

For more information on fault monitoring, see the *Alarm and Troubleshooting Guide*.

### Events

In addition to alarms, the BTI 7000 Series generates autonomous event messages. These messages provide information to the management interfaces on module insert and unplug events; database backup, load, and restore events; software upgrade progress indications; and state-change notifications. BTI 7000 Series event reports include details of the type of event, source and time of issue.

Events are logged on the BTI 7000 Series and are available for viewing through the TL1 or proNX 900 Node Controller interfaces.

For more information on BTI 7000 Series events, see the *Operations Solutions Guide*.

### State management

The state model provides availability information on entities and also indicates the cause if an entity is not available. The BTI 7000 Series supports the Telcordia state model as defined in GR-1093-CORE Generic State Requirements for Network Elements. The Telcordia model is based on the service condition of an entity such as equipment or a facility.

State changes on the BTI 7000 Series are reported autonomously through the TL1 or proNX 900 Node Controller interfaces. In addition, state information is also available on demand through the same interfaces.

For more information on state management, see the *Operations Solutions Guide*.

## 1.7 Logs

---

The BTI 7000 Series maintains individual logs for each action on the shelf. The log information replicates the information sent in alarm, event and performance monitoring autonomous reports. The logs are organized using the following categorization filters:

- Commands
- Database Changes
- Events
- Alarms
- Security

System logs are maintained in a circular buffer and are retained after system restarts. Logs can be sorted and filtered using the proNX 900 Node Controller. For more information about logs, see the *Operations Solutions Guide*.



## 1.8 Power monitoring

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The BTI 7000 Series provides non-intrusive power monitoring for amplifiers and multiplexers.

### **Non-intrusive power monitoring for amplification**

The single-channel and C-Band DWDM amplifiers, combining both built-in power monitoring and the ability to collect power received and power transmitted PMs, provide non-intrusive power monitoring. The power monitor allows one percent of the signal to be redirected for monitoring purposes. The power monitor ports on these amplifiers can be connected to either a power meter or an Optical Spectrum Analyzer (OSA).

For more information about amplifiers with built-in power monitors, see [Chapter 5, “Optical Amplifiers”](#).

## 1.9 In-Service software upgrade

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BTI 7000 Series system software can be upgraded using either the proNX 900 or TL1 without affecting traffic on the system.

For detailed information about upgrading the system software for this release, see the *Upgrade Guide*.

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## 1.10 High temperature automatic shutdown

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High temperature automatic shutdown (HTAS) is a system-level feature supported on modules equipped with a temperature sensor. HTAS is disabled by default.

If HTAS is enabled, a module automatically shuts down when it exceeds the high temperature threshold (75°C to 80°C). These are fixed values and are not configurable. When the module shuts down, a **Circuit pack high temperature automatic shutdown** (REPLUNITHHTAS) alarm is raised against the inventory AID in the format of SLOT-<shelf>-<slot>.

After clearing the REPLUNITHHTAS alarm, the module can be powered on by one of the following procedures:

- Using the INIT-SYS command: INIT-SYS:[TID]:[<aid>]:[CTAG]:[<ph>], where <ph> is the number 2 option—power on following a temperature shutdown; for example: INIT-SYS:BTI7000:TPR-1-3:100::2;
- Physical re-seat.

HTAS is available on supported modules on BTI 7200 shelves and on those BTI 7060 shelves with MSI BT7A53BB. HTAS is not available on BTI 7030 and BTI 2060 shelves.

### HTAS Unsupported Alarm

Although HTAS may be enabled, it is not supported if any of the following conditions exist:

- The main shelf interface (MSI) is not upgraded to BTI software release 10.3.0 or later.
- An MSI upgrade fails.
- The MSI is not field upgradable, for example the MSI for the BTI 7060—BT7A53BA, and all MSIs in the BTI 7030 and Netstender 2060.

If the MSI does not support HTAS, when a module exceeds the high temperature threshold it does not automatically shutdown, however, a **High temperature automatic shutdown unsupported** alarm is raised—**HTASUNS**.

For detailed information about the REPLUNITHHTAS and HTASUNS alarms and clearing procedures refer to the *BTI 7000 Series Alarm and Troubleshooting Guide*.

## 1.11 Operational support systems

---

The value of any networking device is directly related to its availability, reliability, usability and performance. Customer support services for the BTI 7000 Series help you protect and optimize the value of your network equipment, and meet your operational requirements and commitments to customers.

### **Rapid turn-up**

The BTI 7000 Series is designed to be installed and capable of carrying live traffic in two hours or less, including unpacking the system, rack installation and initial provisioning. Shelves in the BTI 7000 Series support auto-detection of modules and provide default values for these components.

For more information on activating the system, refer to the *Common Equipment Installation Guide*.

### **Documentation and training**

A full suite of carrier-grade user documentation and reference material is provided to support the operation, administration and provisioning of the BTI 7000 Series. Documentation is available in PDF format on CD-ROM and via the web.

In addition, comprehensive online help is available for the proNX 900 Node Controller to assist with provisioning, monitoring and managing tasks.

BTI 7000 Series training consists of five modules:

- Overview of the BTI 7000 Series system
- Link Engineering
- Installation and Commissioning
- Operations, Administration, Maintenance and Provisioning
- Expert Level

Contact BTI for more information about our training packages.

### **Customer support and advanced equipment replacement**

BTI customer support is available around the clock seven days a week. In addition to a customer support line, BTI also offers an RMA process for faulty equipment, as well as advanced equipment replacement. The advanced replacement program provides a flexible solution to recover from hardware failures.

For more information about BTI support policies, visit the BTI web site at [www.btisystems.com](http://www.btisystems.com). For information about contacting customer support, see the Preface of this document.

## 2.0 BTI 7000 Series shelves and common equipment

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This section provides a detailed overview of the BTI 7000 Series shelves and common equipment.

- [2.1, “BTI 7000 Series shelves”](#)
- [2.2, “Common equipment”](#)
- [2.3, “Shelf configuration”](#)
- [2.4, “Physical specifications”](#)
- [2.5, “BTI 7000 Series shelf environmental specifications”](#)
- [2.6, “Operating temperature ranges for shelves and common equipment”](#)
- [2.7, “DC power distribution and protection requirements”](#)
- [2.8, “AC power distribution and protection requirements”](#)

## 2.1 BTI 7000 Series shelves

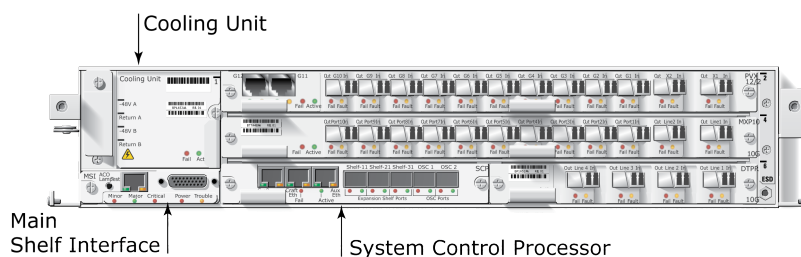
Table 2-1 BTI 7000 Series shelves

Shelf	PEC	System software introduced
BTI 7060	BT7A50AA	7.1.0
BTI 7060 with rear access -48V	BT7A50AR	7.1.0
BTI 7030	BT7A56AA	7.1.0
BTI 7020	BT7A56BA	7.1.0
BTI 7200	BT7A51AA	8.1
BTI 7200 with rear access -48V	BT7A51AR	8.1

### 2.1.1 BTI 7060

The BTI 7060 is a modular and scalable shelf-level system designed to Telcordia and ETSI standards. A single shelf is 2U-high and accommodates five single-width modules or a combination of single- and double-width modules, as well as one double-width, double-height module. The shelf's compact physical size requires minimal rack mounting space.

Figure 2-1 BTI 7060



The shelf can be configured as a main shelf, an expansion shelf, or a passive shelf:

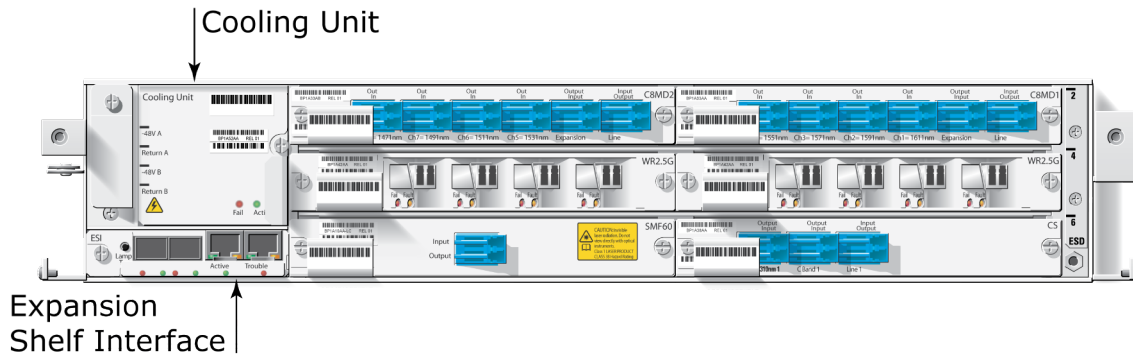
- **Main shelf:** Requires a Main Shelf Interface (MSI) module, a System Control Processor (SCP) module, and a Cooling Unit (CU).
- **Expansion shelf:** Physically the same as the BTI 7060 main shelf. This requires an Expansion Shelf Interface (ESI) module and a Cooling Unit (CU). Refer to [2.1.2, “BTI 7060 expansion shelf”](#) for more information.
- **Passive shelf:** Configured and installed as normal, except no power is required, and the shelf is not equipped with an MSI, cooling unit, or SCP. A filler kit (BT7A55EA - 7060 FILLER PANEL KIT) can be installed, which provides filler panels for the MSI and cooling unit slots in the shelf.

### 2.1.2 BTI 7060 expansion shelf

The BTI 7060 expansion shelf is physically the same as the BTI 7060 main shelf. The same shelf can be configured as either a main shelf or an expansion shelf. Whether to configure the shelf as a main shelf or an expansion shelf is determined automatically by software.

A single shelf is 2RU-high and accommodates six single-width modules or a combination of single- and double-width modules, as well as one double-width, double-height module. The shelf's compact physical size requires minimal rack mounting space.

**Figure 2-2 Expansion Shelf**



Up to three expansion shelves can be connected to a main shelf.

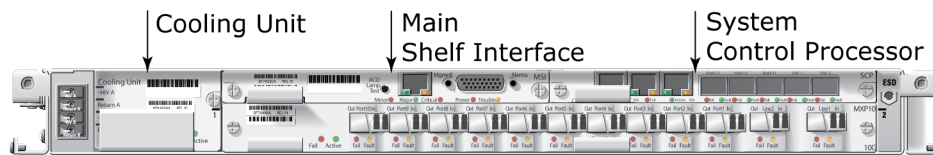
The expansion shelf requires an Expansion Shelf Interface (ESI) module and a Cooling Unit (CU). A System Control Processor (SCP) module is not required because the shelf uses the SCP in the Main Shelf and is part of the NE.

### 2.1.3 BTI 7030 shelf

The BTI 7030 is a modular and scalable shelf-level system designed to Telcordia and ETSI standards. A single shelf is 1U-high and accommodates two single-width modules or one double-width module. The shelf's compact physical size requires minimal rack mounting space.

The BTI 7030 requires a Main Shelf Interface module, a System Control Processor module, and a cooling unit, as shown in the following figure.

**Figure 2-3 BTI 7030 shelf**



### 2.1.4 BTI 7020

The BTI 7020 is a non-powered, auxiliary shelf that can operate with other shelves in the system. The shelf is 1RU-high and accommodates two single-width, non-powered modules, or one double-width, non-powered module.

**Figure 2-4 BTI 7020**

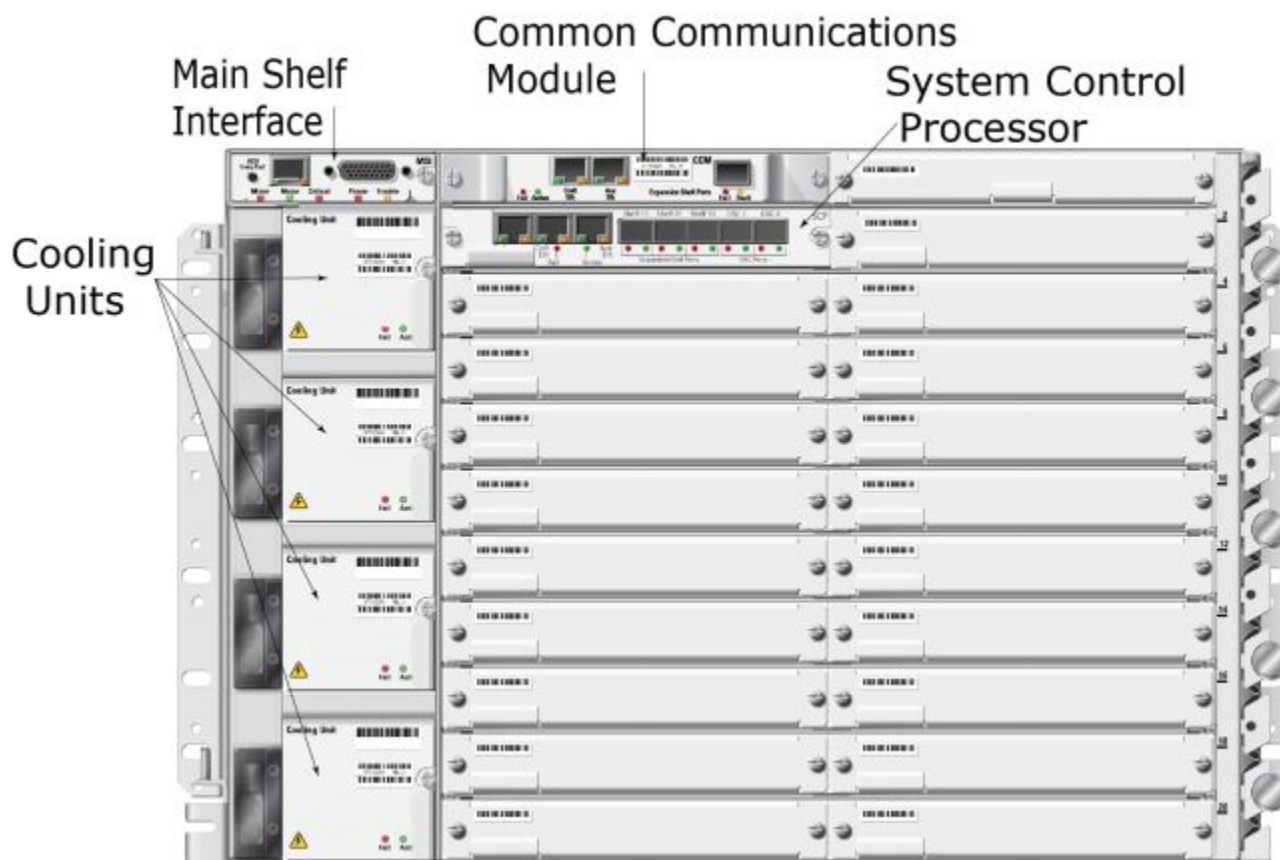


The BTI 7020 does not require any common equipment modules.

## 2.1.5 BTI 7200

The BTI 7200 is a modular and scalable shelf-level system designed to Telcordia and ETSI standards. A single shelf is 7RU-high and accommodates 20 single-width modules or a combination of single- and double-width modules, as well as double-width, double-height modules.

Figure 2-5 BTI 7200 main shelf



Configuring a BTI 7200 as a main shelf requires a Main Shelf Interface (MSI) module, a System Control Processor (SCP) module, a Common Communications Module (CCM), and up to four Cooling Units (CU), depending on how many slots are equipped with service modules.

The BTI 7200 main shelf fully supports one BTI 7200 shelf as an expansion shelf without restrictions, and up to two BTI 7200 shelves as expansion shelves with some restrictions (refer to [2.3.4, “BTI 7200 configuration”](#)). It supports up to 40 Transponders, up to nine Muxponders, up to nine packetVX modules, and up to nine ROADMs-on-a-blade modules. Muxponders can be substituted with amplifiers, and passive modules. The BTI 7200 main shelf does not support the BTI 7060 shelf as an expansion shelf.

For more information about the BTI 7200, contact BTI.



## 2.1.6 BTI 7200 expansion shelf

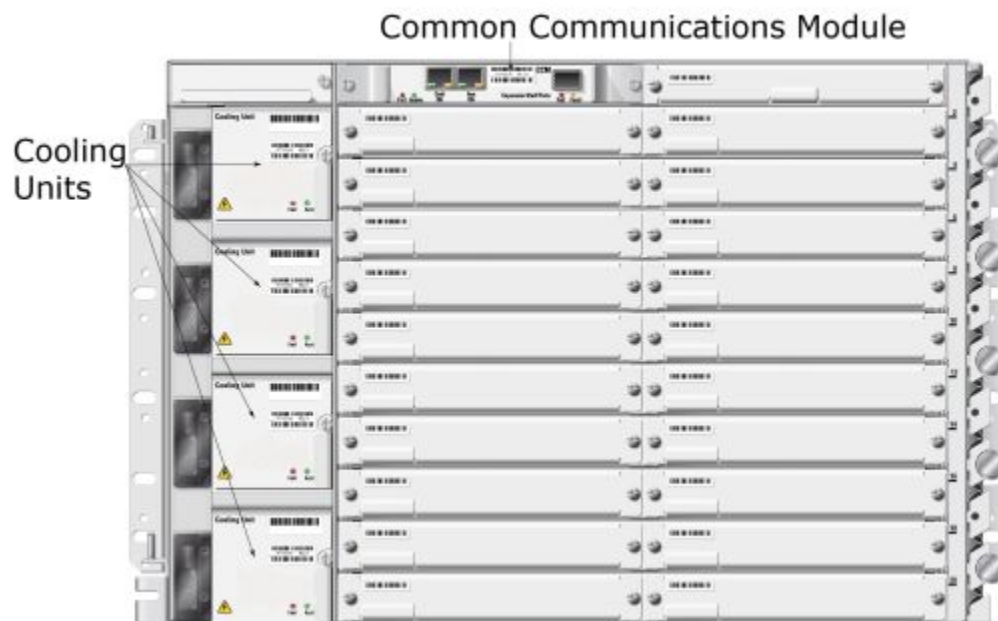
The BTI 7200 expansion shelf is a modular and scalable shelf-level system designed to Telcordia and ETSI standards. A single shelf is 7RU-high and accommodates 20 single-width modules or a combination of single- and double-width modules, as well as double-width, double-height modules. The BTI 7200 expansion shelf can be connected to a BTI 7200 or to a BTI 7060 main shelf.

The BTI 7200 main shelf fully supports one BTI 7200 shelf as an expansion shelf without restrictions, and up to two BTI 7200 shelves as expansion shelves with some restrictions. It does not support the BTI 7060 shelf as an expansion shelf. It supports up to 40 Transponders, up to nine Muxponders, and up to nine packetVX modules. Muxponders can be substituted with amplifiers, and passive modules. For more information, contact BTI.

The BTI 7200 expansion shelf requires a Common Communications Module (CCM), and up to four Cooling Units (CU) depending on how many slots are equipped with service modules. A System Control Processor (SCP) module is not required.

For information on connecting BTI 7200 expansion shelves in a system, see the *BTI 7000 Series Common Equipment Installation Guide*.

**Figure 2-6 BTI 7200 Expansion Shelf**



## 2.1.7 Shelf covers

Shelf covers provide lockable protection for any BTI 7000 Series shelf.

Two sizes of shelf covers are available, designed for either ANSI or ETSI deployment:

- BTI 7020 shelf cover:
  - ANSI version (BT7A5670)

- ETSI version ( BT7A5671)
- BTI 7060 shelf cover:
  - ANSI version (BT7A5070)
  - ETSI version (BT7A5071)
- BTI 7200 shelf covers are not mandatory, and are ordered separately from the shelf. If you order the shelf cover and the shelf under the same purchase order, the shelf cover is installed onto the shelf before the shelf is shipped. If you order the shelf cover under a different purchase order than the shelf, the cover and its associated mounting hardware is shipped separately and must be installed by the customer.

There are two versions of the BTI 7200 shelf cover:

- ANSI - BT7A5180
- ETSI - BT7A5181

BTI 7200 main shelf covers allow you to view the shelf alarm, power, and fault indicator LEDs from the MSI when the cover is closed. LED indicators are located in the upper left hand corner of the shelf cover. LED indicators are not available on the expansion shelves.

## 2.1.8 Fiber and cable routing requirements

The BTI 7000 Series is designed to keep fibers and cables from overlapping. Handles on individual modules enable easy module insertion and removal and also provide fiber guidance.

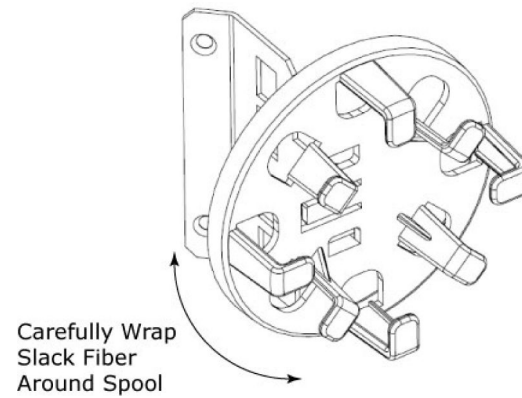
### 2.1.8.1 Fiber management spool for BTI 7060

The fiber management spool is an optional device that stores fiber slack for 2.0 mm fiber patch cables. It does not have any operational impact if it is not installed.

<b>Note</b>	The fiber management spool is not intended to be used for storing off bay fiber slack due to the spool's limited storage capability. Fiber slack storage for off bay fiber is solved by using a recommended fiber management tray that can be located at the top of the frame.
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<b>Note</b>	Due to space constraints with ETSI racks, the fiber management spool can be used only on shelves installed in ANSI racks.
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### Fiber spool for the BTI 7060



**Note** The fiber management spool is available only with the ANSI cover and does not fit in ETSI or 19-inch network racks. It is not sold separately.

## 2.2 Common equipment

This section provides information about common equipment used in the BTI 7000 Series.

**Table 2-2 Common Equipment**

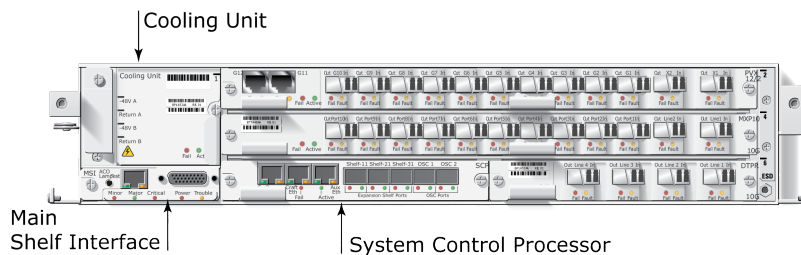
Module	PEC	System software introduced
BTI 7060 Cooling Unit	BT7A52DA	7.1.0
	BT7A52EA	8.1
BTI 7060 Main Shelf Interface	BT7A53BA	7.1.0
BTI 7060 Main Shelf Interface	BT7A53BB	8.2
BTI 7060 Expansion Shelf Interface	BT7A54BA	7.1.0
BTI 7060 System Control Processor (Common with the BTI 7200 )	BT7A20CA	7.1.0
BTI 7030 Cooling Unit	BT7A57BA	7.1.0
BTI 7030 Main Shelf Interface	BT7A53CA	7.1.0
BTI 7030 Main Shelf Interface	BT7A53CB	8.2
BTI 7030 System Control Processor	BT7A21BA	7.1.0
BTI 7200 Cooling Unit	BT7A52EA	8.1
BTI 7200 MSI	BT7A53EA	8.1
BTI 7200 CCM	BT7A54EA	8.1
Filler module	BP1A55AA	7.1.0

### 2.2.1 Common equipment for the BTI 7060 main shelf

The BTI 7060 main shelf supports both common equipment and optional modules. The common equipment for the main shelf includes:

- BTI 7060 Cooling Unit module
- BTI 7060 Main Shelf Interface module
- BTI 7060 System Control Processor module

**Figure 2-8 Main Shelf Common Equipment**



### Cooling Unit (CU) module

The cooling unit (BT7A52DA, BT7A52EA) consists of two independent, multispeed fans. During startup, the fans are programmed to initialize one after the other. As a result, you will hear the fans come up to speed independently.

The fans draw air from the right-side of the shelf across the modules and exhaust the air to the left rear. The cooling unit has two LEDs - failed and active - to indicate its state.

The BTI 7060 cooling unit supports outside plant operations.

<b>Note</b>	Do not use earlier vintage cooling units (that is, BP1A52AA, BP1A52BA or BP1A52CA) in a BTI 7060.
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Should one fan fail, replace the failed cooling unit in the next available maintenance window.

The cooling unit features a local air temperature monitor that checks the temperature in the cooling unit itself. The fans of the cooling unit run at full speed at approximately 45°C and turn off at approximately 5°C.

Faster fan speeds at higher temperatures generate more noise than slower fan speeds at lower temperatures.

### Main Shelf Interface (MSI) module

The BTI 7060 main shelf supports two types of MSI modules.

MSI module PEC	Description
BT7A53BA	Provides communication and alarm indicators. An IP addressable Ethernet port using an RJ-45 connector provides communication to a management Ethernet LAN. A 26-pin HD-subminiature connector provides alarm indications to the central office or network operations center.
BT7A53BB	Provides the same capabilities as the BT7A53BA . Also supports environmental alarm and condition indicators through six pinouts on the 26-pin HD-subminiature connector.

Both MSI modules have several LEDs to provide a visible indication of alarms. The MSI module has three system alarm indicators - critical (red), major (red) and minor (yellow). The MSI also has two shelf status indicators - trouble (red) and power (green). The MSI module also has an alarm cutoff (ACO)/Lamp Test switch to test the LEDs.

### System Control Processor (SCP) module

The SCP module (BT7A20CA) controls the operation of the BTI 7000 Series. For external communication, the SCP has three RJ-45 connectors - one IP addressable, one RS-232 serial, and one auxiliary, which is reserved for future use. These ports can be directly connected to a craft person's computer. For connectivity to a LAN, the Ethernet port on the MSI module should be used.

The SCP also includes three SFP cages for SFP transceivers that are used for communications with expansion shelves.

For OSC communications, there are two additional SFP cages for SFP transceivers. For details about OSC operation, see the *Management Communications Channel Solutions Guide*.

The SCP supports TL1, SNMP and CLI. The SCP runs a TL1 agent to support management and configuration. TL1 commands can be sent to the SCP using Telnet through the Ethernet interface or using a VT100 terminal emulator through the RS-232 serial interface.

The SCP has two LEDs - fail (red) and active (green) - to indicate its status. Additionally, there are two LEDs per SFP cage to indicate the status of the port - fail (red) and fault (yellow).

### **BTI 7060 with rear access -48V power**

The BTI 7060 with rear access -48V power (BT7A50AR) is a factory installed version of the BTI 7060. This shelf allows users to power their shelf from the rear rather than from the front in 23-inch racks only.

### **Optional BTI 7060 AC power module**

The optional BTI 7060 AC power module (BT7A58AA) permits the operation of the BTI 7060 with either 115V or 230V AC power. The BTI 7060 AC plug-in modules are attached to the rear of the BTI 7060 using the BTI 7060 AC power assembly kit (BT7A50BA).

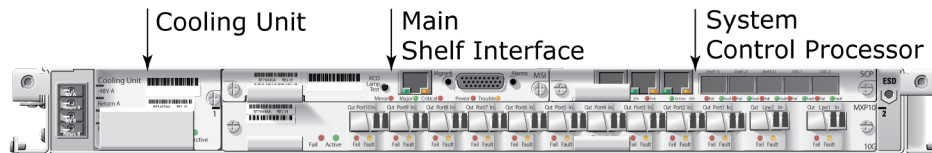
## **2.2.2 Common equipment for the BTI 7030**

The BTI 7030 supports both common equipment and optional modules. The common equipment for the shelf includes:

- BTI 7030 Cooling Unit module
- BTI 7030 Main Shelf Interface module
- BTI 7030 System Control Processor module

As shown in the following figure, the BTI 7030 contains the Cooling Unit, Main Shelf Interface, and the System Control Processor.

**Figure 2-9 BTI 7030 Common Equipment**



### **Cooling Unit (CU) module**

The BTI 7030 contains a cooling unit consisting of independent fans. The fans draw air from the right-side of the shelf across the modules and exhaust the air to the left rear. The cooling unit has two LEDs - failed and active - to indicate its state.

The BTI 7030 cooling unit supports outside plant operations.

This cooling unit features a local air temperature monitor that checks the temperature in the cooling unit itself. The fans of the cooling unit run at full speed at approximately 45°C and turn off at approximately 5°C.

Should one fan fail, replace the failed cooling unit in the next available maintenance window.

### Main Shelf Interface (MSI) module

The function of the MSI module is to provide communication and alarm indicators. An IP addressable Ethernet port using an RJ-45 connector provides communication to a management Ethernet LAN. A 26-pin HD-subminiature connector provides alarm indications to the central office or network operations center.

The MSI has several LEDs to provide a visible indication of alarms. The MSI has three system alarm indicators - critical (red), major (red) and minor (yellow). The MSI also has two shelf status indicators - trouble (red) and power (green). The MSI also has an alarm cutoff (ACO)/Lamp Test switch to test the LEDs.

### Main Shelf Interface (MSI) module

The BTI 7030 shelf supports three types of MSI modules.

MSI Module PEC	Description
BT7A53CA	Provides communication and alarm indicators. An IP addressable Ethernet port using an RJ-45 connector provides communication to a management Ethernet LAN. A 26-pin HD-subminiature connector provides alarm indications to the central office or network operations center.
BT7A53CB	Supports communication and alarm indicators. Also supports environmental alarm and condition indicators through six pinouts on the 26-pin HD-subminiature connector.
BT7A53BB	Provides the same capabilities as the BT7A53CA . Also supports environmental alarm and condition indicators through six pinouts on the 26-pin HD-subminiature connector.

Both MSI modules have several LEDs to provide a visible indication of alarms. The MSI has three system alarm indicators - critical (red), major (red) and minor (yellow). The MSI also has two shelf status indicators - trouble (red) and power (green). The MSI also has an alarm cutoff (ACO)/Lamp Test switch to test the LEDs.

### System Control Processor (SCP) module

The SCP module controls the operation of the BTI 7000 Series. For external communication, the SCP has three RJ-45 connectors - one IP addressable, one RS-232 serial, and one auxiliary, which is reserved for future use. These ports can be directly connected to a craft person's computer. For connectivity to a LAN, the Ethernet port on the MSI module should be used.

The SCP also includes three SFP cages for SFP transceivers that are used for communications with expansion shelves.

For OSC communications, there are two additional SFP cages for SFP transceivers. For details about OSC operation, see the *Management Communications Channel Solutions Guide*.

The SCP supports TL1, SNMP, and CLI. TL1 commands can be sent to the SCP using Telenet through the Ethernet interface or using a VT100 terminal emulator through the RS-232 serial interface.

The SCP has two LEDs - fail (red) and active (green) - to indicate its status. Additionally, there are two LEDs per SFP cage to indicate the status of the port - fail (red) and fault (yellow).

### Optional BTI 7030 AC power module

The optional BTI 7030 AC power module (BT7A58BA) permits the operation of the BTI 7030 with either 115V or 230V (50 Hz or 60 Hz) AC power. The 7030 AC plug-in modules are attached to the rear of the BTI 7030 using the BTI 7030 AC power assembly kit (BT7A56CA).

## 2.2.3 Common equipment for the BTI 7020

As shown in the following figure, the BTI 7020 supports either two single-width passive modules or one double-width passive module. No common equipment or front cover options are required.

**Figure 2-10 BTI 7020**

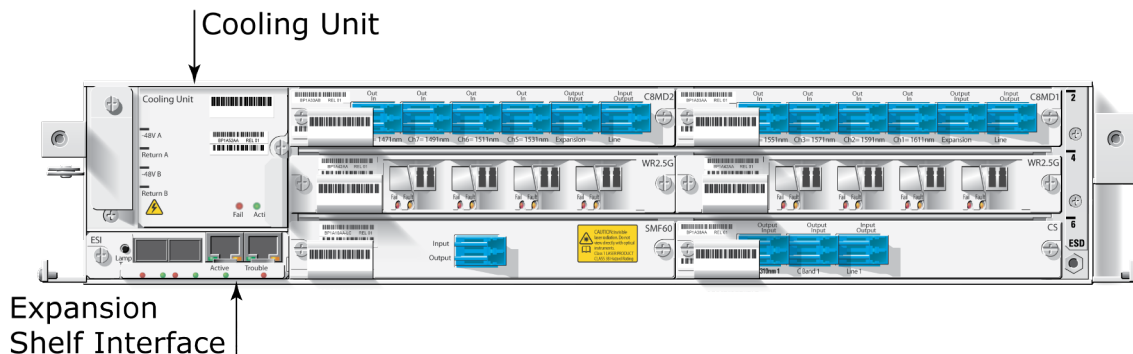


## 2.2.4 Common equipment for the BTI 7060 expansion shelf

The BTI 7060 expansion shelf supports both common equipment and optional modules. The common equipment for the expansion shelf includes:

- BTI 7060 Cooling Unit module
- BTI 7060 Expansion Shelf Interface module

**Figure 2-11 Expansion Shelf Common Equipment**



### Cooling Unit (CU) module

The cooling unit (BT7A52DA, BT7A52EA) consists of two independent, multispeed fans. During startup, the fans are programmed to initialize one after the other. As a result, you will hear the fans come up to speed independently.



The fans draw air from the right-side of the shelf across the modules and exhaust the air to the left rear. The cooling unit has two LEDs - failed and active - to indicate its state.

<b>Note</b>	Do not use earlier model cooling units (that is, BP1A52AA, BP1A52BA or BP1A52CA) in an expansion shelf.
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Should one fan fail, replace the failed cooling unit in the next available maintenance window.

The cooling unit features a local air temperature monitor that checks the temperature in the cooling unit itself. The fans of the cooling unit run at full speed at approximately 45°C and turn off at approximately 5°C.

Faster fan speeds at higher temperatures generate more noise than slower fan speeds at lower temperatures.

### **Expansion Shelf Interface (ESI) module**

The ESI module (BT7A54BA) connects the expansion shelf to the System Control Processor module of the main shelf. The ESI houses SFP-based inter-shelf connectors in addition to RJ-45 Craft Serial and Ethernet ports.

### **BTI 7060 with rear access -48V power**

The BTI 7060 with rear access -48V power (BT7A50AR) is a factory installed version of the BTI 7060. This shelf allows users to power their shelf from the rear rather than from the front in 23-inch racks only.

### **Optional BTI 7060 AC power module**

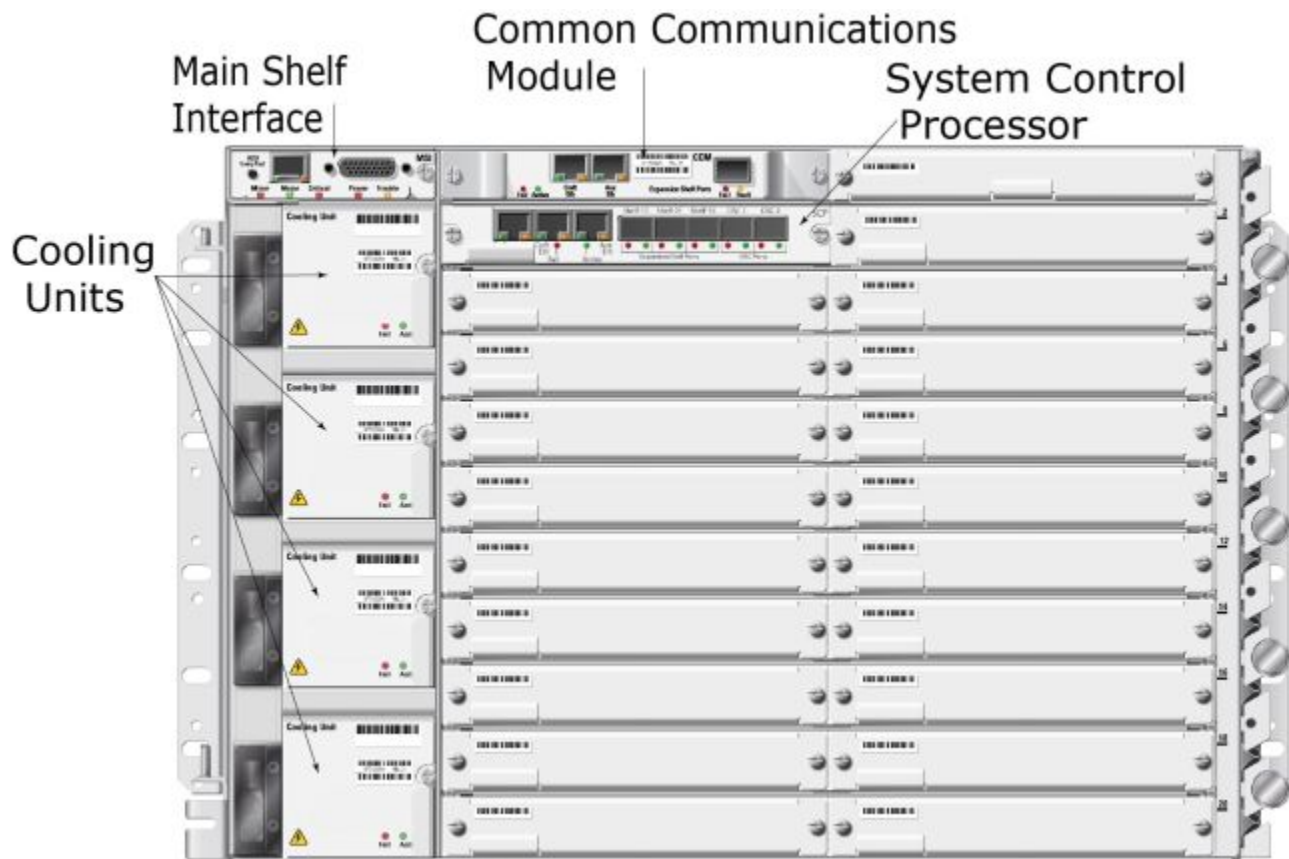
The optional BTI 7060 AC power module (BT7A58AA) supports the operation of the BTI 7060 with 100 to 240 VAC, 1.5 A, 50/60 Hz power. The AC power module is intended for deep cabinet enterprise racks with the capability to house equipment that is 18 inches in depth. To install the BTI 7060 AC power module, use the BTI 7060 AC power assembly kit (BT7A50BA).

## **2.2.5 Common equipment for the BTI 7200 main shelf**

The BTI 7200 main shelf supports both common equipment and optional modules. The common equipment for the main shelf includes:

- Up to four Cooling Units (CU) depending on how many slots are equipped with service modules (common with the BTI 7060)
- Main Shelf Interface module
- Common Communication module
- System Control Processor module (common with the BTI 7060)

## Main Shelf Common Equipment Module Locations



## Cooling Unit (CU) modules

The BTI 7200 requires up to four cooling unit modules depending on how many slots are equipped with service modules. Each cooling unit (BT7A52EA or later) consists of two independent, multispeed fans. During startup, the fans are programmed to initialize one after the other. As a result, you will hear the fans come up to speed independently.

If a cooling unit other than a BT7A52EA is inserted into the BTI 7200, an “Unknown Cooling Unit” alarm is raised.

The fans draw air from the right-side of the shelf across the modules and exhaust the air to the left rear. The cooling unit has two LEDs - failed and active - to indicate its state.

**Note** Do not use earlier vintage cooling units (that is, BP1A52AA, BP1A52BA, BP1A52CA, or BP1A52DA) in a BTI 7200.

Should one fan fail, replace the failed cooling unit in the next available maintenance window.

The cooling unit features a local air temperature monitor that checks the temperature in the cooling unit itself. The fans of the cooling unit run at full speed at approximately 45°C and turn off at approximately 5°C.

Faster fan speeds at higher temperatures generate more acoustic noise than slower fan speeds at lower temperatures.

### **Main Shelf Interface (MSI) module**

The function of the MSI module (BT7A53EA) is to provide communication and alarm indicators. An IP addressable port using an RJ-45 connector provides communication to a management LAN. A 26-pin HD-subminiature connector provides alarm indications to the central office or network operations center.

The MSI also supports environmental alarm and condition indicators through six pinouts on the 26-pin HD-subminiature connector.

The MSI has several LEDs to provide a visible indication of alarms. The MSI has three system alarm indicators - critical (red), major (red) and minor (yellow). The MSI also has two shelf status indicators - trouble (red) and power (green). The MSI also has an alarm cutoff (ACO)/Lamp Test switch to test the LEDs.

### **Common Communication Module (CCM)**

The CCM module (BT7A54EA) manages the system communications to the 20 service slots. The CCM houses one SFP-based intershelf port for connection to the main shelf when the CCM is used in an expansion shelf. The two RJ-45 ports on the CCM are reserved for future use.

### **System Control Processor (SCP) module**

The SCP module (BT7A20CA) controls the operation of the BTI 7000 Series. For external communication, the SCP has three RJ-45 connectors - one IP addressable, one RS-232 serial, and one auxiliary, which is reserved for future use. These ports can be connected, directly, to a craft port on a personal computer or laptop computer. The Ethernet port on the MSI module should be used, for connectivity to a LAN.

The SCP also includes three SFP cages for SFP transceivers that are used for communications with expansion shelves.

For OSC communications, there are two additional SFP cages for SFP transceivers. For details about OSC operation, see the *Management Communications Channel Solutions Guide*.

The SCP supports TL1, SNMP and CLI. The SCP runs a TL1 agent to support management and configuration. TL1 commands can be sent to the SCP using Telnet through the Ethernet interface or using a VT100 terminal emulator through the RS-232 serial interface.

The SCP has two LEDs - fail (red) and active (green) - to indicate its status. Additionally, there are two LEDs per SFP cage to indicate the status of the port - fail (red) and fault (yellow).

### **Optional BTI 7200 with rear access -48V power**

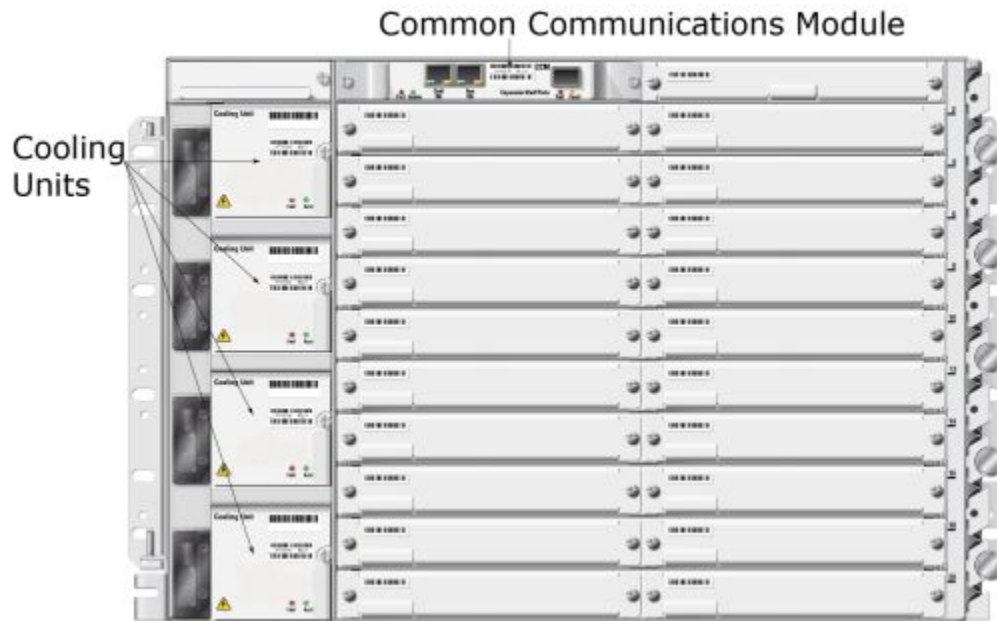
The optional BTI 7200 with rear access -48V power (BT7A51AR) is a factory installed version of the BTI 7200. This shelf allows users to power their shelf from the rear rather than from the front, and fits in all 19, 21, and 23-inch racks except for ETSI 300x600 mm racks.

## **2.2.6 Common equipment for the BTI 7200 expansion shelf**

The BTI 7200 expansion shelf supports both common equipment and optional modules. The common equipment for the expansion shelf includes:

- Up to four Cooling Units (CU) depending on how many slots are equipped with service modules (common with the BTI 7060)
- Common Communication module

**Figure 2-13 Expansion Shelf Common Equipment Module Locations**



### Cooling Unit (CU) modules

The BTI 7200 requires up to four cooling unit modules depending on how many slots are equipped with service modules.. Each cooling unit (BT7A52EA or later) consists of two independent, multispeed fans. During startup, the fans are programmed to initialize one after the other. As a result, you will hear the fans come up to speed independently.

If a cooling unit other than a BT7A52EA is inserted into the BTI 7200, an “Unknown Cooling Unit” alarm is raised.

The fans draw air from the right-side of the shelf across the modules and exhaust the air to the left rear. The cooling unit has two LEDs - failed and active - to indicate its state.

**Note** Do not use earlier model cooling units (that is, BP1A52AA, BP1A52BA, BP1A52CA, or BP1A52DA) in an expansion shelf.

Should one fan fail, replace the failed cooling unit in the next available maintenance window.

The cooling unit features a local air temperature monitor that checks the temperature in the cooling unit itself. The fans of the cooling unit run at full speed at approximately 45°C and turn off at approximately 5°C.

Faster fan speeds at higher temperatures generate more acoustic noise than slower fan speeds at lower temperatures.

### **Common Communication Module (CCM)**

The CCM module (BT7A54EA) manages the system communications to the 20 service slots. The CCM houses one SFP-based intershelf port for connection to the main shelf when the CCM is used in an expansion shelf. The two RJ-45 ports on the CCM are reserved for future use.

### **Optional BTI 7200 with rear access -48V power**

The optional BTI 7200 with rear access -48V power (BT7A51AR) is a factory installed version of the BTI 7200. This shelf allows users to power their shelf from the rear rather than from the front, and fits in all 19, 21, and 23-inch racks except for ETSI 300x600 mm racks.

## **2.2.7 Additional common equipment**

The following additional common equipment is available:

- Filler module (BP1A55AA) for the BTI 7060 and BTI 7030
- Fiber management spool for the BTI 7060 in a 23-inch ANSI rack only
- Filler panels (BT7A55AA) for the BTI 7200 - The BTI 7200 is shipped with filler panels pre-installed in slots 2-20, including empty common equipment slots.

A filler module or a filler panel must be installed in each empty slot in a BTI 7060 or a BTI 7200 or a BTI 7030. The filler ensures adequate air flow to cool the system; otherwise, unfilled slots may cause overheating. An alarm is not generated if a slot remains empty (that is, no module or filler module is plugged in and seated) so it is very important to visually verify that all filler modules and panels are installed before operating the shelf. To provision alarms for missing filler modules for the BTI 7060 and BTI 7030, refer to the *Operations Solutions Guide*.

## 2.3 Shelf configuration

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### 2.3.1 BTI 7060 configuration

The BTI 7060 can be configured to accept double-width modules and double-height modules. To accommodate these modules, the center supports in the shelf must be removed to create double-width slots, and the EMI plates must be removed to create double-height slots.

**Note** For details about removing the center supports, see the *Common Equipment Installation Guide*.

#### Main shelf

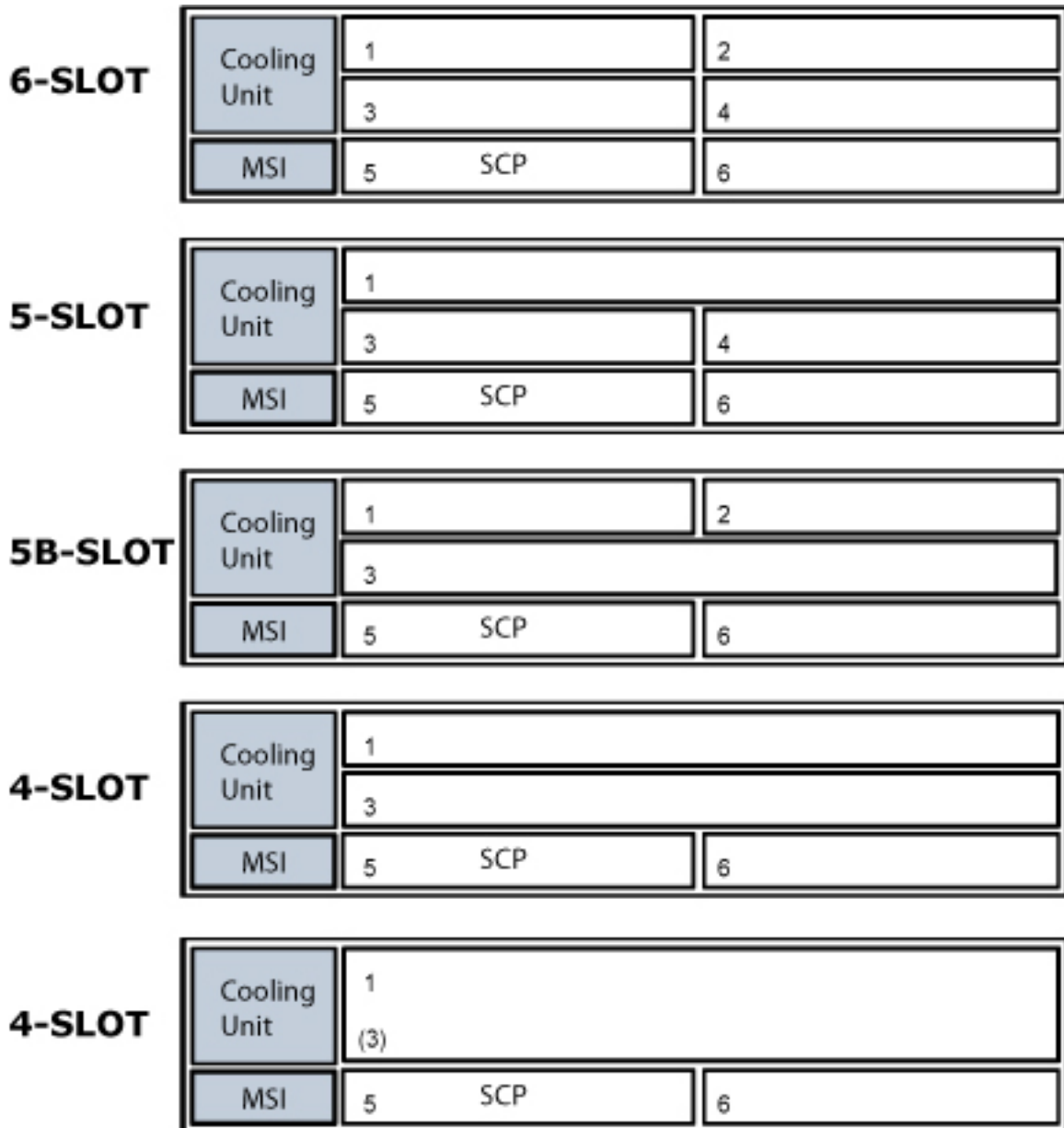
The following table indicates the slot configurations that are available for a main shelf.

**Table 2-3 BTI 7060 Main shelf configuration values**

Variable	Meaning
2-SLOT	2-slot shelf (BTI 7030 only)
4-SLOT	4-slot shelf with the center support for slots 1 and 2 and slots 3 and 4 removed  or  4-slot shelf with the center support for slots 1 and 2 and slots 3 and 4 removed and the EMI plate between slots 1/2 and 3/4 removed to create a double-height slot. In this case, although there are three physical slots (one of which is a double height slot) the system still considers this to be a 4-slot shelf. The system considers that slot 1 is provisioned with the module, and that slot 3 is present but empty.
5-SLOT	5-slot shelf with the center support for slots 1 and 2 removed
5B-SLOT	5-slot shelf with the center support for slots 3 and 4 removed
6-SLOT	6-slot shelf
INVALID	Invalid configuration

The following figure illustrates the BTI 7060 main shelf slot configurations.

Figure 2-14 BTI 7060 – Main Shelf Slot Configurations



### Expansion shelf

In addition to the slot configurations supported by a main shelf, the expansion shelf supports the slot configurations listed in the following table.

Table 2-4 BTI 7060 Expansion shelf configuration values

Variable	Meaning
3-SLOT	3-slot shelf with all of the center supports removed or

**Table 2-4 BTI 7060 Expansion shelf configuration values (Continued)**

Variable	Meaning
	<p>3-slot shelf with all of the center supports removed and the EMI plate between slots 1/2 and 3/4 removed to create a double-height slot. In this case, although there are two physical slots (one of which is a double height slot) the system still considers this to be a 3-slot shelf. The system considers that slot 1 is provisioned with the module, and that slot 3 is present but empty.</p> <p>or</p> <p>3-slot shelf with all of the center supports removed and the EMI plate between slots 3/4 and 5/6 removed to create a double-height slot. In this case, although there are two physical slots (one of which is a double height slot) the system still considers this to be a 3-slot shelf. The system considers that slot 3 is provisioned with the module, and that slot 5 is present but empty.</p>
4-SLOT	<p>4-slot shelf with the center supports for slots 1 and 2, and slots 3 and 4 removed</p> <p>or</p> <p>4-slot shelf with the center support for slots 1 and 2 and slots 3 and 4 removed and the EMI plate between slots 1/2 and 3/4 removed to create a double-height slot. In this case, although there are three physical slots (one of which is a double height slot) the system still considers this to be a 4-slot shelf. The system considers that slot 1 is provisioned with the module, and that slot 3 is present but empty.</p>
4B-SLOT	4-slot shelf with the center supports for slots 1 and 2, and slots 5 and 6 removed
4C-SLOT	<p>4-slot shelf with the center supports for slots 3 and 4, and slots 5 and 6 removed</p> <p>or</p> <p>4-slot shelf with the center support for slots 3 and 4 and slots 5 and 6 removed and the EMI plate between slots 3/4 and 5/6 removed to create a double-height slot. In this case, although there are three physical slots (one of which is a double height slot) the system still considers this to be a 4C-slot shelf. The system considers that slot 3 is provisioned with the module, and that slot 5 is present but empty.</p>
5-SLOT	5-slot shelf with the center support for slots 1 and 2 removed
5B-SLOT	5-slot shelf with the center support for slots 3 and 4 removed
5C-SLOT	5-slot shelf with the center support for slots 5 and 6 removed
6-SLOT	6-slot shelf

The following figures illustrate the BTI 7060 expansion shelf slot configurations



Figure 2-15 BTI 7060 – Expansion Shelf 6- and 5-Slot Configurations

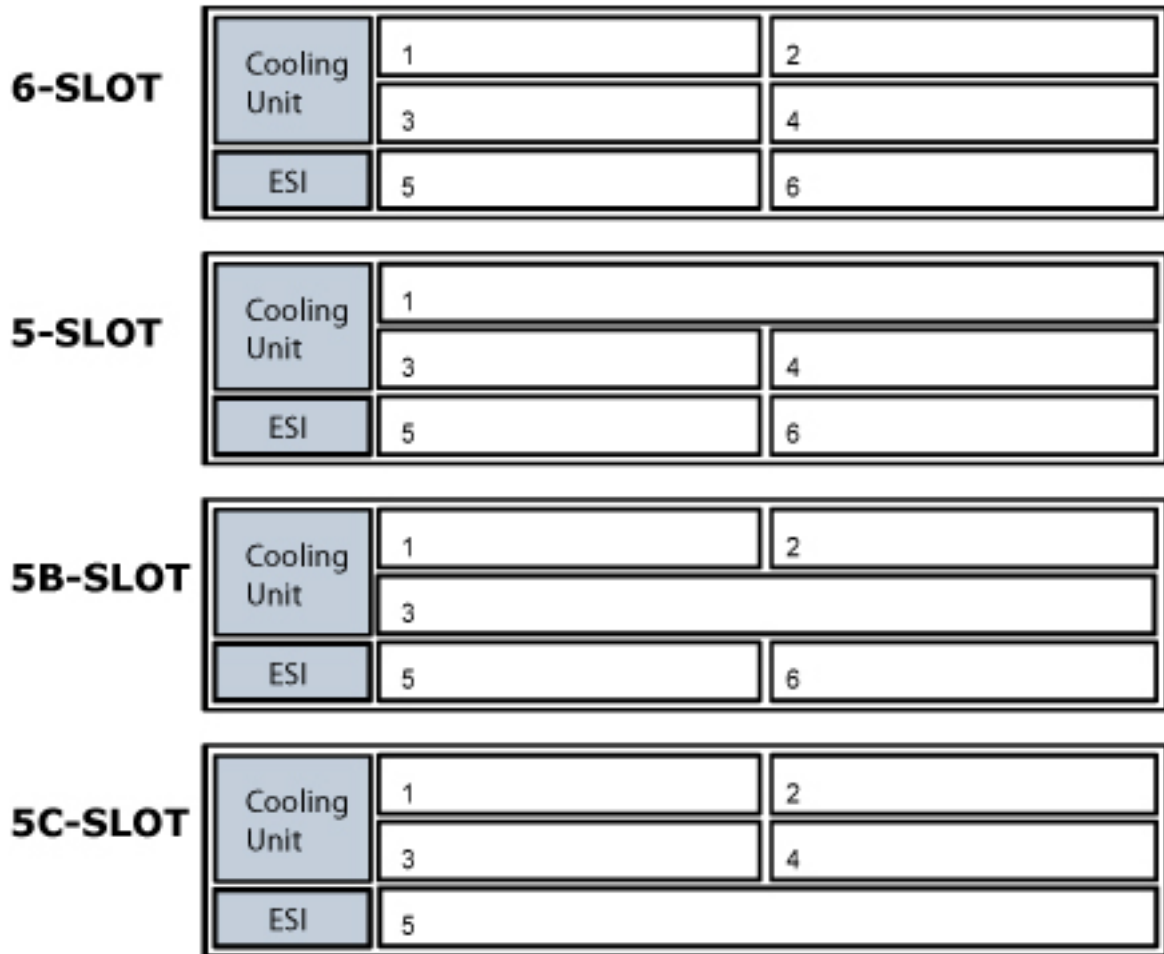


Figure 2-16 BTI 7060 – Expansion Shelf 4-Slot Configurations

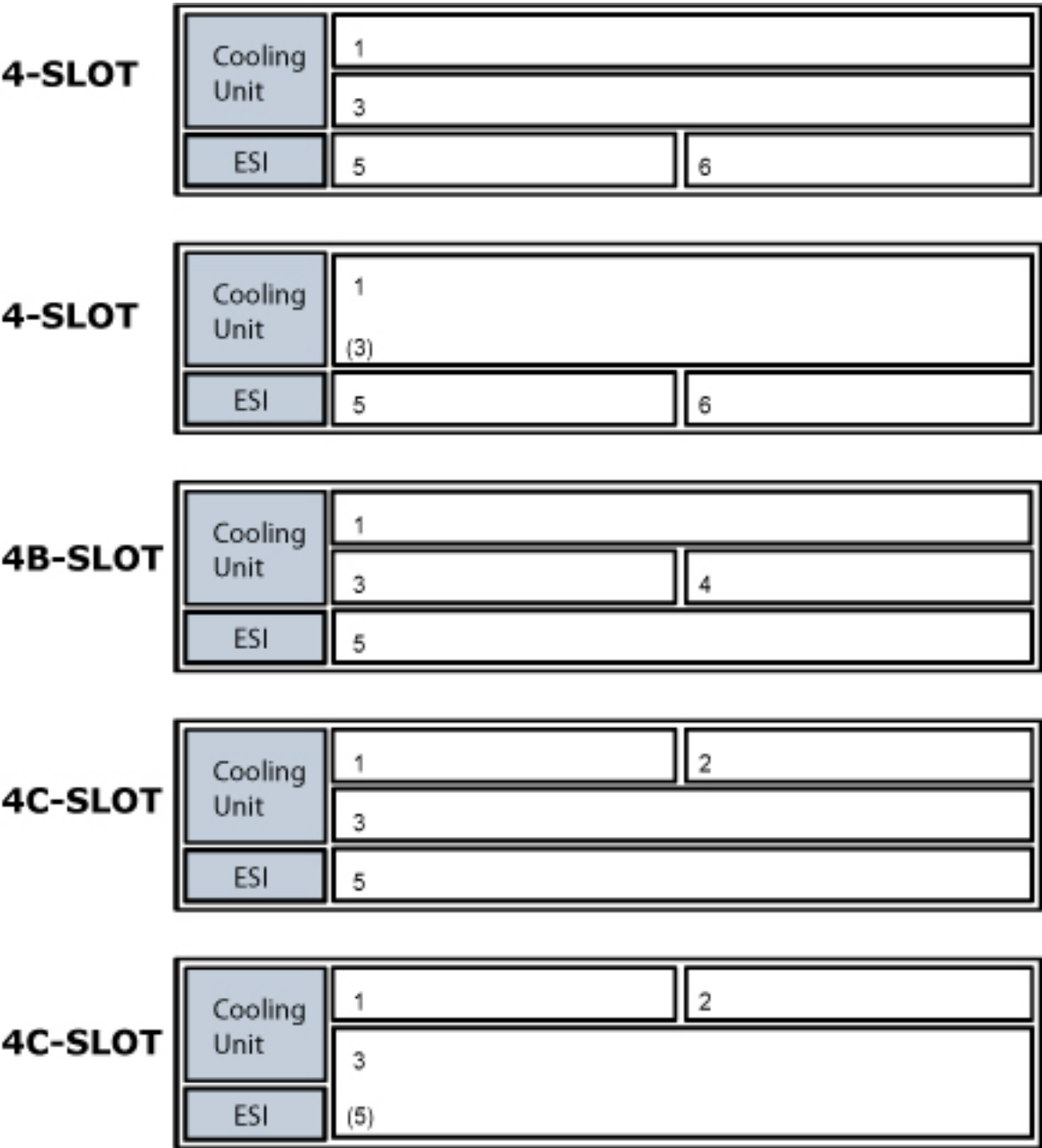
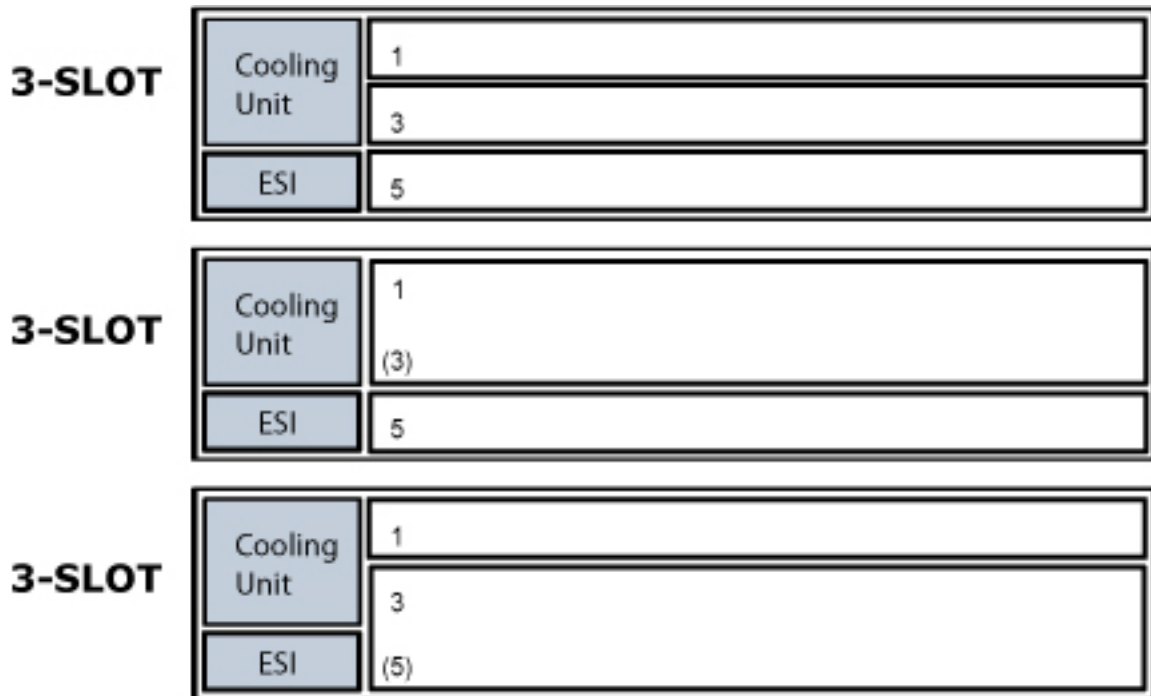


Figure 2-17 BTI 7060 – Expansion Shelf 3-Slot Configurations



### 2.3.2 BTI 7030 slot configuration

The BTI 7030 can be configured to accept a double-width module by removing the center support from the shelf.

**Note** For details about removing the center supports, see *Common Equipment Installation Guide*.

Slot 1 and slot 2 can be combined to create a double-width slot 1. The following figure indicates the various slot configuration that are available for a BTI 7030.

Table 2-5 BTI 7030 Slot Configurations

Slot	4-Slot Configuration	3-Slot Configuration
1	Single-width slot	Double-width slot
2	Single-width slot	

#### BTI 7030 2-Slot Configuration



Figure 2-19 BTI 7030 1-Slot Shelf Configuration



2.3.3 BTI 7020 configuration

The BTI 7020 can be configured to accept a double-width module by removing the center support from the shelf.

**Note** For details about removing the center supports, see the *Common Equipment Installation Guide*.

Slot 1 and slot 2 can be combined to create a double-width slot 1. The following table indicates the slot configurations that are available for a BTI 7020.

Table 2-6 BTI 7020 Slot Configurations

Slot	2-Slot Configuration	1-Slot Configuration
1	Single-width slot	Double-width slot
2	Single-width slot	

2-Slot Configuration for the BTI 7020



1-Slot Configuration for the BTI 7020



2.3.4 BTI 7200 configuration

The BTI 7200 can be configured to accept double-width modules and double-height modules. To accommodate these modules, the center supports in the shelf must be removed to create double-width slots and the EMI plates must be removed to create double-height slots.

**Note** For details about removing the center supports, see the *BTI 7000 Series Common Equipment Installation Guide*.

## BTI 7200 shelf restrictions

The slot restrictions for the BTI 7200 shelf are as follows:

- The Common Communication Module (CCM) slot accepts only a CCM module, or a CCM filler panel.
- The MSI slot accepts only an MSI module or an MSI filler panel.
- Where a BTI 7200 is used as a stand-alone main shelf, slot 1 is dedicated for the system control processor (SCP) module. All of the remaining slots can be provisioned with any provisionable module.
- Where a BTI 7200 is used as a main shelf in a 2-shelf configuration, slot 1 of the main shelf is dedicated for the system control processor (SCP) module. All of the remaining slots in both shelves can be provisioned with any provisionable module.
- Where a BTI 7200 is used as a main shelf in a 3-shelf configuration with restrictions, slot 1 of the main shelf is dedicated for the system control processor (SCP) module. All of the remaining slots in all of the shelves can be provisioned with up to 40 10G Transponders, up to nine 10G Muxponders, up to nine packetVX modules, and up to nine ROADM-on-a-blade modules. Muxponders can be substituted with amplifiers, and passive modules.
- Where a BTI 7060 is used as a main shelf with a BTI 7200 as an expansion shelf, slot 5 of the BTI 7060 main shelf is dedicated for the system control processor (SCP) module. All of the remaining slots in both shelves slots can be provisioned with any provisionable module.
- As seen in the following table, each cooling unit in a BTI 7200 shelf provides cooling for a specific set of slots on the shelf. When a module is inserted into a slot, a cooling unit must be installed to provide cooling for that set of slots. Some slots require the installation of two cooling units. A “Circuit Pack Missing” alarm is raised against the specific cooling unit slot when any of the corresponding slots have a module installed, but the cooling unit for that set of slots is not installed. If there are no modules installed in any of the slots in a specific set, then the associated cooling unit for that set of slots is not required.

**Table 2-7 BTI 7200 cooling unit deployment**

Slot numbers	Cooling unit(s) required
1-4	CU1
5-6	CU1 and CU2
7-10	CU2
11-14	CU3
15-16	CU3 and CU4
17-20	CU4

Figure 2-22 BTI 7200 block diagram (front power version)

MSI		CCM	Reserved for future use
P o w e r	Cooling Unit 1	1 SCP	2
		3	4
		5	6
P o w e r	Cooling Unit 2	7	8
		9	10
P o w e r	Cooling Unit 3	11	12
		13	14
		15	16
P o w e r	Cooling Unit 4	17	18
		19	20

## 2.4 Physical specifications

### 2.4.1 BTI 7060 physical specifications

Table 2-8 BTI 7060 specifications

Parameter	Units
Height x Width x Depth	<b>ANSI</b> 88.9 mm x 439.5 mm x 279.4 mm (without cover) or 304.8 mm (with cover) 3.5 inches x 17.3 inches x 11 inches (without cover) or 12 inches (with cover) <b>ETSI</b> 88.9 mm x 439.5 mm x 279.4 mm (without or without cover)
Weight (empty shelf)	5.9 kg 13 lbs
Weight (fully loaded shelf)	12.6 kg 28 lbs
Mounting options	23-inch or 19-inch frames <b>Note</b> Contact BTI for 19-inch frame engineering rules. ETSI cabinets <b>Note</b> ETSI mounting brackets are shipped with each BTI 7060. 19-inch cabinet
Density	20 shelves per 7-foot rack

### 2.4.2 BTI 7020 and BTI 7030 physical specifications

Table 2-9 Physical attributes of the BTI 7020 and BTI 7030

Parameter	Units
Height x Width x Depth	<b>ANSI</b> 44.4 mm tall x 439.5 mm wide x 279.4 mm deep (without cover) or 304.8 mm deep (with cover) 1.75 in tall x 17.30 in wide x 11.00 in deep (without cover) or 12.00 in deep (with cover) <b>ETSI</b> 44.4 mm tall x 439.5 mm wide x 279.4 mm deep (with or without cover)
Weight (empty shelf)	2.5 kg 5.5 lbs
Weight (fully loaded shelf)	5.9 kg 13 lbs
Mounting options	23-inch or 19-inch frames

**Table 2-9 Physical attributes of the BTI 7020 and BTI 7030 (Continued)**

Parameter	Units
	<b>Note</b> Contact BTI for 19-inch frame engineering rules.  ETSI cabinets
	<b>Note</b> ETSI mounting brackets are shipped with each BTI 7020 and BTI 7030.  19 in cabinet
Density	40 shelves per 7 foot rack

### 2.4.3 BTI 7200 physical specifications

**Table 2-10 Physical attributes of the BTI 7200**

Parameter	Units
Height x Width x Depth	<b>ANSI</b> 310.5 mm tall x 439.5 mm wide x 279.4 mm deep (without cover) or 304.8 mm deep (with cover) 12.22 in tall x 17.30 in wide x 11.00 in deep (without cover) or 12.00 in deep (with cover)  <b>ETSI</b> 310.5 mm tall x 439.5 mm wide x 279.4 mm deep (with or without cover)
Weight (empty shelf)	15.8 kg 35 lbs
Weight (fully loaded shelf)	36 kg 80 lbs
Mounting options	23-inch or 19-inch frames ETSI 465mm and 515mm-center racks  <b>Note</b> ETSI mounting brackets are shipped with each BTI 7200.  19-inch cabinet
Density	6 shelves per 7 foot rack

### 2.4.4 BTI 7060 System Control Processor specifications

**Table 2-11 BTI 7060 SCP (BT7A20CA) specifications**

Parameter	Description
Craft Serial port	DB-9 female, 300 to 115,000 bps
Craft Ethernet port	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps Autosensing



**Table 2-11 BTI 7060 SCP (BT7A20CA) specifications (Continued)**

Parameter	Description
Management protocols	TL1 over Telnet and RS-232 (command line interface and message based) SNMP V1 and SNMP V2c for traps Command Line Interface (CLI)
Intershef communication	Proprietary one-shelf configuration
Alarm reporting	Active and Fail status indicators (LEDs)

## 2.4.5 BTI 7030 System Control Processor specifications

**Table 2-12 BTI 7030 SCP (BT7A21BA) specifications**

System Control Processor (SCP)	
Craft Serial port	DB-9 female, 300 to 115,000 bps
Craft Ethernet port	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps Autosensing
Management protocols	TL1 over Telnet and RS-232 (command line interface and message based) SNMP V1 and SNMP V2c for traps Command Line Interface (CLI)
Alarm reporting	Active and Fail status indicators (LEDs)

## 2.4.6 BTI 7060 Main Shelf Interface specifications

**Table 2-13 BTI 7060 MSI BT7A53BA specifications**

Parameter	Description
Connector	26-pin High-Density (HD) subminiature Office Alarms Connector (HD DB-15 female)
Contact closure	Form C relays for: Critical, Major, Minor audible alarms Critical, Major, Minor visual alarms
Environmental inputs	2 inputs for contract closure detection
External control	1 Form A relay
Relay contacts	60V, 1 Amp
Remote control alarm cutoff	Contact closure
Management LAN Interface	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps Autosensing
Alarm reporting	Critical/Major/Minor alarms (contact closures and LEDs), Shelf trouble indicator (LED) Shelf power indicator (LED)

**Table 2-13 BTI 7060 MSI BT7A53BA specifications**

Parameter	Description
	Lamp test and alarm cutoff (ACO) switch

**Note**

**Table 2-14 BTI 7200 MSI BT7A53EA specifications**

Parameter	Description
Connector	26-pin High-Density (HD) subminiature Office Alarms Connector (HD DB-15 female)
Contact closure	Form C relays for: Critical, Major, Minor audible alarms Critical, Major, Minor visual alarms
Environmental inputs	6 inputs for contract closure detection
External control	1 Form A relay
Relay contacts	60V, 1 Amp
Remote control alarm cutoff	Contact closure
Management LAN Interface	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps Autosensing
Alarm reporting	Critical/Major/Minor alarms (contact closures and LEDs), Shelf trouble indicator (LED) Shelf power indicator (LED) Lamp test and alarm cutoff (ACO) switch

## 2.4.7 BTI 7200 CCM specifications

**Table 2-15 BTI 7200 CCM BT7A54EA specifications**

Parameter	Description
Management LAN Interface - two ports (reserved for future use)	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps Autosensing
Expansion shelf interface port	SFP-based, 100Base-FX
Alarm reporting	Module fail (LED) Module active (LED) SFP port fail (LED) SFP port fault (LED)

## 2.4.8 BTI 7030 Main Shelf Interface specifications

**Table 2-16 BTI 7030 MSI BT7A53CA specifications**

Parameter	Description
Connector	26-pin High-Density (HD) subminiature Office Alarms Connector (HD DB-15 female)
Contact closure	Form C relays for: Critical, Major, Minor audible alarms Critical, Major, Minor visual alarms
Environmental inputs	2 inputs for contract closure detection
External control	1 Form A relay
Relay contacts	60V, 1 Amp
Remote control alarm cutoff	Contact closure
Management LAN Interface	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps Autosensing
Alarm reporting	Critical/Major/Minor alarms (contact closures and LEDs), Shelf trouble indicator (LED) Shelf power indicator (LED) Lamp test and alarm cutoff (ACO) switch

**Table 2-17 BTI 7030 MSI BT7A53CB specifications**

Parameter	Description
Connector	26-pin High-Density (HD) subminiature Office Alarms Connector (HD DB-15 female)
Contact closure	Form C relays for: Critical, Major, Minor audible alarms Critical, Major, Minor visual alarms
Environmental inputs	Inputs 1 to 6
Relay contacts	60V, 1 Amp
Remote control alarm cutoff	Contact closure
Management LAN Interface	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps Autosensing
Alarm reporting	Critical/Major/Minor alarms (contact closures and LEDs), Shelf trouble indicator (LED) Shelf power indicator (LED) Lamp test and alarm cutoff (ACO) switch

## 2.4.9 BTI 7060 Expansion Shelf Interface specifications

**Table 2-18 ESI (BT7A54BA) specifications**

Parameter	Description
Craft Serial port	RJ-45, 300 to 115,000 bps
Craft Ethernet port	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps Autosensing (not available in this release)
Intershef communication	One SFP-based connector
Alarm reporting	Critical/Major/Minor alarms (contact closures and LEDs), Shelf trouble indicator (LED) Shelf power indicator (LED) Lamp test switch

## 2.5 BTI 7000 Series shelf environmental specifications

Table 2-19 BTI 7000 Series shelf environmental specifications

Parameter	Range
Storage temperature	-40°C to +70°C (-40°F to +158°F)
Temperature for Class 1 and Class 2 equipment	See 2.6, “ <a href="#">Operating temperature ranges for shelves and common equipment</a> ”.
Humidity	Operating: 5% to 90% non-condensing Short-term <sup>1</sup> : 5% to 95% non-condensing <b>Note</b> Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days during a 1-year period. As detailed in GR-63-CORE.
Mechanical, shock, and vibration	Telcordia NEBS Level 3, Earthquake Zone 4, GR-63-CORE, GR-78-CORE
Electromagnetic compatibility/ Radio Frequency Interference	FCC Part 15 Class A, GR-1089-CORE
Safety	IEC/UL/CSA 60950, IEC 60825

## 2.6 Operating temperature ranges for shelves and common equipment

Table 2-20 Operating temperature ranges for shelves and common equipment

Module	0°C to +40°C long term	-5°C to +50°C short term	-20°C to +65°C long term	-40°C to +65°C long term
BTI 7060 Shelf	X	X	X	X
BTI 7060 Shelf with Rear Access -48V	X	X		
BTI 7060 /BTI 7200 System Control Processor	X	X	X	
BTI 7060 Main Shelf Interface	X	X	X	X
BTI 7060 /BTI 7200 Cooling Unit	X	X	X	X
BTI 7060 Expansion Shelf Interface	X	X		
BTI 7060 AC power assembly kit (BT7A50BA)	X	X		
BTI 7060 AC power module (BT7A58AA)	X	X		
2U Cover - ANSI	X	X	X	X
2U Cover - ETSI	X	X	X	X
Filler Module	X	X	X	X
BTI 7030 Shelf	X	X		
BTI 7030 System Control Processor	X	X		
BTI 7030 Main Shelf Interface	X	X		
BTI 7030 Cooling Unit	X	X		
BTI 7030 AC Power Assembly Kit	X	X		
BTI 7030 AC Power Unit	X	X		
1U Cover - ANSI	X	X		
1U Cover - ETSI	X	X		
BTI 7020 Passive Shelf	X	X	X	X
BTI 7200 Shelf	X	X		
BTI 7200 Shelf with Rear Access -48V	X	X		
BTI 7200 Main Shelf Interface	X	X		
BTI 7200 Common Communication Module	X	X		
7U Cover	X	X	X	X

**Note** At -40°C to +65°C operating ranges, startup is at -40°C.

**Note** Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days during a 1-year period (as detailed in GR-63-CORE).

## 2.7 DC power distribution and protection requirements

Verify that the installation site meets the power distribution and protection requirements of the BTI 7000 Series equipment. Power distribution panels are recommended to ensure that there is proper power filtering for battery noise and sufficient circuit breaker or fuse protection for each shelf installed. Additionally, the shelf must be grounded to the frame in which it is mounted.

Determine the length of wire that is required for your site-specific installation.

**Note** All power measurements are taken at the -48 VDC terminal block.

The following table lists the DC power distribution and protection requirements.

**Table 2-21 DC Power Distribution and Power Protection Requirements**

Power Feeds A and B	Nominal Voltage	Input Voltage Tolerance	Copper Wire Gauge	Circuit Breaker/Fuse
BTI 7060	-48 VDC	-44 to -56 VDC	14 AWG	10 A
BTI 7030	-48 VDC	-44 to -56 VDC	14 AWG	5 A
BTI 7200	-48 VDC	-44 to -56 VDC	When using a breaker panel that is mounted locally on the frame with the shelf, use 10-12 AWG hook-up wire with the ring lugs that are provided in the installation kit.  When using a breaker panel that is located remotely from the shelf, use 6 AWG flexible wire with the single-stud copper crimp lugs that are provided in the installation kit.	35 A

**Note** The minimum start-up voltage is -44 VDC.

**Note** If you have a requirement to meet FCC Class B emission requirements, contact BTI.

## 2.8 AC power distribution and protection requirements

To use an AC power source with the BTI 7000 Series equipment, an AC power module is required for the BTI 7060 and the BTI 7030. The power modules, listed in the following table, are available from BTI.

BTI can provide a third-party AC power module for the BTI 7200. Contact your BTI Systems representative for details.

**Note** The BTI 7000 Series AC power modules are not NEBS compliant.

**Table 2-22 AC Power Modules**

Equipment	PEC
BTI 7060 AC Power Module	BT7A58AA
BTI 7060 AC Power Assembly Kit (chassis extension)	BT7A50BA
BTI 7030 AC Power Module	BT7A58BA
BTI 7030 AC Power Assembly Kit (chassis extension)	BT7A56CA

The AC power modules use the IEC C14 type of power receptacle.

**Note** The physical depth of the equipment increases from 12 inches (305 mm) to 18 inches (457 mm) assuming installation on 19-inch (483 mm) mounting centers in a cabinet environment.

Verify that the installation site meets the power distribution and protection requirements of the BTI 7000 Series equipment. Power distribution panels are recommended and sufficient circuit breaker or fuse protection for each shelf installed. Additionally, the shelf must be grounded to the frame in which it is mounted.

Determine the length of wire that is required for your site-specific installation.

**Note** All power measurements are taken at the AC terminal block.

The following table lists the AC power distribution and protection requirements.

**Table 2-23 AC Power Distribution and Power Protection Requirements**

Power Feeds A and B	Nominal Voltage	Input Voltage Tolerance	Copper Wire Gauge	Circuit Breaker/Fuse
BTI 7060	115/230 VAC	85 to 264 VAC at 47 to 63 Hz	14 AWG	10 A
BTI 7030	115/230 VAC	85 to 264 VAC at 47 to 63 Hz	14 AWG	5 A

**Note** For the BTI 7060 and BTI 7030, the minimum start-up voltage is 85 VAC at 63 Hz.



## 3.0 Modules and transceivers

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This section provides an overview of the modules and transceivers that the BTI 7000 Series supports.

- 3.1, “BTI 7000 Series modules”
- 3.2, “Shelf and module compatibility”
- 3.3, “SFP transceivers”
- 3.4, “XFP transceivers”
- 3.5, “Module and transceiver compatibility”
- 3.6, “Power consumption of modules, SFPs and XFPs”

## 3.1 BTI 7000 Series modules

The following tables list the BTI 7000 Series modules by product portfolio. For module specifications, see the chapter in this guide that corresponds to the module's product portfolio. For more detailed information, see the *Solutions Guide* for the portfolio.

**Table 3-1 Optical Amplifiers**

Module	PEC	System Software introduced
DWDM C-Band Pre-Amplifier (OPA)	BP1A01DA	7.1.0
DWDM C-Band Booster Amplifier (OBA)	BP1A02DA	7.1.0
DWDM Optical Line Amplifier (OLA)	BP1A03AA	7.1.0
DWDM Optical Line Amplifier with Mid-Stage Access (OLAM)	BP1A04BA	7.1.0
Single-Channel/Sub-Band Booster Amplifier (SBA)	BP1A05BB	7.1.0
Single-Channel/Sub-Band Pre-Amplifier (SPA)	BP1A05PB	7.1.0
DWDM C-Band Low Gain Amplifier (LGA)	BT7A02AA	12.1
DWDM C-Band Mid Gain Amplifier (MGA)	BT7A03AA	12.1
DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM)	BT7A04AA	12.1

**Table 3-2 Dispersion Compensation modules**

Module	PEC	System software introduced
<b>Dispersion Compensation Modules (DCF-type)</b>		
SMF DCM 20 KM	BP1A10CH-UC	7.1.0
SMF DCM 40 KM	BP1A10CC-SC	7.1.0
SMF DCM 60 KM	BP1A10CA-SC	7.1.0
SMF DCM 80 KM	BP1A10CB-SC	7.1.0
<b>C-Band Dispersion Compensation Modules (FBG-type)</b>		
SMF 100 GHz C-Band DCM 40 KM	BP1A10AA-UC	7.1.0
SMF 100 GHz C-Band DCM 60 KM	BP1A10AB-UC	7.1.0
SMF 100 GHz C-Band DCM 80 KM	BP1A10AC-UC	7.1.0
<b>Dispersion Compensation Modules (Expandable)</b>		
Dispersion Compensation Module - SMF 5 km	BT7A13AA	9.1
Dispersion Compensation Module - SMF 10 km	BT7A12AA	9.1
Dispersion Compensation Module - SMF 15 km	BT7A13BA	9.1
Dispersion Compensation Module - SMF 20 km	BT7A12BA	9.1
Dispersion Compensation Module - SMF 30 km	BT7A12CA	9.1
Dispersion Compensation Module - SMF 40 km	BT7A12DA	9.1

**Table 3-2 Dispersion Compensation modules (Continued)**

<b>Module</b>	<b>PEC</b>	<b>System software introduced</b>
Dispersion Compensation Module - SMF 50 km	BT7A12EA	9.1
Dispersion Compensation Module - SMF 60 km	BT7A12FA	9.1
Dispersion Compensation Module - SMF 70 km	BT7A12GA	9.1
Dispersion Compensation Module - SMF 80 km	BT7A12HA	9.1
Dispersion Compensation Module - SMF 90 km	BT7A12JA	9.1
Dispersion Compensation Module - SMF 100 km	BT7A12KA	9.1

**Table 3-3 Optical Multiplexers**

<b>Modules</b>	<b>PEC</b>	<b>System software introduced</b>
<b>Passive multiplexing modules</b>		
1-Channel DWDM Optical Add/Drop Module	BP1A36AA	7.1.0
Double 1-Channel CWDM OADM/Double OSC Coupler Splitter	BP1A32CA	7.1.0
4-Channel CWDM Mux/Demux, Channel 1 - 4		7.1.0
4-Channel CWDM Mux/Demux, Channel 5 - 8	BP1A33BB	7.1.0
4-Channel CWDM Mux/Demux, Channel 9 - 12	BP1A33BC	7.1.0
4-Channel CWDM Mux/Demux, Channel 13 - 16	BP1A33BD	7.1.0
4-Channel CWDM Mux/Demux, Channel 1 - 4, LC (without inventory)		
4-Channel CWDM Mux/Demux, Channel 5 - 8, LC (without inventory)		
4-Channel CWDM Mux/Demux, Channel 9 - 12, LC (without inventory)		
4-Channel CWDM Mux/Demux, Channel 13 - 16, LC (without inventory)		
32-Channel DWDM Mux/Demux Module 1	BP1A35AA	7.1.0
32-Channel DWDM Mux/Demux Module 2	BP1A35AB	7.1.0
32-Channel DWDM Mux/Demux Module 3	BP1A35AC	7.1.0
32-Channel DWDM Mux/Demux Module 4	BP1A35AD	7.1.0
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 1, Demux Band 2)	BP1A35DA-12	7.1.0
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 2, Demux Band 1)	BP1A35DA-21	7.1.0
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 4, Demux Band 2)	BP1A35DA-42	7.1.0
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 2, Demux Band 4)	BP1A35DA-24	7.1.0
2-Channel DWDM OADM	BP1A36AB	7.1.0

**Table 3-3 Optical Multiplexers (Continued)**

<b>Modules</b>	<b>PEC</b>	<b>System software introduced</b>
4-Channel DWDM OADM	BP1A36AC	7.1.0
4-Channel DWDM OADM, BTI Channels E1, E3, E5, E7	BP1A36BC	7.1.0
<b>Coupler/Splitter modules</b>		
1310 nm and C-Band Coupler/Splitter	BP1A38AA	7.1.0
CWDM + DWDM Splitter Combiner	BP1A30AA	7.1.0
DWDM Bidirectional Coupler/Splitter	BP1A39CA	7.1.0
Single 50/50 Coupler/Splitter	BP1A39DA	7.1.0
<b>Multiplexer/Demultiplexer passive shelves</b>		
40-Channel DWDM Mux/Demux	BT7A37AA	7.1.0
40-Channel DWDM Mux/Demux (ETSI)	BT7A37CA	7.1.0
96-Channel DWDM Mux/Demux	BT8A96MD01-I02	10.3
96-Channel DWDM Mux/Demux (ETSI)	BT8A96MD02-I02	10.3
96-Channel DWDM Mux/Demux (FMD96)	BT8A78MD03	13.2

**Table 3-4 Transponders**

<b>Modules</b>	<b>PEC</b>	<b>System software introduced</b>
<b>Dual 2.5G Multiprotocol Transponders</b>		
2.5G Wavelength Regenerator	BP1A42AA	7.1.0
2.5G Wavelength Manager	BP1A43AA	7.1.0
<b>Dual 4G Multiprotocol Transponders</b>		
Dual 4G Multiprotocol Transponder	BT7A41CA	7.2.0
<b>10G Transponders</b>		
Dual 10G Multiprotocol Transponder	BT7A49AA	7.1.0
	BT7A49AA-I02	10.4.1
Dual 10G Multiprotocol Transponder Lite	BT7A49AC	7.2.0
10G Multiprotocol Transponder	BT7A49AB	7.1.0

**Table 3-5 Muxponders**

<b>Modules</b>	<b>PEC</b>	<b>System software introduced</b>
<b>2-Port GbE Muxponders</b>		
2-Port GbE Muxponder – SONET	BP1A46AA	7.1.0
2-Port GbE Muxponder SDH	BP1A46BA	7.1.0
<b>8-Port Multiprotocol Muxponders</b>		
8-Port Multiprotocol Muxponder – SONET	BT7A47JA	7.2.0

**Table 3-5 Muxponders (Continued)**

<b>Modules</b>	<b>PEC</b>	<b>System software introduced</b>
8-Port Multiprotocol Muxponder – SDH	BT7A47KA	7.2.0
8-Port Multiprotocol Muxponder – SDH CCAT	BT7A47MA	
<b>10-Port Multiprotocol Muxponders</b>		
10-Port Multiprotocol Muxponder – SONET	BT7A48AA	7.1.1
	BT7A48AA-I02	13.1
10-Port Multiprotocol Muxponder – SDH	BT7A48BA	7.1.1
10-Port Multiprotocol Muxponder – SDH CCAT	BT7A48BA-I02	13.1
	BT7A48DA	7.1.1

**Table 3-6 packetVX modules**

<b>Module</b>	<b>PEC</b>	<b>System software introduced</b>
packetVX 12/2	BT7A81AA	7.1.2
packetVX 24/2	BT7A81BA	7.1.2
packetVX 24/4	BT7A81CA	7.1.2
packetVX 80	BT7A81GA	10.2.0

**Table 3-7 ROADM-on-a-Blade modules**

<b>Module</b>	<b>PEC</b>	<b>System software introduced</b>
2D ROADM-on-a-Blade	BT7A07AA	9.1
40-channel 4D ROADM-on-a-Blade	BT7A07BA	10.1
96-channel 4D ROADM-on-a-Blade	BT7A07CA	11.2

## 3.2 Shelf and module compatibility

The following tables identify the BTI 7000 Series modules that are supported on shelves that have been upgraded to the BTI 7000 Series platform and on BTI 7000 Series shelves. For information about upgrading Netstender 2060 shelves to the BTI 7000 Series platform, see the *Upgrade Guide — Release 6.2 to Release 7.1.0*.

**Note** The Netstender 1030 shelf cannot be upgraded to support BTI 7000 Series modules.

**Table 3-8 Common equipment**

Module	PEC	Upgraded 2060 Shelf	BTI 7030	BTI 7060	BTI 7200
2060 Cooling Unit (10,000 rpm)	BP1A52CA	Yes	No	No	No
2060 Main Shelf Interface	BP1A53AA <sup>1</sup> BP1A53BA <sup>1</sup>	Yes	No	No	No
2060 Expansion Shelf Interface	BP1A54AA	Yes	No	No	No
2060 Multiport System Control Processor	BP1A20BA	No	No	No	No
1030 Cooling Unit	BP1A57AA	No	No	No	No
1030 System Control Processor	BP1A21AA	No	No	No	No
BTI 7060 Cooling Unit	BT7A52DA	No	No	Yes	No
BTI 7060/BTI 7200 Cooling Unit	BT7A52EA	No	No	Yes	Yes
BTI 7060 Main Shelf Interface	BT7A53BA <sup>1</sup> BT7A53BB	No	No	Yes	No
BTI 7060 Expansion Shelf Interface	BT7A54BA	No	No	Yes	No
BTI 7060/BTI 7200 System Control Processor	BT7A20CA	Yes	No	Yes	Yes
BTI 7030 Cooling Unit	BT7A57BA	No	Yes	No	No
BTI 7030 Main Shelf Interface	BT7A53CA <sup>1</sup> BT7A53CB <sup>1</sup>	No	Yes	No	No

**Table 3-8 Common equipment (Continued)**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
BTI 7030 System Control Processor	BT7A21BA	No	Yes	No	No
BTI 7200 ANSI	BT7A51AA	No	No	No	Yes
BTI 7200 ETSI	BT7A51AB	No	No	No	Yes
BTI 7200 with rear access -48V	BT7A51AR	No	No	No	Yes
BTI 7200 Main Shelf Interface (MSI)	BT7A53EA	No	No	No	Yes
BTI 7200 Common Communication Module (CCM)	BT7A54EA	No	No	No	Yes

<sup>1</sup>This module is not field upgradable.

**Table 3-9 Optical Amplifier modules**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
DWDM C-Band Pre- Amplifier	BP1A01DA-UC	Yes	Yes	Yes	Yes
DWDM C-Band Booster Amplifier	BP1A02DA-UC	Yes	Yes	Yes	Yes
Optical Line Amplifier	BP1A03AA-SC	Yes	Yes	Yes	Yes
Optical Line Amplifier with mid-stage access	BP1A04BA-SC	Yes	Yes	Yes	Yes
Single Channel and Sub-band Booster Amplifier	BP1A05BB-UC	Yes	Yes	Yes	Yes
Single Channel and Sub-band Pre- Amplifier	BP1A05PB-UC	Yes	Yes	Yes	Yes
DWDM C-Band Low Gain Amplifier (LGA)	BT7A02AA-LC	No	No	Yes	Yes
DWDM C-Band Mid Gain Amplifier (MGA)	BT7A03AA-LC	No	No	Yes	Yes
DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM)	BT7A04AA-LC	No	No	Yes	Yes

**Table 3-10 Dispersion Compensation modules**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
SMF Dispersion Compensation Module 20km	BP1A10CH-UC	Yes	Yes	Yes	Yes
SMF Dispersion Compensation Module 40km	BP1A10CC-SC	Yes	Yes	Yes	Yes
SMF Dispersion Compensation Module 60km	BP1A10CA-SC	Yes	Yes	Yes	Yes
SMF Dispersion Compensation Module 80km	BP1A10CB-SC	Yes	Yes	Yes	Yes
SMF 100 GHz C-Band DCM 40km	BP1A10AA-UC	Yes	Yes	Yes	Yes
SMF 100 GHz C-Band DCM 60km	BP1A10AB-UC	Yes	Yes	Yes	Yes
SMF 100 GHz C-Band DCM 80km	BP1A10AC-UC	Yes	Yes	Yes	Yes

**Table 3-11 Optical Multiplexing modules**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
4-Channel CWDM Mux/Demux, Channel 1 - 4	BP1A33BA	Yes	Yes	Yes	Yes
4-Channel CWDM Mux/Demux, Channel 5 - 8	BP1A33BB	Yes	Yes	Yes	Yes
4-Channel CWDM Mux/Demux, Channel 9 - 12	BP1A33BC	Yes	Yes	Yes	Yes
4-Channel CWDM Mux/Demux, Channel 13- 16	BP1A33BD	Yes	Yes	Yes	Yes
Double 1-Channel OADM	BP1A32CA	Yes	Yes	Yes	Yes
32-Channel DWDM Mux/Demux Module 1	BP1A35AA	Yes	Yes	Yes	Yes
32-Channel DWDM Mux/Demux Module 2	BP1A35AB	Yes	Yes	Yes	Yes



**Table 3-11 Optical Multiplexing modules (Continued)**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
32-Channel DWDM Mux/Demux Module 3	BP1A35AC	Yes	Yes	Yes	Yes
32-Channel DWDM Mux/Demux Module 4	BP1A35AD	Yes	Yes	Yes	Yes
32-Channel DWDM Bidirectional Mux/ Demux <sup>1</sup>	BP1A35DA-24 BP1A35DA-42)	No	No	No	No
32-Channel DWDM Bidirectional Mux/ Demux <sup>2</sup>	BP1A35DA-12 BP1A35DA-21	No	No	No	No
2-Channel DWDM OADM	BP1A36AB	Yes	Yes	Yes	Yes
4-Channel DWDM OADM	BP1A36AC	Yes	Yes	Yes	Yes
4-Channel DWDM OADM, BTI Channels E1, E3, E5, E7	BP1A36BC	Yes	Yes	Yes	Yes
CWDM + DWDM Splitter Combiner	BP1A30AA	Yes	Yes	Yes	Yes
1310nm and C-Band Coupler/Splitter	BP1A38AA	Yes	Yes	Yes	Yes
DWDM Bidirectional Coupler/Splitter	BP1A39CA	Yes	Yes	Yes	Yes
Single 50/50 Coupler/ Splitter	BP1A39DA	Yes	Yes	Yes	Yes

<sup>1</sup>Supported on BTI 7020 only.<sup>2</sup>Supported on BTI 7020 only.**Table 3-12 Transponder modules**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
2.5G Wavelength Regenerator	BP1A42AA	Yes	Yes	Yes	Yes
2.5G Wavelength Manager	BP1A43AA	Yes	Yes	Yes	Yes
Dual 4G Multiprotocol Transponder	BT7A41CA	Yes	Yes	Yes	Yes

**Table 3-12 Transponder modules (Continued)**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
Dual 10G Multiprotocol Transponder	BT7A49AA	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
	BT7A49AA-I02	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Dual 10G Multiprotocol Transponder Lite	BT7A49AC	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
10G Multiprotocol Transponder	BT7A49AB	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>

**Table 3-13 Muxponder modules**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
2-Port GbE Muxponder (OC-48 with protection)	BP1A46AA	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
2-Port GbE Muxponder (STM-16 with protection)	BP1A46BA	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
8-Port Multiprotocol Muxponder – SONET	BT7A47JA	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
8-Port Multiprotocol Muxponder – SDH	BT7A47KA	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
8-Port Multiprotocol Muxponder – SDH	BT7A47MA	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
10-port 10G Multiprotocol Muxponder – SONET	BT7A48AA	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
	BT7A48AA-I02	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
10-port 10G Multiprotocol Muxponder – SDH	BT7A48BA	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
	BT7A48BA-I02	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
10-port 10G Multiprotocol Muxponder – SDH CCAT	BT7A48DA	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>

**Table 3-14 packetVX modules**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
packetVX Integrated Services Module 12/2	BT7A81AA	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
packetVX Integrated Services Module 24/2	BT7A81BA	<b>No</b>	<b>No</b>	<b>Yes</b>	<b>Yes</b>

**Table 3-14 packetVX modules (Continued)**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
packetVX Integrated Services Module 24/4	BT7A81CA	No	No	Yes	Yes
packetVX Integrated Services Module 80	BT7A81GA	No	No	Yes	Yes

**Table 3-15 Dynamic Optical Layer modules**

<b>Module</b>	<b>PEC</b>	<b>Upgraded 2060 Shelf</b>	<b>BTI 7030</b>	<b>BTI 7060</b>	<b>BTI 7200</b>
DWDM Line Amplifier (DLA2)	BT7A06CA	No	Yes	Yes	Yes
2DROADM-on-a-blade (ROB2)	BT7A07AA	No	No	Yes	Yes
40-channel 4D ROADM-on-a-blade (ROB4)	BT7A07BA	No	No	Yes	Yes
96-channel 4D ROADM-on-a-blade (ROB4)	BT7A07CA	No	No	Yes	Yes

### 3.3 SFP transceivers

The following table lists the SFP transceivers available from BTI. For specifications information, see [11.4, “SFP specifications”](#) and [12.1, “Optical Supervisory Channel integrated on the System Control Processor”](#).

**Table 3-16 SFP portfolio**

SFP Type	SFP	PEC
<b>850 nm SFPs</b>	2.5G 850 nm SX	BP3AD1SS
	4 Gigabyte Quad-Rate 850 nm	BP3AD2SS
<b>1310 nm SFPs</b>	2.5G 1310 nm SR	BP3AM1MS
	2.5G 1310 nm IR	BP3AM1MI
	4 Gigabyte Quad-Rate 1310 nm	BP3AD2MS
<b>Bidirectional SFPs</b>	1310 TX/1550nm RX	BP3AM5MB
	1550 TX/1310nm RX	BP3AM5LB
	100BX, 1310nm TX/1490nm RX GE, SR	BP3AM5PB
	100BX, 1490nm TX/1310nm RX GE, SR	BP3AM5QB
	100BX, 1310nm TX/1490nm RX GE, IR	BP3AM5PI
	100BX, 1490nm TX/1310nm RX GE, IR	BP3AM5QI
<b>CWDM SFPs</b>	2.5G CWDM LR	BP3AM1CL
	4G CWDM	BP3AM2CL
<b>DWDM SFPs</b>	2.5G Multirate DWDM ER	BP3AM1DE
	4G DWDM	BP3AM2DL
<b>Copper SFPs</b>	10/100/1000BT Copper	BP3AD3ES
	1000BT Copper	BP3AE2ES
<b>SFPs for OSC or multishelf use</b>	1510 XR (for OSC)	BP3AE1CX
	CWDM ER (for OSC)	BP3AE1CE
	Multimode 1310 SR (for multishelf use)	BP3AE1MM

## 3.4 XFP transceivers

The following table lists the XFP transceivers available from BTI. For specifications information, see [11.5, “XFP specifications”](#).

**Table 3-17 XFP portfolio**

XFP	PEC
850 nm XFP	BP3AM4SS
1310 nm SR XFP	BP3AM4MS
1550 nm IR XFP	BP3AM4LI
CWDM XFP	BP3AM4CL
DWDM XFP	BP3AM4DL
Tunable XFP	BP3AM4TL (manufacture discontinued, use BP3AM4TF instead) BP3AM4TF (50 GHz full-band 96-channel) BP3AM4TB-Bnn (100 GHz sub-band 40-channel) BP3AM4TC-Bnn (50 GHz sub-band 96-channel)
	<b>Note</b> The BP3AM4TC-Bnn is intended for 50 GHz spacing applications only.

### XFP Cold Reboot

packetVX, transponder, and muxponder modules support an XFP cold reboot on only 10G ports. An XFP cold reboot may be performed provided one of the following conditions exist:

- The associated port is manually put out of service (OOS-MA).
- There is no provisioned port against it.

To perform an XFP cold reboot use the **reset** command from Ethernet interface configuration mode.

## 3.5 Module and transceiver compatibility

The following tables provide information about the transceiver types supported on Transponders, Muxponders, and packetVX modules. For a list of BTI-qualified transceivers, see [3.3, “SFP transceivers”](#) and [3.4, “XFP transceivers”](#).

### Module–SFP compatibility

Module	Supported SFP type
<b>Transponders</b>	
Dual 1G Multiprotocol Transponders, Dual 2.5G Multiprotocol Transponders, Dual 4G Multiprotocol Transponder	All 850nm All 1310nm All Birdirectional All CWDM All DWDM 1000BTCopper <b>Note</b> 1000BT Copper SFP not supported on 1G Wavelength Translator and 2.5G Wavelength Manager modules.
<b>Muxponders</b>	
2-Port Gbe Muxponders, 8-Port Multiprotocol Muxponders, 10-Port Multiprotocol Muxponders (Client ports only)	All 850nm All 1310nm All Birdirectional All CWDM All DWDM 1000BTCopper
<b>packetVX</b>	
packetVX 12/2, packetVX 24/2, packetVX 24/4, packetVX 80	2.5G 850nm SX 2.5G 1310nm SR 2.5G 1310nm IR 2.5G CWDM 23 dB 2.5G CWDM LR 2.5G Multirate DWDM ER 10/100/1000BT Copper

### Module–XFP compatibility

Module	Supported XFP type
<b>Transponders</b>	
Dual 10G Multiprotocol Transponder, Dual 10G Multiprotocol Transponder Lite, 10G Multiprotocol Transponder	All 850nm All 1310nm

Module	Supported XFP type
	All CWDM All DWDM Tunable
<b>Muxponders</b>	
10-Port Multiprotocol Muxponders (Line ports only)	All 850nm All 1310nm All CWDM All DWDM Tunable
<b>packetVX</b>	
packetVX 12/2, packet VX 24/2, packetvx 24/4	All 850nm All 1310nm All CWDM All DWDM Tunable

## 3.6 Power consumption of modules, SFPs and XFPs

**Note** For BTI 7060 and BTI 7200 installations, Dispersion Compensation modules, Mux/Demux modules, and OADMs draw power from the Main Shelf Interface. However, these modules are passive and require power only for module identification. These modules do not need to be installed in a powered active shelf. For BTI 7030 shelf installations, Dispersion Compensation Fiber modules, Mux/Demux modules, and OADMs draw power from the System Control Processor.

**Table 3-18 Equipment power consumption**

Equipment	Power Consumption
<b>Common Equipment</b>	
BTI 7060/BTI 7200 Cooling Unit	< 30 W
BTI 7060 Main Shelf Interface	< 2.5 W
BTI 7060 Expansion Shelf Interface	< 5.0 W
BTI 7060 System Control Processor	< 17 W
BTI 7060 AC Power Module	< 40 W
BTI 7030 Cooling Unit	< 20 W
BTI 7030 Main Shelf Interface	< 2.5 W
BTI 7030 System Control Processor	< 17 W
BTI 7030 AC Power Module	< 20 W
BTI 7200 Main Shelf Interface	< 2 W
BTI 7200 Common Communication Module	< 15 W
Filler module	0 W
<b>Amplifier Modules</b>	
Single-Channel/ Sub-Band Booster Amplifier	< 15 W
Single-Channel/ Sub-Band Pre-Amplifier	< 15 W
DWDM C-band Optical Booster Amplifier	< 15 W
DWDM C-band Optical Pre-Amplifier	< 15 W
Optical Line Amplifier	< 15 W
Optical Line Amplifier with Mid-Stage Access (OLAM)	< 15 W
<b>Dispersion Compensation Modules</b>	
Dispersion Compensating Fiber Module - 20 km	< 0.25 W
Dispersion Compensating Fiber Module - 40 km	< 0.25 W
Dispersion Compensating Fiber Module - 60 km	< 0.25 W
Dispersion Compensating Fiber Module - 80 km	< 0.25 W
SMF ITU-T DCM 40 km	< 0.25 W
SMF ITU-T DCM 60 km	< 0.25 W
SMF ITU-T DCM 80 km	< 0.25 W



Table 3-18 Equipment power consumption (Continued)

Equipment	Power Consumption
<b>Transponder Modules</b>	
Dual 2.5G Multiprotocol Transponders	< 20 W
Dual 4G Multiprotocol Transponder	< 32 W
10G Multiprotocol Transponder	< 30 W
Dual 10G Multiprotocol Transponder	< 37 W
Dual 10G Multiprotocol Transponder Lite	< 32 W
<b>Muxponder Modules</b>	
2-Port GE Muxponder - SONET	< 25 W
2-Port GE Muxponder - SDH	< 25 W
8-Port Multiprotocol Muxponder - SONET	< 72 W
8-Port Multiprotocol Muxponder - SDH	< 72 W
10-Port Multiprotocol Muxponder - SONET	< 80 W
10-Port Multiprotocol Muxponder - SDH	< 80 W
<b>Packet Services Modules</b> (without SFPs/XFPs installed)	
packetVX Integrated Packet Services Module 12/2	< 50 W
packetVX Integrated Packet Services Module 24/2	< 65 W
packetVX Integrated Packet Services Module 24/4	< 70 W
packetVX Integrated Packet Services Module 80	< 150 W
<b>Optical Multiplexing Modules</b>	
1-Channel CWDM OADM	< 0.3 W
2-Channel CWDM OADM	< 0.3 W
4-Channel CWDM Mux/Demux, Modules 1 - 4	< 0.3 W
32-Channel DWDM Mux/Demux, Modules 1 - 4	< 0.3 W
1-Channel DWDM OADM	< 0.3 W
2-Channel DWDM OADM	< 0.3 W
4-Channel DWDM OADM	< 0.3 W
1310 nm & C-Band Coupler/Splitter	< 0.3 W
CWDM and DWDM Splitter/Combiner	< 0.3 W
Double Bidirectional Coupler/Splitter	< 0.3 W
<b>Optical Multiplexing Passive Shelves</b>	
40-Channel DWDM Mux/Demux	< 0 W
96-channel DWDM Mux/Demux	< 0 W
<b>DOL Modules</b>	
DWDM Line Amplifier (DLA)	< 35 W
2D ROADM on a Blade (ROB2)	< 53 W
4D ROADM on a Blade (ROB4)	< 53 W
SMF Dispersion Compensation Module 5km, LC	< 0.25 W
SMF Dispersion Compensation Module 10km, LC	< 0.25 W

**Table 3-18 Equipment power consumption (Continued)**

<b>Equipment</b>	<b>Power Consumption</b>
SMF Dispersion Compensation Module 15km, LC	< 0.25 W
SMF Dispersion Compensation Module 20km, LC	< 0.25 W
SMF Dispersion Compensation Module 30km, LC	< 0.25 W
SMF Dispersion Compensation Module 40km, LC	< 0.25 W
SMF Dispersion Compensation Module 50km, LC	< 0.25 W
SMF Dispersion Compensation Module 60km, LC	< 0.25 W
SMF Dispersion Compensation Module 70km , LC	< 0.25 W
SMF Dispersion Compensation Module 80km , LC	< 0.25 W
SMF Dispersion Compensation Module 90km , LC	< 0.25 W
SMF Dispersion Compensation Module 100km , LC	< 0.25 W

**Table 3-19 SFP power consumption**

<b>SFP Type</b>	<b>SFP</b>	<b>Power Consumption</b>
<b>850 nm SFPs</b>	2.5G 850 nm SX	1.0 W
	4 Gigabyte Quad-Rate 850 nm	1.0 W
<b>1310 nm SFPs</b>	2.5G 1310 nm SR	1.0 W
	2.5G 1310 nm IR	1.3 W
	4 Gigabyte Quad-Rate 1310 nm	1.5 W
<b>Bidirectional SFPs</b>	1310nm TX/1550nm RX	1.3 W
	1550nm TX/1310nm RX	1.3 W
	100BX, 1310nm TX/1490nm RX GE, SR	1.3 W
	100BX, 1490nm TX/1310nm RX GE, SR	1.3 W
	100BX, 1310nm TX/1490nm RX GE, IR	1.3 W
	100BX, 1490nm TX/1310nm RX GE, IR	1.3 W
<b>CWDM SFPs</b>	2.5G CWDM LR	1.3 W
	4G CWDM	1.5 W
<b>DWDM SFPs</b>	2.5G Multirate DWDM ER	1.3 W
	4G DWDM	1.5 W
<b>Copper SFPs</b>	10/100/1000BT Copper	1.3 W
	1000BT Copper	1.3 W
<b>SFPs for OSC or multishelf use</b>	1510 XR SFP (for OSC)	1.1 W
	CWDM ER SFP (for OSC)	1.1 W
	Multimode 1310 SR	1.0 W

**Table 3-20 XFP power consumption**

<b>XFP</b>	<b>Power Consumption</b>
850 nm XFP	1.5 W

**Table 3-20 XFP power consumption (Continued)**

<b>XFP</b>	<b>Power Consumption</b>
1310 nm SR XFP	2.5 W
1550 nm IR XFP	3.5 W
CWDM XFP	3.5 W
DWDM XFP	4.0 W
Tunable XFP	4.0 W



## 4.0 Dynamic Optical Layer overview

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The BTI 7000 Series Dynamic Optical Layer (DOL) is an integrated component of the BTI 7000 Series packet optical platform. It is a system-oriented network foundation that combines reconfigurable optical add/drop multiplexing, reach extension, and end-to-end service management capabilities to provide simplified operations and enhanced automation. The modular architecture simplifies the design, installation, operation and optimization of metro service delivery networks.

The DOL consists of 2-and 4-degree ROADM-on-a-blade (ROB) modules for flexible, point-and-click enabled wavelength routing, and DWDM Line Amplifier (DLA) modules for reach extension in an extremely compact form factor. The common control system embedded in ROB and DLA modules enables plug-and-play operation to simplify the planning, deployment, service provisioning, ongoing optimization, and power management of the network. The solution also provides end-to-end channel performance metrics that supports comprehensive service visibility and enables rapid network troubleshooting. These elements are the foundation for packet optical service delivery networks to support up to a full 96 wavelength (960Gbps) system capacity and offer “any-wavelength anywhere” add/drop access, automated network equalization, and per-channel performance monitoring metrics.

The system-oriented nature of the DOL allows communication between modular elements through an integrated Optical Service Channel (OSC). Through the OSC, modular elements share information and automatically measure span loss, adjusts the system gain, and leverage a multi-span feedback loop that enables per-channel pre-emphasis to address wavelength tilt and ripple. The OSC enables turning up of the optical layer without any service wavelengths, and provides accurate span measurement, and robust optical shutdown capabilities.

The DOL dispersion management strategy compensates for chromatic dispersion following each span. Express wavelengths and add wavelengths on a network span are launched with minimal residual dispersion.

## **ROADM-on-a-Blade (ROB)**

ROADM-on-a-Blade (ROB) modular elements provide per-wavelength path switching and power equalization. ROB modules offer access to up to 96 channels on each fiber pair, and services can be provisioned over a network with point-and-click simplicity that reduces operational effort and reduces network operating costs.

The DOL supports the following ROADM-on-a-blade modules:

- 2D ROADM-on-a-blade 40ch: BT7A07AA
- 4D ROADM-on-a-blade 40ch: BT7A07BA
- 4D ROADM-on-a-blade 96ch: BT7A07CA

### **40-channel 2D ROADM-on-a-blade (ROB2) - 100 GHz channel spacing**

The ROB2 is a double-width, single-height module that provides bidirectional DWDM amplification to provide channel-level power control, and supports channel add/drop reconfigurability. It has a single, bidirectional east- or west-facing WDM line port. The client side is equipped with two bidirectional ports: C1 and C2.

The ROB2 can be used in various nodal configurations. It may be deployed at a terminal site, in which the C1 client port is connected to mux/demux equipment for access to individual WDM channels. At a line site, the ROB2 may be combined with other ROB modules to implement a 2-degree reconfigurable optical add/drop multiplexer node (ROADM node).

### **40-channel 4D ROADM-on-a-blade (ROB4) - 100 GHz channel spacing**

The 40-channel ROB4 is a double-width, single-height module that provides four bi-directional client ports. The 40-channel ROB4 can generally be used wherever a ROB2 is used, but its main application is for reconfigurable add/drop nodes where three or four WDM network spans intersect. These configurations are referred to as 3- and 4-degree optical add/drop sites.

Ingress traffic (received on the line port and forwarded through client ports) is split into four equivalent WDM composites for forwarding to each of the client output ports. For each channel in the system, egress traffic is selected from one of four client ports.

The 40-channel ROB4 module can switch up to 40 wavelengths.

### **96-channel 4D ROADM-on-a-blade (ROB4) - 50 GHz channel spacing**

The 96-channel ROB4 is a double-width, single-height module that provides four bi-directional client ports. Its main application is for reconfigurable add/drop nodes where three or four WDM network spans intersect. These configurations are referred to as 3- and 4-degree optical add/drop sites.

Ingress traffic (received on the line port and forwarded through client ports) is split into four equivalent WDM composites for forwarding to each of the client output ports. In the egress direction, the WSS is connected to all four client inputs, for channel selection from one of four sources.

The 96-channel ROB4 operates on 50 GHz wavelength spacing, and is therefore incompatible with existing 100 GHz wavelength spacing equipment (such as the ROB2, the 40-channel ROB4,

the 40-channel Mux/Demux, and the DLA2). The 96-channel ROB4 cannot be used to replace the ROB2 or the 40-channel ROB4 module, and can only work with the 96-channel Mux/Demux. The 96-channel ROB4 module can switch up to 96 wavelengths.

### **DWDM Line Amplifier**

DWDM Line Amplifier (DLA) modular elements are engineered to streamline the design, deployment and operation of the optical layer. The amplifiers are fully plug-and-play, and designed to auto-configure power levels and tilt when powered on. DLA elements integrate a per-direction amplification, dynamic optical layer control system, and management connectivity within a single slot. DLAs continuously monitor the line and adjust power levels as needed and interoperate with ROB elements to ensure end-to-end wavelength power control across the entire network.

DLA elements can only work with 100 GHz channel spacing equipment, and cannot work with the 96-channel ROB4 module.

### **DCMs**

The DOL uses DCMs that are designed specifically for compatibility with DOL configurations. DCMs provide dispersion compensation for standard single mode fiber spans (SMF), and variants are available to provide coverage for different span lengths. All (100km) DCMs include two ports— DCM and Expansion:

- DCM port: Connects to a DLA or ROB module.
- Expansion port: Connects to another DCM module to form a chain of DCM modules.

All DOL DCM modules are a single-width, single-height, and support 100 km.

### **Multiplexers**

The DOL supports the 40-channel Mux/Demux passive shelf, the 96-channel Mux/Demux passive shelf, and the 8-channel Mux/Demux module.

#### **40-channel Mux/Demux - 100 GHz channel spacing**

The 40-channel Mux/Demux module performs channel aggregation at 100 GHz spacing for all wavelengths in the DWDM channel plan onto a single fiber. This module has a single bidirectional line port, an input and output monitor port, and 40 bi-directional channel ports. This module is a standalone, passive, rack-mounted module that does not reside in any BTI 7000 Series shelf, but is installed alongside the system and is connected only by the Line fiber. The module is not equipped with a programmed inventory record (FRU data) and provides no communications interface to the SCP. A 40-channel Mux/Demux module can be provisioned as part of a network element so that the line and channel ports can be represented as part of the DOL.

The 40-channel Mux/Demux module can only be used with the ROB2 or the 40-channel ROB4 module. It cannot be used with the 96-channel ROB4 module.

#### **96-channel Mux/Demux - 50 GHz channel spacing**

The 96-channel Mux/Demux module performs channel aggregation at 50 GHz spacing for all wavelengths in the DWDM channel plan onto a single fiber. This module has a single bidirectional line port, an input and output monitor port, and 96 bi-directional channel ports. This module is a standalone, passive, rack-mounted module that does not reside in any BTI 7000 Series shelf, but is installed alongside the system and is connected only by the Line fiber. The module is not equipped with a programmed inventory record (FRU data) and provides no communications interface to the SCP. A 96-channel Mux/Demux module can be provisioned as part of a network element so that the line and channel ports can be represented as part of the DOL.

The 96-channel Mux/Demux module can be used with the 96-channel ROB4 module. It cannot be used with the ROB2, the 40-channel ROB4 module, or the DLA2. There are different types of the 96-channel Mux/Demux module. See the *BTI 7000 Series Multiplexing Solutions Guide* for more information.

**Note** The 96-channel Mux/Demux is currently not NEBS-3 certified.

### **8-channel Mux/Demux - 100 GHz channel spacing**

The 8-channel Mux/Demux module performs channel aggregation at 100 GHz spacing for all wavelengths in the DWDM channel plan onto a single fiber. Four variants of the 8-channel Mux/Demux modules are supported in DOL configurations. These modules must be installed in active BTI 7000 Series shelves, and are integrated into DOL configurations. For information about these modules, see the *BTI 7000 Series Multiplexing Solutions Guide*.

The 8-channel Mux/Demux module can only be used with the ROB2 or the 40-channel ROB4 module. It cannot be used with the 96-channel ROB4 module.



## 4.1 DOL hardware

This section provides information about the DOL hardware.

### 4.1.1 Supported platforms and modules

The DOL supports the following platforms.

**Table 4-1 DOL supported platforms**

Shelf	PEC	Configuration
BTI 7060	BT7A50AA	Line amplifier node ROADM terminal
BTI 7060 with rear access -48V	BT7A50AR	Line amplifier node ROADM terminal
BTI 7060 Shelf plus BTI 7060 Expansion Or BTI 7060 Shelf plus BTI 7200 Expansion	BT7A50AA plus BT7A54BA Or BT7A50AA plus BT7A51AA	Line amplifier node ROADM node ROADM terminal
BTI 7200	BT7A51AA	ROADM node ROADM terminal Amplifier terminal Line equalizing node
BTI 7200 with rear access -48V	BT7A51AR	ROADM node ROADM terminal Amplifier terminal Line equalizing node
BTI 7200 plus BTI 7200 Expansion	BT7A51AA	ROADM node ROADM terminal Amplifier terminal Line equalizing node

- ROADM terminal and Line equalization node configurations are supported on only the 2D ROADM-on-a-blade
- ROADM degrees can be in the same main or expansion shelf.
- ROADM degrees can be split between the main and expansion shelves.
- Replacing a failed 2D ROADM-on-a-blade with a 40-channel 4D ROADM-on-a-blade (BT7A07BA) is supported in any configuration.
- Replacing a 2D ROADM-on-a-blade or a 40-channel 4D ROADM-on-a-blade (BT7A07BA) with a 96-channel 4D ROADM-on-a-blade (BT7A07CA) is not supported.

The DOL supports the following modules:

**Table 4-2 DOL modules**

Module	PEC	System software introduced
<b>Dispersion Compensation Modules (Expandable)</b>		
Dispersion Compensation Module - SMF 5 km	BT7A13AA	9.1
Dispersion Compensation Module - SMF 10 km	BT7A12AA	9.1
Dispersion Compensation Module - SMF 15 km	BT7A13BA	9.1
Dispersion Compensation Module - SMF 20 km	BT7A12BA	9.1
Dispersion Compensation Module - SMF 30 km	BT7A12CA	9.1
Dispersion Compensation Module - SMF 40 km	BT7A12DA	9.1
Dispersion Compensation Module - SMF 50 km	BT7A12EA	9.1
Dispersion Compensation Module - SMF 60 km	BT7A12FA	9.1
Dispersion Compensation Module - SMF 70 km	BT7A12GA	9.1
Dispersion Compensation Module - SMF 80 km	BT7A12HA	9.1
Dispersion Compensation Module - SMF 90 km	BT7A12JA	9.1
Dispersion Compensation Module - SMF 100 km	BT7A12KA	9.1
<b>DWDM Line Amplifier</b>		
DLA2 (line/pre+booster)	BT7A06CA	9.1
<b>DWDM - ROADM-on-a-Blade</b>		
2D ROADM-on-a-Blade	BT7A07AA	9.1
40-channel 4D ROADM-on-a-Blade	BT7A07BA	10.1
96-channel 4D ROADM-on-a-Blade	BT7A07CA	11.2

## 4.1.2 Hardware specifications

This section describes the specifications for DOL modules. For DCM specifications, see [6.4, “SMF \(Expandable\) Dispersion Compensation Module specifications”](#).

### 4.1.2.1 2D ROADM-on-a-blade optical specifications

**Table 4-3 2D ROADM-on-a-blade**

Parameter	Min	Max	Units
Wavelength	1528.77	1563.05	nm
Number of Channels (100GHz spacing)	-	44	Channels
Supported Span Loss	0	35	dB
Maximum Supported Span Loss with 1 Channel	-	30	dB
Maximum Supported Span Loss with 2 Channels	-	33	dB
Maximum Supported Span Loss with 4 Channels	-	35	dB
Monitor Port Loss	16	18	dB
Per Channel Input Power - C1	-8	1	dBm
Per Channel Input Power - C2	-11	-3	dBm

**Table 4-3 2D ROADM-on-a-blade (Continued)**

Parameter	Min	Max	Units
Power Monitor Accuracy - composite	-	0.6	dB
Power Monitor Accuracy - per channel	-	1	dB
Line Launch Power	0	20	dBm
Module Dimensions	2Wx1H		
Power Consumption	65W		
Environmental	-5 to +50C		
Product Code	BT7A07AA		

#### 4.1.2.2 40-Channel 4D ROADM-on-a-blade optical specifications

**Table 4-4 40-Channel 4D ROADM-on-a-blade**

Parameter	Min	Max	Units
Wavelength <sup>1</sup>	1529.55	1560.61	nm
Number of Channels (100GHz spacing)	-	40 + 4	Channels
Supported Span Loss	0	35	dB
Maximum Supported Span Loss with 1 Channel	-	30	dB
Maximum Supported Span Loss with 2 Channels	-	33	dB
Maximum Supported Span Loss with 4 Channels	-	35	dB
Monitor Port Loss	16	18	dB
Per Channel Input Power - C1	-8	1	dBm
Per Channel Input Power - C2	-11	-3	dBm
Per Channel Input Power - C3	-11	-3	dBm
Per Channel Input Power - C4	-11	-3	dBm
Power Monitor Accuracy - composite	-	0.6	dB
Power Monitor Accuracy - per channel	-	1	dB
Line Launch Power	0	20	dBm
Module Dimensions	2Wx1H		
Power Consumption	65W		
Environmental	-5 to +50C		
Product Code	BT7A07BA		

<sup>1</sup>The range including the C2 channels is 1528.77 nm to 1563.05 nm.

#### 4.1.2.3 96-Channel 4D ROADM-on-a-blade optical specifications

**Table 4-5 96-Channel 4D ROADM-on-a-blade**

Parameter	Min	Max	Units
Wavelength	1528.77	1566.72	nm

**Table 4-5 96-Channel 4D ROADM-on-a-blade (Continued)**

Parameter	Min	Max	Units
Number of Channels (50 GHz spacing)	-	96	Channels
Supported Span Loss	0	31	dB
Maximum Supported Span Loss with 1 Channel	-	26	dB
Maximum Supported Span Loss with 2 Channels	-	29	dB
Maximum Supported Span Loss with 4 Channels	-	31	dB
Monitor Port Loss	16	18	dB
Per Channel Input Power - C1	-8	1	dBm
Per Channel Input Power - C2	-11	-3	dBm
Per Channel Input Power - C3	-11	-3	dBm
Per Channel Input Power - C4	-11	-3	dBm
Power Monitor Accuracy - composite	-	0.6	dB
Power Monitor Accuracy - per channel	-	1	dB
Line Launch Power	-3	20	dBm
Module Dimensions	2Wx1H		
Power Consumption	65W		
Environmental	-5 to +50C		
Product Code	BT7A07CA		

#### 4.1.2.4 DWDM Optical Line Amplifier (DLA) optical specifications

**Table 4-6 DWDM Optical Line Amplifier (DLA) optical specifications**

Parameter	Min	Max	Units
Wavelength	1528.77	1563.05	nm
Supported Span Loss	0	30	dB
Monitor Port Loss	16	18	dB
Power Monitor Accuracy - composite	-	0.6	dB
Line Launch Power	0	20	dBm
Module Dimensions	1Wx1H		
Power Consumption	40W		
Environmental	-5 to +50C		
Product Code	BT7A06CA		

**Note** This module is not compatible with the 96-channel 4D ROADM-on-a-blade or the 96-channel mux/demux modules.

## 5.0 Optical Amplifiers

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This section provides information about the Optical Amplifier modules that the BTI 7000 Series supports.

- 5.1, “Optical Amplifier portfolio”
- 5.2, “Optical Amplifier applications”
- 5.3, “Single-channel/Sub-band amplifier specifications”
- 5.4, “DWDM amplifier specifications”
- 5.5, “ Amplifier PMs”

## 5.1 Optical Amplifier portfolio

This section provides information about the modules in the Optical Amplifier portfolio and covers the following topics:

- [5.1.1, “Optical Amplifier modules”](#)
- [5.1.2, “Optical Amplifier comparison”](#)
- [5.1.3, “Optical Amplifier operating temperature ranges”](#)

### 5.1.1 Optical Amplifier modules

**Table 5-1 Optical Amplifiers**

Module	PEC	System Software introduced
DWDM C-Band Pre-Amplifier (OPA)	BP1A01DA	7.1.0
DWDM C-Band Booster Amplifier (OBA)	BP1A02DA	7.1.0
DWDM Optical Line Amplifier (OLA)	BP1A03AA	7.1.0
DWDM Optical Line Amplifier with Mid-Stage Access (OLAM)	BP1A04BA	7.1.0
Single-Channel/Sub-Band Booster Amplifier (SBA)	BP1A05BB	7.1.0
Single-Channel/Sub-Band Pre-Amplifier (SPA)	BP1A05PB	7.1.0
DWDM C-Band Low Gain Amplifier (LGA)	BT7A02AA	12.1
DWDM C-Band Mid Gain Amplifier (MGA)	BT7A03AA	12.1
DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM)	BT7A04AA	12.1

### 5.1.2 Optical Amplifier comparison

The portfolio of Optical Amplifier modules includes single-channel amplifiers and DWDM amplifiers. For information, see [5.1.1, “Optical Amplifier modules”](#).

#### DWDM C-Band Booster Amplifier (OBA)

The DWDM C-Band Booster Amplifier (OBA) is designed to amplify the output signals at the transmit end of an optical link after the DWDM signals have been multiplexed together. The OBA is typically deployed at the output of a multiplexer at the head of an optical link, but it can be used anywhere in an optical link where the input power to the amplifier is high and the required gain is low.

#### Optical Line Amplifier (OLA)

The Optical Line Amplifier (OLA) is designed to increase the power level of a signal at intermediate sites along an optical link. The OLA has high gain and high output levels. Although this amplifier is intended for applications at line sites, it can be used at terminal and regen sites

where high gain and high output power are required. For more information, see the *Product Guide*.

### **Optical Line Amplifier with Mid-Stage Access (OLAM)**

The Optical Line Amplifier with Mid-Stage Access is designed to increase the power level of a signal at intermediate sites along an optical link. The OLAM also provides two connectors between the first- and second-stage amplifiers so that devices such as Dispersion Compensation modules can be inserted without increasing the span loss.

### **DWDM C-Band Pre-Amplifier (OPA)**

The DWDM C-Band Pre-Amplifier (OPA) is designed to provide high gain and moderate output power for operating conditions typically found at the receiver end of an optical link. The OPA can be used anywhere along an optical link where the input and output power and the gain meet the requirements of the application under consideration.

### **Single Channel/Sub-Band Booster Amplifier (SBA), Single Channel/Sub-Band Pre-Amplifier (SPA), DWDM C-Band Booster Amplifier (OBA), and DWDM C-Band Pre-Amplifier (OPA)**

The Single-Channel/Sub-Band Amplifiers (SBA, SPA) and DWDM C-Band amplifiers (OBA, OPA), combining both built-in power monitoring and the ability to collect PMs for power received and power transmitted, provide non-intrusive power monitoring. The power monitor allows one percent of the signal to be redirected for monitoring purposes. The power monitor ports on these amplifiers can be connected to either a power meter or an Optical Spectrum Analyzer (OSA).

### **Low Gain Amplifier (LGA)**

The Low Gain Amplifier (LGA) is a variable gain amplifier for low gain and high output applications, and includes a monitor port for power monitoring and troubleshooting. The LGA supports the BTI 96-channel plan, and can be used in place of the OBA and SBA amplifiers. This is the highest input power amplifier, and is suitable as a post-amp function.

### **Mid Gain Amplifier (MGA)**

The Mid Gain Amplifier (MGA) is a variable gain amplifier for moderate to high gain and high output applications, and includes a monitor port for power monitoring and troubleshooting. The MGA supports the BTI 96-channel plan, and can be used in place of the SPA, OLA, and OPA amplifiers.

### **Mid Gain Amplifier with Mid-stage access (MGM)**

The Mid Gain Amplifier with Mid-stage access (MGM) is a variable gain amplifier for moderate to high gain and high output applications, and includes mid-stage access for a dispersion compensation module (DCM) and a monitor port for power monitoring and troubleshooting. The MGM supports the BTI 96-channel plan, and can be used in place of the OLAM amplifier.

### Amplifier feature comparison

The following table provides comparison information for each Optical Amplifier module in the portfolio.

**Table 5-2 Amplifier comparison**

Module	Operating Wavelength	Input levels (dBm)	Maximum output (dBm)	Gain (dB)	Power monitor
SBA	Single: 1528–1563nm DWDM: 1546.12–1559.79nm	$-15 \leq P_{in} \leq 9$	18	18	Yes
SPA	Single: 1528–1563nm DWDM: 1546.12–1559.79nm	$-35 \leq P_{in} \leq -10$	5	27	Yes
OBA	DWDM: 1528–1563nm	$-15 \leq P_{in} \leq 10$	20	10	Yes
OLA	DWDM: 1528–1563nm	$-28 \leq P_{in} \leq -5$	16	16 to 26	No
OLAM	DWDM: 1528–1563nm	$-28 \leq P_{in} \leq -5$	18	19 to 29	No
OPA	DWDM: 1528–1563nm	$-35 \leq P_{in} \leq -1$	10	27	Yes
LGA	DWDM: 1528–1567nm	$-21 \leq P_{in} \leq 10$	20	5 to 16	Yes
MGA	DWDM: 1528–1567nm	$-33 \leq P_{in} \leq 0$	16	16 to 26	Yes
MGM	DWDM: 1528–1567nm	$-36 \leq P_{in} \leq -1$	18	19 to 29	Yes

### 5.1.3 Optical Amplifier operating temperature ranges

**Table 5-3 Optical Amplifier module operating temperature ranges**

Module	0°C to +40°C long term	-5°C to +50°C short term
DWDM C-Band Pre-Amplifier (OPA)	X	X
DWDM C-Band Booster Amplifier (OBA)	X	X
DWDM Optical Line Amplifier (OLA)	X	X
DWDM Optical Line Amplifier with Mid-Stage Access (OLAM)	X	X
Single-Channel/Sub-Band Booster Amplifier (SBA)	X	X
Single-Channel/Sub-Band Pre-Amplifier (SPA)	X	X
DWDM C-Band Low Gain Amplifier (LGA)	X	X
DWDM C-Band Mid Gain Amplifier (MGA)	X	X
DWDM C-Band Mid Gain Amplifier with Mid-Stage Access (MGM)	X	X



**Note** Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days during a 1-year period (as detailed in GR-63-CORE).

## 5.2 Optical Amplifier applications

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This section provides information about the applications that Optical Amplifier modules support.

- [5.2.1, “DWDM amplification”](#)
- [5.2.2, “Single-channel and sub-band amplification”](#)
- [5.2.3, “About back reflection”](#)
- [5.2.4, “Nonlinear fiber effects in single-channel amplified systems”](#)

### 5.2.1 DWDM amplification

The DWDM C-Band Optical Booster Amplifier (OBA), DWDM Optical Line Amplifier (OLA), and DWDM C-Band Optical Pre-Amplifier (OPA) can be used to extend the length of DWDM links of up to 80 channels in the wavelength band. The Optical Line Amplifier with Mid-Stage Access (OLAM) allows passive devices, such as Dispersion Compensation modules, to be inserted between the first-and second-stage amplifiers without increasing span loss.

For signals of up to 10 Gbps and typical fiber and dispersion characteristics, the combination of OBA, OLAM, and OPA modules boosts power levels to extend reach up to 350km for a 40-wavelength channel count when combined with Dispersion Compensation modules and Forward Error Correction.

The DWDM C-Band Low Gain Amplifier (LGA) and the DWDM C-Band Mid Gain Amplifier (MGA) support a wide range of line, pre- and post-amp applications, with a gain range extending from a low of 5 dB on the LGA to a high of 29 dB on the MGA, and an input power range from -36 dBm on the MGA to 10 dBm on the LGA. The DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM) allows passive devices, such as Dispersion Compensation modules, to be inserted between the first-and second-stage amplifiers without increasing span loss. The LGA, MGA, and MGM all operate on the full BTI 96-channel wavelength plan.

### 5.2.2 Single-channel and sub-band amplification

The Single-Channel/Sub-Band Booster Amplifier (SBA) and Single-Channel/Sub-Band Pre-Amplifier (SPA) modules provide an affordable alternative to the full C-Band amplifiers for single-channel amplification or low-to-moderate count systems.

SBA and SPA modules are cost optimized for use in single-channel optical links in the wavelength region from 1528nm to 1563nm.

SBAs and SPAs can also be used to extend the length of single 1550nm-channel or DWDM signals from one to 16 wavelengths within the ITU-T C-band between the wavelengths 1546.12nm and 1559.79nm. This corresponds to Band 1 (1554.13nm – 1559.79nm) and Band 2 (1546.12nm – 1551.72nm).

For signals of up to 10 Gbps and typical fiber and dispersion characteristics, the SBA and SPA boost power levels to extend reach up to 160km point-to-point when combined with Dispersion Compensation modules.

### 5.2.3 About back reflection

The Optical Back Reflection High Threshold Safety (OBR-HTS) alarm feature is implemented on amplifiers that are capable of producing output power greater than 10 dBm. The Optical Back Reflection threshold is -4 dBm. For systems using these high-power amplifiers, the Optical Return Loss (ORL) must be higher than 24 dB to prevent shutdown of the amplifier lasers.

### 5.2.4 Nonlinear fiber effects in single-channel amplified systems

In single-channel non-amplified optical systems, the optical power coupled into a fiber is usually too low to induce any nonlinear effects in the fiber. The only impairments that the fiber will introduce are attenuation and dispersion. When amplifiers are introduced into these systems, the launch power can become high enough to trigger undesirable nonlinear effects in the fiber that will further degrade signal integrity. Stimulated Brillouin Scattering (SBS) and Self-Phase Modulation (SPM) are two power-dependent effects that can significantly limit the launch power in a single-channel amplified link and restrict system reach.

#### Stimulated Brillouin Scattering (SBS)

SBS is a scattering process in which a portion of the forward propagating light energy is reflected back, resulting in power loss and increasing noise in the system. In an amplified system, for amplifiers upstream from the fiber, the reflected power can trigger the optical back reflection safety mechanism, resulting in either a reduction of the amplifier's output power or the complete shutdown of the amplifier. Two approaches can be used to manage SBS:

- 1 Limit the signal input power to the fiber to below the power threshold at which the intensity of scattered light started to grow exponentially.
- 2 Increase the power threshold by increasing the laser linewidth since the SBS threshold is directly proportional to the linewidth of the signal.

When a typical communication-grade laser with a linewidth of a few MHz and modulated to transmit data at a rate of 10 Gbps is used, the SBS threshold in NDSF can be as low as 6 dBm. In addition to laser linewidth, the SBS threshold is also proportional to fiber attenuation and the effective area of the fiber. Hence, the threshold is different in different fiber types. More precise values need to be further determined for a given modulated laser linewidth, fiber attenuation, and the effective area of the fiber.

Increasing the laser linewidth of the signal to increase the SBS threshold has the undesirable effect of increasing the dispersion penalty. In order to avoid excessive dispersion penalty, the laser drive current can be modulated with a low-frequency sinusoidal dither. Typical dithering signals have frequencies in the kHz range. The peak-to-peak intensity modulation of the signal is a few percent, and the effective modulated laser linewidth increases from tens of MHz to a few hundred MHz. For external modulated lasers, a dither signal can be applied to the phase modulation input of the external modulator to suppress SBS as well. The SBS threshold increases due to the addition of the dithering signal and can be estimated once the resultant laser linewidth is known.

Contact BTI for more information on SBS effects when designing optical links.

### **Self-Phase Modulation (SPM)**

Self-Phase Modulation (SPM) results from the power dependency of the refractive index of the fiber. It leads to spectral broadening of the optical signal. The frequency chirp induced by SPM further interacts with the dispersion in the fiber, changing the rate at which the pulse broadens. Ignoring dispersion in the fiber, the SPM threshold is a function of the physical property of the fiber, including the nonlinear index, attenuation, and effective area of the fiber.

Unlike SBS, where dithering can be used to increase the threshold, there are no effective ways of managing SPM other than to take these parameters that affect SPM into consideration when designing a system. For a single-channel system with span lengths of about 150 km, the SPM threshold is in the range of 10 dBm for NDSF. This threshold can be used as a guideline only. The system penalty as a result of SPM is impacted by:

- transmitted pulse shape
- bit rate
- exact dispersion characteristics of the fiber, including the effects of dispersion compensation, together with other deviations from assumed fiber parameter values

Contact BTI for more information on SPM effects when designing optical links.

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## 5.3 Single-channel/Sub-band amplifier specifications

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The Single-channel/Sub-band amplifiers do not employ a gain flattening filter. As a result, the gain spectrum has the spectral shape typical of erbium-doped fiber amplifiers and the gain ripple across the C-band is high. Since the gain ripple is low in Band 1 and Band 2, these amplifiers are suitable as banded amplifiers within these two bands. The Single-channel/Sub-band amplifiers are currently not qualified for applications in the two high ripple sub-bands: 1538.19 nm to 1543.73 nm (Band 3) and 1530.33 nm to 1535.82 nm (Band 4). Contact BTI to assess the performance of this amplifier for applications in these two wavelength bands.

While the SBA is intended for applications after the Mux and/or the transmitter, and the SPA is intended for applications before the Demux and/or before the receiver, these amplifiers can be used in any application where the input/output power and gain requirements meet the specifications of the amplifier. In order to determine which amplifier is most appropriate for the application in question, the overall gain, power and noise performance requirements must be evaluated, as well as other operational considerations of the optical link under study.

For amplified single-channel OC-3 applications, contact BTI for more information.

### Notes on optical specifications for single-channel amplifiers

- 1 When the input power falls below the minimum specified level, the signal is still amplified, but the accuracy of the input power, gain, and output power will not meet the specifications provided.
- 2 When the input power exceeds the maximum specified level, the signal is still amplified, but the accuracy of the input power, gain, and output power will not meet the specifications provided.
- 3 All specifications quoted are for worst-case temperature and aging scenarios.

This section covers the following topics:

- [5.3.1, “Single-channel/Sub-band Booster Amplifier \(SBA\)”](#)
- [5.3.2, “Single-channel/Sub-band Pre-Amplifier \(SPA\)”](#)

### 5.3.1 Single-channel/Sub-band Booster Amplifier (SBA)

#### Amplifier features

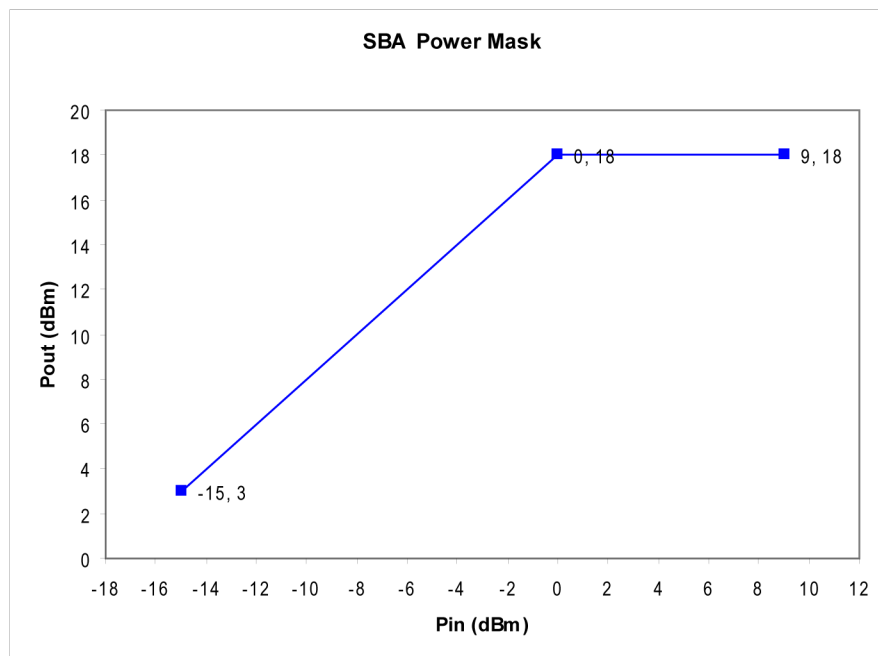
There are two modes of operation for the SBA:

- Constant gain mode
- Constant output power mode

#### Constant gain mode

Amplified Spontaneous Emission (ASE) correction for the SBA is calibrated across the C-band. When the SBA is used as a single-channel amplifier, the signal gain is accurate to  $\pm 0.5$  dB. The output power versus input power curve is shown in the following figure.

#### SBA power mask



#### Constant power mode

Constant power mode is supported only for single-channel operation. In this mode of operation, the total output power, including signal and ASE power, is controlled to the user-specified level. ASE correction is not applied.

#### Sub-band application

When the SBA is deployed as a banded amplifier in Bands 1 and 2, a default wavelength of 1550 nm is selected as the reference and the signal gain is accurate to  $\pm 0.5$  dB. Improved accuracy and gain flatness can be achieved by selecting a mid-band wavelength within the desired wavelength band as the reference channel.

This section covers the following topics:

- 5.3.1.1, “Single-channel/Sub-band Booster Amplifier general specifications”
- 5.3.1.2, “Single-channel/Sub-band Booster Amplifier single-channel application specifications”
- 5.3.1.3, “Single-channel/Sub-band Booster Amplifier sub-band application specifications”

### 5.3.1.1 Single-channel/Sub-band Booster Amplifier general specifications

**Table 5-4 Single-Channel/Sub-band Booster Amplifier (SBA) BP1A05BB general specifications**

Parameter	Value
Features	Constant Gain Constant Power (specified for single channel only)
Input/Output Ports	1 input (amplifier in) 2 output (amplifier out and monitor port)
Input/Output Connector	SC/PC, FC/PC, ST/PC
Power Monitor Port	1% monitor tap

### 5.3.1.2 Single-channel/Sub-band Booster Amplifier single-channel application specifications

**Table 5-5 Single-Channel/Sub-band Booster Amplifier (SBA) BP1A05BB single-channel application specifications**

Parameter	Minimum/Typical	Maximum	Units
Operating Wavelength	1528	1563	nm
Composite Input Level	-15/—	9	dBm
Output Signal Power	3/—	18	dBm
<b>Note</b> Output power reported by the photodetector includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Monitor Port Insertion Loss Ratio	—	22 /1	dB
Input/Output Power Accuracy	—	±0.2	dBm
<b>Note</b> Refers to the accuracy of the amplifier's photodetector, which is calibrated against a standard power meter with a variation of ±0.2 dB.			
Polarization Mode Dispersion			
Polarization Dependent Gain	—	0.5	ps
		0.5	dB
<b>Constant Gain</b>			
Signal Gain	18		dB

**Table 5-5 Single-Channel/Sub-band Booster Amplifier (SBA) BP1A05BB single-channel application specifications (Continued)**

Parameter	Minimum/Typical	Maximum	Units
<b>Note</b> Gain reported is signal gain only.			
Average Gain Accuracy	—/±0.2	±0.5	dB
Gain Flatness (Up to 8 channels in either Band 1 or Band 2)	—	±0.5	dB
Gain Flatness (Up to 16 channels in Band 1 and Band 2)	—	±0.75	dB
Noise Figure (at minimum input power)	—/≤6	6.5	dB
Noise Figure (at maximum input power)	—	6.5	dB
<b>Constant Power</b>			
Output Power Accuracy	—	±0.5	dBm
Gain	—	26	dB

### 5.3.1.3 Single-channel/Sub-band Booster Amplifier sub-band application specifications

**Table 5-6 Single-channel/Sub-band Booster Amplifier (SBA) BP1A05BB sub-band application specifications**

Parameter	Minimum/Typical	Maximum	Units
Operating Wavelength	1546	1560	nm
Channel Capacity	Up to 16 ITU-T channels in 1554.13 to 1559.79 nm and/or 1546.12 to 1551.72 nm		
Input Level Per Channel (number of wavelengths ≥2)	-18/—	—	dBm
Composite Input Level	-15/—	+9	dBm
Output Signal Power	3/—	18	dBm
<b>Note</b> Output power reported by the photodetector includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Monitor Port Insertion Loss Ratio	—	22 /1	dB
Input/Output Power Accuracy	—	±0.2	dBm
<b>Note</b> Refers to the accuracy of the amplifier's photodetector, which is calibrated against a standard power meter with a variation of ±0.2 dB.			
Polarization Mode Dispersion	—/0.4	0.5	ps
Polarization Dependent Gain	—	0.5	dB
<b>Constant Gain</b>			
Signal Gain	18		dB



**Table 5-6 Single-channel/Sub-band Booster Amplifier (SBA) BP1A05BB sub-band application specifications (Continued)**

Parameter	Minimum/Typical	Maximum	Units
<b>Note</b>			
Gain reported is signal gain only.			
Average Gain Accuracy	$-\pm 0.2$	$\pm 0.5$	dB
Gain Flatness (Up to 8 channels in either Band 1 or Band 2)	—	$\pm 0.5$	dB
Gain Flatness (Up to 16 channels in Band 1 and Band 2)	—	$\pm 0.75$	dB
Noise Figure (at minimum input power)	$-\lt 6$	6.5	dB
Noise Figure (at maximum input power)	—	6.5	dB
<b>Transient Performance</b>			
Overshoot/Undershoot for Transient Rise/Fall time for 12 dB A/D			
<b>Note</b>			
Average control ripple is $\pm 0.2$ dB.			
1 ms	—	1.8	dB
100 ns	—	3	dB
Surviving Channel Gain Offset	—	1	dB
Gain Settling Time for Transient Rise/Fall time			
1 ms	—	5	ms
100 ns	—	3	ms

### 5.3.2 Single-channel/Sub-band Pre-Amplifier (SPA)

#### Amplifier features

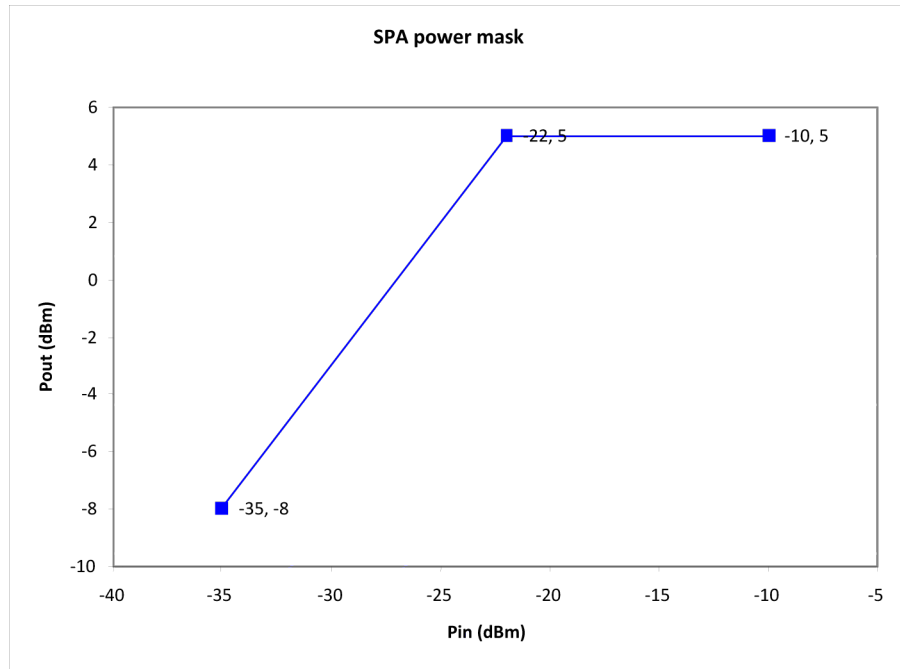
There are two modes of operation for the SPA:

- Constant gain mode
- Constant output power mode

#### Constant gain mode

ASE correction for the SPA is calibrated across the C-band. When the SPA is used as a single-channel amplifier, the signal gain is accurate to  $\pm 0.5$  dB. The output power versus input power curve is shown in the following figure.

## SPA Power Mask



### Constant power mode

Constant power mode is supported only for single-channel SPA operation. In this mode of operation, the total output power, including signal and ASE power, is controlled to the user-specified level. ASE correction is not applied.

### Sub-band application

When the SPA is deployed as a banded amplifier in Bands 1 and 2, a default wavelength of 1550 nm is selected as the reference and the signal gain is accurate to  $\pm 0.5$  dB. Improved accuracy and gain flatness can be achieved by selecting a mid-band wavelength within the desired wavelength band as the reference channel.

This section covers the following topics:

- [5.3.2.1, “Single-channel/Sub-band Pre-Amplifier general specifications”](#)
- [5.3.2.2, “Single-channel/Sub-band Pre-Amplifier single-channel application specifications”](#)
- [5.3.2.3, “Single-channel/Sub-band Pre-Amplifier sub-band application specifications”](#)

### 5.3.2.1 Single-channel/Sub-band Pre-Amplifier general specifications

Table 5-7 Single-Channel/Sub-band Pre-Amplifier (SPA) BP1A05PB general specifications

Parameter	Value
Features	Constant Gain
	Constant Power (specified for single channel only)
Input/Output Ports	1 input (amplifier in)

**Table 5-7 Single-Channel/Sub-band Pre-Amplifier (SPA) BP1A05PB general specifications (Continued)**

Parameter	Value
	2 output (amplifier out and monitor port)
Input/Output Connector	SC/PC, FC/PC, ST/PC
Power Monitor Port	1% monitor tap

### 5.3.2.2 Single-channel/Sub-band Pre-Amplifier single-channel application specifications

**Table 5-8 Single-Channel/Sub-band Pre-Amplifier (SPA) BP1A05PB single-channel application specifications**

Parameter	Minimum/Typical	Maximum	Units
Operating Wavelength	1528	1563	nm
Composite Input Level	-35/—	-10	dBm
Output Signal Power	-8/—	5	dBm
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Monitor Port Insertion Loss Ratio	—	22 /1	dB
Input/Output Power Accuracy	—	±0.2	dBm
<b>Note</b> Refers to the accuracy of the amplifier's photodetector, which is calibrated against a standard power meter with a variation of ±0.2 dB.			
Polarization Mode Dispersion	—/0.4	0.5	ps
Polarization Dependent Gain	—	0.5	dB
<b>Constant Gain</b>			
Signal Gain	27		dB
<b>Note</b> Gain reported is signal gain only.			
Average Gain Accuracy	—/±0.2	±0.5	dB
Gain Flatness (Up to 8 channels in either Band 1 or Band 2)	—	±0.5	dB
Gain Flatness (Up to 16 channels in Band 1 and Band 2)	—	±0.75	dB
Noise Figure (at minimum input power)	—/<6	5.5	dB
Noise Figure (at maximum input power)	—	5.5	dB
<b>Constant Power</b>			
Output Power Accuracy	—	±0.75	dBm
Gain	—	>27	dB

### 5.3.2.3 Single-channel/Sub-band Pre-Amplifier sub-band application specifications

Table 5-9 Single-Channel/Sub-band Pre-Amplifier (SPA) BP1A05PB sub-band application specifications

Parameter	Minimum/Typical	Maximum	Units
Operating Wavelength	1546	1560	nm
Channel Capacity	Up to 16 ITU-T channels in 1554.13 to 1559.79 nm and/or 1546.12 to 1551.72 nm		
Input Level Per Channel (number of wavelengths $\geq 2$ )	-38/—	—	dBm
Composite Input Level	-35/—	-10	dBm
Output Signal Power	-8/—	5	dBm
<b>Note</b> Output power reported by the photodetector includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Monitor Port Insertion Loss Ratio	—	22 /1	dB
Input/Output Power Accuracy	—	$\pm 0.2$	dBm
<b>Note</b> Refers to the accuracy of the amplifier's photodetector, which is calibrated against a standard power meter with a variation of $\pm 0.2$ dB.			
Polarization Mode Dispersion	—/0.4	0.5	ps
Polarization Dependent Gain	—	0.5	dB
<b>Constant Gain</b>			
Signal Gain	27		dB
<b>Note</b> Gain reported is signal gain only.			
Average Gain Accuracy	—/ $\pm 0.2$	$\pm 0.5$	dB
Gain Flatness (Up to 8 channels in either Band 1 or Band 2)	—	$\pm 0.5$	dB
Gain Flatness (Up to 16 channels in Band 1 and Band 2)	—	$\pm 0.75$	dB
Noise Figure (at minimum input power)	—/ $<6$	5.5	dB
Noise Figure (at maximum input power)	—	5.5	dB
<b>Transient Performance</b>			
Overshoot/Undershoot for Transient Rise/Fall time for 12 dB A/D			
<b>Note</b> Average control ripple is $\pm 0.2$ dB.			
1 ms			
100 ns			
Surviving Channel Gain Offset	—	1	dB
Gain Settling Time for Transient Rise/Fall time			

**Table 5-9 Single-Channel/Sub-band Pre-Amplifier (SPA) BP1A05PB sub-band application specifications  
(Continued)**

Parameter	Minimum/Typical	Maximum	Units
1 ms	—	5	ms
100 ns	—	3	ms

## 5.4 DWDM amplifier specifications

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### Tilt compensation

Tilt compensation is available for all line amplifiers running in constant gain mode, including the OLA and OLAM, LGA, MGA, and MGM amplifiers. Gain tilt results primarily from wavelength dependent losses in an optical link. Amplifiers operating in saturation can also result in gain tilt. Applying appropriate tilt compensation along an optical link can improve the flatness of the signal output profile at the end of the link, ensuring that the input power stays within the dynamic range of the receivers. When tilt compensation is applied, the gain per channel will increase or decrease depending on the channel power profile and whether a positive or negative tilt is applied. However, the average gain will remain the same.

### Notes on optical specifications:

- 1 Constant gain mode is supported on all amplifiers. This is the default and recommended setting.
- 2 Constant power mode is supported for single-channel applications on the LGA, MGA, MGM, OBA, and OPA amplifiers. When these amplifiers are operating in constant power mode, the total output power, including signal and ASE power, is controlled to the user-specified level as long as the input power is within specifications. ASE correction is not applied.
- 3 When the input power falls below the minimum specified level, the signal is still amplified, but the accuracy of the input power, gain, and output power will not meet the specifications provided.
- 4 When the input power exceeds the maximum specified level, the signal is still amplified, but the accuracy of the input power, gain, and output power will not meet the specifications provided.
- 5 All specifications quoted are for worst-case temperature and aging scenarios.

This section covers the following topics:

- [5.4.1, “Optical Booster Amplifier”](#)
- [5.4.2, “Optical Line Amplifier”](#)
- [5.4.3, “Optical Line Amplifier with Mid-Stage Access”](#)
- [5.4.4, “DWDM C-Band Pre-Amplifier”](#)
- [5.4.5, “DWDM C-Band Low Gain Amplifier \(LGA\)”](#)
- [5.4.6, “DWDM C-Band Mid Gain Amplifier \(MGA\)”](#)
- [5.4.7, “DWDM C-Band Mid Gain Amplifier with Mid-stage access \(MGM\)”](#)

## 5.4.1 Optical Booster Amplifier

### Amplifier features

There are two modes of operation for the booster amplifier:

- Constant gain mode — the output power is given by the input power plus gain.
- Constant power mode — the total output power (signal + ASE) is set to a user selected level.

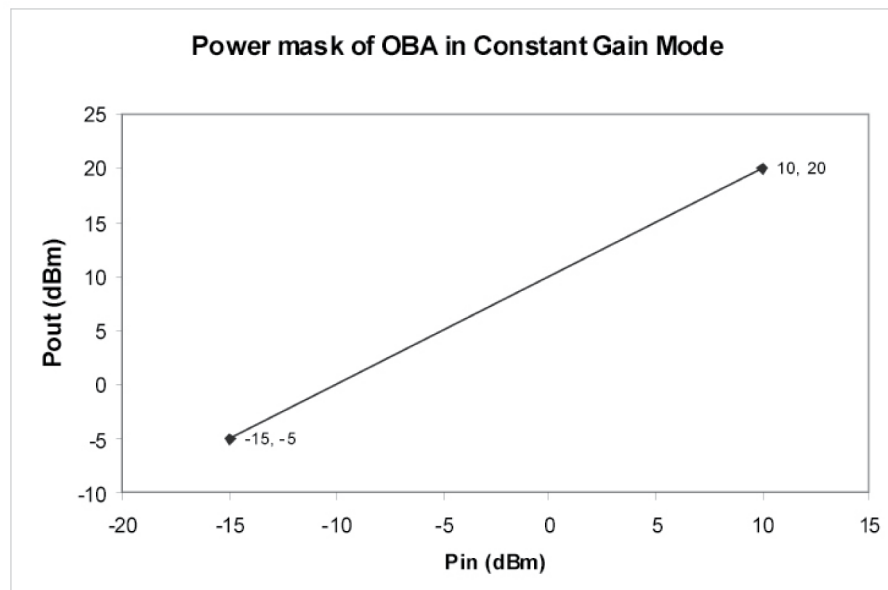
### Constant gain mode

**Note** Constant gain mode is the recommended setting.

The Optical Booster Amplifier is typically deployed at the output of a mux at the head end of an optical link, but they can be used anywhere in an optical link where the input power to the amplifier is high and the required gain is low. For example, they may be used at mid-link at the end of a short optical span.

The power mask for the DWDM C-band Booster Amplifier in constant gain mode is shown in the following figure.

### DWDM C-band Booster Amplifier constant gain mode



### Constant power mode

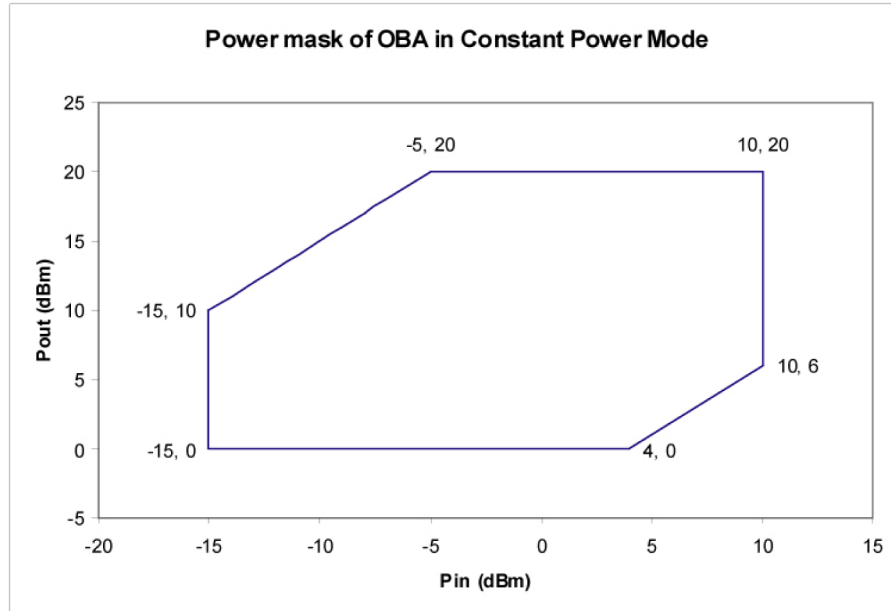
**Note** Constant power mode is supported for single-channel applications only.

When the amplifier is in constant power mode, the signal gain cannot exceed the maximum gain of the amplifier. When the output power selected is such that  $P_{out} - P_{in} > \text{Design Flat Gain (DFG)}$  of 10 dB for the C-Band Booster Amplifier, the output spectrum will have a negative tilt across the operating wavelength range. The tilt is equal to  $(P_{out} - P_{in}) - \text{DFG}$ . When the output power

selected is such that  $P_{out} - P_{in} < DFG$ , the output spectrum will have a positive tilt across the operating wavelength range. The tilt is equal to  $DFG - (P_{out} - P_{in})$  from 1528 to 1563 nm.

The following figure shows the power mask for the DWDM C-Band Booster Amplifier in constant power mode.

#### DWDM C-Band Booster Amplifier in constant power mode



This section covers the following topics:

- 5.4.1.1, “DWDM C-Band Booster Amplifier with Power Monitor general specifications”
- 5.4.1.2, “DWDM C-Band Booster Amplifier with Power Monitor optical specifications”

#### 5.4.1.1 DWDM C-Band Booster Amplifier with Power Monitor general specifications

Table 5-10 DWDM C-Band Booster Amplifier (OBA) BP1A02DA general specifications

Parameter	Value
Features	Gain Flattening Filter (GFF)
	Constant Gain
	Constant Power (specified for single channel only)
Input/Output Ports	1 input (amplifier in)
	2 output (amplifier out and monitor port)
Input/Output Connector	SC/PC, FC/PC, ST/PC
Power Monitor Port	1% monitor tap



### 5.4.1.2 DWDM C-Band Booster Amplifier with Power Monitor optical specifications

Table 5-11 DWDM C-Band Booster Amplifier (OBA) with Power Monitor BP1A02DA optical specifications

Parameter	Minimum/Typical	Maximum	Units
Operating Wavelength	1528/—	1563	nm
Composite Input Level	-15/—	10	dBm
Per channel Input (number of wavelengths $\geq 2$ )	-18/—	—	dBm
Composite Output Signal Power	-5/—	20	dBm
<b>Note</b> Output power reported by the photodetector includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Input/Output Power Accuracy	—	$\pm 0.2$	dBm
<b>Note</b> Refers to the accuracy of the amplifier's photodetector, which is calibrated against a standard power meter with a variation of $\pm 0.2$ dB.			
Monitor Port Insertion Loss Ratio	—	22 /1	dB
Polarization Mode Dispersion	—/0.4	0.5	ps
Polarization Dependent Gain	—	0.5	dB
<b>Constant Gain</b>			
Signal Gain	10		dB
<b>Note</b> Gain reported is signal gain only.			
Average Gain Accuracy	—/ $\pm 0.2$	$\pm 0.5$	dB
Gain Flatness (1528 - 1563 nm)	$\pm 0.5$	$\pm 0.75$	dB
Gain Flatness (Band 1, Band 2, Band 1 + Band 2)	—	$\pm 0.5$	dB
Noise Figure (at minimum input power)	—/ $<5$	5.5	dB
Noise Figure (at maximum input power)	—	7.5	dB
<b>Constant Power</b>			
Output Power Accuracy	—	$\pm 0.5$	dBm
Gain	—	$>16$	dB
Noise Figure	—/5.5	7.5	dB
<b>Transient Performance</b>			
Overshoot/Undershoot for Transient Rise/Fall time for 15 dB A/D			
<b>Note</b> Average control ripple is $\pm 0.2$ dB.			
1 ms	—	1.8	dB
100 ns	—	3	dB

**Table 5-11 DWDM C-Band Booster Amplifier (OBA) with Power Monitor BP1A02DA optical specifications (Continued)**

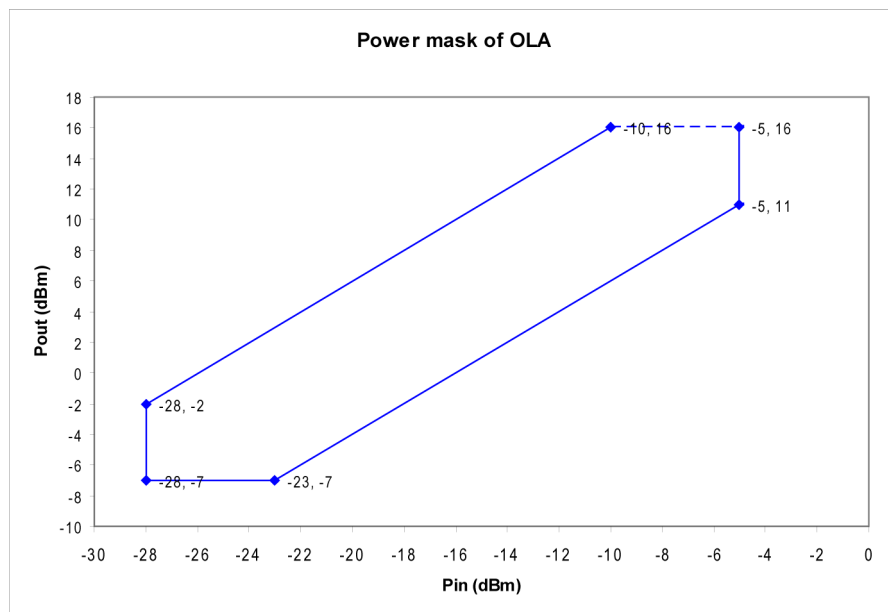
Parameter	Minimum/Typical	Maximum	Units
Surviving Channel Gain Offset	—	1	dB
Gain Settling Time for Transient Rise/Fall time			
1 ms	—	5	ms
100 ns	—	3	ms

## 5.4.2 Optical Line Amplifier

### Amplifier features

The Optical Line Amplifier (OLA) operates in constant gain mode. The power mask of the OLA is shown in the following figure.

#### OLA Power Mask



When the OLA is operating in saturation (as shown by the dashed line in the power mask), the output spectrum may have a positive tilt across the spectrum. There is no tilt when the gain is set to the achievable gain constrained by  $P_{out} - P_{in}$ . If the specified gain exceeds the achievable gain, then the tilt is equal to the difference between the specified gain and the achievable gain across the operating wavelength range from 1528 to 1563 nm.

This section covers the following topics:

- 5.4.2.1, “Optical Line Amplifier general specifications”
- 5.4.2.2, “Optical Line Amplifier optical specifications”

### 5.4.2.1 Optical Line Amplifier general specifications

Table 5-12 Optical Line Amplifier (OLA) BP1A03AA general specifications

Parameter	Value
<b>Features</b>	Gain Flattening Filter (GFF) Adjustable Gain Constant Gain Tilt Compensation
<b>Input/Output Ports</b>	2 (input, output)
<b>Input/Output Connector</b>	SC/PC, FC/PC, ST/PC

### 5.4.2.2 Optical Line Amplifier optical specifications

Table 5-13 Optical Line Amplifier (OLA) BP1A03AA optical specifications

Parameter	Minimum/Typical	Maximum	Units
Operating Wavelength	1528/—	1563	nm
Composite Input Level	-28/—	-5	dBm
Per channel Input (number of wavelengths $\geq 2$ )	-31/—	—	dBm
Composite Output Signal Power	-7/—	16	dBm
<b>Note</b> Output power reported includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Input/Output Power Accuracy	—	$\pm 0.2$	dBm
<b>Note</b> Refers to the accuracy of the amplifier's photodetector, which is calibrated against a standard power meter with a variation of $\pm 0.2$ dB.			
Polarization Mode Dispersion	—/0.4	0.5	ps
Polarization Dependent Gain	—	0.5	dB
<b>Constant Gain</b>			
Signal Gain	16/—	26	dB
<b>Note</b> Gain reported refers to signal gain only.			
Average Gain Variation	—/ $\pm 0.2$	$\pm 0.5$	dB
Gain Flatness	—/ $\pm 0.5$	$\pm 0.75$	dB
Adjustable Gain Range	10		dB
Tilt Compensation			
	Negative Tilt	18.5 - VOA setting or 3, whichever is smaller	dB

**Table 5-13 Optical Line Amplifier (OLA) BP1A03AA optical specifications (Continued)**

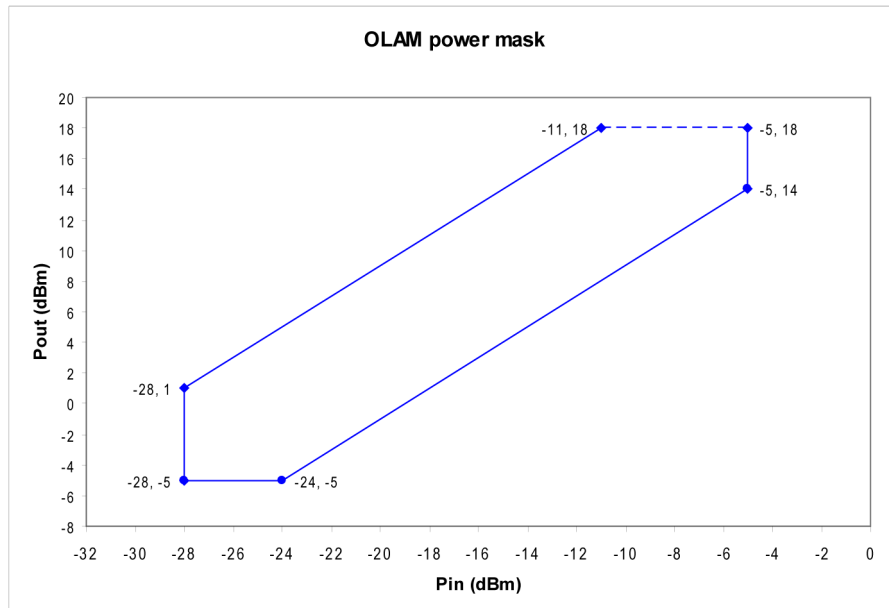
Parameter	Minimum/Typical	Maximum	Units
Positive Tilt	VOA setting or 3, whichever is smaller		dB
Noise Figure (at minimum input power and maximum gain)	—/ <5	5.5	dB
Noise Figure (at maximum input power and minimum gain)	—/ <5.5	6.5	dB
<b>Constant Power</b>			
Output Power Accuracy	—	±0.5	dBm
Gain	—	>16	dB
Noise Figure	—/5.5	7.5	dB
<b>Transient Performance (3 dB Add/Drop)</b>			
Settling Time	—/80	200	μs
Gain Offset	—	0.15	dB

### 5.4.3 Optical Line Amplifier with Mid-Stage Access

#### Amplifier features

The Optical Line Amplifier with Mid-Stage Access (OLAM) operates in constant gain mode. The power mask of the OLAM is shown in the following figure.

#### OLAM Power Mask



When the OLAM is operating in saturation (as shown by the dashed line in the power mask), the output spectrum may have a positive tilt across the spectrum. There is no tilt when the gain is set to the achievable gain constrained by  $P_{out} - P_{in}$ . If the specified gain exceeds the achievable gain,

then the tilt is equal to the difference between the specified gain and the achievable gain across the operating wavelength range from 1528 to 1563 nm.

This section covers the following topics:

- 5.4.3.1, “Optical Line Amplifier with Mid-Stage Access general specifications”
- 5.4.3.2, “Optical Line Amplifier with Mid-Stage Access optical specifications”

### 5.4.3.1 Optical Line Amplifier with Mid-Stage Access general specifications

Table 5-14 Optical Line Amplifier with 0 – 15 dB Mid-Stage Access (OLAM) BP1A04BA general specifications

Parameter	Value
<b>Features</b>	Gain Flattening Filter (GFF) Adjustable Gain Constant Gain Constant Power (specified for single channel only) Tilt Compensation
<b>Input/Output Ports</b>	2 (input, output)
<b>Input/Output Connector</b>	SC/PC, FC/PC, ST/PC
<b>Mid-Stage Access Connector</b>	Dual LC

### 5.4.3.2 Optical Line Amplifier with Mid-Stage Access optical specifications

Table 5-15 Optical Line Amplifier with 0 – 15 dB Mid-Stage Access (OLAM) BP1A04BA optical specifications

Parameter	Minimum/Typical	Maximum	Units
Operating Wavelength	1528/—	1563	nm
Composite Input Level	-28 /—	-5	dBm
Per channel Input (number of wavelengths >=2)	-31/—	—	dBm
Composite Output Signal Power	-5/—	18	dBm
<b>Note</b> Output power reported includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Input/Output Power Accuracy	—	±0.2	dBm
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Mid-Stage Loss (MSL)	0/—	15	dB
Polarization Mode Dispersion	—/0.4	0.5	ps
Polarization Dependent Gain	—	0.5	dB
<b>Constant Gain</b>			

**Table 5-15 Optical Line Amplifier with 0 – 15 dB Mid-Stage Access (OLAM) BP1A04BA optical specifications (Continued)**

Parameter	Minimum/Typical	Maximum	Units
Signal Gain	19/—	29	dB
Average Gain Variation	—/±0.2	±0.5	dB
Gain Flatness (1528 - 1563 nm)	—/±0.5	±0.75	dB
Gain Flatness (Band 1, Band 2, Band 1 + Band 2)	—	±0.5	dB
Adjustable Gain Range			
Mid-Stage Loss ≤5	Tunable gain range = 10 dB		
Mid-Stage Loss ≥5	Tunable gain range = 15 - Mid-Stage Loss dB		
	<b>Note</b> For example, if DCM loss is 6 dB, the Adjustable Gain Range is 9 dB (19 dB to 28 dB Optical Gain).		
Tilt Compensation			
Negative Tilt	18.5 - VOA setting or 3, whichever is smaller		dB
Positive Tilt	VOA setting or 3, whichever is smaller		dB
Noise Figure (at minimum input power and maximum gain)			
Wavelength > 1538 nm	—/≤5	5.5	dB
Wavelength ≤ 1538 nm	—/≤5	6.0	dB
Noise Figure (at maximum input power and minimum gain)	—/≤5.5	8.5	dB
<b>Transient Performance</b>			
3dB Add/Drop			
At minimum input power			
Overshoot/Undershoot	—	±1.0	dB
Settling time for gain to reach ±0.2 dB of target	—	600	μs
At maximum input power			
Overshoot/Undershoot	—	±2.8	dB
Settling time for gain to reach ±0.2 dB of target	—	400	μs
9 dB Add/Drop			
At minimum input power			
Overshoot/Undershoot	—	±2.0	dB
Settling time for gain to reach ±0.2 dB of target	—	600	μs
At maximum input power			
Overshoot/Undershoot	—	±8.0	dB
Settling time for gain to reach ±0.2 dB of target	—	1	ms
12 dB Add/Drop			
At minimum input power			
Overshoot/Undershoot	—	±3.5	dB
Settling time for gain to reach ±0.2 dB of target	—	750	μs
At maximum input power			

**Table 5-15 Optical Line Amplifier with 0 – 15 dB Mid-Stage Access (OLAM) BP1A04BA optical specifications (Continued)**

Parameter	Minimum/Typical	Maximum	Units
Overshoot/Undershoot	—	±7.0	dB
Settling time for gain to reach ±0.2 dB of target	—	1.3	ms
<b>Constant Power</b>			
Output Power Accuracy (1546 nm - 1560 nm)	—	±0.5	dBm
Maximum Gain	—	≥31	dB

## 5.4.4 DWDM C-Band Pre-Amplifier

### Amplifier features

There are two modes of operation for the DWDM C-Band Pre-Amplifier (OPA):

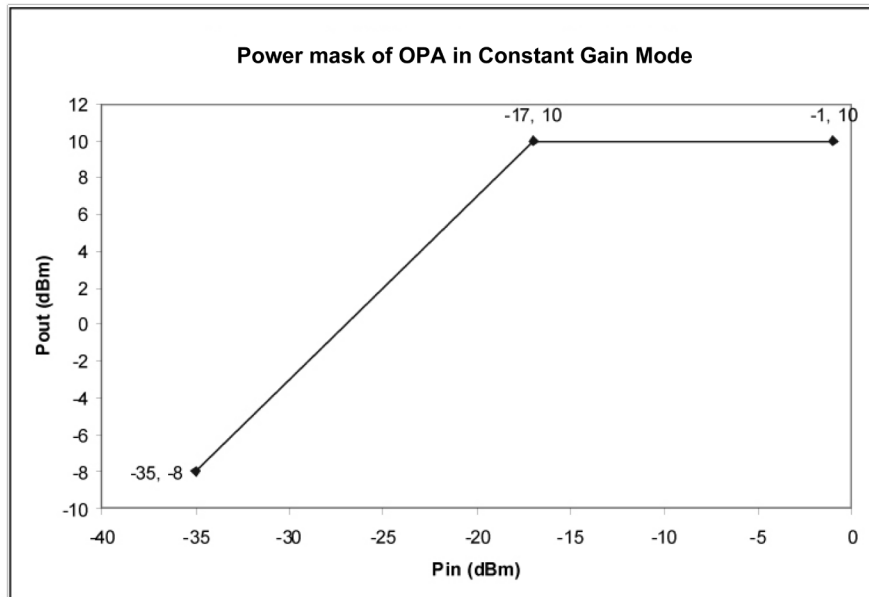
- Constant gain mode — the output power is given by the input power plus gain.
- Constant power mode — the total output power (signal + ASE) is set to a user selected level.

### Constant gain mode

**Note** Constant gain mode is the recommended setting.

The power mask for the DWDM C-Band Pre-Amplifier in constant gain mode is shown in the following figure.

### DWDM C-Band Pre-Amplifier power mask in constant gain mode



When the OPA is operating in saturation, the output spectrum will have a positive tilt across the operating wavelength range from 1528 to 1563 nm. The gain tilt is equal to  $(P_{in} + \text{Gain} - P_{out})$ .

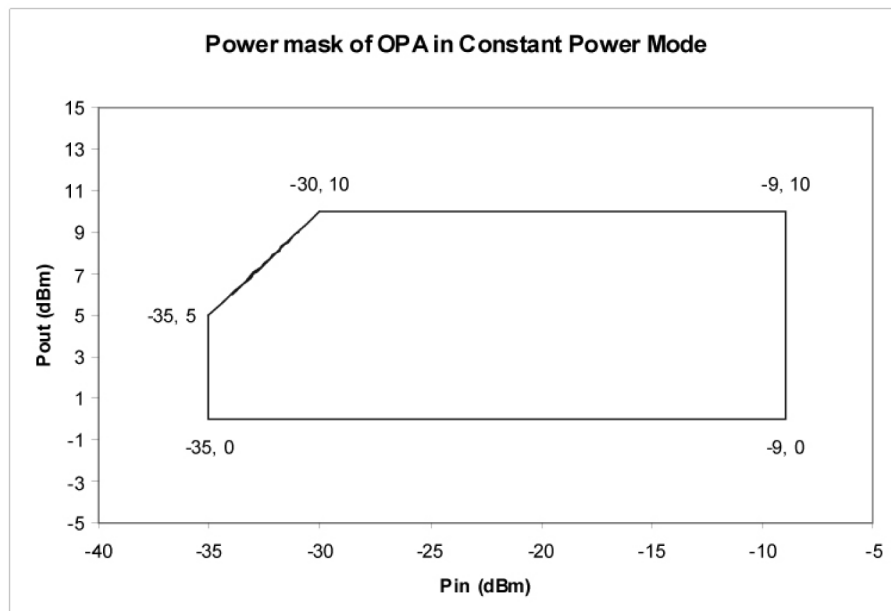
## Constant power mode

**Note** Constant power mode is supported for single-channel applications only.

When the amplifier is in constant power mode, the signal gain cannot exceed the maximum gain of the amplifier. When the output power selected is such that  $P_{out} - P_{in} > \text{Design Flat Gain (DFG)}$  of 27 dB for the OPA, the output spectrum will have a negative tilt across the operating wavelength range. The tilt is equal to  $(P_{out} - P_{in}) - \text{DFG}$ . When the output power selected is such that  $P_{out} - P_{in} < \text{DFG}$ , the output spectrum will have a positive tilt across the operating wavelength range. The tilt is equal to  $\text{DFG} - (P_{out} - P_{in})$  from 1528 to 1563 nm.

The power mask for the OPA in constant power mode is shown in the following figure.

### DWDM C-Band Pre-Amplifier in constant power mode



This section covers the following topics:

- [5.4.4.1, “DWDM C-Band Pre-Amplifier general specifications”](#)
- [5.4.4.2, “DWDM C-Band Pre-Amplifier optical specifications”](#)

#### 5.4.4.1 DWDM C-Band Pre-Amplifier general specifications

**Table 5-16 DWDM C-Band Pre-Amplifier (OPA) with Power Monitor BP1A01DA general specifications**

Parameter	Value
Features	Gain Flattening Filter (GFF)
	Constant Gain
	Constant Power (specified for single channel only)
Input/Output Ports	1 input (amplifier in)
	2 output (amplifier out and monitor port)



**Table 5-16 DWDM C-Band Pre-Amplifier (OPA) with Power Monitor BP1A01DA general specifications (Continued)**

Parameter	Value
Input/Output Connector	SC/PC, FC/PC, ST/PC
Power Monitor Port	1% monitor tap

#### 5.4.4.2 DWDM C-Band Pre-Amplifier optical specifications

**Table 5-17 DWDM C-Band Pre-Amplifier (OPA) with Power Monitor BP1A01DA optical specifications**

Parameter	Minimum/Typical	Maximum	Units
Operating Wavelength	1528/—	1563	nm
Composite Input Level	-35/—	-1	dBm
Per channel Input (number of wavelengths >=2)	-38/—	—	dBm
Composite Output Signal Power	-8/—	10	dBm
<b>Note</b> Output power reported includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Input/Output Power Accuracy	—	±0.2	dBm
<b>Note</b> Refers to the accuracy of the amplifier's photodetector, which is calibrated against a standard power meter with a variation of ±0.2 dB.			
Monitor Port Insertion Loss Ratio	—	22 /1	dB
Polarization Mode Dispersion	—/0.4	0.5	ps
Polarization Dependent Gain	—	0.5	dB
<b>Constant Gain</b>			
Signal Gain	27		dB
<b>Note</b> Gain reported refers to signal gain only.			
Average Gain Accuracy	—/±0.2	±0.5	dB
Gain Flatness (1528 - 1563 nm)	—	±0.75	dB
Gain Flatness (Band 1, Band 2, Band 1 + Band 2)	—	±0.5	dB
Noise Figure (at minimum input power)	—/<6	6.5	dB
Noise Figure (at maximum input power)	—	6.5	dB
<b>Constant Power</b>			
Output Power Accuracy	—	±0.75	dBm
Gain	—	>27	dB
<b>Transient Performance</b>			
Overshoot/Undershoot for Transient Rise/Fall time for 15 dB A/D			

**Table 5-17 DWDM C-Band Pre-Amplifier (OPA) with Power Monitor BP1A01DA optical specifications (Continued)**

Parameter	Minimum/Typical	Maximum	Units
<b>Note</b> Average control ripple is $\pm 0.2$ dB.			
1 ms	—	1.8	dB
100 ns	—	3	dB
Surviving Channel Gain Offset	—	1	dB
Gain Settling Time for Transient Rise/Fall time			
1 ms	—	5	ms
100 ns	—	3	ms

### 5.4.5 DWDM C-Band Low Gain Amplifier (LGA)

#### Amplifier features

There are two modes of operation for the DWDM C-Band Low Gain Amplifier (LGA):

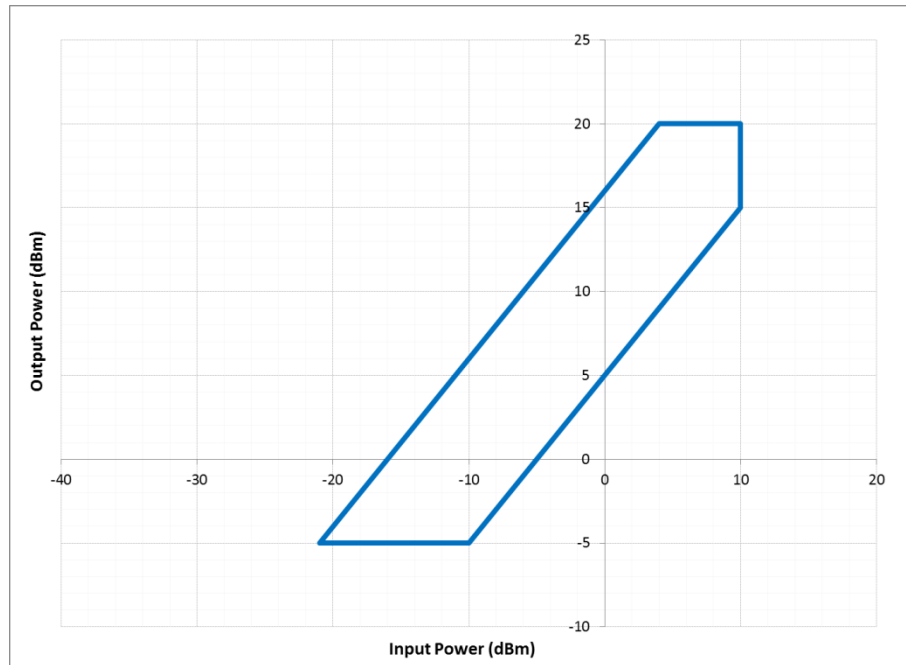
- Constant gain mode — the output power is determined by the input power plus gain.
- Constant power mode — the total output power (signal + ASE) is set to a user selected level.

#### Constant gain mode

**Note** Constant gain mode is the recommended setting.

The power mask for the LGA in constant gain mode is shown in the following figure.

### LGA power mask in constant gain mode



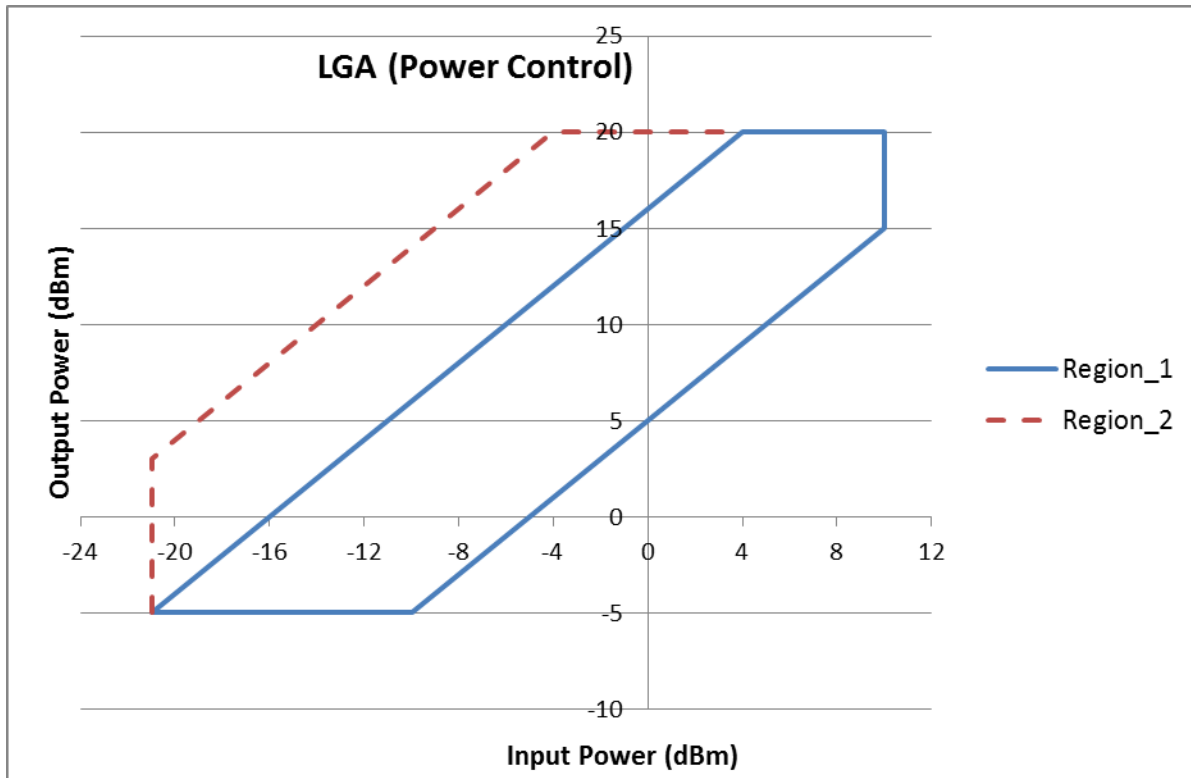
When the amplifier is operating in saturation, the output spectrum will have a positive tilt across the operating wavelength range. The gain tilt is equal to  $(P_{in} + \text{Gain} - P_{out})$ .

### Constant power mode

**Note** Constant power mode is supported for single-channel applications only.

When the amplifier is in constant power mode, the signal gain cannot exceed the maximum gain of the amplifier. When the output power selected is such that  $P_{out} - P_{in} > \text{Design Flat Gain (DFG)}$  for the amplifier, the output spectrum will have a negative tilt across the operating wavelength range. The tilt is equal to  $(P_{out} - P_{in}) - \text{DFG}$ . When the output power selected is such that  $P_{out} - P_{in} < \text{DFG}$ , the output spectrum will have a positive tilt across the operating wavelength range. The tilt is equal to  $\text{DFG} - (P_{out} - P_{in})$  over the operating wavelength range.

The power mask for the LGA in constant power mode is shown in the following figure. Region\_1 is the supported power mask. Region\_2 extends the power mask to provide a greater range (but with a lower power control accuracy), and is supported on a best effort basis.

**LGA power mask in constant power mode**

This section covers the following topics:

- 5.4.5.1, “DWDM C-Band Low Gain Amplifier (LGA) general specifications”
- 5.4.5.2, “DWDM C-Band Low Gain Amplifier (LGA) optical specifications”

**5.4.5.1 DWDM C-Band Low Gain Amplifier (LGA) general specifications**

**Table 5-18 DWDM C-Band Low Gain Amplifier (LGA) BT7A02AA general specifications**

Parameter	Value
Features	Variable Optical Attenuator (VOA) for flat gain and desired tilt Adjustable Gain Constant Gain Constant Power Tilt Compensation
Input/Output Ports	1 input (amplifier in) 2 output (amplifier out and monitor port)
Input/Output Connector	LC
Power Monitor Port	1% monitor tap

### 5.4.5.2 DWDM C-Band Low Gain Amplifier (LGA) optical specifications

Table 5-19 DWDM C-Band Low Gain Amplifier (LGA) BT7A02AA optical specifications

Parameter	Minimum	Maximum	Units
Operating Wavelength	1528	1567	nm
Composite Input Level	-21	10	dBm
Per channel Input	-21	—	dBm
Composite Output Signal Power	-5	20	dBm
<b>Note</b> Output power reported includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Monitor Port Accuracy	-0.5	0.5	dB
Monitor Port Insertion Loss Ratio	18.5	21.5	dB
Polarization Mode Dispersion	—	0.3	ps
Polarization Dependent Loss	—	0.3	dB
<b>Constant Gain</b>			
Signal Gain	5	16	dB
<b>Note</b> Gain reported refers to signal gain only.			
Average Gain Accuracy	-0.5	0.5	dB
Gain Ripple (1545 nm - 1560 nm) at 0 dB tilt setting	—	0.8	dBpp
Gain Ripple (full band) at 0 dB tilt setting	—	1.3	dBpp
Noise Figure (at gain = 5 dB) at 0 dB tilt setting	—	14.3	dB
Noise Figure (at gain = 10 dB) at 0 dB tilt setting	—	7.8	dB
Noise Figure (at gain = 16 dB) at 0 dB tilt setting	—	6.2	dB
<b>Constant Power</b>			
Output Power Accuracy (Region_1)	-0.5	0.5	dB
Output Power Accuracy (Region_2)	-1	1	dB
<b>Transient Performance</b>			
Overshoot	—	2	dB
Undershoot	—	-2	dB
Surviving Channel Gain Offset	—	1	dB
Settling time (1 ms transient event)	—	5	ms

## 5.4.6 DWDM C-Band Mid Gain Amplifier (MGA)

### Amplifier features

There are two modes of operation for the DWDM C-Band Mid Gain Amplifier (MGA):

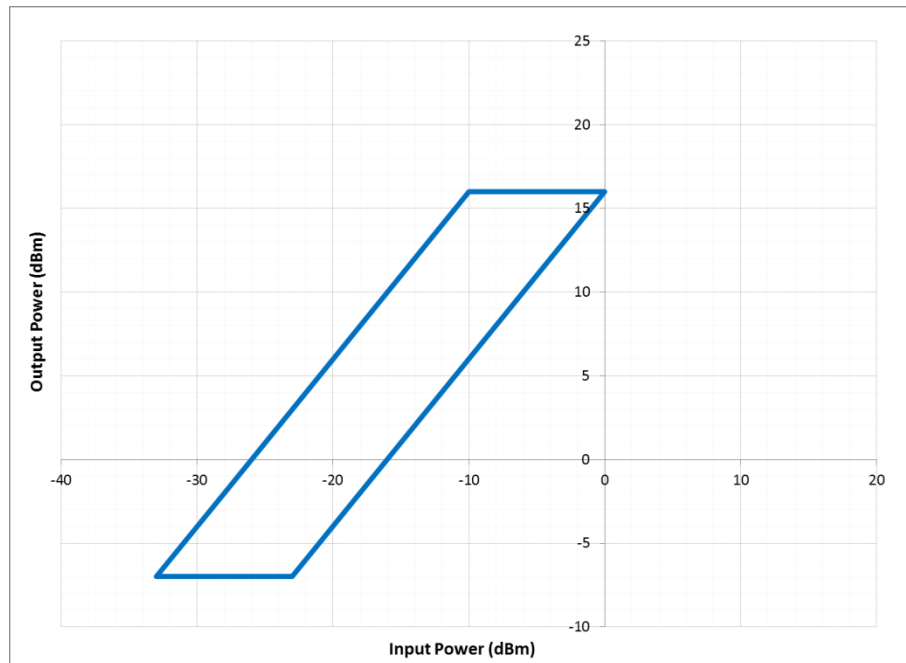
- Constant gain mode — the output power is determined by the input power plus gain.
- Constant power mode — the total output power (signal + ASE) is set to a user selected level.

### Constant gain mode

**Note** Constant gain mode is the recommended setting.

The power mask for the MGA in constant gain mode is shown in the following figure.

### MGA power mask in constant gain mode



When the amplifier is operating in saturation, the output spectrum will have a positive tilt across the operating wavelength range. The gain tilt is equal to  $(P_{in} + \text{Gain} - P_{out})$ .

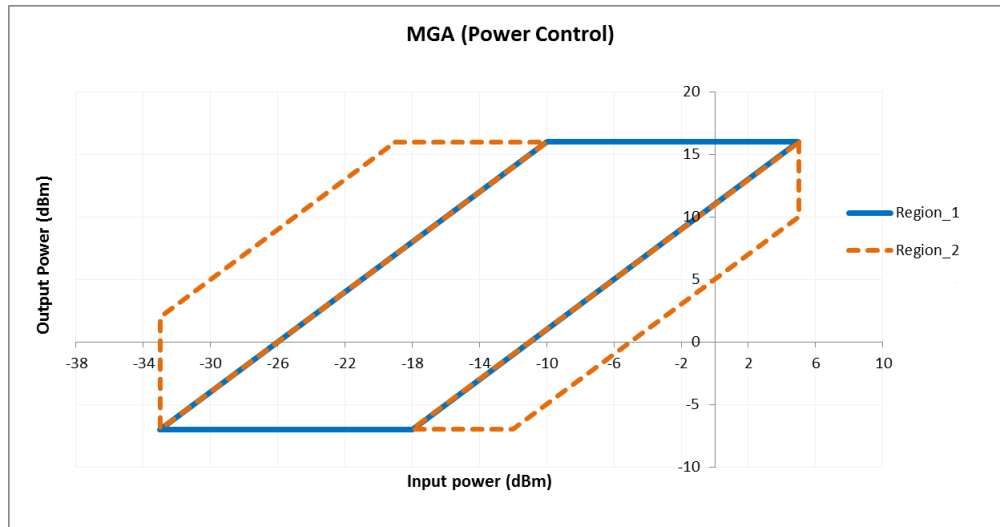
### Constant power mode

**Note** Constant power mode is supported for single-channel applications only.

When the amplifier is in constant power mode, the signal gain cannot exceed the maximum gain of the amplifier. When the output power selected is such that  $P_{out} - P_{in} > \text{Design Flat Gain (DFG)}$  for the amplifier, the output spectrum will have a negative tilt across the operating wavelength range. The tilt is equal to  $(P_{out} - P_{in}) - \text{DFG}$ . When the output power selected is such that  $P_{out} - P_{in} < \text{DFG}$ , the output spectrum will have a positive tilt across the operating wavelength range. The tilt is equal to  $\text{DFG} - (P_{out} - P_{in})$  over the operating wavelength range.

The power mask for the MGA in constant power mode is shown in the following figure. Region\_1 is the supported power mask. Region\_2 extends the power mask to provide a greater range (but with a lower power control accuracy), and is supported on a best effort basis.

#### MGA power mask in constant power mode



This section covers the following topics:

- [5.4.6.1, “DWDM C-Band Mid Gain Amplifier \(MGA\) general specifications”](#)
- [5.4.6.2, “DWDM C-Band Mid Gain Amplifier \(MGA\) optical specifications”](#)

#### 5.4.6.1 DWDM C-Band Mid Gain Amplifier (MGA) general specifications

Table 5-20 DWDM C-Band Mid Gain Amplifier (MGA) BT7A03AA general specifications

Parameter	Value
Features	Variable Optical Attenuator (VOA) for flat gain and desired tilt Adjustable Gain Constant Gain Constant Power Tilt Compensation
Input/Output Ports	1 input (amplifier in) 2 output (amplifier out and monitor port)
Input/Output Connector	LC
Power Monitor Port	1% monitor tap

### 5.4.6.2 DWDM C-Band Mid Gain Amplifier (MGA) optical specifications

Table 5-21 DWDM C-Band Mid Gain Amplifier (MGA) BT7A03AA optical specifications

Parameter	Minimum	Maximum	Units
Operating Wavelength	1528	1567	nm
Composite Input Level	-33	0	dBm
Per channel Input	-33	—	dBm
Composite Output Signal Power	-7	16	dBm
<b>Note</b> Output power reported includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Monitor Port Accuracy	-0.5	0.5	dB
Monitor Port Insertion Loss Ratio	18.5	21.5	dB
Polarization Mode Dispersion	—	0.5	ps
Polarization Dependent Loss	—	0.5	dB
<b>Constant Gain</b>			
Signal Gain	16	26	dB
<b>Note</b> Gain reported refers to signal gain only.			
Average Gain Accuracy	-0.5	0.5	dB
Gain Ripple (1545 nm - 1560 nm) at 0 dB tilt setting	—	0.8	dBpp
Gain Ripple (full band) at 0 dB tilt setting	—	1.3	dBpp
Noise Figure (at gain = 16 dB) at 0 dB tilt setting	—	6.0	dB
Noise Figure (at gain = 21 dB) at 0 dB tilt setting	—	5.9	dB
Noise Figure (at gain = 26 dB) at 0 dB tilt setting	—	6.0	dB
<b>Constant Power</b>			
Output Power Accuracy	-0.5	0.5	dB
<b>Transient Performance</b>			
Overshoot	—	2	dB
Undershoot	—	-2	dB
Surviving Channel Gain Offset	—	1	dB
Settling time (1 ms transient event)	—	5	ms

### 5.4.7 DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM)

#### Amplifier features

There are two modes of operation for the DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM):



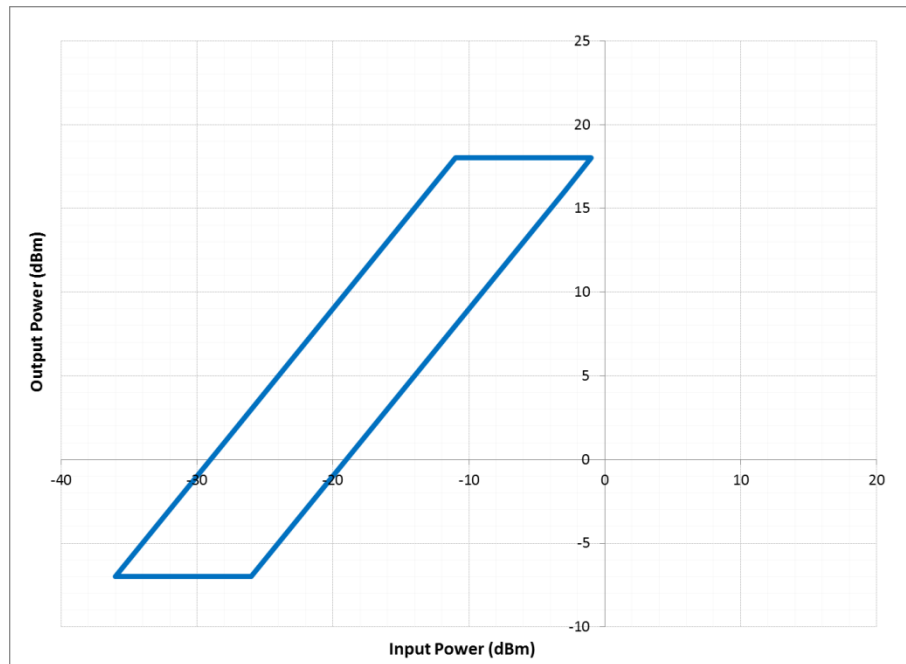
- Constant gain mode — the output power is determined by the input power plus gain.
- Constant power mode — the total output power (signal + ASE) is set to a user selected level.

### Constant gain mode

**Note** Constant gain mode is the recommended setting.

The power mask for the MGM in constant gain mode is shown in the following figure.

#### MGM power mask in constant gain mode



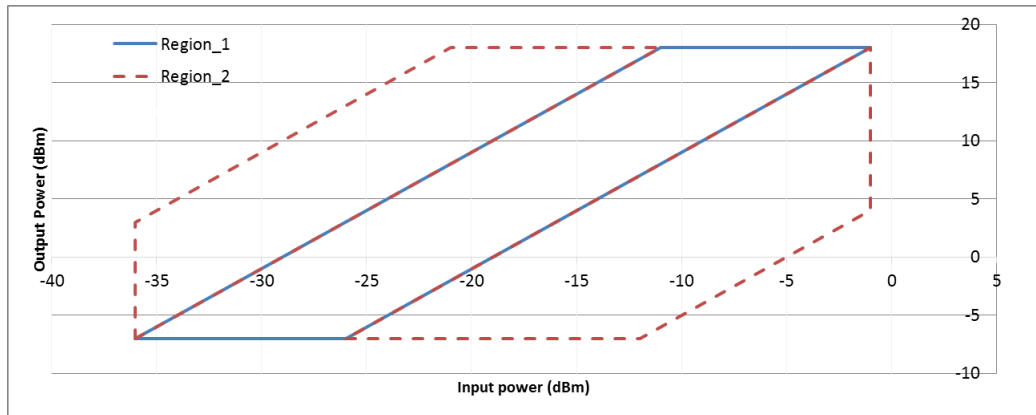
When the amplifier is operating in saturation, the output spectrum will have a positive tilt across the operating wavelength range. The gain tilt is equal to  $(P_{in} + \text{Gain} - P_{out})$ .

### Constant power mode

**Note** Constant power mode is supported for single-channel applications only.

When the amplifier is in constant power mode, the signal gain cannot exceed the maximum gain of the amplifier. When the output power selected is such that  $P_{out} - P_{in} > \text{Design Flat Gain (DFG)}$  for the amplifier, the output spectrum will have a negative tilt across the operating wavelength range. The tilt is equal to  $(P_{out} - P_{in}) - \text{DFG}$ . When the output power selected is such that  $P_{out} - P_{in} < \text{DFG}$ , the output spectrum will have a positive tilt across the operating wavelength range. The tilt is equal to  $\text{DFG} - (P_{out} - P_{in})$  over the operating wavelength range.

The power mask for the MGA in constant power mode is shown in the following figure. Region\_1 is the supported power mask. Region\_2 extends the power mask to provide a greater range (but with a lower power control accuracy), and is supported on a best effort basis.

**MGM power mask in constant power mode**

This section covers the following topics:

- 5.4.7.1, “DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM) general specifications”
- 5.4.7.2, “DWDM C-Band Mid Gain Amplifier with Mid Stage Access (MGM) optical specifications”

### 5.4.7.1 DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM) general specifications

Table 5-22 DWDM C-Band Mid Gain Amplifier with Mid-stage access (MGM) BT7A04AA general specifications

Parameter	Value
Features	Variable Optical Attenuator (VOA) for flat gain and desired tilt Adjustable Gain Constant Gain Constant Power Tilt Compensation
Input/Output Ports	2 input (amplifier in, mid-stage in) 3 output (amplifier out, mid-stage out, and monitor port)
Input/Output/Mid-Stage Access Connectors	LC
Power Monitor Port	1% monitor tap

### 5.4.7.2 DWDM C-Band Mid Gain Amplifier with Mid Stage Access (MGM) optical specifications

Table 5-23 DWDM C-Band Mid Gain Amplifier with Mid Stage Access (MGM) BT7A04AA optical specifications

Parameter	Minimum	Maximum	Units
Operating Wavelength	1528	1567	nm

**Table 5-23 DWDM C-Band Mid Gain Amplifier with Mid Stage Access (MGM) BT7A04AA optical specifications (Continued)**

Parameter	Minimum	Maximum	Units
Composite Input Level	-36	-1	dBm
Per channel Input	-36	-21	dBm
Composite Output Signal Power	-7	18	dBm
<b>Note</b> Output power reported includes signal and ASE power.			
<b>Note</b> Maximum output signal power may be greater than the specified value when an amplifier operates in its saturation region in constant gain mode.			
Mid-Stage Loss	0	15	dB
Monitor Port Accuracy	-0.5	0.5	dB
Monitor Port Insertion Loss Ratio	18.5	21.5	dB
Polarization Mode Dispersion	—	0.35	ps
Polarization Dependent Loss	—	0.35	dB
<b>Constant Gain</b>			
Signal Gain	19	29	dB
<b>Note</b> Gain reported refers to signal gain only.			
Mid-Stage Loss <= 5 dB	Tunable gain range = 10 dB		
Mid-Stage Loss > 5 dB	Tunable gain range = 15 - <Mid-Stage Loss> dB		
	<b>Note</b> For example, if DCM loss is 6 dB, the tunable gain range is 9 dB (19 dB to 28 dB optical gain).		
Average Gain Accuracy	-0.5	0.5	dB
Gain Ripple (1545 nm - 1560 nm) at 0 dB tilt setting	—	0.8	dBpp
Gain Ripple (full band) at 0 dB tilt setting	—	1.3	dBpp
Noise Figure (at gain = 19 dB) at 0 dB tilt setting	—	6.4	dB
Noise Figure (at gain = 21 dB) at 0 dB tilt setting	—	5.9	dB
Noise Figure (at gain = 29 dB) at 0 dB tilt setting	—	5.3	dB
<b>Constant Power</b>			
Output Power Accuracy	-0.5	0.5	dB
<b>Transient Performance</b>			
Overshoot	—	2	dB
Undershoot	—	-2	dB
Surviving Channel Gain Offset	—	1	dB
Settling time (1 ms transient event)	—	5	ms

## 5.5 Amplifier PMs

Table 5-24 Optical Amplifier PMs (gauges)

PM (montype)	Supported modules
<b>CTEMP</b> Case Temperature measures the amplifier's case temperature in degrees Celsius	OBA OPA OLA OLAM SBA SPA
<b>EFFGAIN</b> Effective Gain measures the amplifier's effective gain level in dB	All
<b>Note</b> The EFFGAIN is compensated for amplified spontaneous emissions (ASE).	
<b>L1CUR</b> Laser One Current measures the amplifier's laser number one current in milliamperes	OLA OLAM
<b>L1PWR</b> Laser One Power measures the amplifier's laser one's power in milliwatts	OLA OLAM
<b>L1TEMP</b> Laser One Temperature measures the amplifier's laser one's temperature in degrees Celsius	OLA OLAM
<b>L2CUR</b> Laser Two Current measures the amplifier's laser two's current in milliamperes	OBA OPA OLA OLAM SBA SPA
<b>L2PWR</b> Laser Two Power measures the amplifier's laser two's power in milliwatts	OBA OPA OLA OLAM SBA SPA
<b>L2TEMP</b> Laser Two Temperature measures the amplifier's laser two's temperature in degrees Celsius	OBA OPA OLA OLAM SBA SPA
<b>OBR</b>	All

Table 5-24 Optical Amplifier PMs (gauges) (Continued)

PM (montype)	Supported modules
Optical Backreflection measures the amplifier's optical backreflection level in dB	
<b>OPR</b>	All
Optical Power Received measures the amplifier's optical power received level in dBm	
<b>OPR-MIN</b>	LGA
Optical Power Received Minimum measures the amplifier's minimum optical power received level in dBm	MGA
	MGM
<b>OPR-MAX</b>	LGA
Optical Power Received Maximum measures the amplifier's maximum optical power received level in dBm	MGA
	MGM
<b>OPR-AVG</b>	LGA
Optical Power Received Average measures the amplifier's average optical power received level in dBm	MGA
	MGM
<b>OPT</b>	All
Optical Power Transmitted measures the amplifier's optical power transmitted level in dBm	
<b>OPT-MIN</b>	LGA
Optical Power Transmitted Minimum measures the amplifier's minimum optical power transmitted level in dBm	MGA
	MGM
<b>OPT-MAX</b>	LGA
Optical Power Transmitted Maximum measures the amplifier's maximum optical power transmitted level in dBm	MGA
	MGM
<b>OPT-AVG</b>	LGA
Optical Power Transmitted Average measures the amplifier's average optical power transmitted level in dBm	MGA
	MGM
<b>FSSOPT</b>	OLAM
First-stage output optical power transmitted measures the amplifier's first-stage output optical power transmitted level in dBm	MGM
<b>SSIOPR</b>	OLAM
Second-Stage Input Optical Power Received measures the amplifier's second-stage input optical power received level in dBm	MGM
<b>MSLOSS</b>	OLAM
Mid-stage insertion loss measures the amplifier's mid-stage insertion loss in dB	MGM
<b>VOAATN</b>	OLA
Variable Optical Attenuator Attenuation measures the amplifier's variable optical attenuator's attenuation level in dB	OLAM
<b>TILT-ACH</b>	LGA
Tilt Achieved measures the amount of tilt that has been achieved	MGA
	MGM

**Note** All composite power measurements reported by optical amplifiers are accurate to  $\pm 0.2$  dB. As a result, gain or loss measurements may vary by  $\pm 0.4$  dB.

## 6.0 Dispersion Compensation modules

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This section provides information about the Dispersion Compensation modules that the BTI 7000 Series supports.

- [6.1, “Dispersion Compensation module portfolio”](#)
- [6.2, “Dispersion Compensation module applications”](#)
- [6.3, “SMF \(DCF-Type\) Dispersion Compensation module specifications”](#)
- [6.4, “ SMF \(Expandable\) Dispersion Compensation Module specifications”](#)
- [6.5, “SMF 100 GHz C-Band Dispersion Compensation module specifications”](#)

## 6.1 Dispersion Compensation module portfolio

This section provides information about the modules in the Dispersion Compensation module portfolio and covers the following topics:

- 6.1.1, “Dispersion Compensation modules”
- 6.1.2, “Dispersion Compensation module operating temperature ranges”

### 6.1.1 Dispersion Compensation modules

Table 6-1 Dispersion Compensation modules

Module	PEC	System software introduced
<b>Dispersion Compensation Modules (DCF-type)</b>		
SMF DCM 20 KM	BP1A10CH-UC	7.1.0
SMF DCM 40 KM	BP1A10CC-SC	7.1.0
SMF DCM 60 KM	BP1A10CA-SC	7.1.0
SMF DCM 80 KM	BP1A10CB-SC	7.1.0
<b>C-Band Dispersion Compensation Modules (FBG-type)</b>		
SMF 100 GHz C-Band DCM 40 KM	BP1A10AA-UC	7.1.0
SMF 100 GHz C-Band DCM 60 KM	BP1A10AB-UC	7.1.0
SMF 100 GHz C-Band DCM 80 KM	BP1A10AC-UC	7.1.0
<b>Dispersion Compensation Modules (Expandable)</b>		
Dispersion Compensation Module - SMF 5 km	BT7A13AA	9.1
Dispersion Compensation Module - SMF 10 km	BT7A12AA	9.1
Dispersion Compensation Module - SMF 15 km	BT7A13BA	9.1
Dispersion Compensation Module - SMF 20 km	BT7A12BA	9.1
Dispersion Compensation Module - SMF 30 km	BT7A12CA	9.1
Dispersion Compensation Module - SMF 40 km	BT7A12DA	9.1
Dispersion Compensation Module - SMF 50 km	BT7A12EA	9.1
Dispersion Compensation Module - SMF 60 km	BT7A12FA	9.1
Dispersion Compensation Module - SMF 70 km	BT7A12GA	9.1
Dispersion Compensation Module - SMF 80 km	BT7A12HA	9.1
Dispersion Compensation Module - SMF 90 km	BT7A12JA	9.1
Dispersion Compensation Module - SMF 100 km	BT7A12KA	9.1



## 6.1.2 Dispersion Compensation module operating temperature ranges

Table 6-2 Dispersion Compensation modules operating temperature ranges

Module	0°C to +40°C long term	-5°C to +50°C short term
<b>DCF-type</b>		
SMF Dispersion Compensation Module 20 km - UC	X	X
SMF Dispersion Compensation Module 40 km -SC	X	X
SMF Dispersion Compensation Module 60 km-SC	X	X
SMF Dispersion Compensation Module 80 km -SC	X	X
<b>C-band FBG-type</b>		
SMF 100 GHz C-Band DCM 40 km - UC	X	X
SMF 100 GHz C-Band DCM 60 km - UC	X	X
SMF 100 GHz C-Band DCM 80 km - UC	X	X
<b>Dispersion Compensation Modules (Expandable)</b>		
Dispersion Compensation Module - SMF 5 km	X	X
Dispersion Compensation Module - SMF 10 km	X	X
Dispersion Compensation Module - SMF 15 km	X	X
Dispersion Compensation Module - SMF 20 km	X	X
Dispersion Compensation Module - SMF 30 km	X	X
Dispersion Compensation Module - SMF 40 km	X	X
Dispersion Compensation Module - SMF 50 km	X	X
Dispersion Compensation Module - SMF 60 km	X	X
Dispersion Compensation Module - SMF 70 km	X	X
Dispersion Compensation Module - SMF 80 km	X	X
Dispersion Compensation Module - SMF 90 km	X	X
Dispersion Compensation Module - SMF 100 km	X	X

**Note** Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days during a 1-year period (as detailed in GR-63-CORE).

## 6.2 Dispersion Compensation module applications

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This section provides information about the applications that Dispersion Compensation modules support.

### 6.2.1 Dispersion management

The Dispersion Compensation module (DCM) portfolio provides different compensation levels to correct for the amount of chromatic dispersion in a specific fiber span (or link) and slope matched to the fiber type.

DWDM Channelized DCMs use Fiber Bragg Grating (FBG) technology to provide reduced insertion loss for specific wavelength configurations. Greater reach and lower cost is achieved than with standard Dispersion Compensating Fiber modules. Modules can be selected to compensate for 40, 60, or 80km of dispersion. ITU-T DWDM wavelengths to be compensated must be in the 100 GHz grid for these modules to work.

Dispersion Compensating Fiber modules support any wideband signal at any wavelength inside the C-band independently of the ITU-T grid used. A wide range of compensating distances is available to adjust the dispersion compensation cost to the specific link requirements.

## 6.3 SMF (DCF-Type) Dispersion Compensation module specifications

The following table provides specifications for SMF Dispersion Compensation modules at 1550 nm.

**Table 6-3 SMF Dispersion Compensation module BP1A10CH/CC/CA/CB specifications**

Parameter	20 km	40 km	60 km	80 km	Units
Dispersion	-340 $\pm$ 2%	-680 $\pm$ 2%	-1020 $\pm$ 2%	-1345 $\pm$ 2%	ps/nm
Relative Dispersion Slope	0.0035 $\pm$ 20%	0.0035 $\pm$ 20%	0.0035 $\pm$ 20%	0.0035 $\pm$ 20%	nm <sup>-1</sup>
Insertion Loss (IL)	1.5<IL< 2.7	2.8<IL< 4.0	4.2<IL<6.3	5.5<IL<8.0	dB
<b>Note</b> Insertion Loss is specified at room temperature. An additional 0.5 dB must be added to account for worst case loss variation due to temperature over the entire operational range.					
Polarization Mode Dispersion	<0.44	<0.55	<0.58	<0.67	ps
Polarization Dependent Loss	<0.1	<0.1	<0.1	<0.1	dB

**Note** Relative Dispersion Slope (RDS) is calculated as follows:

$$\text{RDS} = \frac{\text{Dispersion Slope of DCF}}{\text{Dispersion of DCF}} = \frac{\text{Dispersion Slope of Fiber}}{\text{Dispersion of Fiber}}$$

## 6.4 SMF (Expandable) Dispersion Compensation Module specifications

This section lists the specifications for the following Dispersion Compensation Modules (DCMs):

**Table 6-4 Dispersion Compensation Modules**

Module	PEC
Dispersion Compensation Module - SMF 5 km	BT7A13AA
Dispersion Compensation Module - SMF 10 km	BT7A12AA
Dispersion Compensation Module - SMF 15 km	BT7A13BA
Dispersion Compensation Module - SMF 20 km	BT7A12BA
Dispersion Compensation Module - SMF 30 km	BT7A12CA
Dispersion Compensation Module - SMF 40 km	BT7A12DA
Dispersion Compensation Module - SMF 50 km	BT7A12EA
Dispersion Compensation Module - SMF 60 km	BT7A12FA
Dispersion Compensation Module - SMF 70 km	BT7A12GA
Dispersion Compensation Module - SMF 80 km	BT7A12HA
Dispersion Compensation Module - SMF 90 km	BT7A12JA
Dispersion Compensation Module - SMF 100 km	BT7A12KA

Table 6-5 DCM module specifications (BT7A13AA/13BA, BT7A12AA to BT7A12KA)

Distance	Dispersion ps/nm	Relative Dispersion Slope nm <sup>-1</sup>	Insertion Loss (IL) dB	Polarization Mode Dispersion ps	Polarization Dependent Loss dB	Loopback loss dB	Expansion connection loss dB
5 km	-85 ±2%	0.0035 ±20%	0.5<IL< 1.4	0.2	0.1	0.2<IL<1.0	0<IL<0.6
10 km	-170 ±2%	0.0035 ±20%	0.8<IL< 1.8	0.2	0.1	0.2<IL<1.0	0<IL<0.6
15 km	-255 ±2%	0.0035 ±20%	1.0<IL< 2.1	0.3	0.1	0.2<IL<1.0	0<IL<0.6
20 km	-340 ±2%	0.0035 ±20%	1.2<IL< 2.5	0.3	0.1	0.2<IL<1.0	0<IL<0.6
30 km	-510 ±2%	0.0035 ±20%	1.7<IL< 3.2	0.4	0.1	0.2<IL<1.0	0<IL<0.6
40 km	-680 ±2%	0.0035 ±20%	2.3<IL< 4.0	0.4	0.1	0.2<IL<1.0	0<IL<0.6
50 km	-850 ±2%	0.0035 ±20%	3.0<IL< 4.8	0.5	0.1	0.2<IL<1.0	0<IL<0.6
60 km	-1020 ±2%	0.0035 ±20%	3.7<IL<5.4	0.5	0.1	0.2<IL<1.0	0<IL<0.6
70 km	-1190 ±2%	0.0035 ±20%	4.4<IL< 6.1	0.6	0.1	0.2<IL<1.0	0<IL<0.6
80 km	-1345 ±2%	0.0035 ±20%	5.0<IL< 6.7	0.6	0.1	0.2<IL<1.0	0<IL<0.6
90 km	-1530 ±2%	0.0035 ±20%	4.3<IL< 7.1	0.6	0.1	0.2<IL<1.0	0<IL<0.6
100 km	-1700 ±2%	0.0035 ±20%	4.8<IL< 7.5	0.7	0.1	0.2<IL<1.0	0<IL<0.6

**Note** Dispersion and Relative dispersion slopes are specified at a wavelength of 1550 nm.

**Note** Insertion Loss is specified at room temperature. An additional 0.5 dB must be added to account for worst case loss variation due to temperature over the entire operational range.

**Note** Relative Dispersion Slope (RDS) is calculated as follows:

$$\text{RDS} = \frac{\text{Dispersion Slope of DCF}}{\text{Dispersion of DCF}} = \frac{\text{Dispersion Slope of Fiber}}{\text{Dispersion of Fiber}}$$

## 6.5 SMF 100 GHz C-Band Dispersion Compensation module specifications

Table 6-6 SMF 100 GHz C-Band Dispersion Compensation module BP1A10AA/AB/AC specifications

Parameter	40 km	60 km	80 km	Units
Wavelength Range	See 7.4.1, “40-channel DWDM wavelength plan”			
Channel Bandwidth	30			GHz
Peak to Peak Group Delay Ripple (averaged)	≤11	≤12	≤13	ps/nm
<b>Dispersion</b>				
1530.33 nm	-635 ±5%	-950 ±5%	-1270 ±5%	ps/nm
1559.79 nm	-700 ±5%	-1050 ±5%	-1400 ±5%	ps/nm
Insertion Loss (IL)	≤5.5			dB
Insertion Loss Ripple	≤1.0			dB
Polarization Mode Dispersion	<0.7	<1.0	<1.5	ps
Polarization Dependent Loss	<0.3			dB

**Note** Dispersion at ITU-T  $\lambda$  =

$$0.0223 \times (\lambda - 1309.1^4) \times \text{fiber length compensated (km)} \\ \lambda^3$$



## 7.0 Multiplexing modules

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This section provides information about the Multiplexing modules that the BTI 7000 Series supports.

- [7.1, “Optical Multiplexer portfolio”](#)
- [7.2, “Multiplexing and demultiplexing applications”](#)
- [7.3, “CWDM Multiplexer specifications”](#)
- [7.4, “DWDM Multiplexer specifications”](#)
- [7.5, “Splitter Combiner specifications”](#)

## 7.1 Optical Multiplexer portfolio

This section provides information about the modules in the Optical Multiplexing portfolio and covers the following topics:

- 7.1.1, “Multiplexing modules”
- 7.1.2, “Multiplexing module operating temperature ranges”

### 7.1.1 Multiplexing modules

**Table 7-1 Optical Multiplexers**

Modules	PEC	System software introduced
<b>Passive multiplexing modules</b>		
1-Channel DWDM Optical Add/Drop Module	BP1A36AA	7.1.0
Double 1-Channel CWDM OADM/Double OSC Coupler Splitter	BP1A32CA	7.1.0
4-Channel CWDM Mux/Demux, Channel 1 - 4		7.1.0
4-Channel CWDM Mux/Demux, Channel 5 - 8	BP1A33BB	7.1.0
4-Channel CWDM Mux/Demux, Channel 9 - 12	BP1A33BC	7.1.0
4-Channel CWDM Mux/Demux, Channel 13 - 16	BP1A33BD	7.1.0
4-Channel CWDM Mux/Demux, Channel 1 - 4, LC (without inventory)		
4-Channel CWDM Mux/Demux, Channel 5 - 8, LC (without inventory)		
4-Channel CWDM Mux/Demux, Channel 9 - 12, LC (without inventory)		
4-Channel CWDM Mux/Demux, Channel 13 - 16, LC (without inventory)		
32-Channel DWDM Mux/Demux Module 1	BP1A35AA	7.1.0
32-Channel DWDM Mux/Demux Module 2	BP1A35AB	7.1.0
32-Channel DWDM Mux/Demux Module 3	BP1A35AC	7.1.0
32-Channel DWDM Mux/Demux Module 4	BP1A35AD	7.1.0
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 1, Demux Band 2)	BP1A35DA-12	7.1.0
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 2, Demux Band 1)	BP1A35DA-21	7.1.0
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 4, Demux Band 2)	BP1A35DA-42	7.1.0
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 2, Demux Band 4)	BP1A35DA-24	7.1.0
2-Channel DWDM OADM	BP1A36AB	7.1.0
4-Channel DWDM OADM	BP1A36AC	7.1.0

Table 7-1 Optical Multiplexers (Continued)

Modules	PEC	System software introduced
4-Channel DWDM OADM, BTI Channels E1, E3, E5, E7	BP1A36BC	7.1.0
<b>Coupler/Splitter modules</b>		
1310 nm and C-Band Coupler/Splitter	BP1A38AA	7.1.0
CWDM + DWDM Splitter Combiner	BP1A30AA	7.1.0
DWDM Bidirectional Coupler/Splitter	BP1A39CA	7.1.0
Single 50/50 Coupler/Splitter	BP1A39DA	7.1.0
<b>Multiplexer/Demultiplexer passive shelves</b>		
40-Channel DWDM Mux/Demux	BT7A37AA	7.1.0
40-Channel DWDM Mux/Demux (ETSI)	BT7A37CA	7.1.0
96-Channel DWDM Mux/Demux	BT8A96MD01-I02	10.3
96-Channel DWDM Mux/Demux (ETSI)	BT8A96MD02-I02	10.3
96-Channel DWDM Mux/Demux (FMD96)	BT8A78MD03	13.2

## 7.1.2 Multiplexing module operating temperature ranges

Table 7-2 Multiplexing module operating temperature ranges

Module	0°C to +40°C long term	-5°C to +50°C short term	-20°C to +65°C long term	-40°C to +65°C long term
1-Channel CWDM OADM	X	X	X	X
2-Channel CWDM OADM	X	X	X	X
Double 1-Channel CWDM OADM/Double OSC Coupler Splitter	X	X	X	X
4-Channel CWDM Mux/Demux (Ch. 1 – 4)	X	X	X	X
4-Channel CWDM Mux/Demux (Ch. 5 – 8)	X	X	X	X
4-Channel CWDM Mux/Demux (Ch. 9 – 12)	X	X	X	X
4-Channel CWDM Mux/Demux (Ch. 13 – 16)	X	X	X	X
32-Channel DWDM Mux/Demux Module 1	X	X	X	X
32-Channel DWDM Mux/Demux Module 2	X	X	X	X
32-Channel DWDM Mux/Demux Module 3	X	X	X	X
32-Channel DWDM Mux/Demux Module 4	X	X	X	X
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 1, Demux Band 2)	X	X	X	X
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 2, Demux Band 1)	X	X	X	X
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 2, Demux Band 4)	X	X	X	X
32-Channel DWDM Bidirectional Mux/Demux (Mux Band 4, Demux Band 2)	X	X	X	X

**Table 7-2 Multiplexing module operating temperature ranges (Continued)**

Module	0°C to +40°C long term	-5°C to +50°C short term	-20°C to +65°C long term	-40°C to +65°C long term
1-Channel DWDM OADM	X	X	X	X
2-Channel DWDM OADM	X	X	X	X
4-Channel DWDM OADM	X	X	X	X
1310nm and C-Band Coupler/Splitter	X	X	X	X
DWDM Bidirectional Coupler/Splitter	X	X		
CWDM and DWDM Splitter Combiner	X	X		
Single 50/50 Coupler/Splitter	X	X		
40-Channel DWDM Mux/Demux	X	X		
96-Channel DWDM Mux/Demux	X	X		
Y-cable (single mode)	X	X	X	

**Note** Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days during a 1-year period (as detailed in GR-63-CORE).

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## 7.2 Multiplexing and demultiplexing applications

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This section provides information about the applications that Optical Multiplexing modules support.

- [7.2.1, “Capacity expansion”](#)
- [7.2.2, “Fiber exhaust”](#)
- [7.2.3, “Single-fiber applications”](#)

### 7.2.1 Capacity expansion

CWDM and DWDM Multiplexing modules and passive shelves expand the capacity of a fiber up to 96 channels for applications such as fiber relief and overlay of new-generation services on existing fiber networks. WDM technology offers significant return on investment by combining multiple services into a single pair of fibers.

DWDM multiplexing modules are suitable for applications in which a higher number of channels is required. The DWDM infrastructure provides for more than extension, allowing any other protocol to be multiplexed into the same fiber pair. This added flexibility enables you to consolidate and scale data, voice, video, storage, and SONET/SDH infrastructures. CWDM is optimized for lower channel counts and shorter distances.

OADM capability enables deployment of a complete photonic layer, with the ability to add and drop services at intermediate sites for simple, economical, and scalable site connectivity.

### 7.2.2 Fiber exhaust

CWDM and DWDM Multiplexing modules and passive shelves can be used to overlay new broadband services and expand fiber capacity up to 96 DWDM and/or 16 CWDM channels on a single fiber pair. No changes to existing client equipment are required: mux/demux ports connect directly to CWDM or DWDM client ports, or connect to 850nm, 1310nm, 1550nm, or 1610nm client ports through a Transponder module. A CWDM to DWDM hybrid combination can be provided with the CWDM/DWDM coupler/splitter.

### 7.2.3 Single-fiber applications

The 32-Channel DWDM Bidirectional Mux/Demux and Double Bidirectional Coupler/Splitter modules provide a single-fiber, bidirectional transmission solution that meets the growing bandwidth demands of metro and regional networks.

Bidirectional transmission allows signals to be transmitted and received on one fiber, which is particularly beneficial for operators using leased dark fiber, since only one leased fiber is required instead of two. With reduced costs and optimized usage of a single fiber, this solution for fiber-constrained networks is available for both amplified and non-amplified applications.

The 32-Channel DWDM Bidirectional Mux/Demux supports up to 16 channel configurations of eight channels transmitting and receiving in each direction. Eight signals are multiplexed and demultiplexed at each site. The following band combinations are available:

- Band 1/Band 2
- Band 2/Band 4

Bands 1 and 2 are recommended in 16-channel configurations (eight channels per direction) using BTI 7000 Series single-channel amplifiers.

## 7.3 CWDM Multiplexer specifications

The CWDM multiplexers provide optical multiplexing in CWDM network architectures. A low-cost alternative to DWDM network architectures, a CWDM solution is ideal for low-channel-count networks.

This section covers the following topics:

- [7.3.1, “CWDM wavelength plan”](#)
- [7.3.2, “Double 1-Channel CWDM OADM/Double OSC Coupler Splitter ”](#)
- [7.3.3, “4-Channel CWDM Mux/Demux Modules 1 to 4 specifications”](#)

### 7.3.1 CWDM wavelength plan

The 4-channel CWDM multiplexer/demultiplexer modules support 4 channels in each module. The 16 wavelengths supported by the modules combined are listed in the following table.

**Note** Channels 1391 nm and 1441 nm are not supported as a result of high fiber attenuation at those wavelengths.

**Table 7-3 CWDM Wavelength Plan**

Available Wavelengths (nm)	Mux/Demux Modules	BTI Channel Numbers
1271	4	16
1291	4	15
1311	4	14
1331	4	13
1351	3	12
1371	3	11
1431	3	10
1451	3	9
1471	2	8
1491	2	7
1511	2	6
1531	2	5
1551	1	4
1571	1	3
1591	1	2
1611	1	1

### 7.3.2 Double 1-Channel CWDM OADM/Double OSC Coupler Splitter

**Note** Channels 9 to 16 (1451 nm to 1271 nm) are manufacture discontinued (MD) and are no longer orderable.

**Table 7-4 Double 1-Channel CWDM OADM/Double OSC Coupler Splitter (BP1A32CA) specifications**

Parameter	Standard	Hardened	Units
Center Wavelength	1271 to 1611		nm
Center Wavelength Accuracy	±0.5		nm
Channel Spacing	See 7.3.1, “CWDM wavelength plan”.		nm
Channel Pass Band	±6.5		nm
Channel Ripple			
Passband	≤0.5	≤0.5	dB
Express Channel	≤0.5	≤0.5	dB
Insertion Loss			
Add/Drop Channel	≤1.3	≤1.5	dB
Express Channel	≤1.0	≤1.2	dB
Isolation			
Adjacent Channel	NA/≥30		dB
Non-Adjacent Channel	NA/≥40		dB
Express Channel	NA/≥15		dB
Directivity	≥50		dB
Return Loss	≥45		dB
Polarization Dependent Loss	≤0.1		dB
Polarization Mode Dispersion	≤0.1		pS

### 7.3.3 4-Channel CWDM Mux/Demux Modules 1 to 4 specifications

**Table 7-5 4-Channel CWDM Mux/Demux BP1A33BA/BB/BC/BD specifications**

Parameter	Standard	Hardened	Units
Wavelength Range			
Module 1	1551 to 1611		nm
Module 2	1471 to 1531		nm
Module 3	1351 to 1451		nm
Module 4	1271 to 1331		nm
Channel Wavelength Accuracy	$\pm 0.5$		nm
Channel Spacing	See 7.3.1, "CWDM wavelength plan".		nm
Channel Pass Band	$\pm 6.5$		nm
Channel Ripple	$\leq 0.5$	$\leq 0.5$	dB
Express Band Ripple	$\leq 0.8$	$\leq 0.8$	dB



**Table 7-5 4 -Channel CWDM Mux/Demux BP1A33BA/BB/BC/BD specifications (Continued)**

Parameter	Standard	Hardened	Units
Insertion Loss			
In to Drop 1, Add 4 to Out	≤1.3	≤1.5	dB
In to Drop 2, Add 3 to Out	≤1.6	≤2.0	dB
In to Drop 3, Add 2 to Out	≤2.0	≤2.2	dB
In to Drop 4, Add 1 to Out	≤2.3	≤2.5	dB
Expansion Port Loss	≤2.0	≤2.2	dB
Insertion Loss Uniformity			
Module	≤1.6	≤1.8	dB
Pair	≤1.5	≤1.5	dB
Isolation			
Adjacent Channel	NA/≥30		dB
Non-Adjacent Channel	NA/≥40		dB
Express Channel	NA/≥15		dB
Directivity	≥50		dB
Return Loss	≥45		dB
Polarization Dependent Loss	≤0.2		dB
Polarization Mode Dispersion	≤0.2		ps

### 7.3.4 1310nm + CWDM Optical Add/Drop Multiplexer specifications

**Table 7-6 1310 CWDM Optical Add/Drop (BT7A32DA) Multiplexer specifications**

1310 CWDM Optical Add/Drop Multiplexer			
Parameter	Standard	Hardened	Units
Center Wavelength – CWDM Add/Drop	1471 to 1611		nm
Operating Wavelength Range			
1310 Add/Drop	1260 to 1360		nm
1310 Thru	1460	1620	nm
Channel Spacing	see 7.3.1, “CWDM wavelength plan”		nm
Channel Pass Band (CWDM)	±6.5		nm
Channel Ripple			
CWDM Pass band	≤0.3		dB
1310 Pass band	≤0.35		dB
Insertion Loss			
Line In to 1310 Drop	1.2	1.4	dB
Line In to CWDM Drop	2.2	2.4	dB
Line In to Line Out	3.4	3.8	dB
CWDM Add to Line Out	2.2	2.4	dB

**Table 7-6 1310 CWDM Optical Add/Drop (BT7A32DA) Multiplexer specifications (Continued)**

1310 CWDM Optical Add/Drop Multiplexer			
1310 Add to Line Out	1.2	1.4	dB
Express CWDM Channel Uniformity - max loss variation within Passband from Line In to Line Out	≤0.7		dB
CWDM/1310 Isolation			
CWDM In 1310 Drop	≥25		dB
1310 In CWDM Drop	≥45		dB
CWDM Channel Isolation			
CWDM Add/Drop Channel Line In to Line Out	≥30		dB
CWDM Adjacent Channel In CWDM Drop	≥30		dB
CWDM Non-adjacent Channel In CWDM Drop	≥40		dB
Directivity	≥50		dB
Return Loss	≥45		dB
Polarization Dependent Loss	≤0.1		dB
Polarization Mode Dispersion	≤0.1		dB

## 7.4 DWDM Multiplexer specifications

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This section contains specifications and additional information about DWDM Multiplexer modules and covers the following topics:

- [7.4.1, “40-channel DWDM wavelength plan”](#)
- [7.4.2, “96-channel DWDM wavelength plan”](#)
- [7.4.3, “DWDM Mux/Demux specifications”](#)
- [7.4.4, “DWDM OADM specifications”](#)
- [7.4.5, “40-Channel DWDM Mux/Demux specifications”](#)
- [7.4.6, “96-Channel DWDM Mux/Demux specifications”](#)
- [7.4.7, “96-Channel Fixed Mux/Demux Specifications”](#)

### 7.4.1 40-channel DWDM wavelength plan

This DWDM wavelength plan applies to the following modules:

- 40-Channel DWDM Mux/Demux
- SMF 100 GHz C-Band DCM
- 32-Channel DWDM Mux/Demux
- 32-Channel DWDM Bidirectional Mux/Demux
- 2-, and 4-Channel DWDM OADMs

**Important** DWDM OADMs support only channels 1 to 32.

**Table 7-7 DWDM Wavelength Plan**

Wavelength (nm)	BTI Channel Numbers	Wavelength (nm)	BTI Channel Numbers
1529.55	E8	1545.32	E4
1530.33	32	1546.12	16
1531.12	31	1546.92	15
1531.90	30	1547.72	14
1532.68	29	1548.51	13
1533.47	28	1549.32	12
1534.25	27	1550.12	11
1535.04	26	1550.92	10
1535.82	25	1551.72	9
1536.61	E7	1552.52	E3
1537.40	E6	1553.33	E2
1538.19	24	1554.13	8
1538.98	23	1554.94	7
1539.77	22	1555.75	6
1540.56	21	1556.55	5
1541.35	20	1557.36	4
1542.14	19	1558.17	3
1542.94	18	1558.98	2
1543.73	17	1559.79	1
1544.53	E5	1560.61	E1

## 7.4.2 96-channel DWDM wavelength plan

The following table lists the DWDM wavelength plan for the BTI 7000 Series 96-channel Mux/Demux passive shelf:

**Table 7-8 96-channel DWDM Wavelength Plan**

DOLChannel Numbers	Frequency (THz)	Wavelength (nm)
610	196.10	1528.77
605	196.05	1529.16
600	196.00	1529.55
595	195.95	1529.94
590	195.90	1530.33
585	195.85	1530.72
580	195.80	1531.12
575	195.75	1531.51
570	195.70	1531.90
565	195.65	1532.29
560	195.60	1532.68
555	195.55	1533.07
550	195.50	1533.47
545	195.45	1533.86
540	195.40	1534.25
535	195.35	1534.64
530	195.30	1535.04
525	195.25	1535.43
520	195.20	1535.82
515	195.15	1536.22
510	195.10	1536.61
505	195.05	1537.00
500	195.00	1537.40
495	194.95	1537.79
490	194.90	1538.19
485	194.85	1538.58
480	194.80	1538.98
475	194.75	1539.37
470	194.70	1539.77
465	194.65	1540.16
460	194.60	1540.56
455	194.55	1540.95
450	194.50	1541.35

**Table 7-8 96-channel DWDM Wavelength Plan (Continued)**

<b>DOLChannel Numbers</b>	<b>Frequency (THz)</b>	<b>Wavelength (nm)</b>
445	194.45	1541.75
440	194.40	1542.14
435	194.35	1542.54
430	194.30	1542.94
425	194.25	1543.33
420	194.20	1543.73
415	194.15	1544.13
410	194.10	1544.53
405	194.05	1544.92
400	194.00	1545.32
395	193.95	1545.72
390	193.90	1546.12
385	193.85	1546.52
380	193.80	1546.92
375	193.75	1547.32
370	193.70	1547.72
365	193.65	1548.11
360	193.60	1548.51
355	193.55	1548.91
350	193.50	1549.32
345	193.45	1549.72
340	193.40	1550.12
335	193.35	1550.52
330	193.30	1550.92
325	193.25	1551.32
320	193.20	1551.72
315	193.15	1552.12
310	193.10	1552.52
305	193.05	1552.93
300	193.00	1553.33
295	192.95	1553.73
290	192.90	1554.13
285	192.85	1554.54
280	192.80	1554.94
275	192.75	1555.34
270	192.70	1555.75
265	192.65	1556.15
260	192.60	1556.55

**Table 7-8 96-channel DWDM Wavelength Plan (Continued)**

<b>DOLChannel Numbers</b>	<b>Frequency (THz)</b>	<b>Wavelength (nm)</b>
255	192.55	1556.96
250	192.50	1557.36
245	192.45	1557.77
240	192.40	1558.17
235	192.35	1558.58
230	192.30	1558.98
225	192.25	1559.39
220	192.20	1559.79
215	192.15	1560.20
210	192.10	1560.61
205	192.05	1561.01
200	192.00	1561.42
195	191.95	1561.83
190	191.90	1562.23
185	191.85	1562.64
180	191.80	1563.05
175	191.75	1563.45
170	191.70	1563.86
165	191.65	1564.27
160	191.60	1564.68
155	191.55	1565.09
150	191.50	1565.50
145	191.45	1565.91
140	191.40	1566.31
135	191.35	1566.72

### 7.4.3 DWDM Mux/Demux specifications

Multiplexers include the 32-Channel DWDM Mux/Demux modules, which are available as the following 8-channel modules:

- 32-Channel DWDM Mux/Demux Module 1
- 32-Channel DWDM Mux/Demux Module 2
- 32-Channel DWDM Mux/Demux Module 3
- 32-Channel DWDM Mux/Demux Module 4

The following 32-Channel Bidirectional DWDM Mux/Demux modules are also available:

- 32-Channel DWDM Bidirectional Mux/Demux (Mux Band 1, Demux Band 2)

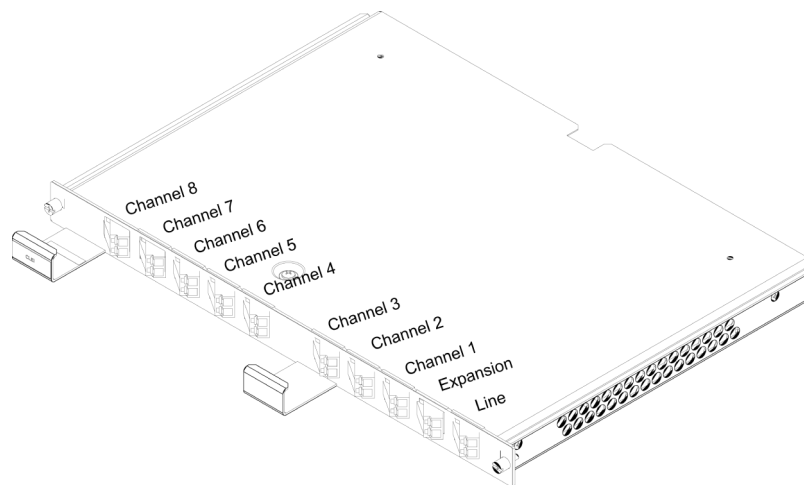
- 32-Channel DWDM Bidirectional Mux/Demux (Mux Band 2, Demux Band 1)
- 32-Channel DWDM Bidirectional Mux/Demux (Mux Band 2, Demux Band 4)
- 32-Channel DWDM Bidirectional Mux/Demux (Mux Band 4, Demux Band 2)

The following band combinations are available:

- Band 1/Band 2
- Band 2/Band 4

The following figure shows the key physical features of the 32-Channel DWDM Mux/Demux modules.

#### 8-channel module for 32-Channel DWDM Mux/Demux



This section covers the following topic:

- [7.4.3.1, “32-Channel DWDM Mux/Demux specifications”](#)

### 7.4.3.1 32-Channel DWDM Mux/Demux specifications

**Table 7-9 32-Channel DWDM Mux/Demux BP1A35AA/AB/AC/AD/DA-12/DA-21/DA-24/DA-42 specifications**

Parameter	Standard	Hardened	Units
Wavelength Range			
Module 1	1554.13 to 1559.79		nm
Module 2	1546.12 to 1551.72		nm
Module 3	1538.19 to 1543.73		nm
Module 4	1530.33 to 1535.82		nm
Channel Wavelength	ITU 100 GHz Grid		
Channel Wavelength Accuracy	±0.1		nm
Channel Spacing	100		GHz
Channel Pass Band	±12.5		GHz
Channel Ripple	≤0.5		dB



**Table 7-9 32-Channel DWDM Mux/Demux BP1A35AA/AB/AC/AD/DA-12/DA-21/DA-24/DA-42 specifications (Continued)**

Parameter	Standard	Hardened	Units
Insertion Loss	$0.5 \leq IL \leq 3.8$	$0.5 \leq IL \leq 4.3$	dB
Insertion Loss Uniformity	$\leq 2.5$		dB
Insertion Loss for Mux/Demux pair	$3 \leq IL \leq 6.0$	$3 \leq IL \leq 6.5$	dB
Insertion Loss Uniformity for Mux/Demux pair	$\leq 1.5$		dB
Expansion Port Loss	$\leq 0.8$	$\leq 1.0$	dB
<b>Note</b> Upgrade port insertion loss includes a 0.3 dB channel ripple.			
Chromatic Dispersion for Mux/Demux pair	Min = -85 Max = +65		ps/nm
<b>Note</b> Chromatic dispersion is specified over a $\pm 15$ GHz bandwidth.			
Adjacent Channel Isolation (Mux/Demux)	NA/ $\geq 25$		dB
Non-Adjacent Channel Isolation (Mux/Demux)	NA/ $\geq 40$		dB
Drop channel residual @ Expansion Port Out	$\geq 15$		dB
Directivity	$\geq 50$		dB
Return Loss	$\geq 45$		dB
Polarization Dependent Loss	$\leq 0.2$	$\leq 0.25$	dB
Polarization Mode Dispersion	$\leq 0.2$		ps
Latency	$\leq 10$		ns

**Note** Total insertion losses for networks with cascaded filters are dependent on the connection order of the expansion ports.

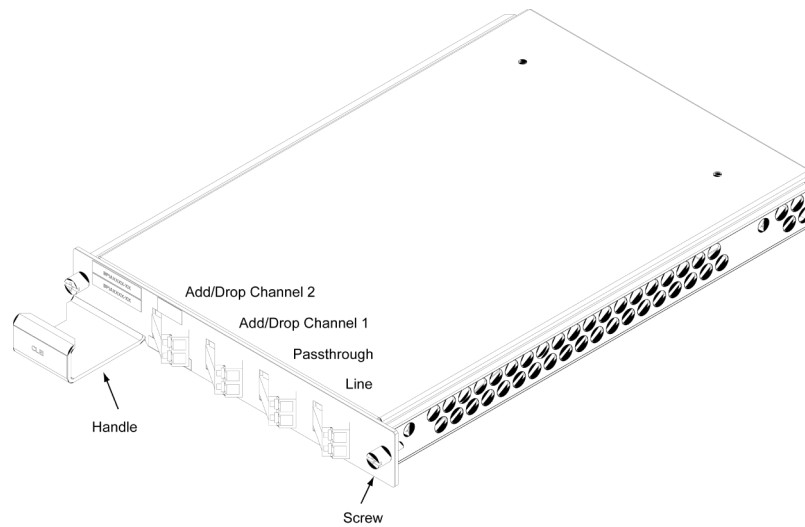
**Note** All Insertion Loss values include connector loss.

#### 7.4.4 DWDM OADM specifications

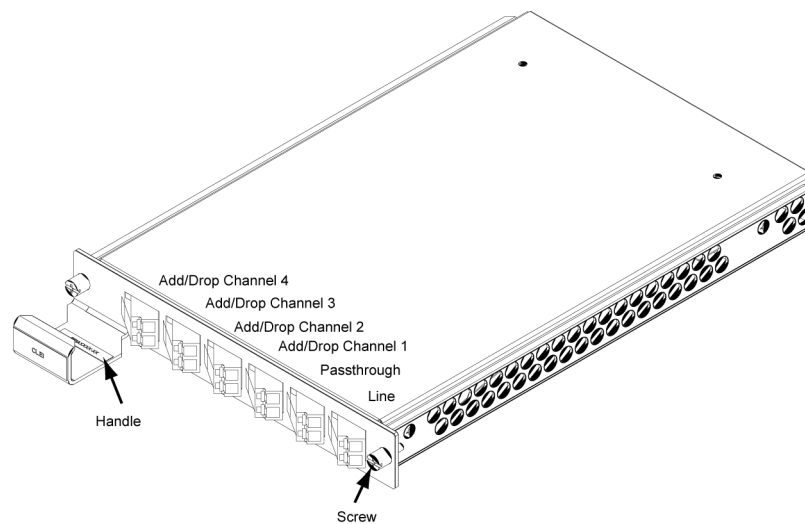
The DWDM OADM modules complement the passive 32-Channel DWDM Mux/Demux modules, enabling customers to expand capacity when required. For a listing of available DWDM OADM modules, see [7.1.1, “Multiplexing modules”](#).

The following figures show the key physical features of the 2-Channel, and 4-Channel DWDM Optical Add/Drop modules.

## 2-Channel OADM



## 4 -Channel OADM



### 7.4.4.1 2-Channel DWDM Optical Add/Drop Module specifications

Table 7-10 2-Channel DWDM OADM BP1A36AB specifications

Parameter	Add/Drop	Units
Wavelength Range	See <a href="#">7.4.1, “40-channel DWDM wavelength plan”</a> .	nm
Channel Wavelength	ITU 100 GHz Grid	
Channel Wavelength Accuracy	±0.1	nm
Channel Spacing	100	GHz
Channel Pass Band	±12.5	GHz

**Table 7-10 2-Channel DWDM OADM BP1A36AB specifications (Continued)**

Parameter	Add/Drop	Units
Insertion Loss (In to Drop 1, Add 2 to Out)	$\leq 1.5$ $\leq 1.7$ (Hardened)	dB
Insertion Loss (In to Drop 2, Add 1 to Out)	$\leq 1.9$ $\leq 2.1$ (Hardened)	dB
Insertion Loss (Pass Through channels)	$\leq 1.8$ $\leq 2.0$ (Hardened)	dB
A/D Channel Ripple	$\leq 0.5$	dB
Isolation @ A/D channel (Adjacent)	NA $\geq 25$	dB
Isolation @ A/D channel (Non-adjacent)	NA $\geq 50$	dB
<b>Add/Drop Filter Isolation</b>		
Drop channel residual @ Pass Through Out	$\geq 15$	dB
Drop channel residual from Pass Through In to Line Out	$\geq 15$	dB
Drop channel residual @ Line Out as Pass Through Out connected to Pass Through In directly (looped)	$\geq 30$	dB
Directivity	$\geq 50$	dB
Return Loss	$\geq 45$	dB
Polarization Dependent Loss	$\leq 0.2$	dB
Polarization Mode Dispersion	$\leq 0.15$	ps

**Note** All insertion loss values include connector losses.

### Available channel combinations

For adjacent channel modules, the combinations are:

- xx, xx+1
- xx=01, 03, 05, 07, 09, 11, 13, 15... 31

where xx, for channels 1 and 2, is 01, as in BP1A36AB-01.

### 7.4.4.2 4-Channel DWDM Optical Add/Drop Module specifications

**Table 7-11 4-Channel DWDM Optical Add-Drop Module BP1A36AC/BC specifications**

Parameter	Add/Drop	Units
Wavelength Range	See 7.4.1, "40-channel DWDM wavelength plan".	nm
Channel Wavelength	ITU 100 GHz Grid	
Channel Wavelength Accuracy	$\pm 0.1$	nm

**Table 7-11 4-Channel DWDM Optical Add-Drop Module BP1A36AC/BC specifications (Continued)**

Parameter	Add/Drop	Units
Channel Spacing	100	GHz
Channel Pass Band	$\pm 12.5$	GHz
Insertion Loss (A/D channel)		
In to Drop 1, Add 4 to Out	$\leq 1.5$ $\leq 1.7$ (Hardened)	dB
In to Drop 2, Add 3 to Out	$\leq 1.8$ $\leq 2.0$ (Hardened)	dB
In to Drop 3, Add 2 to Out	$\leq 2.1$ $\leq 2.3$ (Hardened)	dB
In to Drop 4, Add 1 to Out	$\leq 2.4$ $\leq 2.5$ (Hardened)	dB
Insertion Loss (Pass Through channels)	$\leq 3.0$	dB
A/D Channel Ripple	$\leq 0.5$	dB
Isolation @ A/D channel (Adjacent)	NA $\geq 25$	dB
Isolation @ A/D channel (Non-adjacent)	NA $\geq 50$	dB
<b>Add/Drop Filter Isolation</b>		
Drop channel residual @ Pass Through Out	$\geq 15$	dB
Drop channel residual from Pass Through In to Line Out	$\geq 15$	dB
Drop channel residual @ Line Out as Pass Through Out connected to Pass Through In directly (looped)	$\geq 30$	dB
Directivity	$\geq 50$	dB
Return Loss	$\geq 45$	dB
Polarization Dependent Loss	$\leq 0.2$	dB
Polarization Mode Dispersion	$\leq 0.15$	ps

**Note** All insertion loss values include connector losses.

### Available channel combinations

For adjacent channel modules, the combinations are:

- xx, xx+1, xx+2, xx+3
- xx=01, 05, 09, 13... 29

where xx, for channels 1, 2, 3 and 4 is 01, as in BP1A36AC-01.

In addition to the 4-Channel DWDM OADM module (BP1A36AC), which supports channels 1 to 32, the 4-Channel DWDM OADM (BP1A36BC) supports channels 53, 55, 57, and 59 (1560.

61 nm, 1552.52 nm, 1544.53 nm and 1536.61 nm). Channels 53, 55, 57, and 59 correspond to channels 1, 2, 3 and 4 on the OADM module.

**Note** The four channels must be adjacent to each other.

### 7.4.5 40-Channel DWDM Mux/Demux specifications

The 40-Channel DWDM Mux/Demux supports the multiplexing of 40 ITU DWDM wavelengths onto a single fiber. This module integrates a line in and line out monitor port, an optical isolator, and a 40-channel DWDM Mux/Demux filter.

**Table 7-12 40-Channel DWDM Mux/Demux (BT7A37AA/CA) specifications**

Parameter	Mux	Demux	Units
Wavelength Range	1529.55 to 1560.61		nm
Channel Wavelength	ITU 100 GHz Grid		
Channel Wavelength Accuracy	±0.06		nm
Channel Spacing	100		GHz
Channel Pass Band	±12.5		GHz
Channel Ripple	≤0.6		dB
Insertion Loss (IL)	$3.1 \leq IL \leq 6.5$	$3.4 \leq IL \leq 7.0$	dB
Insertion Loss Uniformity	≤1.5		dB
Chromatic Dispersion (CD)	$-20 \leq CD \leq 20$		ps/nm
Adjacent Channel Isolation	–	≥25	dB
Non-Adjacent Channel Isolation	–	≥30	dB
Directivity	≥45		dB
Return Loss	≥45	≥40	dB
Polarization Dependent Loss	≤0.6		dB
Polarization Mode Dispersion	≤0.6		dB
Latency	≤15		ns

**Note** All insertion loss values include connector losses.

### 7.4.6 96-Channel DWDM Mux/Demux specifications

The 96-Channel DWDM Mux/Demux supports the multiplexing of 96 ITU DWDM wavelengths onto a single fiber. This module can support 1610 nm OSC add/drop management through a passthrough port to which you can connect a pre-amplifier and booster-amplifier; this eliminates the need for a separate 1610 nm filter.

**Table 7-13 96-Channel DWDM Mux/Demux (BT8A96MD01-I02/MD02-I02) specifications**

Parameter		Mux		Demux		Units
Wavelength Range		1566.72 to 1528.77				nm
Channel Wavelength		ITU 50 GHz Grid				
Channel Frequency		196.10 to 191.35				THz
Channel Spacing		50				GHz
ITU Band		±6.25				GHz
Channel Ripple		≤0.5				dB
OSC Wavelength		1600 to 1640				nm
Insertion Loss (IL) - Mux	C-Band	CH <sub>ADD</sub> to Line <sub>OUT</sub>	3.0 ≤ IL ≤ 6.2			dB
	C-Band	PT <sub>IN</sub> to Line + 1610 <sub>OUT</sub>	0.6 typical 0.8 maximum			dB
	C-Band	MON <sub>OUT</sub> to Line <sub>OUT</sub>	18.0 ≤ IL ≤ 22.0			dB
	1600-1640nm	OSC <sub>IN</sub> to Line + OSC <sub>OUT</sub>	≤1.0			dB
Insertion Loss (IL) - Demux	C-Band			Line <sub>IN</sub> to CH <sub>DROP</sub>	3.0 ≤ IL ≤ 6.8	dB
	C-Band			Line + 1610 <sub>IN</sub> to PT <sub>OUT</sub>	0.6 typical 0.9 maximum	dB
	C-Band			Line <sub>IN</sub> to MON <sub>IN</sub>	18.0 ≤ IL ≤ 22.0	dB
	1600-1640nm			Line + 1610 <sub>IN</sub> to OSC <sub>OUT</sub>	≤1.3	dB
Insertion Loss Uniformity		≤1.5				dB
Chromatic Dispersion (CD)		-42 ≤ CD ≤+42				ps/nm
Adjacent Channel Isolation		≥23		≥23		dB
Non-Adjacent Channel Isolation		≥30		≥30		dB
Directivity		≥40				dB
Return Loss		≥40		≥40		dB
Polarization Dependent Loss		≤0.65				dB

**Table 7-13 96-Channel DWDM Mux/Demux (BT8A96MD01-I02/MD02-I02) specifications (Continued)**

Parameter		Mux	Demux	Units
Polarization Mode Dispersion		≤0.85	≤0.9	ps
Passband	0.5 dB down	20.0		GHz
	1.0 dB down	24.5		GHz
	3.0 dB down	35.0		GHz

**Note** All insertion loss values include connector losses.

## 7.4.7 96-Channel Fixed Mux/Demux Specifications

**Table 7-14 FMD96 (BT8A78MD03) Specifications**

Parameters	Range		
Physical			
Width	438 mm		
Height	88 mm		
Depth	280 mm		
Weight			
Environmental			
Power Consumption	Not applicable, passive		
Optical	Minimum	Typical	Maximum
Central Wavelengths (C-Band)	1528.77 nm		1566.72 nm
Number of channels (50GHz spacing)			96 channels
Insertion Loss (client in to line out)	4.0 dB		6.5 dB
Insertion Loss (line in to client out)	4.0 dB		6.5 dB
Monitor In Port Loss <sup>1</sup>	19.6 dB		22.3 dB
Monitor Out Port Loss <sup>2</sup>	17.9 dB		21.2 dB
L1 Composite Input Signal Power			23 dBm
Client Input Signal Power			5 dBm/port <sup>3</sup>
Wavelength (OSC, Line Port) <sup>4</sup>	1266 nm	1310nm	1360 nm
Fiber Type	SMF-28 or equivalent		
Connector	LC/UPC		

<sup>1</sup> Relative to L1 In.

<sup>2</sup> Relative to L1 Out.

<sup>3</sup> The input power per client port must not exceed this limit to ensure that the optical safety on line output is within Class 1M requirements.

<sup>4</sup> For connection to ROADM client ports.





## 7.5 Splitter Combiner specifications

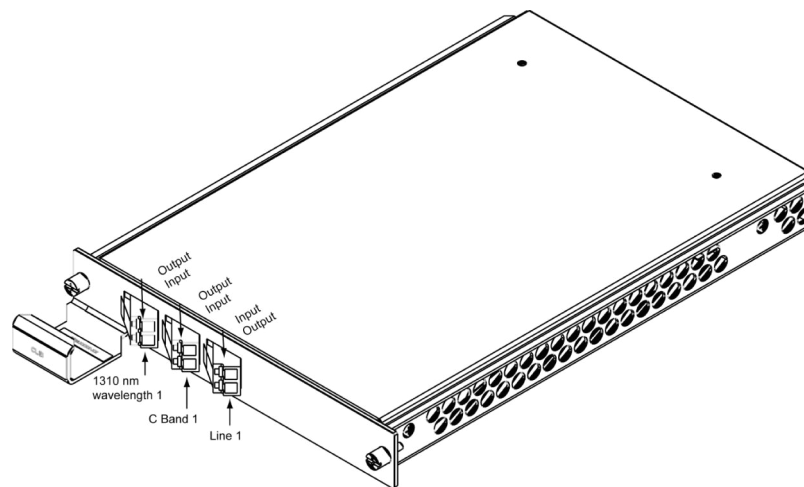
This section contains specifications and additional information about Splitter Combiner modules, and covers the following topics:

- 7.5.1, “1310nm Coupler/Splitter specifications”
- 7.5.2, “Double DWDM Bidirectional Coupler/Splitter specifications”
- 7.5.3, “CWDM + DWDM Splitter Combiner specifications”
- 7.5.5, “Single 50/50 Coupler/Splitter specifications”

### 7.5.1 1310nm Coupler/Splitter specifications

The 1310nm and C-Band Coupler/Splitter is bidirectional and may be used as a coupler to combine signals, or as a splitter to divide a signal.

#### 1310nm and C-Band Coupler/Splitter



This section covers the following topic:

- 7.5.1.1, “1310nm and C-Band Coupler/Splitter specifications”

#### 7.5.1.1 1310nm and C-Band Coupler/Splitter specifications

Table 7-15 1310 nm and C-Band Coupler/Splitter BP1A38AA specifications

Parameter	Standard/Hardened	Units
C-Band wavelength port	1460 to 1620	nm
1310 nm I/O wavelength port	1260 to 1360	nm
Insertion Loss	≤1.5	dB
Channel Ripple	≤0.4	dB
Isolation on C-Band wavelength	≥45	dB
Isolation on 1310 nm wavelength band	≥25	dB

**Table 7-15 1310 nm and C-Band Coupler/Splitter BP1A38AA specifications (Continued)**

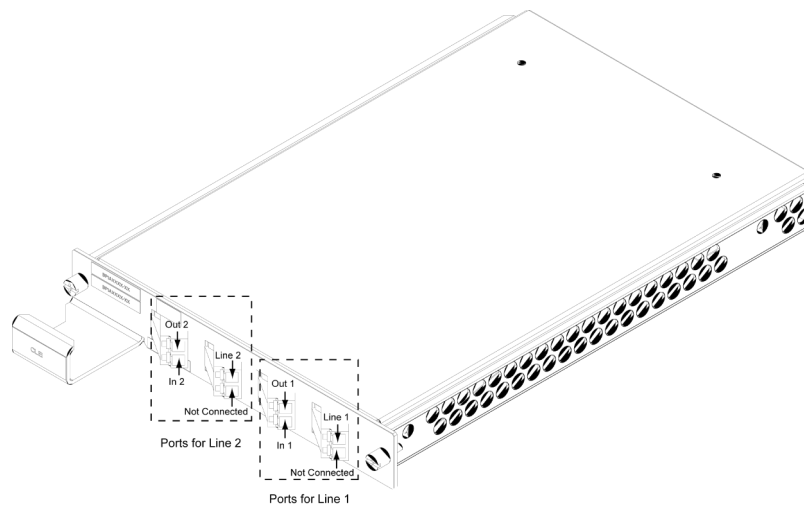
Parameter	Standard/Hardened	Units
Polarization Dependent Loss	$\leq 0.1$	dB
Polarization Mode Dispersion	$\leq 0.1$	ps
Directivity	$\geq 50$	dB
Optical return loss	$\geq 45$	dB

## 7.5.2 Double DWDM Bidirectional Coupler/Splitter specifications

The six-port Double Bidirectional Coupler/Splitter is a key device in a single-fiber bidirectional transmission solution. Used in conjunction with passive 32-Channel Bidirectional DWDM Mux/Demux modules, the DWDM Bidirectional Coupler/Splitter separates the two counter-propagating signals on a single fiber according to their direction of transmission, enabling a separate transmit channel in one direction and the receive channel in the other direction.

The following figure shows the key physical features of the Double Bidirectional Coupler/Splitter module.

### Double Bidirectional Coupler/Splitter module



This section covers the following topic:

- [7.5.2.1, “Double Bidirectional Coupler/Splitter specifications”](#)

### 7.5.2.1 Double Bidirectional Coupler/Splitter specifications

**Table 7-16 Double Bidirectional Coupler/Splitter BP1A39CA specifications**

Parameter		Value	Units
Wavelength Range		1528 to 1565	nm
Insertion Loss	In → Line	$\leq 1.5$	dB
	Line → Out	$\leq 1.5$	dB

**Table 7-16 Double Bidirectional Coupler/Splitter BP1A39CA specifications (Continued)**

Parameter		Value	Units
Isolation	Line → In	≥35	dB
	Out → Line	≥35	dB
Directivity	In → Out	≥45	dB
Polarization Dependent Loss		≤0.1	dB
Polarization Mode Dispersion		≤0.05	ps
Return Loss		≥50	dB

### 7.5.3 CWDM + DWDM Splitter Combiner specifications

**Table 7-17 CWDM + DWDM Splitter Combiner (CDSC) BP1A30AA specifications**

Parameter	Minimum	Maximum	Units
<b>DWDM Wavelengths</b>			
DWDM Wavelength Range	1528.77	1559.79	nm
Insertion Loss	—	1.4	dB
Ripple	—	0.3	dB
Isolation of CWDM wavelengths	25	—	dB
<b>CWDM Wavelengths</b>			
Wavelength Range	1451 to 1511 and 1571 to 1611	nm	
Insertion Loss	—	1.1	dB
Ripple	—	0.4	dB
Isolation of CWDM wavelengths	13	—	dB
<b>For both CWDM and DWDM wavelengths</b>			
Directivity	50	—	dB
Return Loss	45	—	dB
Polarization Dependent Loss	—	0.1	dB
Polarization Mode Dispersion	—	0.1	ps

**Note** All insertion loss values include connector losses.

### 7.5.4 Double DWDM Red/Blue Splitter Combiner

**Table 7-18 Double DWDM Red/Blue Splitter Combiner BP1A39BA specifications**

Parameter	Minimum	Maximum	Units
Wavelength Range	1500	1620	nm
Passband Wavelength Range	1543.83	1562.11	nm
Insertion Loss	—	1.4	dB
Ripple			

**Table 7-18 Double DWDM Red/Blue Splitter Combiner BP1A39BA specifications (Continued)**

Parameter	Minimum	Maximum	Units
Passband	—	0.4	dB
Add/Drop	—	0.3	dB
Isolation	25	—	dB
Express	24	—	dB
Add/Drop	30	—	dB
Directivity	45	—	dB
Return Loss	45	—	dB
Polarization Dependent Loss	—	0.2	dB
Polarization Mode Dispersion	—	0.2	ps

**Note** All insertion loss values include connector losses.

## 7.5.5 Single 50/50 Coupler/Splitter specifications

**Table 7-19 Single 50/50 Coupler/Splitter BP1A39DA specifications**

Parameter	Minimum	Maximum	Units
Wavelength Range	1528	1563	nm
Insertion Loss (Ports A and B)	2.9	3.6	dB
Wavelength Dependent Loss	—	0.5	dB
Directivity	45	—	dB
Return Loss	55	—	dB
Polarization Dependent Loss	—	0.1	dB

**Note** All insertion loss values include connector losses.

## 8.0 Transponders

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This section provides information about the Transponder modules that the BTI 7000 Series supports.

- [8.1, “Transponder portfolio”](#)
- [8.2, “Transponder applications”](#)
- [8.3, “Transponder specifications”](#)
- [8.4, “Transponder PMs”](#)

## 8.1 Transponder portfolio

This section provides information about the modules in the Transponder portfolio and covers the following topics:

- 8.1.1, “Transponder modules”
- 8.1.2, “Transponder module operating temperature ranges”

### 8.1.1 Transponder modules

**Table 8-1 Transponders**

Modules	PEC	System software introduced
<b>Dual 2.5G Multiprotocol Transponders</b>		
2.5G Wavelength Regenerator	BP1A42AA	7.1.0
2.5G Wavelength Manager	BP1A43AA	7.1.0
<b>Dual 4G Multiprotocol Transponders</b>		
Dual 4G Multiprotocol Transponder	BT7A41CA	7.2.0
<b>10G Transponders</b>		
Dual 10G Multiprotocol Transponder	BT7A49AA	7.1.0
	BT7A49AA-I02	10.4.1
Dual 10G Multiprotocol Transponder Lite	BT7A49AC	7.2.0
10G Multiprotocol Transponder	BT7A49AB	7.1.0

### 8.1.2 Transponder module operating temperature ranges

**Table 8-2 Transponder module operating temperature ranges**

Module	0°C to +40°C long term	-5°C to +50°C short term	-20°C to +65°C long term
2.5G Wavelength Manager	X	X	X
2.5G Wavelength Regenerator	X	X	X
Dual 4G Multiprotocol Transponder	X	X	
Dual 10G Multiprotocol Transponder	X	X	
Dual 10G Multiprotocol Transponder Lite	X	X	
10G Multiprotocol Transponder	X	X	

**Note** Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days during a 1-year period (as detailed in GR-63-CORE).

## 8.2 Transponder applications

This section provides information about the applications that Transponder modules support.

- 8.2.1, “Reach extension”
- 8.2.2, “Private Line connectivity”

### 8.2.1 Reach extension

#### Ethernet, SONET, SDH and FC reach extension

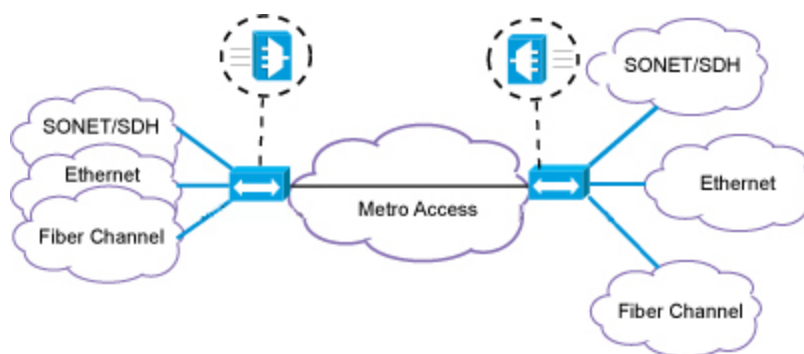
Transponders can provide Optical-Electrical-Optical (OEO) conversion to extend the reach of Ethernet, SONET, SDH, and FC protocols and regenerate optical signals in three domains: power, shape, and time.

Transponders provide in-line regeneration where the physical distance between the source and destination nodes of the optical system exceeds the maximum transmission reach.

Transponder modules can be either collocated with terminal equipment or deployed at intermediate line sites. When a Transponder module is collocated with terminal equipment, it accepts limited-reach 850nm or 1310nm signals and converts them to extended-reach 1550nm or DWDM wavelengths. When deployed at an intermediate line site, the Transponder module can accept and regenerate two bidirectional 1550nm or DWDM wavelengths.

When used to extend the reach of 10GELAN, OC192, and STM64 signals, the Transponder module accepts client interface ports from a router, SONET/SDH ADM or any other terminal device at 850nm, 1310nm, or 1550nm. The signal is regenerated and can be transmitted up to 80km over an optical link, without external amplifiers. With the addition of optical amplifier modules and dispersion compensation modules, signals can be transmitted up to 160km without an intermediate site.

#### Reach extension



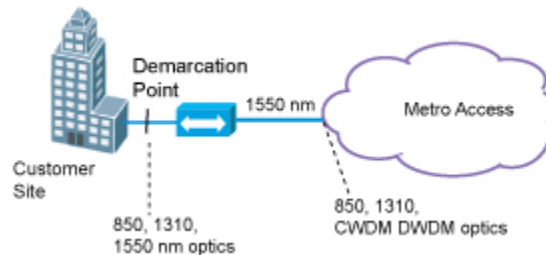
### 8.2.2 Private Line connectivity

Transponder modules can be used to provide demarcation of wholesale and enterprise Private Line services. The service interface can be at 850nm, 1310nm, or 1550nm. Client- and line-side loopback provides the ability to isolate the service to the customer boundary during provisioning

and fault isolation. Performance monitoring provides measurement to Service Level Agreements (SLAs).

Transponder modules can be deployed on their own or in combination with DWDM multiplexers or amplifiers to extend the service over the fiber network.

### Private Line connectivity



## 8.2.3 Client protection

The BTI 7000 Series provides full client-interface equipment redundancy between the client equipment and two separate BTI 10G Transponder modules: Dual 10G Multiprotocol Transponder—BT7A49AA and BT7A49AA-I02 or 10G Multiprotocol Transponder — BT7A49AB, using a combination of a Y-cable component and redundant transponder.

The Y-cable is a 50/50 passive optical splitter device that supports the following, client side XFP interfaces:

- 1310 nm SR: BP3AM4MS
- 1550 nm IR: BP3AM4LI

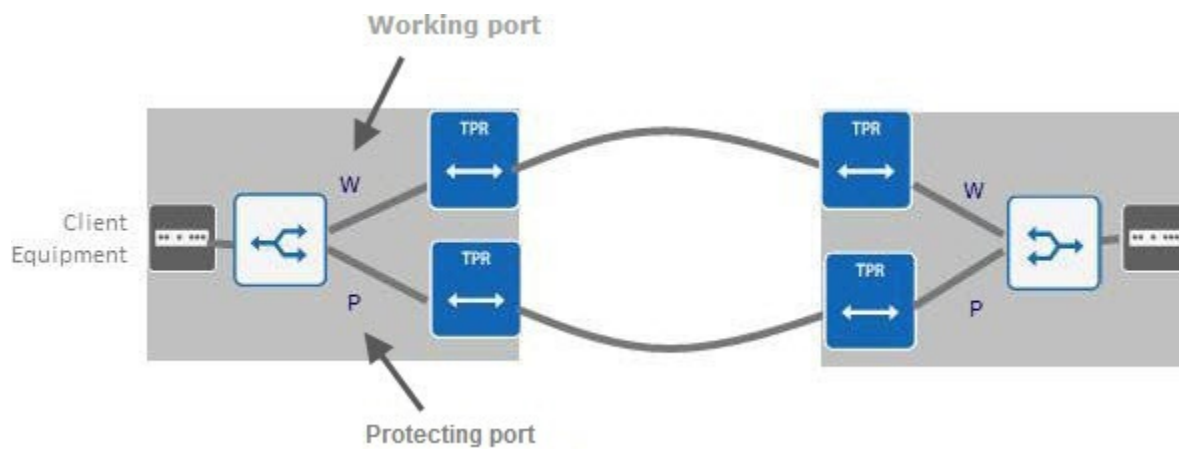
The client ports of each of the transponders are connected by two Y-cable pairs—BT7A57AA:

- One of the Y-cable connectors (combiner end) is terminated onto the CPE transmitter, and the dual cable end (splitter side) terminates to the receiving client port of both the working and protection transponder modules.
- The second Y-cable connector (combiner end) is terminated onto the CPE receiver, and the dual cable end (splitter side) terminates to the transmitting client port of both the working and protection transponder modules.

One client is active (working) and transmits toward the CPE. The other client transmitter (standby) is disabled. Both active and standby clients receive from the CPE. The associated line side port on each module is actively transmitting and receiving. When a fault is detected on the working port, the working port transmitter is automatically turned off and the system switches the transmission to the protecting port. The transmitter on the protecting port turns on, and the port becomes the working client port.

The following example shows a Y-cable set up. The two ports—working and protecting—connected to the transponders make up the protection group. The protection group monitors the optical, OTN and client signal layers on the receiving end.



**Figure 8-3 Y-cable client protection set-up**

**Note** Client protection switching is always bidirectional. The transponders at both ends choose the same path as the working path.

## 8.3 Transponder specifications

This section provides specifications for Transponder modules and covers the following topics:

- 8.3.1, “2.5G Wavelength Manager specifications”
- 8.3.2, “2.5G Wavelength Regenerator specifications”
- 8.3.3, “Dual 4G Multiprotocol Transponder specifications”
- 8.3.4, “Dual 10G Multiprotocol Transponder specifications”
- 8.3.5, “Dual 10G Multiprotocol Transponder Lite specifications”
- 8.3.6, “10G Multiprotocol Transponder specifications”

### 8.3.1 2.5G Wavelength Manager specifications

Table 8-3 2.5G Wavelength Manager BP1A43AA specifications

Parameter	Value
Ports	4
Mode	3R
SFPs supported	See 3.5, “Module and transceiver compatibility”.
<b>Protocols supported</b>	
SONET OC48/SDH STM16	2.488 Gbps
SONET OC12	622.08 Mbps
SONET OC3	155.52 Mbps
Gigabit Ethernet	1.25 Gbps
<b>Performance monitoring</b>	Current and historical (15mins, 24hours, untimed). See 8.4, “Transponder PMs”.
<b>Jitter</b>	Compliant with Telcordia GR-253-CORE.
<b>Eye mask of optical output</b>	Compliant with GR-253 and ITU-T G.957.
<b>Latency</b>	<1 $\mu$ s

### 8.3.2 2.5G Wavelength Regenerator specifications

Table 8-4 2.5G Wavelength Regenerator BP1A42AA specifications

Parameter	Value
Ports	4
Mode	3R
SFPs supported	See 3.5, “Module and transceiver compatibility”.
<b>Protocols supported</b>	
SONET OC3/SDH STM1	155.52 Mbps
SONET OC12/SDH STM4	622.08 Mbps

Table 8-4 2.5G Wavelength Regenerator BP1A42AA specifications (Continued)

Parameter	Value
SONET OC48/SDH STM16	2.488 Gbps
SONET OC48FEC	2.666 Gbps
Fast Ethernet	125 Mbps
Gigabit Ethernet	1.25 Gbps
Fibre Channel 100	1.062 Gbps
Fibre Channel 200	2.122 Gbps
FDDI	125 Mbps
ESCON	200 Mbps
<b>Performance monitoring</b>	Current and historical (15mins, 24hours, untimed). See <a href="#">8.4, "Transponder PMs"</a> .
<b>Jitter</b>	Compliant with Telcordia GR-253-CORE (sections 5.6.2.1 Transfer, 5.6.2.2 Tolerance and 5.6.2.3 Generation) when equipped with 1310nm, CWDM, or DWDM SFPs; compliant with IEEE 802.3-2002 (part 3) and ANSI INCITS 352-2002 when equipped with 850nm, 1310nm, CWDM, or DWDM SFPs.
<b>Eye mask of optical output</b>	Compliant with GR-253 and ITU-T G.957.
<b>Latency</b>	<1 $\mu$ s

### 8.3.3 Dual 4G Multiprotocol Transponder specifications

Table 8-5 Dual 4G Multiprotocol Transponder BT7A41CA specifications

Parameter	Value
Ports	4
Mode	3R
SFPs supported	See <a href="#">3.5, "Module and transceiver compatibility"</a> .
<b>Protocols supported</b>	
Gigabit Ethernet	1 Gbps
Fibre Channel 1G/FICON	1 Gbps
Fibre Channel 2G/FICON	2 Gbps
Fibre Channel 4G	4 Gbps
<b>Performance monitoring</b>	Current and historical (15mins, 24hours, untimed). See <a href="#">8.4, "Transponder PMs"</a> .
<b>Jitter</b>	Compliant with 802.3 and ANSI INCITS 352-2002.
<b>Eye mask of optical output</b>	Compliant with 802.3 and ANSI INCITS 352-2002.
<b>Latency</b>	< 1 $\mu$ s

### 8.3.4 Dual 10G Multiprotocol Transponder specifications

Table 8-6 Dual 10G Multiprotocol Transponder BT7A49AA specifications

Parameter	Value
Ports	4
Mode	3R
XFPs supported	See 3.5, "Module and transceiver compatibility".
<b>Protocols supported</b>	
SONET OC192/SDH STM64	9.953 Gbps
SONET OC192FEC/SDH STM64FEC	10.709 Gbps
10GELAN PHY	10.313 Gbps
10GELANFEC	10.7 Gbps
10G FC	10.519 Gbps
10GELAN E/FEC EPCMF	10.709 Gbps
<b>Latency</b>	
Transparent client to line	< 1 $\mu$ s
Transparent line to client	< 1 $\mu$ s
Client to OTU2 FEC line	< 1 $\mu$ s
OTU2 FEC line to client	8 $\mu$ s
Client to OTU2 EFEC line	3 $\mu$ s
OTU2 EFEC line to client	50 $\mu$ s
<b>Performance monitoring</b>	Current and historical (15mins, 24hours, untimed). See 8.4, "Transponder PMs".
<b>Jitter</b>	Compliant with Telcordia GR-253-CORE when equipped with 850nm or 1310nm XFPs and compliant with ITU-T G.783.
<b>Eye mask of optical output</b>	Compliant with GR-253 and ITU-T G.957.
<b>Jitter Tolerance</b>	Compliant with GR-253.
<b>Eye Mask</b>	Compliant with GR 253/G.691.
<b>Jitter Generation</b>	Compliant with GR 253/G.691.

### 8.3.5 Dual 10G Multiprotocol Transponder Lite specifications

Table 8-7 Dual 10G Multiprotocol Transponder Lite BT7A49AC specifications

Parameter	Value
Ports	4
Mode	3R
XFPs supported	See 3.5, "Module and transceiver compatibility".
<b>Protocols supported</b>	
SONET OC192/SDH STM64	9.953 Gbps
SONET OC192FEC/SDH STM64FEC	10.709 Gbps

Table 8-7 Dual 10G Multiprotocol Transponder Lite BT7A49AC specifications (Continued)

Parameter	Value
10GELAN PHY	10.313 Gbps
10GELANFEC	10.7 Gbps
10G FC	10.519 Gbps
10GELAN E/FEC EPCMF	10.709 Gbps
<b>Latency</b>	
Transparent client to line	< 1 $\mu$ s
Transparent line to client	< 1 $\mu$ s
Client to OTU2 FEC line	< 1 $\mu$ s
OTU2 FEC line to client	8 $\mu$ s
Client to OTU2 EFEC line	3 $\mu$ s
OTU2 EFEC line to client	50 $\mu$ s
<b>Performance monitoring</b>	Current and historical (15mins, 24hours, untimed). See <a href="#">8.4, "Transponder PMs"</a> .
<b>Jitter</b>	Compliant with Telcordia GR-253-CORE when equipped with 850nm or 1310nm XFPs and compliant with ITU-T G.783.
<b>Eye mask of optical output</b>	Compliant with GR-253 and ITU-T G.957.
<b>Jitter Tolerance</b>	Compliant with GR-253.
<b>Eye Mask</b>	Compliant with GR 253/G.691.
<b>Jitter Generation</b>	Compliant with GR 253/G.691.

### 8.3.6 10G Multiprotocol Transponder specifications

Table 8-8 10G Multiprotocol Transponder BT7A49AB specifications

Parameter	Value
Ports	2
Mode	3R
XFPs supported	See <a href="#">3.5, "Module and transceiver compatibility"</a> .
<b>Protocols supported</b>	
SONET OC192/SDH STM64	9.953 Gbps
SONET OC192FEC/SDH STM64FEC	10.709 Gbps
10GELAN PHY	10.313 Gbps
10GELANFEC	10.7 Gbps
10G FC	10.519 Gbps
10GELAN E/FEC EPCMF	10.709 Gbps
<b>Latency</b>	
Transparent client to line	< 1 $\mu$ s

**Table 8-8 10G Multiprotocol Transponder BT7A49AB specifications (Continued)**

Parameter	Value
Transparent line to client	< 1 $\mu$ s
Client to OTU2 FEC line	< 1 $\mu$ s
OTU2 FEC line to client	8 $\mu$ s
Client to OTU2 EFEC line	3 $\mu$ s
OTU2 EFEC line to client	50 $\mu$ s
<b>Performance monitoring</b>	Current and historical (15mins, 24hours, untimed). See <a href="#">8.4, "Transponder PMs"</a> .
<b>Jitter</b>	Compliant with Telcordia GR-253-CORE when equipped with 850nm or 1310nm XFPs and compliant with ITU-T G.783.
<b>Eye mask of optical output</b>	Compliant with GR-253 and ITU-T G.957.
<b>Jitter Tolerance</b>	Compliant with GR-253.
<b>Eye Mask</b>	Compliant with GR 253/G.691.
<b>Jitter Generation</b>	Compliant with GR 253/G.691.

## 8.4 Transponder PMs

The following table lists the PM types each Transponder module supports.

PM type	Supported on
Physical	All Transponder modules. See <a href="#">11.6, “Physical PMs”</a> .
Layer 1 GE	2.5G Wavelength Manager Dual 4G Multiprotocol Transponder
SONET section	2.5G Wavelength Manager Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
SDH section	2.5G Wavelength Manager Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
Layer 1 Fibre Channel	Dual 4G Multiprotocol Transponder Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
10GELAN	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
OTN	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder

This section covers the following topics:

- [8.4.1, “Layer 1 Gigabit Ethernet protocol PMs supported on Transponder modules”](#)
- [8.4.2, “SONET PMs supported on Transponder modules”](#)
- [8.4.3, “SDH PMs supported on Transponder modules”](#)
- [8.4.4, “10GELAN PMs supported on Transponder modules”](#)
- [8.4.5, “Layer 1 Fibre Channel protocol PMs supported on Transponder modules”](#)
- [8.4.6, “OTN protocol PMs supported on Transponder modules”](#)
- [8.4.7, “Embedded PM support for 10G Multiprotocol Transponder and Dual 10G Multiprotocol Transponder modules”](#)

## 8.4.1 Layer 1 Gigabit Ethernet protocol PMs supported on Transponder modules

Table 8-9 Layer 1 Gigabit Ethernet PMs (counters)

PM (montype)	PM threshold default values		Supported modules
	15-minute	1-day	
<b>CV</b> 8B/10B Coding Violations measure the number of 8B/10B coding violations and disparity errors.	382	3820	Dual 4G Multiprotocol Transponder 2.5G Wavelength Manager
<b>ES</b> Errored Seconds measures the number of seconds during which one or more coding violations are detected, or a Loss of Synchronization (LOSYNC) or Loss of Signal (LOS) defect is present.	25	250	Dual 4G Multiprotocol Transponder 2.5G Wavelength Manager
<b>SES</b> Severely Errored Seconds measures the number of seconds during which the number of detected coding violations exceeds the severely errored seconds level (SESLVL), or a Loss of Synchronization (LOSYNC) defect or Loss of Signal (LOS) defect is present. The SESLVL value for Layer 1 Gigabit Ethernet is 1250.	4	40	Dual 4G Multiprotocol Transponder 2.5G Wavelength Manager
<b>UAS</b> Unavailable Seconds measures the number of seconds during which the link was considered unavailable. A link becomes unavailable at the onset of 10 consecutive seconds that qualify as SES, and continues to be unavailable until the onset of 10 consecutive seconds that do not qualify as SES. In seconds that are counted as unavailable, the counting of CV, ES, and SES is inhibited.	10	10	Dual 4G Multiprotocol Transponder 2.5G Wavelength Manager

## 8.4.2 SONET PMs supported on Transponder modules

SONET protocol PMs are supported on the following Transponder modules.

- 2.5G Wavelength Manager
- Dual 4G Multiprotocol Transponder
- Dual 10G Multiprotocol Transponder
- 10G Multiprotocol Transponder



Table 8-10 SONET PMs (counters)

PM (montype)	PM threshold default values		Supporting entities
	15-minute	1-day	
<b>CVS</b> Section Coding Violations measures the number of B1 Bit Interleaved Parity (BIP) errors detected at the section layer.	382	3820	OC3, OC12, OC48, OC192
<b>ESS</b> Section Errored Seconds measures the number of seconds during which one or more B1 Bit Interleaved Parity (BIP) errors were detected or a Severely Errored Frame (SEF) or a Loss of Signal (LOS) defect was present.	25	250	OC3, OC12, OC48, OC192
<b>SEFS-S</b> Section Severely Errored Framing Seconds measures the number of seconds during which a section SEF defect was present.	2	8	OC3, OC12, OC48, OC192
<b>SESS</b> Section Severely Errored Seconds measures number of seconds during which the number of detected B1 Bit Interleaved Parity (BIP) errors exceeds the severely errored seconds level (SESLVL), or a Severely Errored Frame (SEF) or a Loss of Signal (LOS) defect was present. The SESLVL value for SONET section level is as follows: <ul style="list-style-type: none"> <li>• OC3 = 155</li> <li>• OC12 = 616</li> <li>• OC48 = 2392</li> <li>• OC192 = 8554</li> </ul>	4	40	OC3, OC12, OC48, OC192
<b>UAS-S</b> Section Unavailable Seconds measures the number of seconds during which the SONET section is unavailable. A second is considered UAS-S at the onset of 10 consecutive SESS seconds, and is no longer considered UAS-S after 10 consecutive seconds that are not SESS seconds. In seconds that are counted as unavailable, the counting of CVS, ESS and SESS are inhibited.	10	10	OC3, OC12, OC48, OC192

### 8.4.3 SDH PMs supported on Transponder modules

SDH protocol PMs are supported on the following Transponder modules.

- 2.5G Wavelength Manager
- Dual 4G Multiprotocol Transponder
- Dual 10G Multiprotocol Transponder
- 10G Multiprotocol Transponder

**Table 8-11 SDH PMs (counters)**

PM (montype)	PM threshold default values		Supported entities
	15-minute	1-day	
<b>RS-EB</b> Regenerator Section Errored Blocks measures the number of regenerator section errored blocks. An errored block is one that contains one or more (up to eight per block) B1 Bit Interleaved Parity (BIP) errors.	0	0	STM16, STM64
<b>RS-BBE</b> Regenerator Section Background Block Errors measures the number of errored blocks not occurring during seconds counted as RS-SES seconds.	382	3820	STM16, STM64
<b>RS-ES</b> Regenerator Section Errored Seconds measures the number of seconds during which one or more errored blocks were detected or a Loss of Frame (LOF) or a Loss of Signal (LOS) defect was present.	25	250	STM16, STM64
<b>RS-OFS</b> Regenerator Section out of Frame Seconds measures the number of seconds during which an Out of Frame (OOF) defect was present.	2	8	STM16, STM64
<b>RS-SES</b> Regenerator Section Severely Errored Seconds measures the number of seconds during which the number of detected errored blocks exceeds the severely errored seconds level (SESLVL), or a Loss of Frame (LOF) or Loss of Signal (LOS) defect was present. The SESLVL value for SDH regenerator section is 30% of the nominal block rate.	4	40	STM16, STM64
<b>RS-UAS</b> Regenerator Section Unavailable Seconds measures the number of seconds during which the regenerator section is unavailable. A second is considered RS-UAS at the onset of 10 consecutive RS-SES seconds, and is no longer considered RS-UAS after 10 consecutive seconds that are not RS-SES seconds. In seconds that are counted as unavailable, the counting of RS-EB, RS-BBE, RS-ES, and RS-SES is inhibited.	10	10	STM16, STM64

## 8.4.4 10GELAN PMs supported on Transponder modules

Table 8-12 10GELAN PMs (counters)

PM (montype)	PM threshold default values		Supported modules
	15-minute bin	1-day bin	
<b>INVBLK</b> Invalid Blocks measures the number of invalid 64/66B coding blocks.	382	3820	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>ES</b> Errored Seconds measures the number of seconds during which one or more errored blocks/code violations are detected, or LOSYNC (Loss of Synchronization) or LOS (Loss of Signal) is detected.	25	250	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>SES</b> Severely Errored Seconds measures the number of detected invalid blocks exceeds the severely errored seconds level (SESLVL), or in which a Loss of Synchronization (LOSYNC) defect or Loss of Frame (LOF) defect is present. The SESLVL value for 10GELAN is 8554.	4	40	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>UAS</b> Unavailable Seconds measures the number of seconds during which the link was considered unavailable. A link becomes unavailable at the onset of 10 consecutive seconds that qualify as SES, and continues to be unavailable until the onset of 10 consecutive seconds that do not qualify as SES. In seconds that are counted as unavailable, the counting of In seconds that are counted as unavailable, the counting of INVBLK, ES, and SES is inhibited	10	10	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>FCSE-RX</b> Total number of received frames with CRC (Cyclic Redundancy Check) errors measures the number of received frames that had a valid length but had either a bad Frame Check Sequence (FCS Error) or a bad FCS with a non-integral number of OCTETS (alignment errors).	0	0	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>FRDR</b> Total number of discarded frames measures the total number of frames dropped due to a lack of resources or other reasons. This number is not necessarily the number of frames dropped, but rather the number of time that dropped frames could be detected.	0	0	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>FRGT</b> Total fragmented Frame Count in Receive Direction measures the total number of received frames that were less than 64 octets long (excluding framing bits, but including Frame Check Sequence (FCS) octets) and had either a bad FCS with a	0	0	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder

Table 8-12 10GELAN PMs (counters) (Continued)

PM (montype)	PM threshold default values		Supported modules
	15-minute bin	1-day bin	
integral number of octets (FCS error) or a bad FCS with a non-integral number of octets (alignment error).			
<b>JABR</b> Total Jabber Frame Count in Receive Direction measures the total number of received frames that were longer than the maximum frame size <sup>1</sup> (excluding framing bits, but including Frame Check Sequence (FCS) octets), and had either a bad FCS with an integral number of octets (FCS error) or a bad FCS with a non-integral number of octets (alignment error).	0	0	Dual 10G Multiprotocol Transponder  10G Multiprotocol Transponder
<b>BCST</b> Total Broadcast Frame Count in Receive Direction measures the total number of good frames received that were directed to the broadcast address. (This number does not include frames that were directed to the multicast address.)			Dual 10G Multiprotocol Transponder  10G Multiprotocol Transponder
<b>MCST</b> Total multicast Frame Count in Receive Direction measures the total number of good frames received that were directed to a multicast address. (This number does not include frames that were directed to the broadcast address.)			Dual 10G Multiprotocol Transponder  10G Multiprotocol Transponder
<b>OSIZE</b> Total oversized Frame Count in Receive Direction measures the total number of received frames that were greater than the maximum frame size <sup>1</sup> in length (excluding framing bits, but including Frame Check Sequence (FCS) octets) but were otherwise well formed.	0	0	Dual 10G Multiprotocol Transponder  10G Multiprotocol Transponder
<b>OVER1518</b> Total over-1518 Frame Count in Receive Direction measures the total number of frames received that were greater than 1518 bytes but not exceeding the maximum frame size <sup>1</sup> in length (excluding framing bits, but including Frame Check Sequence (FCS) octets).	0	0	Dual 10G Multiprotocol Transponder  10G Multiprotocol Transponder
<b>SIZE64</b> Total 64 Byte Frame Count in Receive Direction measures the total number of 64 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).			Dual 10G Multiprotocol Transponder  10G Multiprotocol Transponder
<b>SIZE65-127</b> Total 65-127 Byte Frame Count in Receive Direction measures the total number of 65-127 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).			Dual 10G Multiprotocol Transponder  10G Multiprotocol Transponder
<b>SIZE128-255</b>			Dual 10G Multiprotocol Transponder

Table 8-12 10GELAN PMs (counters) (Continued)

PM (montype)	PM threshold default values		Supported modules
	15-minute bin	1-day bin	
Total 128-255 Byte Frame Count in Receive Direction measures the total number of 128-255 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).			10G Multiprotocol Transponder
<b>SIZE256-511</b> Total 256-511 Byte Frame Count in Receive Direction measures the total number of 256-511 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).			Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>SIZE512-1023</b> Total 512-1023 Byte Frame Count in Receive Direction measures the total number of 512-1023 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).			Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>SIZE1024-1518</b> Total 1024-1518 Byte Frame Count in Receive Direction measures the total number of 1024-1518 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).			Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>TBYC-RX</b> Total Byte Count in Receive Direction measures the total number of bytes of data (including those in bad frames) received (excluding framing bits, but including Frame Check Sequence (FCS) octets).			Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>TFRC-RX</b> Total Frame Count in Receive Direction measures the total number of frames (bad frames, broadcast frames, and multicast frames) received.			Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>USIZE</b> Undersized Frames measures the total number of frames received that were less than 64 octets long (excluding framing bits, but including Frame Check Sequence (FCS) octets) and were otherwise well formed.	0	0	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder

<sup>1</sup>The maximum frame size on the BT7A49AA and BT7A49AB modules is fixed at 9600 bytes. The maximum frame size on the BT7A49AA-I02 module is fixed at 10200 bytes.

## 8.4.5 Layer 1 Fibre Channel protocol PMs supported on Transponder modules

Table 8-13 Layer 1 Fibre Channel PMs (counters)

PM (montype)	PM threshold default values		Supported modules
	15-minute	1-day	
<b>CV</b> 8B/10B Coding Violations measures the number of 8B/10B coding violations and disparity errors.	382	3820	Dual 4G Multiprotocol Transponder
<b>INVBLK</b> Invalid Blocks measures the number of invalid 64/66B coding blocks.	382	3820	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>ES</b> Errored Seconds measures the number of seconds during which one or more coding violations are detected, or a Loss of Synchronization (LOSYNC) or Loss of Signal (LOS) defect is present.	25	250	Dual 4G Multiprotocol Transponder Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>SES</b> Severely Errored Seconds measures the number of seconds during which the number of detected coding violations exceeds the severely errored seconds level (SESLVL), or a Loss of Synchronization (LOSYNC) defect or Loss of Signal (LOS) defect is present. The SESLVL value for Fiber Channel is 1250.	4	40	Dual 4G Multiprotocol Transponder Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>UAS</b> Unavailable Seconds measures the number of seconds during which the link was considered unavailable. A link becomes unavailable at the onset of 10 consecutive seconds that qualify as SES, and continues to be unavailable until the onset of 10 consecutive seconds that do not qualify as SES.	10	10	Dual 4G Multiprotocol Transponder Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder

## 8.4.6 OTN protocol PMs supported on Transponder modules

Table 8-14 OTN PMs (counters) supported on SONET/SDH line protocols

PM (montype)	PM threshold default values		Supported modules
	15-minute bin	1-day bin	
<b>NUMBITSCR</b> Number of Bits Corrected measures the total number of bits corrected by the Forward Error Correction (FEC)	0	0	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder

Table 8-14 OTN PMs (counters) supported on SONET/SDH line protocols (Continued)

PM (montype)	PM threshold default values		Supported modules
	15-minute bin	1-day bin	
decoder according to the Reed-Solomon RS(255,239) forward error correction scheme.			
<b>NUMBYTESCR</b> Number of Bytes Corrected measures the total number of bytes corrected by the forward error correction scheme. <b>Note</b> Not supported on line protocols OC192EFEC and STM64EFEC.	0	0	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>UNCRCDWRD</b> Number of Uncorrectable Code Words measures the total number of errored code words received that could not be corrected by the Forward Error Correction scheme.	10	100	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>BER</b> Bit Error Ratio provides an estimate of the instantaneous Bit Error Ratio of the line by evaluating the ratio of the number of bits corrected to the total bits received over a 10-second time window. Both the instantaneous and average BER values are only valid for relatively low error rates in the signal. If the BER value is reported to be above 10 <sup>-3</sup> , it should be disregarded as it is not possible to accurately measure BER values above this level. BER values above this level usually indicate another problem, which should be evident in other PM counts.			Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>BER-AVG</b> Average Bit Error Ratio provides an estimate of the average Bit Error Ratio of the line by evaluating the ratio of the number of bits corrected to the total bits received over the duration of the entire collection interval. Both the instantaneous and average BER values are only valid for relatively low error rates in the signal. If the BER value is reported to be above 10 <sup>-3</sup> , it should be disregarded as it is not possible to accurately measure BER values above this level. BER values above this level usually indicate another problem, which should be evident in other PM counts.			Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>OTU-BBE</b> OTU-2 Background Block Error measures the number of errored blocks not occurring during seconds counted as OTU-SES seconds.	382	3820	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>OTU-EB</b> OTU-2 Errored Blocks measures the number of frames containing one or more Bit Interleaved Parity (BIP) errors, using the OTU-2 SM BIP-8 byte in the incoming OTN signal. Up to eight BIP-8 errors can be detected per OTU-2 frame. However, regardless of the number of	0	0	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder

**Table 8-14 OTN PMs (counters) supported on SONET/SDH line protocols (Continued)**

PM (montype)	PM threshold default values		Supported modules
	15-minute bin	1-day bin	
BIP-8 errors detected, a single frame can count for no more than one errored block.			
<b>Note</b> EB counting is suspended when either one of the following faults is active on the port: Loss of Signal, Loss of Frame.			
<b>OTU-ES</b> OTU-2 Errored Seconds measures the number of seconds during which one or more errored blocks is detected or a Loss of Frame (LOF), Loss of Signal (LOS), or Trace Identifier Mismatch (TIM) defect is present.	25	250	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>OTU-SES</b> OTU-2 Severely Errored Seconds measures the number of seconds during which the number of detected errored blocks exceeds the severely errored seconds level (SESLVL), or a Loss of Frame (LOF), Loss of Signal (LOS), or Trace Identifier Mismatch (TIM) defect was present. The SESLVL value for OTN is 30% of the nominal block rate.	4	40	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>OTU-OFS</b> OTU-2 Out of Frame Seconds measures the number of seconds during which a Out of Frame (OOF) defect was present.	2	8	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder
<b>OTU-UAS</b> OTU-2 Unavailable Seconds measures the number of seconds during which the OTN line is unavailable. A second is considered OTU-UAS at the onset of 10 consecutive OTU-SES seconds, and is no longer considered OTU-UAS after 10 consecutive seconds that are not OTU-SES seconds.	10	10	Dual 10G Multiprotocol Transponder 10G Multiprotocol Transponder

## 8.4.7 Embedded PM support for 10G Multiprotocol Transponder and Dual 10G Multiprotocol Transponder modules

### OC192FEC/STM64FEC Regen

Embedded SONET/SDH protocol PMs are not collected.

### OC192/STM64-to-OC192FEC/STM64FEC

Embedded PMs are collected for the egress SONET or SDH signal as it is unwrapped from OTN and reported against the FEC port.



**10GELANFEC/10GELANFEC EPCMF Regen**

Embedded 10GELAN protocol PMs are not collected.

**10GELAN-to-10GELANFEC/EFEC EPCMF and 10GELAN-to-10GELANFEC/EFEC EPV3 Regen**

Embedded Layer 2 Ethernet PMs are collected for the egress 10GELAN signal as it is unwrapped from OTN. No BER is calculated.

**10GELAN-to-OTU2e FEC/EFEC**

Embedded Layer 2 Ethernet PMs are reported for the egress 10GELAN signal.

## 8.5 Single-mode y-cable for client protection

A single-mode y-cable is supported on the following BTI Transponder modules to provide client protection. For detailed information about client protection switching and provisioning on the BTI 7000 Series refer to the *BTI 7000 Series Transponder Solutions Guide*.

**Table 8-15 Transponder module support for client protection**

Transponder Module	Part Number
Dual 10G Multiprotocol Transponder	BT7A49AA
10G Multiprotocol Transponder	BT7A49AB

The transponders used for client protection support the following XFPs:

- 1310 nm SR: BP3AM4MS
- 1550 nm IR: BP3AM4LI

### Y-cable specifications

The BTI y-cable meets Telcordia GR-326-CORE regulatory requirements.

**Table 8-16 Single-mode Y-cable BT7A57AA specifications**

Parameter	Minimum	Maximum	Units
Wavelength Range	1528	1563	nm
Insertion Loss Loss Per Port	2.9	3.6	dB
Wavelength Dependent Loss	—	0.5	dB
Directivity	55	45	dB
Return Loss	45	—	dB
Polarization Dependent Loss	0.1	0.35	dB

**Note** All insertion loss values include connector losses, plus, polarization dependent and wavelength dependent losses.

## 9.0 Muxponders

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This section provides information about the Muxponder modules that the BTI 7000 Series supports.

- [9.1, “Muxponder portfolio”](#)
- [9.2, “Muxponder applications”](#)
- [9.3, “Muxponder specifications”](#)
- [9.4, “Muxponder PMs”](#)

## 9.1 Muxponder portfolio

This section provides information about the modules in the Muxponder portfolio and covers the following topics:

- 9.1.1, “Muxponder modules”
- 9.1.2, “Muxponder comparison”
- 9.1.3, “Overview of Muxponder supported protocols”
- 9.1.4, “Muxponder module operating temperature ranges”

### 9.1.1 Muxponder modules

Table 9-1 Muxponders

Modules	PEC	System software introduced
<b>2-Port GbE Muxponders</b>		
2-Port GbE Muxponder – SONET	BP1A46AA	7.1.0
2-Port GbE Muxponder SDH	BP1A46BA	7.1.0
<b>8-Port Multiprotocol Muxponders</b>		
8-Port Multiprotocol Muxponder – SONET	BT7A47JA	7.2.0
8-Port Multiprotocol Muxponder – SDH	BT7A47KA	7.2.0
8-Port Multiprotocol Muxponder – SDH CCAT	BT7A47MA	
<b>10-Port Multiprotocol Muxponders</b>		
10-Port Multiprotocol Muxponder – SONET	BT7A48AA	7.1.1
	BT7A48AA-I02	13.1
10-Port Multiprotocol Muxponder – SDH	BT7A48BA	7.1.1
10-Port Multiprotocol Muxponder – SDH CCAT	BT7A48BA-I02	13.1
	BT7A48DA	7.1.1

### 9.1.2 Muxponder comparison

Table 9-2 Comparison of Muxponder module features

Feature	2-Port GbE Muxponder	8-Port Multiprotocol Muxponder	10-Port Multiprotocol Muxponder
Client ports	2 SFPs 2 RJ-45	8 SFPs	10 SFPs
Client interfaces	Fast Ethernet (FE) Gigabit Ethernet (GE)	Gigabit Ethernet (GE) OC3 or STM1 OC12 or STM4 Fibre Channel 1G/FICON 1G	Gigabit Ethernet (GE) OC3 or STM1 OC12 or STM4 OC48 or STM16

**Table 9-2 Comparison of Muxponder module features (Continued)**

<b>Feature</b>	<b>2-Port GbE Muxponder</b>	<b>8-Port Multiprotocol Muxponder</b>	<b>10-Port Multiprotocol Muxponder</b>
		Fibre Channel 2G/FICON 2G 100FX (First Office Application only) SD-SDI HD-SDI HD-SDI 1.001 DVB-ASI (First Office Application only)	Fibre Channel 1G/FICON 1G Fibre Channel 2G/FICON 2G Fibre Channel 4G/FICON 4G
Line ports	2 SFPs	2 SFPs	2 XFPs
Supported line protocols	STM16 or OC48	STM16 or OC48	OC192 or STM64
Line mapping	None (SONET or SDH rate)	None (SONET or SDH rate) OTU1 (SONET or SDH rate wrapped in OTU1) SUBODU1-OTU1 (SONET or SDH rate wrapped in SUBODU1-OTU1)	None (SONET or SDH rate) OTU2 (SONET or SDH rate wrapped in OTU2) ODU1-OTU2 (SONET or SDH rate wrapped in ODU1-OTU2)
Data client concatenation	VCAT supported on all destination client ports	VCAT/CCAT supported on all destination client ports	VCAT/CCAT supported on all destination client ports
Line protection	SONET/SDH	SONET/SDH (Line mapping = None) 1+1 OTU1 (Line mapping = OTU1 or SUBODU1-OTU2)	SONET/SDH (Line mapping = None) 1+1 OTU2 (Line mapping = OTU2 or ODU1-OTU2)
Path protection	UPSR/SNCP	UPSR/SNCP (Line mapping = None or OTU1)	UPSR/SNCP (Line mapping = None or OTU2)
In-band management	FE port connected to NMS port	GCC0	GCC0
GE GFP mapping	GFP-F	GFP-F GFP-T	GFP-F GFP-T
FC GFP mapping	Not supported	GFP-T	GFP-T
Total protected line capacity	2.5G	2.5G	10G
Total unprotected line capacity	2.5G	5G	10G
Performance monitoring	Physical GE Layer 1, Layer 2 SONET Section/Line SONET Path SDH Regenerator Section/ Multiplex Section SDH Higher Order Path	Physical GE Layer 1 GE Layer 2 FC Layer 1 SONET Section/Line SONET Path	Physical GE Layer 1 GE Layer 2 FC Layer 1 SONET Section/Line SONET Path

**Table 9-2 Comparison of Muxponder module features (Continued)**

<b>Feature</b>	<b>2-Port GbE Muxponder</b>	<b>8-Port Multiprotocol Muxponder</b>	<b>10-Port Multiprotocol Muxponder</b>
		SDH Regenerator Section/ Multiplex Section	SDH Regenerator Section/ Multiplex Section
		SDH Higher Order Path	SDH Higher Order Path
		OTN	OTN
GE flow control	Full-rate GE	Full-rate and sub-rate GE	Full-rate and sub-rate GE
Operating temperature	Long term: 0°C to 40°C or -20°C to +65°C Short term: -5°C to 50°C	Long term: 0°C to 40°C Short term: -5°C to 50°C	Long term: 0°C to 40°C Short term: -5°C to 50°C

### 9.1.3 Overview of Muxponder supported protocols

**Table 9-3 Muxponder portfolio supported protocols**

<b>Protocol</b>	<b>2-Port GbE Muxponder</b>	<b>8-Port Multiprotocol Muxponder</b>	<b>10-Port Multiprotocol Muxponder</b>
OC3/12	Not supported	Supported (SONET module only)	Supported (SONET module only)
OC48	Supported (SONET module line port only)	Supported (SONET module line ports only)	Supported (SONET module client ports only)
OC192	Not supported	Not supported	Supported (SONET module line ports only)
STM1/4	Not supported	Supported (SDH module client ports only)	Supported (SDH module client ports only)
STM16	Supported (SDH module line port only)	Supported (SDH module line ports only)	Supported (SDH modules client ports only)
STM64	Not supported	Not supported	Supported (SDH modules line ports only)
OTU1	Not supported	Supported	Not supported
OTU2	Not supported	Not supported	Supported
Gigabit Ethernet (GE)	Supported	Supported	Supported
Fast Ethernet (FE)	Supported	Not supported	Not supported
Fibre Channel 1G/ FICON 1G	Not supported	Supported	Supported
Fibre Channel 2G/ FICON 2G	Not supported	Supported	Supported
Fibre Channel 4G/ FICON 4G	Not supported	Not supported	Supported

Table 9-3 Muxponder portfolio supported protocols (Continued)

Protocol	2-Port GbE Muxponder	8-Port Multiprotocol Muxponder	10-Port Multiprotocol Muxponder
OC3	Not supported	Supported	Supported
OC12	Not supported	Supported	Supported
STM1	Not supported	Supported	Supported
STM4	Not supported	Supported	Supported
100FX (First Office Application only)	Not supported	Supported	Not supported
SD-SDI	Not supported	Supported	Not supported
HD-SDI	Not supported	Supported	Not supported
HD-SDI 1.001	Not supported	Supported	Not supported
DVB-ASI (First Office Application only)	Not supported	Supported	Not supported

## 9.1.4 Muxponder module operating temperature ranges

Table 9-4 Muxponder module operating temperature ranges

Module	0°C to +40°C long term	-5°C to +50°C short term	-20°C to +65°C long term
2-Port GbE Muxponder – SONET	X	X	X
2-Port GbE Muxponder – SDH	X	X	X
8-Port Multiprotocol Muxponder – SONET	X	X	
8-Port Multiprotocol Muxponder – SDH	X	X	
10-Port Multiprotocol Muxponder – SONET	X	X	
10-Port Multiprotocol Muxponder – SDH	X	X	

**Note** At -20°C to +65°C operating ranges, startup is at -20°C.

## 9.2 Muxponder applications

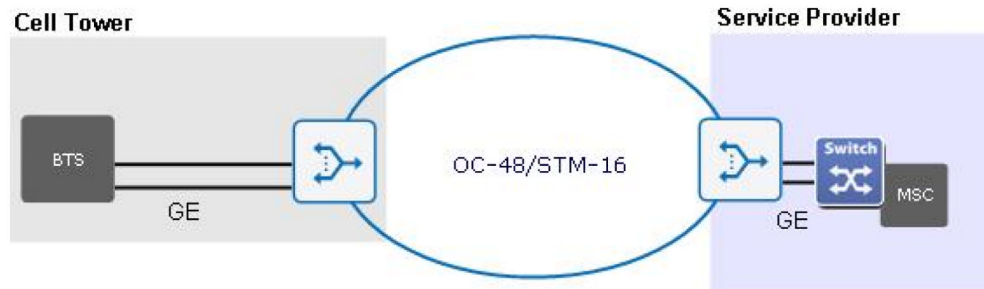
This section provides information about the applications that Muxponder modules support.

- 9.2.1, “Wireless backhaul ”
- 9.2.2, “Business services”
- 9.2.3, “Enterprise networks”
- 9.2.4, “SONET/SDH aggregation and interconnect ”
- 9.2.5, “Data center interconnect”
- 9.2.6, “Transparent network interconnect”

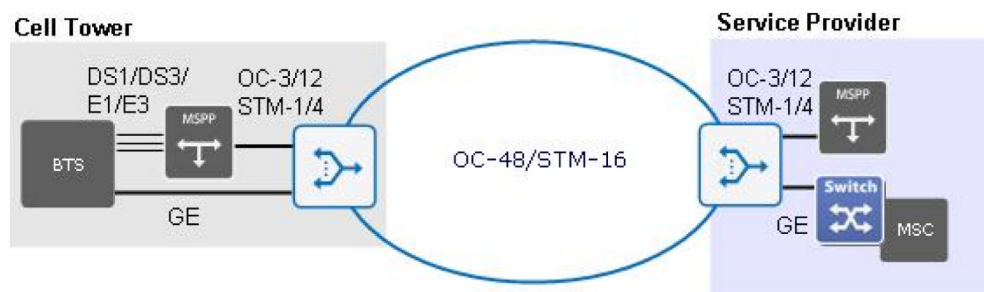
### 9.2.1 Wireless backhaul

Muxponder modules can be used to provide protected backhaul from new broadband access devices, such as WiMAX base stations. The 2-Port GbE Muxponder client ports connect to the two optical GbE ports on the access device at any wavelength. The Muxponder maps the two GbE ports into an OC48 or STM16. The OC48 or STM16 is output on redundant line-side ports that can be routed East and West on a UPSR- or SNCP-protected ring for backhaul to the aggregation site or central office.

**Figure 9-1 2-Port GbE Muxponders or 8-Port Multiprotocol Muxponders deployed for 4G/LTE/WiMAX**



**Figure 9-2 8-Port Multiprotocol Muxponders deployed for 3G/4G wireless backhaul**

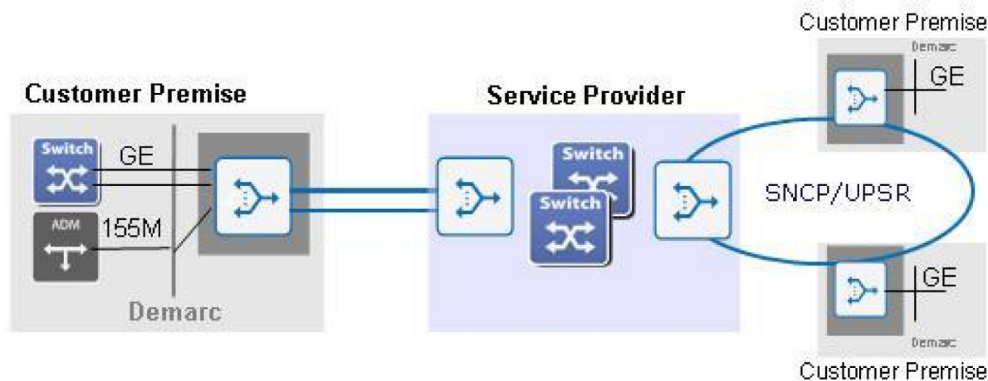




## 9.2.2 Business services

Muxponder modules provide delivery of wholesale and enterprise, full-bandwidth GbE Private Line services and SONET/SDH Private Line services over a service provider's network infrastructure. The service interface can be GbE or SONET/SDH at any wavelength. A full suite of GbE alarms and performance monitoring provides service demarcation, with measurement to Service Level Agreements (SLAs) and simplified billing. UPSR and SNCP protection at sub-50ms provides premium-quality service.

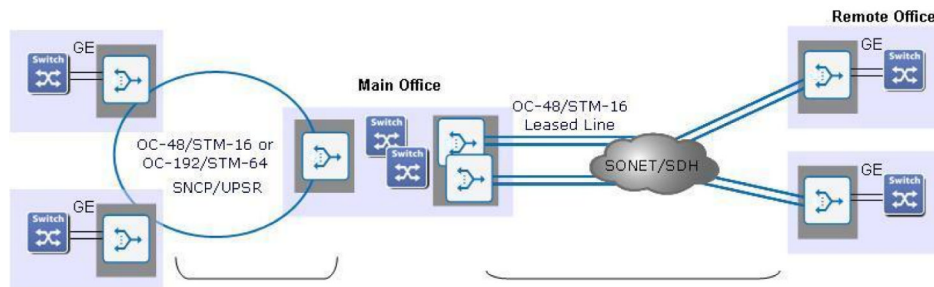
**Figure 9-3 Muxponder modules deployed in a service provider's network infrastructure**

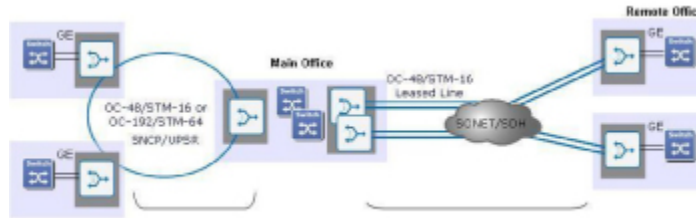


## 9.2.3 Enterprise networks

Muxponder modules can be used in private or carrier networks for the transport of GbE signals between Ethernet switches and routers. GbE signals are mapped into OC48/STM16 or OC192/STM64 line ports to enable transport over existing or new SONET or SDH networks.

**Figure 9-4 8-Port or 10-Port Multiprotocol Muxponders deployed in an enterprise network**

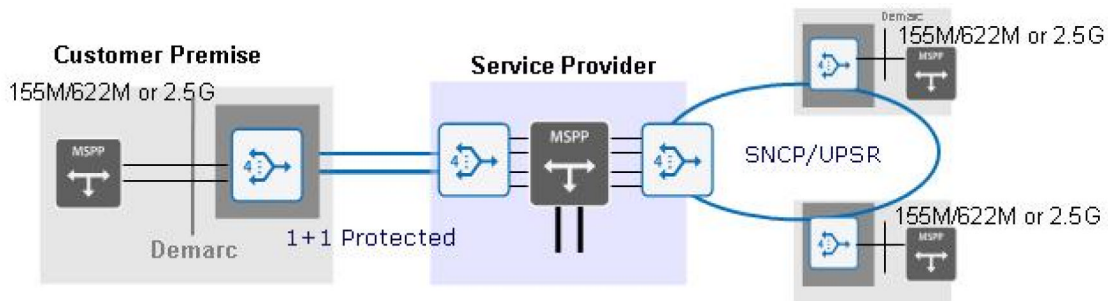


**Figure 9-5 8-Port or 10-Port Multiprotocol Muxponders deployed in an enterprise network**

### 9.2.4 SONET/SDH aggregation and interconnect

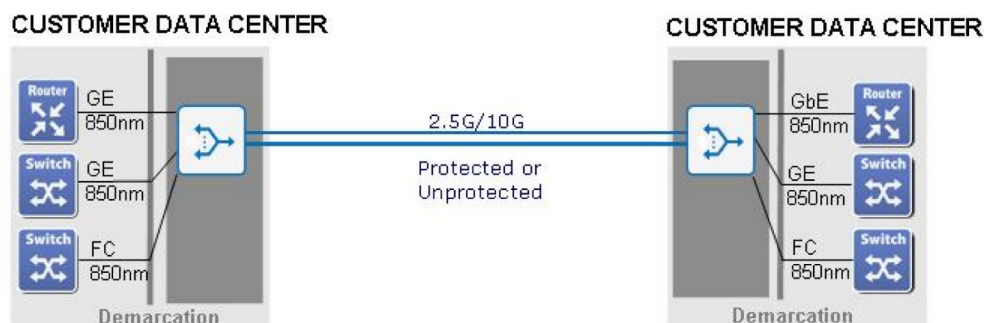
The 8-Port Multiprotocol Muxponder modules enable up to four SONET/SDH carriers to be converged onto a single protected 2.5G wavelength, or two unprotected 2.5G wavelengths, for aggregation of wholesale and service-oriented OC3/STM1 or OC12/STM4 private line and ring services.

The 10-Port Multiprotocol Muxponder modules enable up to four SONET/SDH carriers to be converged onto a single 10G wavelength, with optional line protection, for aggregation of wholesale and service-oriented OC48/STM16 private line and ring services.

**Figure 9-6 8-Port or 10-Port Multiprotocol Muxponder modules deployed for SONET/SDH aggregation**

### 9.2.5 Data center interconnect

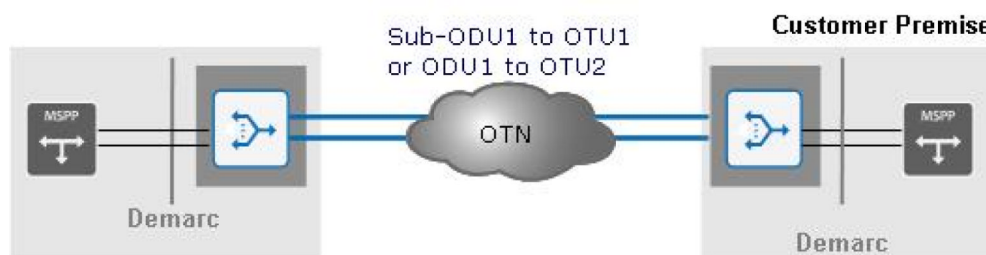
The 8-Port and 10-Port Multiprotocol Muxponders provide high-density fan-in of client ports to support Fibre Channel and Gigabit Ethernet for key data center applications, including Storage Area Network (SAN) extension and Business Continuity/Disaster Recovery plus Network Attached Storage (NAS) interconnect.

**Figure 9-7 8-Port or 10-Port Multiprotocol Muxponders deployed to interconnect data centers**

## 9.2.6 Transparent network interconnect

The 8-Port and 10-Port Multiprotocol Muxponders with transparent mapping provide aggregation and transport of SONET/SDH traffic transparently across the network while retaining individual timing information.

The 8-Port Multiprotocol Muxponder modules support transparent transport for OC3/STM1 or OC12/STM4 clients. 10-Port Multiprotocol Muxponder modules support transparent transport for OC48/STM16 clients.

**Figure 9-8 8-Port or 10-Port Multiprotocol Muxponders deployed in a network**

## 9.3 Muxponder specifications

This section provides specifications for Muxponder modules and covers the following topics:

- [9.3.1, “2-Port GbE Muxponder SONET specifications”](#)
- [9.3.2, “2-Port GbE Muxponder SDH specifications”](#)
- [9.3.3, “8-Port Multiprotocol Muxponder SONET specifications”](#)
- [9.3.4, “8-Port Multiprotocol Muxponder SDH specifications”](#)
- [9.3.5, “10-Port Multiprotocol Muxponder SONET specifications ”](#)
- [9.3.6, “10-Port Multiprotocol Muxponder SDH specifications”](#)

### 9.3.1 2-Port GbE Muxponder SONET specifications

Table 9-5 2-Port GbE Muxponder SONET BP1A46AA specifications

Parameter	Value
Module size	Single slot
Supported shelf	BTI 7060, BTI 7030
Bandwidth management	Mapping of Client GbE and 100BaseT into OC48 using GFP-F and Virtual Concatenation
Protection	Client–traffic unidirectional-path switched ring (UPSR) protection on per STS-1 basis
Loopback	
GbE client ports	Facility, Terminal
OC48 line ports	Facility
GbE client–traffic optical interface	
Number of interfaces	2
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Fast Ethernet client–traffic interface	
Number of interfaces	2
Connector type	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps, Autosensing
OC48 line-side interface	
Number of interfaces	2
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Performance monitoring	Current and historical (15mins, 24hours, untimed). See 9.4, “Muxponder PMs”.
Jitter	Compliant with Telcordia GR-253-CORE (sections 5.6.2.2 Tolerance and 5.6.2.3 Generation) for Jitter Generation and Tolerance.

Table 9-5 2-Port GbE Muxponder SONET BP1A46AA specifications (Continued)

Parameter	Value
Eye mask of optical output	Compliant with GR-253 and ITU-T G.957
Latency	<100 $\mu$ s

### 9.3.2 2-Port GbE Muxponder SDH specifications

Table 9-6 2-Port GbE Muxponder SDH BP1A46BA specifications

Parameter	Value
Module size	Single slot
Supported shelf	BTI 7060, BTI 7030
Bandwidth management	Mapping of Client GbE and 100BaseT into SDH using GFP-F and Virtual Concatenation
Protection	Client-traffic subnetwork connection protection (SNCP) on per VC-4 basis
Loopback	
GbE client ports	Facility, Terminal
STM16 line ports	Facility
GbE client-traffic optical interface	
Number of interfaces	2
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Fast Ethernet client-traffic interface	
Number of interfaces	2
Connector type	RJ-45 IEEE 802.3 Ethernet, 10/100 Mbps, Autosensing
STM16 line-side interface	
Number of interfaces	2
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Performance monitoring	Current and historical (15mins, 24hours, untimed). See 9.4, “Muxponder PMs”.
Jitter	Compliant with Telcordia GR-253-CORE (sections 5.6.2.2 Tolerance and 5.6.2.3 Generation) for Jitter Generation and Tolerance.
Eye mask of optical output	Compliant with GR-253 and ITU-T G.957
Latency	<100 μs

### 9.3.3 8-Port Multiprotocol Muxponder SONET specifications

Table 9-7 8-Port Multiprotocol Muxponder SONET BT7A47JA specifications

Parameter	Value
Module size	Double-width slot
Supported shelf	BTI 7060, BTI 7030
Supported line rates	OC48, OTU1
Supported client protocols	
Clients 1 to 4	OC3 OC12 100FX SD-SDI HD-SDI HD-SDI 1.001 DVB-ASI  <b>Note</b> 100FX and DVB-ASI supported for First Office Application only.
Clients 3 to 8	Gigabit Ethernet Fibre Channel 1 Fibre Channel 2
Data client encapsulation	
Gigabit Ethernet	GFP-F, GFP-T
Fibre Channel	GFP-T
Data client concatenation	VCAT, CCAT
Protection	UPSR
Loopback	
Client ports	Facility, Terminal
Line ports	Facility
Client-Traffic Optical Interface	
Number of interfaces	8
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Line-side Interface	
Number of interfaces	2
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Performance monitoring	Current and historical (15mins, 24hours, untimed). See 9.4, “Muxponder PMs” .
Jitter	Compliant with Telcordia GR-253-CORE (sections 5.6.2.2 Tolerance and 5.6.2.3 Generation) for Jitter Generation and Tolerance.

Table 9-7 8-Port Multiprotocol Muxponder SONET BT7A47JA specifications (Continued)

Parameter	Value
Eye mask of optical output	Compliant with GR-253 and ITU-T G.957
Latency	<255 $\mu$ s per link (VCAT) <15 $\mu$ s per link (CCAT)

### 9.3.4 8-Port Multiprotocol Muxponder SDH specifications

Table 9-8 8-Port Multiprotocol Muxponder SDH BT7A47KA/MA specifications

Parameter	Value
Module size	Double-width slot
Supported shelf	BTI 7060, BTI 7030
Supported line rates	STM16, OTU1
Supported client protocols	
Clients 1 to 4	STM1 STM4 100FX SD-SDI HD-SDI HD-SDI 1.001 DVB-ASI <b>Note</b> 100FX and DVB-ASI supported for First Office Application only.
Clients 3 to 8	Gigabit Ethernet Fibre Channel 1 Fibre Channel 2
Data client encapsulation	
Gigabit Ethernet	GFP-F, GFP-T
Fibre Channel	GFP-T
Data client concatenation	VCAT, CCAT
Protection	SNCP
Loopback	
Client ports	Facility, Terminal
Line ports	Facility
Client-traffic optical interface	
Number of interfaces	8
Connector type	See 3.5, "Module and transceiver compatibility".
Output wavelength	
Output power/receiver sensitivity	
Line-side interface	

**Table 9-8 8-Port Multiprotocol Muxponder SDH BT7A47KA/MA specifications (Continued)**

Parameter	Value
Number of interfaces	2
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
<b>Performance monitoring</b>	Current and historical (15mins, 24hours, untimed). See 9.4, “Muxponder PMs” .
<b>Jitter</b>	Compliant with Telcordia GR-253-CORE (sections 5.6.2.2 Tolerance and 5.6.2.3 Generation) for Jitter Generation and Tolerance.
<b>Eye mask of optical output</b>	Compliant with GR-253 and ITU-T G.957
<b>Latency</b>	<255 $\mu$ s per link (VCAT) <15 $\mu$ s per link (CCAT)

### 9.3.5 10-Port Multiprotocol Muxponder SONET specifications

**Table 9-9 10-Port Multiprotocol Muxponder SONET BT7A48AA, BT7A48AA-I02 specifications**

Parameter	Value
Module size	Double-width slot
Supported shelf	BT7A48AA:BTI 7060, BTI 7030
Supported shelf	BT7A48AA-I02:BTI 7060
Supported line rates	OC192, G.709 OTU2
<b>Supported client protocols</b>	
Clients 1 and 2	Fibre Channel 4
Clients 1 to 4	OC3 OC12 OC48
Clients 1 to 10	Gigabit Ethernet Fibre Channel 1 Fibre Channel 2
<b>Data client encapsulation</b>	
Gigabit Ethernet	GFP-F, GFP-T
Fibre Channel	GFP-T
Data client concatenation	VCAT, CCAT
Protection	UPSR
<b>Loopback</b>	
Client ports	Facility, Terminal
Line ports	Facility
<b>Client-traffic optical interface</b>	
Number of interfaces	10
Connector type	See 3.5, “Module and transceiver compatibility”.



**Table 9-9 10-Port Multiprotocol Muxponder SONET BT7A48AA, BT7A48AA-I02 specifications (Continued)**

Parameter	Value
Output wavelength	
Output power/receiver sensitivity	
Line-side interface	
Number of interfaces	2
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Performance Monitoring	Current and historical (15mins, 24hours, untimed). See 9.4, “Muxponder PMs”.
Jitter	Compliant with Telcordia GR-253-CORE (sections 5.6.2.2 Tolerance and 5.6.2.3 Generation) for Jitter Generation and Tolerance.
Eye Mask of Optical Output	Compliant with GR-253 and ITU-T G.957
Latency	<255 μs per link (VCAT)
	<15 μs per link (CCAT)

### 9.3.6 10-Port Multiprotocol Muxponder SDH specifications

**Table 9-10 10-Port Multiprotocol Muxponder SDH BT7A48BA/DA, BT7A48BA-I02 specifications**

Parameter	Value
Module size	Double-width slot
Supported shelf	BT7A48BA/DA:BTI 7060, BTI 7030
Supported shelf	BT7A48BA-I02:BTI 7060
Supported line rates	STM64, G.709 OTU2
<b>Supported client protocols</b>	
Clients 1 and 2	Fibre Channel 4
Clients 1 to 4	STM1 STM4 STM16
Clients 1 to 10	Gigabit Ethernet Fibre Channel 1 Fibre Chanel 2
<b>Data client encapsulation</b>	
Gigabit Ethernet	GFP-F, GFP-T
Fibre Channel	GFP-T
Data client concatenation	VCAT, CCAT
Protection	SNCP
<b>Loopback</b>	
Client ports	Facility, Terminal
Line ports	Facility

**Table 9-10 10-Port Multiprotocol Muxponder SDH BT7A48BA/DA, BT7A48BA-I02 specifications (Continued)**

Parameter	Value
Client-traffic optical interface	
Number of interfaces	10
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Line-side interface	
Number of interfaces	2
Connector type	See 3.5, “Module and transceiver compatibility”.
Output wavelength	
Output power/receiver sensitivity	
Performance monitoring	Current and historical (15mins, 24hours, untimed). See 9.4, “Muxponder PMs”.
Jitter	Compliant with Telcordia GR-253-CORE (sections 5.6.2.2 Tolerance and 5.6.2.3 Generation) for Jitter Generation and Tolerance.
Eye Mask of Optical Output	Compliant with GR-253 and ITU-T G.957
Latency	<255 μs per link (VCAT) <15 μs per link (CCAT)

## 9.4 Muxponder PMs

The following table lists the PM types each Muxponder module supports.

PM type	Supported on
Physical	All Muxponder modules. See <a href="#">11.6, “Physical PMs”</a> .
GE	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
SONET section	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
SDH section	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
Layer 1 Fibre Channel	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
OTN	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
BRI	8-Port Multiprotocol Muxponder

This section covers the following topics:

- [9.4.1, “Gigabit Ethernet PMs supported on Muxponder modules”](#)
- [9.4.2, “SONET PMs supported on Muxponder modules”](#)
- [9.4.3, “SDH PMs supported on Muxponder modules”](#)
- [9.4.4, “BRI protocol PMs supported on Muxponder modules”](#)
- [9.4.5, “Layer 1 Fibre Channel PMs supported on Muxponder modules”](#)
- [9.4.6, “OTN PMs supported on Muxponder modules”](#)

### 9.4.1 Gigabit Ethernet PMs supported on Muxponder modules

Table 9-11 Gigabit Ethernet PMs (counters) supported on Muxponder modules

Description	GFP Mode	Supported modules
<b>BCST</b> Total Broadcast Frame Count in Receive Direction measures the total number of good frames received that were directed to the broadcast address. (This number does not include frames that were directed to the multicast address.)	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>CV (Layer 1)</b> 8B/10B Coding Violations measures the number of 8B/10B coding violations.	GFP-F GFP-T	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder

**Table 9-11 Gigabit Ethernet PMs (counters) supported on Muxponder modules (Continued)**

Description	GFP Mode	Supported modules
		10-Port Multiprotocol Muxponder
<b>ES</b> (Layer 1) Errored Seconds measures the number of seconds during which one or more errored blocks/code violations are detected, or LOSYNC (Loss of Synchronization) or LOS (Loss of Signal) is detected.	GFP-F	2-Port GbE Muxponder
	GFP-T	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>FCSE-RX</b> (Layer 2) Total Number of Received Frames with CRC (Cyclic Redundancy Check) Error measures the number of received frames that had a valid length but had either a bad Frame Check Sequence (FCS Error) or a bad FCS with a non-integral number of OCTETS (alignment errors).	GFP-F	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>FRDR</b> (Layer 2) Total Number of Discarded Frames measures the total number of frames dropped due to a lack of resources or other reasons. This number is not necessarily the number of frames dropped, but rather the number of time that dropped frames could be detected.	GFP-F	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>FRGT</b> Total Fragmented Frame Count in Receive Direction measures the total number of received frames that were less than 64 octets long (excluding framing bits, but including Frame Check Sequence (FCS) octets) and had either a bad FCS with a integral number of octets (FCS error) or a bad FCS with a non-integral number of octets (alignment error).	GFP-F	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>MCST</b> Total Multicast Frame Count in Receive Direction measures the total number of good frames received that were directed to a multicast address. (This number does not include frames that were directed to the broadcast address.)	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>OSIZE</b> Total Oversized Frame Count in Receive Direction measures the total number of received frames that were longer than 9600 octets (excluding framing bits, but including Frame Check Sequence (FCS) octets) and were otherwise well formed).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>OVER1518</b> Total > = 1519 Byte Frame Count in Receive Direction Measures the total number of frames received that were greater than or equal to 1519 bytes in length (excluding framing bites, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>SES</b> (Layer 1) Severely Errored Seconds measures the number of seconds during which the number of detected coding violations exceeds the severely errored seconds level (SESLVL), or in which a Loss of Synchronization (LOSYNC) defect or Loss of	GFP-F	2-Port GbE Muxponder
	GFP-T	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder

**Table 9-11 Gigabit Ethernet PMs (counters) supported on Muxponder modules (Continued)**

Description	GFP Mode	Supported modules
Frame (LOF) defect is present. The SESLVL value for Layer 1 Gigabit Ethernet is 1250.		
<b>SIZE64</b> Total 64 Byte Frame Count in Receive Direction measures the total number of 64 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>SIZE65-127</b> Total 65-127 Byte Frame Count in Receive Direction measures the total number of 65-127 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>SIZE128-255</b> Total 128-255 Byte Frame Count in Receive Direction measures the total number of 128-255 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>SIZE256-511</b> Total 256-511 Byte Frame Count in Receive Direction measures the total number of 256-511 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>SIZE512-1023</b> Total 512-1023 Byte Frame Count in Receive Direction measures the total number of 512-1023 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>SIZE1024-1518</b> Total 1024-1518 Byte Frame Count in Receive Direction measures the total number of 1024-1518 byte frames received (excluding framing bits, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>TBYC-RX</b> Total Byte count in Receive Direction measures the total number of bytes of data (including those in bad frames) received (excluding framing bits, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>TBYC-TX</b> Total Byte Count in Transmit Direction measures the total number of bytes of data (including those in bad frames) transmitted (excluding framing bits, but including Frame Check Sequence (FCS) octets).	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>TFRC-RX (Layer 2)</b> Total Frame Count in Receive Direction measures the total number of frames (bad frames, broadcast frames, and multicast frames) received.	GFP-F	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>TFRC-TX (Layer 2)</b>	GFP-F	2-Port GbE Muxponder

**Table 9-11 Gigabit Ethernet PMs (counters) supported on Muxponder modules (Continued)**

Description	GFP Mode	Supported modules
Total Frame Count in Transmit Direction measures the total number of frames (bad frames, broadcast frames, and multicast frames) transmitted.		8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>TPFC-RX</b> Total Pause Frame Count in Receive Direction measures the total number of pause frames received.	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>TPFC-TX</b> Total Pause Frame Count in Transmit Direction measures the total number of pause frames transmitted.	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>UAS</b> Unavailable Seconds measures the number of seconds during which the link was considered unavailable. A link becomes unavailable at the onset of 10 consecutive seconds that qualify as SES, and continues to be unavailable until the onset of 10 consecutive seconds that do not qualify as SES. In seconds that are counted as unavailable, the counting of In seconds that are counted as unavailable, the counting of INVBLK, ES, and SES is inhibited.	GFP-F GFP-T	2-Port GbE Muxponder 8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>USIZE</b> Undersized Frames measures the total number of frames received that were less than 64 octets long (excluding framing bits, but including Frame Check Sequence (FCS) octets) and were otherwise well formed.	GFP-F	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder

## 9.4.2 SONET PMs supported on Muxponder modules

**Note** For information about SONET protocols supported on Muxponder modules, see [9.3, “Muxponder specifications”](#)

**Table 9-12 SONET PMs (counters)**

PM (montype)	Supporting entities
<b>CVS</b> Section Coding Violations measures the number of B1 Bit Interleaved Parity (BIP) errors detected at the section layer.	OC3, OC12, OC48, OC192
<b>ESS</b> Section Errored Seconds measures the number of seconds during which one or more B1 Bit Interleaved Parity (BIP) errors were detected or a Severely Errored Frame (SEF) or a Loss of Signal (LOS) defect was present.	OC3, OC12, OC48, OC192
<b>SEFS-S</b> Section Severely Errored Framing Seconds measures the number of seconds during which a section SEF defect was present.	OC3, OC12, OC48, OC192
<b>SES-S</b> Section Severely Errored Seconds measures number of seconds during which the number of detected B1 Bit Interleaved Parity (BIP) errors exceeds the	OC3, OC12, OC48, OC192

**Table 9-12 SONET PMs (counters) (Continued)**

<b>PM (montype)</b>	<b>Supporting entities</b>
severely errored seconds level (SESLVL), or a Severely Errored Frame (SEF) or a Loss of Signal (LOS) defect was present. The SESLVL value for SONET section level is as follows: <ul style="list-style-type: none"> <li>• OC3 = 155</li> <li>• OC12 = 616</li> <li>• OC48 = 2392</li> <li>• OC192 = 8554</li> </ul>	
<b>UAS-S</b> Section Unavailable Seconds measures the number of seconds during which the SONET section is unavailable. A second is considered UAS-S at the onset of 10 consecutive SESS seconds, and is no longer considered UAS-S after 10 consecutive seconds that are not SESS seconds. In seconds that are counted as unavailable, the counting of CVS, ESS, and SESS are inhibited.	OC3, OC12, OC48, OC192
<b>CV-L</b> Line Coding Violations measures the number of B2 Bit Interleaved Parity (BIP) errors detected at the line layer.	OC3, OC12, OC48 <sup>1</sup> , OC192
<b>ES-L</b> Line Errored Seconds measures the number of seconds during which one or more B2 Bit Interleaved Parity (BIP) errors are detected, or a Line Alarm Indication Signal (AIS-L) defect is present.	OC3, OC12, OC48 <sup>1</sup> , OC192
<b>SES-L</b> Line Severely Errored Seconds measures the number of seconds during which the number of detected B2 Bit Interleaved Parity (BIP) errors exceeds the severely errored seconds level (SESLVL), or a Line Alarm Indication Signal (AIS-L) defect was present. The SESLVL value for SONET line level is as follows: <ul style="list-style-type: none"> <li>• OC3 = 154</li> <li>• OC12 = 615</li> <li>• OC48 = 2459</li> <li>• OC192 = 9835</li> </ul>	OC3, OC12, OC48 <sup>1</sup> , OC192
<b>UAS-L</b> Line Unavailable Seconds measures the number of seconds during which the line is unavailable. A second is considered UAS-L at the onset of 10 consecutive SES-L seconds, and is no longer considered UAS-L after 10 consecutive seconds that are not SES-L seconds. In seconds that are counted as unavailable, the counting of CV-L, ES-L, and SES-L are inhibited.	OC3, OC12, OC48 <sup>1</sup> , OC192
<b>CVP</b> Path Coding Violation measures the number of B3 Bit Interleaved Parity (BIP) errors at the path layer.	STS-n/STS-nc
<b>ESP</b> Path Errored Seconds measures the number of seconds during which one or more B3 Bit Interleaved Parity (BIP) errors are detected, or a Path Alarm Indication Signal (AIS-P), Path Unequipped, or a Path Loss of Pointer (LOP-P) defect is present.	STS-n/STS-nc
<b>FC-P</b>	STS-n/STS-nc

**Table 9-12 SONET PMs (counters) (Continued)**

PM (montype)	Supporting entities
<p>Failure Count at Path Layer measures the number of transitions from a second in which a path failure defect is not detected to a second in which one or more failure defects are detected. The monitored PATH failure defects are:</p> <ul style="list-style-type: none"> <li>• Path Alarm Indication Signal (AIS-P)</li> <li>• Path Unequipped</li> <li>• Path Loss of Pointer (LOP-P)</li> </ul>	
<p><b>SES-P</b></p> <p>Path Severely Errored Seconds measures the number of seconds during which the number of detected B3 Bit Interleaved Parity (BIP) errors exceeds the severely errored seconds level (SESLVL), or a Path Alarm Indication Signal (AIS-P), Path Unequipped, or Path Loss of Pointer (LOP-P) defect was present. The SESLVL value for SONET path level is 2400.</p>	STS-n/STS-nc
<p><b>UAS-P</b></p> <p>Path Unavailable Seconds measures the number of seconds during which service at the path layer is unavailable. A second is considered unavailable at the onset of 10 consecutive seconds that are considered SESP, and is no longer unavailable after 10 seconds that are not SESP. In seconds that are counted as unavailable, the counting of CVP, ESP and SESP are inhibited.</p>	STS-n/STS-nc
<sup>1</sup> Supported on 8-Port and 10-Port Multiprotocol Muxponders only.	

### 9.4.3 SDH PMs supported on Muxponder modules

**Note** For information about SDH protocols supported on Muxponder modules, see [9.3, “Muxponder specifications”](#)

**Table 9-13 SDH PMs (counters)**

PM (montype)	Supported entities
<p><b>RS-EB</b></p> <p>Regenerator Section Errored Blocks measures the number of regenerator section errored blocks. An errored block is one that contains one or more (up to eight per block) B1 Bit Interleaved Parity (BIP) errors.</p>	STM1, STM4, STM16, STM64
<p><b>RS-BBE</b></p> <p>Regenerator Section Background Block Errors measures the number of errored blocks not occurring during seconds counted as RS-SES seconds.</p>	STM1, STM4, STM16, STM64
<p><b>RS-ES</b></p> <p>Regenerator Section Errored Seconds measures the number of seconds during which one or more errored blocks were detected or a Loss of Frame (LOF) or a Loss of Signal (LOS) defect was present.</p>	STM1, STM4, STM16, STM64
<p><b>RS-OFS</b></p> <p>Regenerator Section out of Frame Seconds measures the number of seconds during which an Out of Frame (OOF) defect was present.</p>	STM1, STM4, STM16, STM64
<b>RS-SES</b>	STM1, STM4, STM16, STM64



Table 9-13 SDH PMs (counters) (Continued)

PM (montype)	Supported entities
Regenerator Section Severely Errored Seconds measures the number of seconds during which the number of detected errored blocks exceeds the severely errored seconds level (SESLVL), or a Loss of Frame (LOF) or Loss of Signal (LOS) defect was present. The SESLVL value for SDH regenerator section is 30% of the nominal block rate.	
<b>RS-UAS</b> Regenerator Section Unavailable Seconds measures the number of seconds during which the regenerator section is unavailable. A second is considered RS-UAS at the onset of 10 consecutive RS-SES seconds, and is no longer considered RS-UAS after 10 consecutive seconds that are not RS-SES seconds. In seconds that are counted as unavailable, the counting of RS-EB, RS-BBE, RS-ES, and RS-SES is inhibited.	STM1, STM4, STM16, STM64
<b>MS-EB</b> Multiplex Section Errored Blocks measures the number of multiplex section errored blocks. An errored block is one that contains one or more (up to eight per block) B2 Bit Interleaved Parity (BIP) errors.	STM1, STM4, STM16 <sup>1</sup> , STM64
<b>MS-BBE</b> Multiplex Section Background Block Errors measures the number of errored blocks not occurring during seconds counted as MS-SES seconds.	STM1, STM4, STM16 <sup>1</sup> , STM64
<b>MS-ES</b> Multiplex Section Errored Seconds measures the number of seconds during which one or more errored blocks were detected or a Multiplex Section Alarm Indication Signal (MS-AIS) defect was present	STM1, STM4, STM16 <sup>1</sup> , STM64
<b>MS-SES</b> Multiplex Section Severely Errored Seconds measures the number of seconds during which the number of detected errored blocks exceeds the severely errored seconds level (SESLVL), or a Multiplex Section Alarm Indication Signal (MS-AIS) defect was present. The SESLVL value for SDH multiplex section is 30% of the nominal block rate	STM1, STM4, STM16 <sup>1</sup> , STM64
<b>MS-UAS</b> Multiplex Section Unavailable Seconds measures the number of seconds during which the multiplex section is unavailable. A second is considered MS-UAS at the onset of 10 consecutive MS-SES seconds, and is no longer considered MS-UAS after 10 consecutive seconds that are not MS-SES seconds. In seconds that are counted as unavailable, the counting of MS-EB, MS-BBE, MS-ES and MS-SES is inhibited.	STM1, STM4, STM16 <sup>1</sup> , STM64
<b>HP-EB</b> High Order Path Errored Blocks measures the number of high order path errored blocks. An errored block is one that contains one or more (up to eight per block) B3 Bit Interleaved Parity (BIP) errors.	VC-n/VC-nc
<b>HP-BBE</b> High Order Path Background Block Errors measures the number of errored blocks not occurring during seconds counted as HP-SES seconds.	VC-n/VC-nc
<b>HP-ES</b> High Order Path Errored Seconds measures the number of seconds during which one or more errored blocks were detected, or a High Order Path Alarm	VC-n/VC-nc

**Table 9-13 SDH PMs (counters) (Continued)**

<b>PM (montype)</b>	<b>Supported entities</b>
Indication Signal (HP-AIS), High Order Path Unequipped, or High Order Path Loss of Pointer (HP-LOP) defect was present.	
<b>HP-SES</b> High Order Path Severely Errored Seconds measures the number of seconds during which the number of detected errored blocks exceeds the severely errored seconds level (SESLVL), or a High Order Path Alarm Indication Signal (HP-AIS), High Order Path Unequipped, or High Order Path Loss of Pointer (HP-LOP) defect was present. The SESLVL value for SDH high order path is 2400.	VC-n/VC-nc
<b>HP-UAS</b> High Order Path Unavailable Seconds measures the number of seconds during which the high order path is unavailable. A second is considered HP-UAS at the onset of 10 consecutive HP-SES seconds, and is no longer considered HP-UAS after 10 consecutive seconds that are not HP-SES seconds. In seconds that are counted as unavailable, the counting of HP-EB, HP-BBE, HP-ES and HP-SES are inhibited.	VC-n/VC-nc
<b>UAS-S</b> Section Unavailable Seconds measures the number of seconds during which the SDH section is unavailable. A second is considered UAS-S at the onset of 10 consecutive SESS seconds, and is no longer considered UAS-S after 10 consecutive seconds that are not SESS seconds. In seconds that are counted as unavailable, the counting of CVS, ESS, and SESS are inhibited.	STM1, STM4, STM16 <sup>1</sup> , STM64
<sup>1</sup> Supported on 8-Port and 10-Port Multiprotocol Muxponders only.	

## 9.4.4 BRI protocol PMs supported on Muxponder modules

**Table 9-14 BRI PMs (gauges)**

<b>PM (montype)</b>	<b>Supported modules</b>
<b>LBC</b> Laser Bias Current measures the laser bias current (mA) of the transceiver.	8-Port Multiprotocol Muxponder
<b>OPR</b> Optical Power Received measures the optical power (dBm) received by the transceiver. Measurements are accurate to $\pm 3.0$ dBm.	8-Port Multiprotocol Muxponder
<b>OPT</b> Optical Power Transmitted measures the optical power (dBm) transmitted by the transceiver. Measurements are accurate to $\pm 3.0$ dBm.	8-Port Multiprotocol Muxponder
<b>SUPPLY</b> Supply Voltage measures the supply voltage on the 3.3V supply.	8-Port Multiprotocol Muxponder
<b>TEMP</b> Temperature measures the temperature ( $^{\circ}\text{C}$ ) of the transceiver.	8-Port Multiprotocol Muxponder

## 9.4.5 Layer 1 Fibre Channel PMs supported on Muxponder modules

Table 9-15 Layer 1 Fibre Channel PMs (counters)

PM (montype)	Supported modules
<b>CV</b> 8B/10B Coding Violations measures the number of 8B/10B coding violations and disparity errors.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>ES</b> Errored Seconds measures the number of seconds during which one or more coding violations are detected, or a Loss of Synchronization (LOSYNC) or Loss of Signal (LOS) defect is present.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>SES</b> Severely Errored Seconds measures the number of seconds during which the number of detected coding violations exceeds the severely errored seconds level (SESLVL), or a Loss of Synchronization (LOSYNC) defect or Loss of Signal (LOS) defect is present. The SESLVL value for Fiber Channel is 1250.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>UAS</b> Unavailable Seconds measures the number of seconds during which the link was considered unavailable. A link becomes unavailable at the onset of 10 consecutive seconds that qualify as SES, and continues to be unavailable until the onset of 10 consecutive seconds that do not qualify as SES. In seconds that are counted as unavailable, the counting of In seconds that are counted as unavailable, the counting of INVBLK, ES, and SES is inhibited.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder

## 9.4.6 OTN PMs supported on Muxponder modules

Table 9-16 OTN PMs (counters) supported on SONET/SDH line ports

Description	Supported modules
<b>NUMBITSCR</b> Number of Bits Corrected measures the total number of bits corrected by the Forward Error Correction (FEC) decoder according to the Reed-Solomon RS(255,239) forward error correction scheme.	10-Port Multiprotocol Muxponder
<b>NUMBYTESCR</b> Number of Bytes Corrected measures the total number of bytes corrected by the forward error correction scheme.	10-Port Multiprotocol Muxponder
<b>UNCRCDWRD</b> Number of Uncorrectable Code Words measures the total number of errored code words received that could not be corrected by the Forward Error Correction scheme.	10-Port Multiprotocol Muxponder
<b>BER</b> Bit Error Ratio provides an estimate of the instantaneous Bit Error Ratio of the line by evaluating the ratio of the number of bits corrected to the total bits received over a 10-second time window. Both the instantaneous and average BER values are only valid for relatively low error rates in the signal. If the BER value is reported to be above $10^{-3}$ , it should be disregarded as it is not possible	10-Port Multiprotocol Muxponder

**Table 9-16 OTN PMs (counters) supported on SONET/SDH line ports (Continued)**

Description	Supported modules
to accurately measure BER values above this level. BER values above this level usually indicate another problem, which should be evident in other PM counts.	
<b>BER-AVG</b> Average Bit Error Ratio provides an estimate of the average Bit Error Ratio of the line by evaluating the ratio of the number of bits corrected to the total bits received over the duration of the entire collection interval. Both the instantaneous and average BER values are only valid for relatively low error rates in the signal. If the BER value is reported to be above $10^{-3}$ , it should be disregarded as it is not possible to accurately measure BER values above this level. BER values above this level usually indicate another problem, which should be evident in other PM counts.	10-Port Multiprotocol Muxponder
<b>OTU-BBE</b> OTU-2 Background Block Error measures the number of errored blocks not occurring during seconds counted as OTU-SES seconds.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>OTU-EB</b> OTU-2 Errored Blocks measures the number of frames containing one or more Bit Interleaved Parity (BIP) errors, using the OTU-2 SM BIP-8 byte in the incoming OTN signal. Up to eight BIP-8 errors can be detected per OTU-2 frame. However, regardless of the number of BIP-8 errors detected, a single frame can count for no more than one errored block.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>OTU-ES</b> OTU-2 Errored Seconds measures the number of seconds during which one or more errored blocks was detected or a Loss of Frame (LOF) or a Loss of Signal (LOS) defect was present.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>OTU-SES</b> OTU-2 Severely Errored Seconds measures the number of seconds during which the number of detected errored blocks exceeds the severely errored seconds level (SESLVL), or a Loss of Frame (LOF) or Loss of Signal (LOS) defect was present. The SESLVL value for OTN is 30% of the nominal block rate.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>OTU-OFS</b> OTU-2 Out of Frame Seconds measures the number of seconds during which a Out of Frame (OOF) defect was present.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder
<b>OTU-UAS</b> OTU-2 Unavailable Seconds measures the number of seconds during which the OTN line is unavailable. A second is considered OTU-UAS at the onset of 10 consecutive OTU-SES seconds, and is no longer considered OTU-UAS after 10 consecutive seconds that are not OTU-SES seconds.	8-Port Multiprotocol Muxponder 10-Port Multiprotocol Muxponder

## 10.0 packetVX modules

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This section provides information about the packetVX that the BTI 7000 Series supports.

- [10.1, “packetVX portfolio”](#)
- [10.2, “Features of the packetVX portfolio”](#)
- [10.3, “packetVX applications”](#)
- [10.4, “packetVX specifications”](#)
- [10.5, “packetVX module operating temperature ranges”](#)

## 10.1 packetVX portfolio

**Table 10-1 packetVX modules**

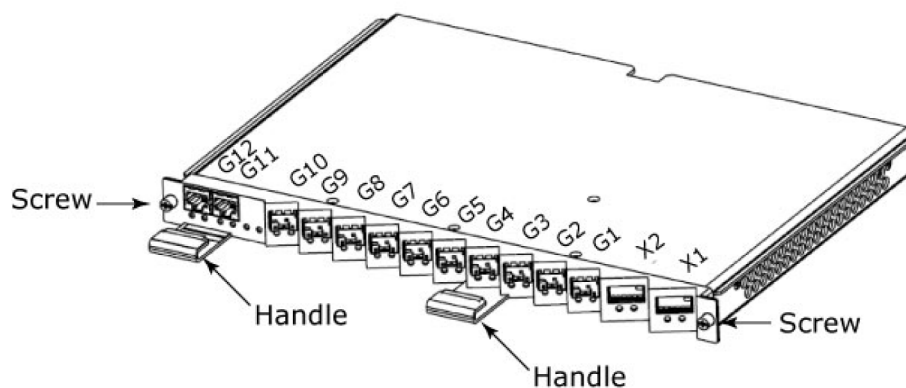
Module	PEC	System software introduced
packetVX 12/2	BT7A81AA	7.1.2
packetVX 24/2	BT7A81BA	7.1.2
packetVX 24/4	BT7A81CA	7.1.2
packetVX 80	BT7A81GA	10.2.0

### packetVX 12/2

The packetVX 12/2 is a double-width, single-height module that provides the following ports:

- 2 RJ45 10/100/1000BASE-T ports
- 2 XFP-based 10GbE ports

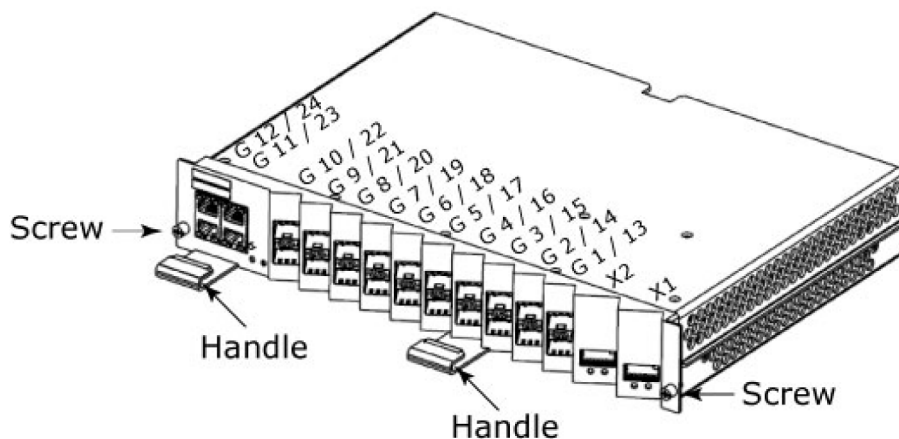
**Figure 10-1 packetVX 12/2**



### packetVX 24/2

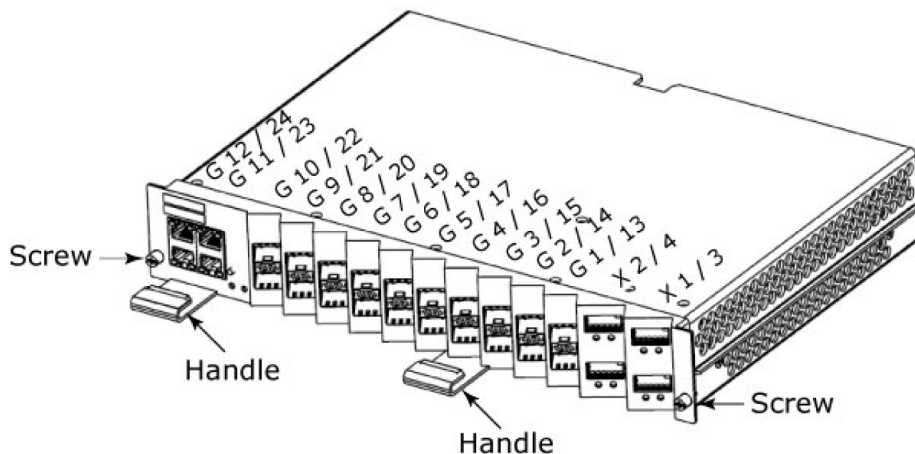
The packetVX 24/2 is a double-width, double-height BTI 7000 Series module that provides the following ports:

- 20 SFP-based GbE ports
- 4 RJ45 10/100/1000BASE-T ports
- 2 XFP-based 10GbE ports

**Figure 10-2 packetVX 24/2****packetVX 24/4**

The packetVX 24/4 is a double-width, double-height module that provides the following ports:

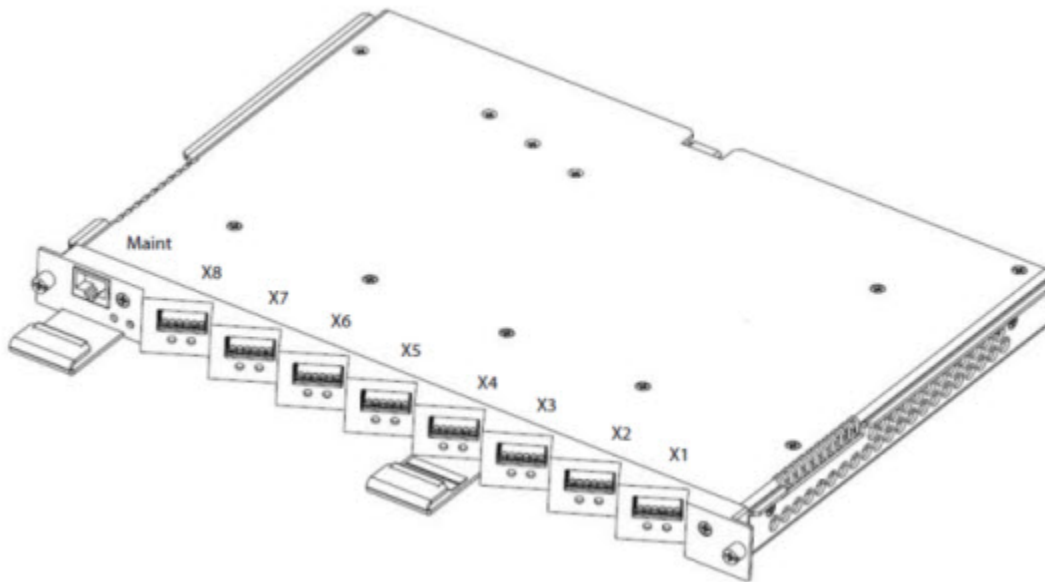
- 20 SFP-based ports
- 4 RJ45 10/100/1000BASE-T ports
- 4 XFP-based 10GbE ports

**Figure 10-3 packetVX 24/4****packetVX 80**

The packetVX 80 is a double-width, single-height module that provides the following ports:

- 1 RJ45 10/100/1000Base-T port—used for maintenance
- 8 XFP-based 10GbE ports

**Figure 10-4 packetVX 80**





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## 10.2 Features of the packetVX portfolio

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The packetVX modules provide the following features:

- GbE, 10GbE, and 10/100/1000BASE-T protocols
- G.709 OTN with enhanced FEC
- Provider bridging (IEEE 802.1ad)
- Ethernet services (EPLINE, EVPLINE, EPLAN, EVPLAN, ETREE)
- Quality of Service and Class of Service
- Link aggregation
- Multiple Spanning Tree Protocol (MSTP) which is compatible with RSTP and STP
- Ethernet Ring Protection Switching, Versions 1 and 2 (ITU-T G.8032)
- Ethernet service OAM (ITU-T Y.1731 and IEEE 802.1ag)
- Ethernet service statistics
- Ethernet and optical performance measurements
- Management VLAN
- Support for jumbo frames
- Access Control List (ACL) and Secure Shell (SSH) security
- System architecture that allows traffic to be carried uninterrupted if the System Control Processor (SCP) fails. A cold restart or a reseal of the SCP does not affect traffic.
- Supports a maximum of 32,000 MAC addresses
- proNX 900 Node Controller management support
- proNX Service Manager support
- CLI, SNMP, and Craft GUI management interfaces
- Extended temperature support (-40°C to +65°C)
- Storm Control
- NEBS <sup>TM</sup> Level 3 certified
- Support for Service Level Agreements ((SLA)
- Link Layer Discovery Protocol (LLDP)
- Stacking

### **VLAN tagging and provider bridging**

The switches supports provider bridging (IEEE 802.1ad). Provider bridging supports the encapsulation of private customer VLANs onto a provider network using stacked tags, or Q-in-Q

tagging, as defined in the IEEE 802.1ad standard. Customers can assign one or more customer VLANs (C-VLAN) to a service provider VLAN (S-VLAN) on any port.

The current provider bridging implementation supports:

- up to 768 individual C-VLAN to S-VLAN mappings (each interface in a LAG requires a separate mapping resource)
- up to 4088 S-VLANs
- Control frame profiles to provide ingress filtering

Provider bridging does not currently support S-VLAN translation.

### **Ethernet services**

- Ethernet Private Line (EPLINE)
- Ethernet Virtual Private Line (EVPLINE)
- Ethernet Private LAN (EPLAN)
- Ethernet Virtual Private LAN (EVPLAN)
- Ethernet Tree (ETREE)

### **Quality of Service and Class of Service**

- 802.1p, DSCP and TOS traffic prioritization
- 8 queues per port, strict priority, round-robin, weighted round-robin and deficit round-robin scheduling
- ingress and egress bandwidth profiles per UNI, EVC, COS

### **Link aggregation**

Link aggregation is an inverse multiplexing technique which uses multiple Ethernet ports in parallel to increase the link capacity beyond the limits of any one port, and to increase the redundancy for higher availability. A group of Ethernets combined in this way is called a Link Aggregation Group (LAG).

The current link aggregation implementation supports:

- up to 27 LAGs
- Eight members per LAG

### **Multiple Spanning Tree Protocol**

Multiple Spanning Tree Protocol (MSTP), part of the IEEE 802.1Q standard, provides the ability to create multiple spanning trees and assign VLANs to a spanning tree that closely reflects its optimal forwarding path. MSTP provides a single Common Spanning Tree Instance (CSTI) that is automatically created and Multiple Spanning Tree Instances (MSTI) that are configured to meet varied forwarding requirements.

The switches currently support up to 16 MSTP instances per switch.

### **Ethernet Ring Protection Switching (ITU-T G.8032 Versions 1 and 2)**

Ethernet Ring Protection Switching (ERPS) is a ring-based control protocol that is standardized under ITU-T G.8032/Y1344. The BTI 7000 Series supports the following ERPS features:

- Ring topologies: single, multiple independent instances, ladder
- Switching: forced, manual and clear
- Ring recovery: revertive and non-revertive
- Sub-rings: with and without virtual channels

### **Ethernet service OAM**

Ethernet service OAM provides end-to-end service visibility and monitoring of service availability/unavailability through check messaging, as well as loopback and linktrace testing capabilities for problem isolation.

### **Ethernet service PM statistics**

The switches support the following Ethernet Service PMs:

- Bandwidth Utilization
- Rx Bytes
- Rx Violate Bytes
- Rx Conform and Exceed Bytes

The switches support the following bins of historical statistics:

- 15 Minutes
- 1 Day
- Un-Timed

The switches support threshold crossing alerts (TCAs) for the following bandwidth utilization policing parameters:

- CIR
- EIR

TCAs can be set or disabled by users. Statistics can be reset and refreshed on demand.

### **Ethernet and optical performance measurements**

- GE Port Physical (Layer 0) PMs for SFP transceivers
- 10GbE Port Physical (Layer 0) PMs for XFP transceivers
- Ethernet (Layer 2) PMs
- Link aggregation group PMs
- MSTP PMs

## Management VLAN

The switches support a management VLAN that allows network operators to manage their network elements remotely.

## Jumbo frames

The switches support jumbo frames of up to 9600 bytes.

## ACL and SSH security

- Access Control Lists (ACLs) filter ingress traffic. The switches support up to 256 ACLs per switch.
- Secure Shell (SSH) is a network protocol that allows data to be exchanged using a secure channel between two networked devices. The encryption used by SSH provides confidentiality and integrity of data over an insecure network, such as the Internet. The switches support up to 50 simultaneous SSH sessions.

## Management interfaces

The switches support the following management interfaces:

- Command Line Interface (CLI) interface
- proNX 900 Node Controller
- proNX Service Manager
- SNMP

The **Command Line Interface (CLI)** supports a comprehensive and interactive set of commands to provision, monitor, and administer switch modules.

The **proNX 900 Node Controller** provides a graphical user interface to provision, operate, monitor, and troubleshoot switches. This interface provides a representational view of the physical configuration of each shelf in the BTI 7000 Series network and the modules in each shelf.

The **proNX Service Manager** provides proactive, service-centric management of network resources to simplify network operations, from visualization and activation of services to troubleshooting and supporting end customers.

The **Simple Network Management Protocol (SNMP)** implementation supports SNMPv1 and SNMPv2c, for messaging and authentication of community strings.

## Extended temperature support

The switches can be deployed in extended temperature environments ranging from -40°C to +65°C (-4°F to +150°F). For more information, refer to Application Note BTI-APN002-2011 *Engineering considerations for packetVX in -40C to +65C applications*.

### **Storm Control**

The packetVX provides Layer-2 storm protection to maintain network performance during periods of excessive traffic. Storm Control is supported on configured NNI ports, on a per-port basis, and on NNI LAGs.

### **SLA monitoring**

The BTI 7000 Series provides SLA support in two ways: In-service monitoring and on-demand testing.

### **Link Layer Discover Protocol (LLDP)**

The BTI packetVX supports LLDP, as specified in the IEEE 802.1AB standard for "Station and Media Access Control Connectivity Discovery." LLDP is a Link Layer protocol that provides network devices the ability to advertise their identity, capabilities, and neighbors to other network devices on an IEEE 802 local area network. For information on how LLDP is implemented on the packetVX refer to the *BTI 7000 Series packetVX Solutions Guide*.

### **Stacking**

The packetVX provides equipment redundancy by stacking two PVX modules. The 12/2 and 24/4 PVX stacking is through one or more 10 gigabit Ethernet interfaces to expand bandwidth to the stacking ports and provide a non-blocking bridge between two stacked modules. Multiple interfaces on the stacking port balances the traffic across the interfaces, which allows more data bandwidth between switches and minimizes the risk for blocking. The packetVX 80 stacking is via the backplane on the BTI 7200. Hence, packetVX 80 stacking is not supported on the BTI 7060.

For more information about stacking refer to the *BTI 7000 Series packetVX Solutions Guide*.

## 10.3 packetVX applications

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This section provides information about the applications that packetVX modules support.

- [10.3.1, “Applications overview”](#)
- [10.3.2, “Ethernet aggregation”](#)
- [10.3.3, “Ethernet business services”](#)
- [10.3.4, “Ethernet video applications”](#)
- [10.3.5, “4G wireless and WiMAX”](#)

### 10.3.1 Applications overview

The BTI packetVX provides an innovative approach for the rapid delivery of new Ethernet-based services. It provides carrier-grade GbE service aggregation onto 10 Gb/s linear and ring topologies, coupling packet switching functionality with wavelength-division multiplexing (WDM).

The packetVX provides point-to-point and ring protection for increased service availability. Innovative service provisioning capabilities dramatically simplify the operation, management, and provisioning of residential, video, and Ethernet business services.

### 10.3.2 Ethernet aggregation

The packetVX module supports the following Ethernet aggregation applications:

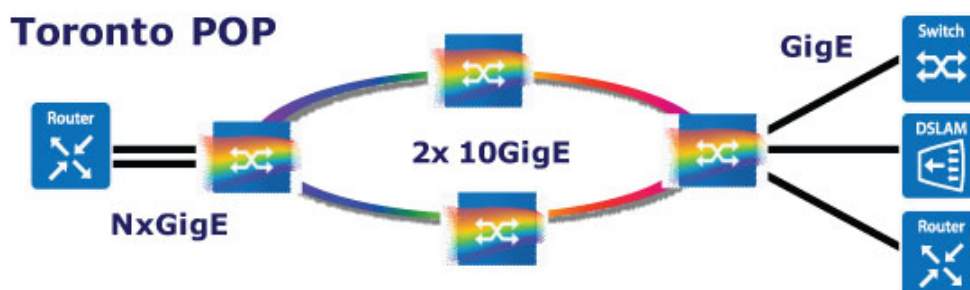
- Simple Ethernet aggregation
- Wholesale access aggregation
- Cable Modem Termination System (CMTS) backhaul

#### Scenario 1 - Simple Ethernet aggregation

This simple Ethernet aggregation scenario shows the following:

- Up to four 10-GbE ports to support the migration to GbE access
- high fan-in density with up to 24 1-GbE ports per module
- Bandwidth when and where it is needed to address traffic unpredictability
- Two 10-GbE-port hand off to enable high-density GbE aggregation

**Figure 10-5 Simple Ethernet aggregation**

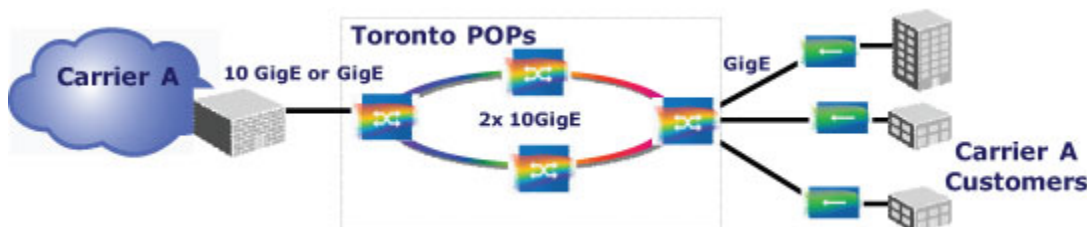


### Scenario 2 - Wholesale access aggregation

This wholesale access aggregation scenario shows the following:

- 802.1ad Q-in-Q tagging with single-tagging or double-tagging on any port
- Tunnel Layer 2 control protocols, as required, for service transparency
- Low frame delay and delay variation
- No packet reordering
- Optical and Ethernet performance measurements

Figure 10-6 Wholesale access aggregation

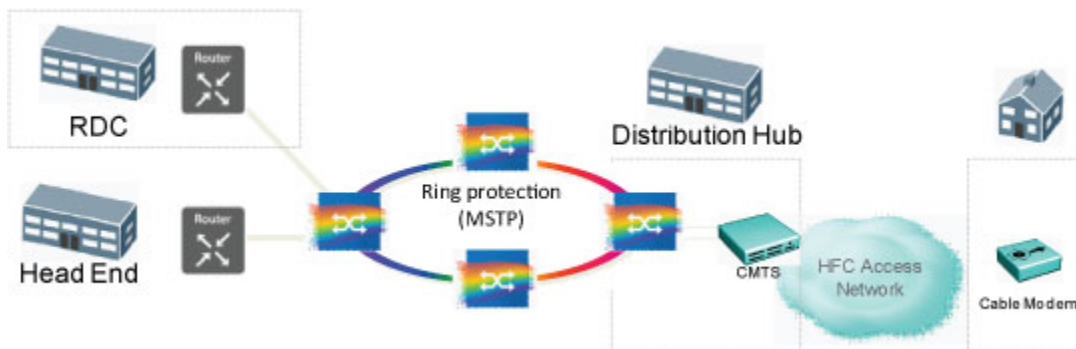


### Scenario 3 - Cable Modem Termination System (CMTS) backhaul

The switch supports the following features for CMTS backhaul:

- 802.1ad Q-in-Q tagging with single-tagging or double-tagging on any port
- Access control lists (ACLs) to filter ingress traffic on SMAC, DMAC, SIP, and DIP

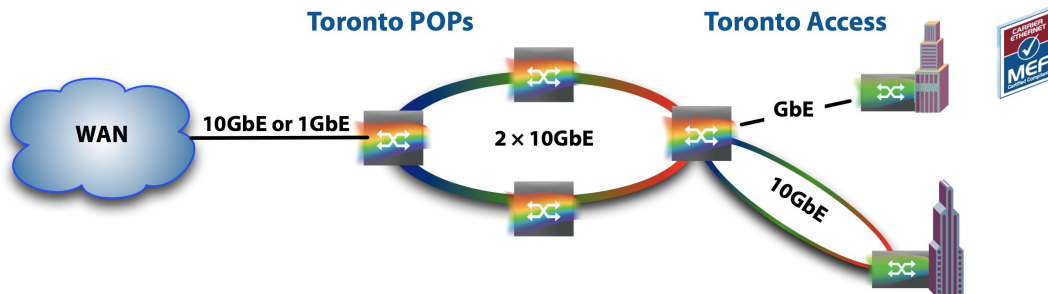
Figure 10-7 CMTS backhaul



### 10.3.3 Ethernet business services

The switch supports Ethernet business services, as shown in the following figure:

**Figure 10-8 Ethernet business services**



The switch supports the following features for Ethernet business services:

- MEF 9 (Service Attributes) and MEF 14 (Traffic Management) for EPL and ELAN
- 802.1ad Q-in-Q tagging with single tagging or double tagging on any port
- Per-port and per VLAN rate limiting in granularities of 1 Mbps.
- CoS on a per-ingress-port, per-EVC, or per-ingress-VLAN basis
- Access control lists (ACLs) to filter ingress traffic on SMAC, DMAC, SIP and DIP

### 10.3.4 Ethernet video applications

The packetVX module supports the following Ethernet video applications:

- Broadcast video
- Video on Demand (VoD)

#### Scenario 1 - Broadcast video

This broadcast video scenario shows the following:

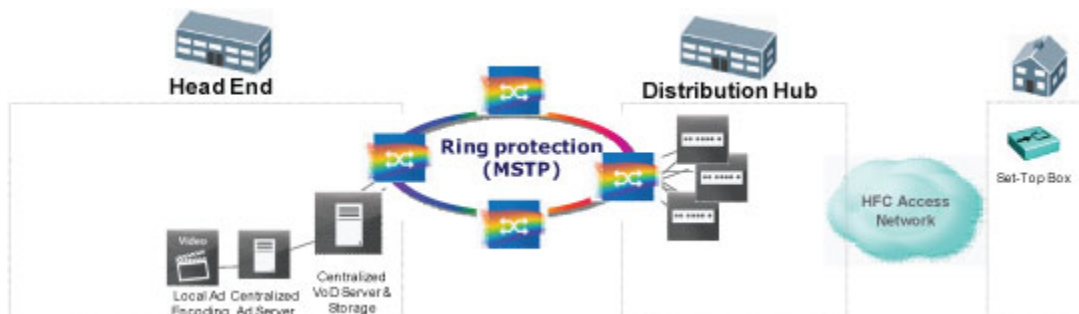
- Up to four 10-GbE ports to support thousands of broadcast video streams
- Optimized network bandwidth with Ethernet aggregation at the network edge
- Delay, delay-variation and packet loss minimized
- No packet reordering
- All traffic arriving at an ingress port is guaranteed to be transmitted out of the egress port at the other end of the connection



**Figure 10-9 Broadcast video****Scenario 2 -Video on Demand**

This video on demand scenario shows the following:

- Up to 4 10GE ports to support the migration to High Definition
- High fan-in density with up to 24 GbE ports per switch
- Bandwidth when and where it is needed to address unpredictability of VoD
- LAG for subtending devices at head end or distribution hub
- MSTP ring protection

**Figure 10-10 Video on Demand****10.3.5 4G wireless and WiMAX**

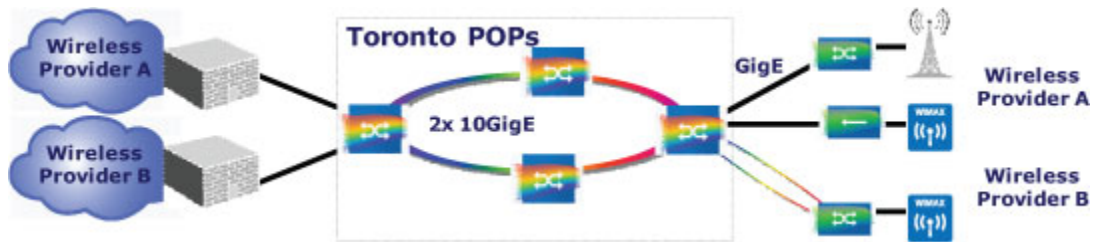
The packetVX module supports 4G wireless and WiMAX applications.

**Scenario 1 - 4G wireless and WiMAX**

This 4G wireless and WiMAX scenario shows the following:

- network capacity enables migration to 4G networks (Gbps per antenna)
- 802.1ad Q-in-Q tagging to accommodate and separate wireless service providers
- low frame delay, delay variation and guaranteed delivery of voice
- suitable for deployment in outside plant modules

**Figure 10-11 4G wireless and WiMAX**



## 10.4 packetVX specifications

**Table 10-2 packetVX 12/2 (BT7A81AA), 24/2 ( BT7A81BA ) , and 24/4 (BT7A81CA) specifications**

Parameter	Value
Number of MAC addresses	32,000
Number of SVLANs	2 to 4089 (SVLANs 0 is an invalid value; 1 and 4090 to 4095 are reserved)
Number of CVLAN to SVLAN map entries	768
Maximum number of per system	11 (requires 4 x BTI 7060 shelves)
Switching capacity	60 Gbps
Number of ACLs	256
Number of LAGs	27
Number of members per LAG	8
Number of MSTP instances	16
Maximum number of SSH sessions	50
Jumbo frame size	9600 bytes

**Table 10-3 packetVX 80 (BT7A81GA) specifications**

Parameter	Value
Number of MAC addresses	32,000
Number of SVLANs	2 to 4089 (SVLANs 0 is an invalid value; 1 and 4090 to 4095 are reserved)
Number of CVLAN to SVLAN map entries	768
Maximum number of per system	11 (requires 4 x BTI 7060 shelves)
Switching capacity	80 Gbps
Number of ACLs	256
Number of LAGs	8
Number of members per LAG	8
Number of MSTP instances	16
Maximum number of SSH sessions	50
Jumbo frame size	9600 bytes

## 10.5 packetVX module operating temperature ranges

Table 10-4 packetVX module operating temperature ranges

Module	0°C to +40°C long term	-5°C to +50°C short term	-20°C to +65°C long term	-40°C to +65°C long term
packetVX 12/2	X	X	X	X
packetVX 24/2	X	X	X	X
packetVX 24/4	X	X	X	X
packetVX 80	X	X	X	X

**Note** Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days during a 1-year period (as detailed in GR-63-CORE).

### Extended temperature support

The switches can be deployed in extended temperature environments ranging from -40°C to +65°C (-4°F to +150°F). For more information, refer to Application Note BTI-APN002-2011 *Engineering considerations for packetVX in -40C to +65C applications*.

# 11.0 Transceivers

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This section provides information about SFP and XFP transceivers that BTI 7000 Series modules support.

- [11.1, “About pluggable transceivers ”](#)
- [11.2, “Benefits of using pluggable transceivers”](#)
- [11.3, “Copper SFP applications”](#)
- [11.4, “SFP specifications”](#)
- [11.5, “XFP specifications ”](#)
- [11.6, “Physical PMs”](#)

## 11.1 About pluggable transceivers

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SFP and XFP transceivers are optimized for simple configurations that support a large number of protocols, bit rates and distances. For information about the transceiver types that a BTI 7000 Series module supports, see the specifications for that module.

Protocols supported by SFPs include:

- ESCON
- FC100 and FC200
- FDDI
- FE
- Gigabit Ethernet
- OC3/OC12/OC48/OC192
- SMPTE-259/SMPTE-292/SMPTE-344
- STM1/STM4/STM16/STM64

Protocols supported by XFPs include:

- OC192
- STM16
- 10GE LAN
- 10GE WAN
- OTN
- 10.7G

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## 11.2 Benefits of using pluggable transceivers

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The inherent advantages of using pluggable transceivers include flexibility, scalability, cost savings and management.

### Flexibility and scalability

Dual 1G and 2.5G Multiprotocol Transponders can be equipped initially with two SFPs and upgraded to four SFPs as needed. Adding SFPs to accommodate speed or distance requirements does not result in service interruption.

### Cost savings

Modules equipped with SFPs/XFPs are simple to use and reconfigure, allowing transceivers to be replaced without taking the rest of the network out of service. This reduces operating expenses by eliminating downtime for parts of the network that are not in the line of a fault.

Modules equipped with pluggables also confer advantages in inventory control. Service providers need only stock SFP/XFP spares instead of the full module replacements necessary when using fixed optic equipment. The use of pluggables reduces on-hand spares inventory, resulting in capital and operational savings. In addition, pluggable replacement does not require taking the entire module out of service.

### Management

SFPs/XFPs used in Transponder modules implement Digital Diagnostics, providing a powerful optical network management and diagnostic tool. SFP/XFP optical interfaces supply a database of information about the component itself. This enables network operators to easily track changes and replacements of components, and to know exactly in which module a pluggable transceiver is provisioned, reducing operating expense when a change is necessary. Digital Diagnostics provide information on a variety of manageable parameters:

- Optical Transmit and Receive Power for monitoring and setting alarm thresholds
- Voltage and temperature measurement for environmental monitoring
- Inventory retrieval of factory set parameters, including vendor code, serial number and wavelength

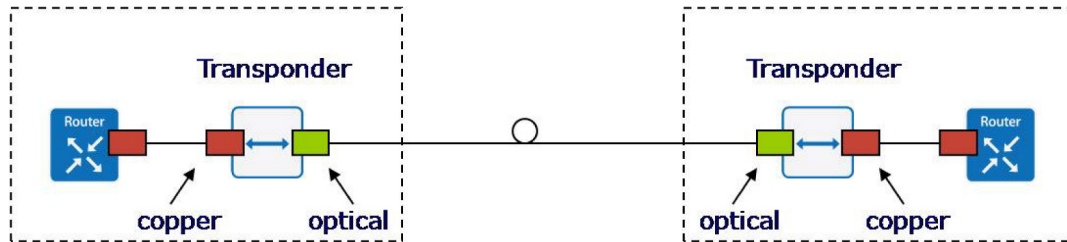
Transponder and muxponder modules with SFPs/XFPs support laser status control. Laser status control enables an operator to turn on or off the transmitting laser on user command.

## 11.3 Copper SFP applications

Copper SFPs can be used in various applications in which Transponders or Muxponders are deployed, including the following applications.

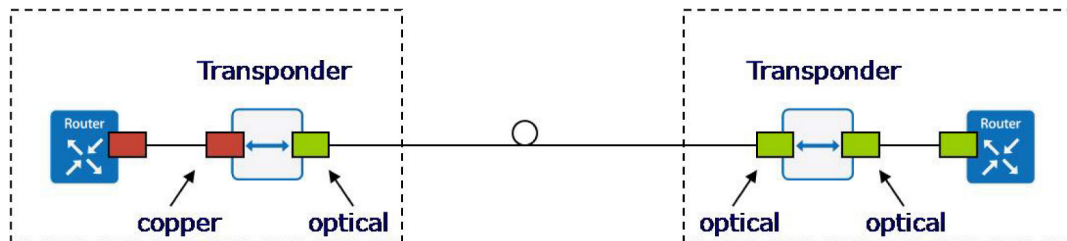
### Copper to optical to fiber to optical to copper

The 1000Base-T signal can be converted into an optical signal for reach extension and DWDM multiplexing, and then be returned to a 1000Base-T signal.



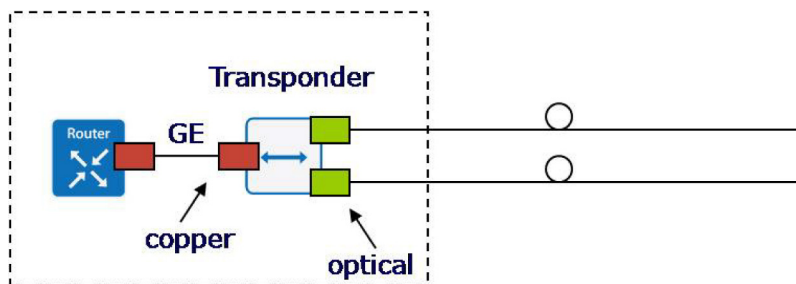
### Copper to optical to fiber to optical to optical

The 1000Base-T signal can be converted into an optical signal for reach extension and DWDM multiplexing, and then be handed off as a 1000Base-X optical signal.



### Copper to optical to fiber with protection

The transponder module can optically protect a client 1000Base-T signal.





## 11.4 SFP specifications

**Note** Optical performance has been characterized for SM fiber. Networks can be deployed on other fiber types. Contact your BTI representative for information about supporting these designs.

This section covers the following topics:

- 11.4.1, “850 nm SFPs”
- 11.4.2, “1310 nm SFPs”
- 11.4.3, “Bidirectional 1310nm TX/1550nm RX SFP specifications”
- 11.4.4, “Bidirectional 1310nm/1490nm SR SFP specifications”
- 11.4.5, “Bidirectional 1310nm/1490nm IR SFP specifications”
- 11.4.6, “CWDM SFPs”
- 11.4.7, “DWDM SFPs”
- 11.4.8, “Copper SFPs”

For specifications on SFPs for multishelf or OSC use, see 12.1, “Optical Supervisory Channel integrated on the System Control Processor”.

### 11.4.1 850 nm SFPs

This section covers the following topics:

- 11.4.1.1, “Tri-rate 850 nm SX SFP optical specifications”
- 11.4.1.2, “Tri-rate 850 nm SX SFP cable and connector specifications”
- 11.4.1.3, “4 Gigabyte Quad-Rate 850 nm SX SFP optical specifications”
- 11.4.1.4, “4 Gigabyte Quad-Rate 850 nm SX SFP cable specifications”

#### 11.4.1.1 Tri-rate 850 nm SX SFP optical specifications

Table 11-1 Tri-rate 850 nm SX SFP BP3AD1SS optical specifications

Parameter	Min	Typ	Max	Units
Bit rate	—	1.0625	—	Gb/s
	—	1.25	—	Gb/s
	—	2.125	—	Gb/s
<b>Transmitter</b>				
Laser source	—			
Tx center wavelength	840	—	860	nm
Average operating power	-9.0	—	-1.5	dBm
Spectral width (-20 dB)	—	—	0.65	nm
Extinction ratio	9	—	—	dB

**Table 11-1 Tri-rate 850 nm SX SFP BP3AD1SS optical specifications (Continued)**

Parameter	Min	Typ	Max	Units
Receiver				
Rx operating wavelength	770	—	860	nm
Stressed Rx sensitivity (BER=1x10 <sup>-12</sup> )				
50/125 μm cable specifications				
1.0625 Gb/s	-14.6	—	3	dBm
1.25 Gb/s	-13.6	—	3	dBm
2.125 Gb/s	-12.2	—	3	dBm
62.5/125 μm cable specifications				
1.0625 Gb/s	-13.7	—	3	dBm
1.25 Gb/s	-12.6	—	3	dBm
2.125 Gb/s	-11.6	—	3	dBm
Reflectance	—	—	-12	dB
Other				
Connector/Latch type	LC/Bail			
SFP MSA 8074 compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 3 dB			
Rx power accuracy	± 3 dB			

### 11.4.1.2 Tri-rate 850 nm SX SFP cable and connector specifications

**Table 11-2 Tri-rate 850 nm SX SFP BP3AD1SS cable and connector specifications**

Parameter	Min	Typ	Max	Units
<b>50/125 µm Cable Specifications (multimode 850 nm)</b>				
Bandwidth @ 850 nm	2000	—	—	MHz-km
Length - 2.125 Gb/s	0.5	—	500	m
Length - 1.0625 Gb/s	0.5	—	860	m
Length - 1.250 Gb/s	0.5	—	860	m
Bandwidth @ 850 nm	500	—	—	MHz-km
Length - 2.125 Gb/s	0.5	—	300	m
Length - 1.0625 Gb/s	0.5	—	550	m
Length - 1.250 Gb/s	0.5	—	550	m
Bandwidth @ 850 nm	400	—	—	MHz-km
Length - 2.125 Gb/s	0.5	—	260	m

Table 11-2 Tri-rate 850 nm SX SFP BP3AD1SS cable and connector specifications (Continued)

Parameter	Min	Typ	Max	Units
Length - 1.0625 Gb/s	0.5	—	500	m
Length - 1.250 Gb/s	0.5	—	500	m
<b>62.5/125 <math>\mu</math>m Cable Specifications (multimode 850 nm)</b>				
Bandwidth @ 850 nm	200	—	—	MHz-km
Length - 2.125 Gb/s	0.5	—	150	m
Length - 1.0625 Gb/s	0.5	—	300	m
Length - 1.250 Gb/s	0.5	—	275	m
Bandwidth @ 850 nm	160	—	—	MHz-km
Length - 2.125 Gb/s	0.5	—	120	m
Length - 1.0625 Gb/s	0.5	—	250	m
Length - 1.250 Gb/s	0.5	—	220	m
<b>LC Optical Connector Specifications (multimode)</b>				
Nominal Attenuation	—	0.25	0.4	dB
Attenuation Standard Deviation	—	0.15	—	dB
Connects/Disconnects	—	—	250	cycles

### 11.4.1.3 4 Gigabyte Quad-Rate 850 nm SX SFP optical specifications

Table 11-3 4 Gigabyte Quad-Rate 850 nm SFP BP3AD2SS optical specifications

Parameter	Min	Typ	Max	Units
Bit rate	—	1.0625	—	Gb/s
	—	1.25	—	Gb/s
	—	2.125	—	Gb/s
	—	4.25	—	Gb/s
<b>Transmitter</b>				
Laser source	—			
Tx center wavelength	830	—	860	nm
Average operating power	-9.0	—	-2.5	dBm
Spectral width (-20 dB)	—	—	0.85	nm
Extinction ratio	9	—	—	dB
<b>Receiver</b>				
Rx operating wavelength	770	—	860	nm
<b>Stressed Rx sensitivity (BER=1x10<sup>-12</sup>)</b>				
1.0625 Gb/s	-14.5	—	0	dBm
1.25 Gb/s	-13.5	—	0	dBm
2.125 Gb/s	-12.0	—	0	dBm
4.25 Gb/s	-10.5	—	0	dBm

**Table 11-3 4 Gigabyte Quad-Rate 850 nm SFP BP3AD2SS optical specifications (Continued)**

Parameter	Min	Typ	Max	Units
Reflectance	—	—	-12	dB
Other				
Connector type	LC			
Latch type	Bail			
SFP MSA 8074 compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 3 dB			
Rx power accuracy	± 3 dB			

#### 11.4.1.4 4 Gigabyte Quad-Rate 850 nm SX SFP cable specifications

**Table 11-4 4 Gigabyte Quad-Rate 850 nm SFP BP3AD2SS cable specifications**

Parameter	Min	Typ	Max	Units
<b>50/125 µm Cable Specifications (multimode 850 nm)</b>				
Bandwidth @ 850 nm	2000	—	—	MHz-km
Length - 4.250 Gbps	2	—	270	m
Length - 2.125 Gbps	2	—	500	m
Length - 1.250 Gbps	0.5	—	860	m
Length - 1.0625 Gbps	2	—	860	m
Bandwidth @ 850 nm	1500	—	—	MHz-km
Length - 4.250 Gbps	2	—	215	m
Length - 2.125 Gbps	2	—	430	m
Length - 1.250 Gbps	0.5	—	740	m
Length - 1.0625 Gbps	2	—	755	m
Bandwidth @ 850 nm	900	—	—	MHz-km
Length - 4.250 Gbps	2	—	175	m
Length - 2.125 Gbps	2	—	350	m
Length - 1.250 Gbps	0.5	—	595	m
Length - 1.0625 Gbps	2	—	630	m
Bandwidth @ 850 nm	500	—	—	MHz-km
Length - 4.250 Gbps	2	—	150	m
Length - 2.125 Gbps	2	—	300	m
Length - 1.250 Gbps	0.5	—	550	m
Length - 1.0625 Gbps	2	—	500	m
<b>62.5/125 µm Cable Specifications (multimode 850 nm)</b>				

Table 11-4 4 Gigabyte Quad-Rate 850 nm SFP BP3AD2SS cable specifications (Continued)

Parameter	Min	Typ	Max	Units
Bandwidth @ 850 nm	200	—	—	MHz-km
Length - 4.250 Gbps	2	—	70	m
Length - 2.125 Gbps	2	—	150	m
Length - 1.250 Gbps	0.5	—	275	m
Length - 1.0625 Gbps	2	—	300	m

**Note** Optical performance has been characterized for SM fiber. Networks can be deployed on other fiber types. Please contact your BTI representative for information about supporting these designs.

## 11.4.2 1310 nm SFPs

This section covers the following topics:

- 11.4.2.1, “1310 nm SR SFP optical specifications”
- 11.4.2.2, “1310 nm IR SFP optical specifications ”
- 11.4.2.3, “4 Gigabyte Quad-Rate 1310 nm SFP optical specifications”

### 11.4.2.1 1310 nm SR SFP optical specifications

Table 11-5 1310 nm SR SFP BP3AM1MS optical specifications

Parameter	Min	Typ	Max	Units
Bit rate	125	—	2.67	Gb/s
<b>Transmitter</b>				
Laser source	single-mode			
Tx operating wavelength	1266	1310	1360	nm
Average operating power	-10	—	-3	dBm
Spectral width (rms)	—	—	4	nm
Extinction ratio	8.2	—	—	dB
<b>Receiver</b>				
Rx operating wavelength	1266	—	1620	nm
Rx sensitivity (BER=1x10 <sup>-10</sup> )	-18	—	—	dBm
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-17	—	—	dBm
Rx overload	-3	—	—	dBm
Optical path penalty	—	—	1	dB
Dispersion	—	—	12	ps/nm
Reach	—	—	2	km
Reflectance	—	—	-27	dB
<b>Other</b>				

**Table 11-5 1310 nm SR SFP BP3AM1MS optical specifications (Continued)**

Parameter	Min	Typ	Max	Units
Connector/Latch type	LC/Bail			
GR 253, ITU-T G.957 compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 3 dB			
Rx power accuracy	± 3 dB			

### 11.4.2.2 1310 nm IR SFP optical specifications

**Table 11-6 1310 nm IR SFP BP3AM1MI optical specifications**

Parameter	Min	Typ	Max	Units
Bit rate	125	—	2.67	Gb/s
Transmitter				
Laser source	single-mode			
Tx operating wavelength	1260	1310	1360	nm
Average operating power	-5	—	0	dBm
Spectral width (-20 dB)	—	—	1	nm
Side mode suppression ratio	30	—	—	dB
Extinction ratio	8.2	—	—	dB
Receiver				
Rx operating wavelength	1260	—	1620	nm
Rx sensitivity (BER=1x10 <sup>-10</sup> )	-18	—	—	dBm
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-17	—	—	dBm
Rx overload	0	—	—	dBm
Optical path penalty	—	—	1	dB
Reach	—	—	15	km
Reflectance	—	—	-24	dB
Other				
Connector/Latch type	LC/Bail			
GR 253, ITU-T G.957 compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 3 dB			

Table 11-6 1310 nm IR SFP BP3AM1MI optical specifications (Continued)

Parameter	Min	Typ	Max	Units
Rx power accuracy	$\pm 3$ dB			

### 11.4.2.3 4 Gigabyte Quad-Rate 1310 nm SFP optical specifications

Table 11-7 4 Gigabyte Quad-Rate 1310 nm SFP BP3AD2MS optical specifications

Parameter	Min	Typ	Max	Units
Bit rate	—	1.0625	—	Gb/s
	—	1.25	—	Gb/s
	—	2.125	—	Gb/s
	—	4.25	—	Gb/s
Transmitter				
Laser source	—			
Tx center wavelength	1285	—	1350	nm
Average operating power	-8.4	—	-1.0	dBm
Spectral width (rms)	—	—	2.0	nm
Extinction ratio	—	6	—	dB
Receiver				
Rx operating wavelength	1270	—	1365	nm
Reach				
4G FC	—	—	4	km
1G/2G FC, GE	—	—	10	km
Stressed Rx sensitivity (BER=1x10 <sup>-12</sup> )				
1.0625 Gb/s	-20	—	1	dBm
1.25 Gb/s	-20	—	1	dBm
2.125 Gb/s	-20	—	1	dBm
4.25 Gb/s	-17	—	1	dBm
Reflectance	—	—	-12	dB
Other				
Connector type	LC			
Latch type	Bail			
SFP MSA 8074 compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 2 dB			
Rx power accuracy	± 2 dB			

### 11.4.3 Bidirectional 1310nm TX/1550nm RX SFP specifications

**Note** This SFP is used for single fiber interconnection. On a single fiber, a matched pair of SFPs must be used; that is, a 1310nm TX/1550nm RX (BP3AM5MB) can only communicate with a 1550nm TX/1310nm RX (BP3AM5LB).

**Table 11-8 Optical specifications for bidirectional SFPs: 1310nm TX/1550nm RX (BP3AM5MB) and 1550nm TX/1310nm RX (BP3AM5LB)**

Parameter	Min	Typ	Max	Units
Bit rate	125	—	1250	Mb/s
Transmitter				
Tx operating wavelength: 1310	1270	1310	1360	nm
Tx operating wavelength: 1550	1530	1550	1570	nm
Average operating power	-9.5	—	-3	dBm
Spectral width (rms) - 1310 nm	—	—	5.5	nm
Spectral width (-20 dB) - 1550 nm	—	—	1	nm
Side Mode Suppression Ratio @ 1550 nm	30	—	—	dB
Extinction ratio	9	—	—	dB
Receiver				
Rx operating wavelength: 1310	1260	—	1360	nm
Rx operating wavelength: 1550	1480	—	1620	nm
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-20	—	—	dBm
Rx overload	-3	—	—	dBm
Reach	—	—	10	km
Reflectance	—	—	-12	dB
Other				
Connector/Latch type	LC/Bail			
IEEE 802.3, SFP MSA compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 3 dB			
Rx power accuracy	± 3 dB			

### 11.4.4 Bidirectional 1310nm/1490nm SR SFP specifications

**Note** This SFP is used for single fiber interconnection. On a single fiber, a matched pair of SFPs must be used; that is, a 1310nm TX/1490nm RX GE, SR (BP3AM5PB) can only communicate with a 1490nm TX/1310nm RX GE, SR (BP3AM5QB).



**Table 11-9 Optical specifications for bidirectional SFPs: 1310nm /1490nm SR (BP3AM5PB) and 1490nm/1310nm SR (BP3AM5QB)**

Parameter	Min	Typ	Max	Units
Bit rate	125	—	1250	Mb/s
Transmitter				
Tx operating wavelength: 1310	1260	1310	1360	nm
Tx operating wavelength: 1490	1480	1490	1500	nm
Average operating power	-5.0	—	0	dBm
Extinction ratio	6	—	—	dB
Receiver				
Rx operating wavelength: 1310	1260	1310	1360	nm
Rx operating wavelength: 1490	1480	1490	1500	nm
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-20	—	—	dBm
Rx overload	—	—	-3	dBm
Reach	—	—	20	km
Other				
Connector/Latch type	LC/Bail			
IEEE 802.3, SFP MSA compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 3 dB			
Rx power accuracy	± 3 dB			

### 11.4.5 Bidirectional 1310nm/1490nm IR SFP specifications

**Note** This SFP is used for single fiber interconnection. On a single fiber, a matched pair of SFPs must be used; that is, a 1310nm TX/1490nm RX GE, IR (BP3AM5PI) can only communicate with a 1490nm TX/1310nm RX GE, IR (BP3AM5QI).

**Table 11-10 Optical specifications for bidirectional SFPs: 1310nm/1490nm IR (BP3AM5PI) and 1490nm/1310nm IR (BP3AM5QI)**

Parameter	Min	Typ	Max	Units
Bit rate	125	—	1250	Mb/s
<b>Transmitter</b>				
Tx operating wavelength: 1310	1260	1310	1360	nm
Tx operating wavelength: 1490	1480	1490	1500	nm
Average operating power	-2	—	+3	dBm
Extinction ratio	6	—	—	dB

**Table 11-10 Optical specifications for bidirectional SFPs: 1310nm/1490nm IR (BP3AM5PI) and 1490nm/1310nm IR (BP3AM5QI) (Continued)**

Parameter	Min	Typ	Max	Units
Receiver				
Rx operating wavelength: 1310	1260	1310	1360	nm
Rx operating wavelength: 1490	1480	1490	1500	nm
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-24	—	—	dBm
Rx overload	—	—	-3	dBm
Reach	—	—	40	km
Other				
Connector/Latch type	LC/Bail			
IEEE 802.3, SFP MSA compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 3 dB			
Rx power accuracy	± 3 dB			

## 11.4.6 CWDM SFPs

This section covers the following topics:

- 11.4.6.1, “CWDM LR SFP optical specifications ”
- 11.4.6.2, “4G CWDM SFP specifications”

### 11.4.6.1 CWDM LR SFP optical specifications

**Table 11-11 CWDM LR SFP BP3AM1CL optical specifications**

Parameter	Min	Typ	Max	Units
Bit rate	125	—	2.67	Gb/s
<b>Transmitter</b>				
Laser source	single-mode			
Tx center wavelength	1271	—	1611	nm
Tx center wavelength accuracy	-6.5	—	+6.5	nm
Average operating power	0	—	4	dBm
Spectral width (-20 dB)	—	—	1	nm
Side mode suppression ratio	30	—	—	dB
Extinction ratio	8.2	—	—	dB
<b>Receiver</b>				
Rx sensitivity (BER=1x10 <sup>-10</sup> )	-28	—	—	dBm

Table 11-11 CWDM LR SFP BP3AM1CL optical specifications (Continued)

Parameter	Min	Typ	Max	Units
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-27	—	—	dBm
Rx overload	-8	—	—	dBm
Dispersion	—	—	1600	ps/nm
Optical path penalty	—	—	2.5	dB
Reflectance	—	—	-24	dB
Other				
Connector/Latch type	LC/Bail			
SFP MSA 8074, GR 253, ITU-T G.957 compliant				
Digital Diagnostics SFF-8472 compliant				
Temperature accuracy	± 3 C			
Supply Voltage accuracy	± 0.1 V			
Tx Bias Current accuracy	± 5 mA			
Tx power accuracy	± 3 dB			
Rx power accuracy	± 3 dB			

### 11.4.6.2 4G CWDM SFP specifications

Table 11-12 4G CWDM SFP BP3AM2CL optical specifications

Parameter	Min	Typ	Max	Units
<b>Bit rate</b>				
GbE	—	1.25	—	Gb/s
OC48	—	2.48832	—	Gb/s
1XFC	—	1.062	—	Gb/s
2XFC	—	2.12	—	Gb/s
4XFC	—	4.24	—	Gb/s
<b>Transmitter</b>				
Tx center wavelength	1471	—	1611	nm
Tx center wavelength accuracy	-6.5	—	6.5	nm
Channel Spacing	See <a href="#">7.3.1, "CWDM wavelength plan"</a> .			GHz
Average operating power	0	—	4	dBm
Spectral width (-20 dB)	—	—	0.3	nm
Side mode suppression ratio	40	—	—	dB
<b>Extinction ratio</b>				
GbE, OC48, 1XFC, 2XFC	—	—	8.2	dB
4XFC	—	—	6	dB
<b>Receiver</b>				
Rx operating wavelength	1461	—	1617.5	nm

**Table 11-12 4G CWDM SFP BP3AM2CL optical specifications (Continued)**

Parameter	Min	Typ	Max	Units
<b>Rx overload</b>				
GbE, OC48, 1XFC, 2XFC	-7	—	—	dBm
4XFC	-9	—	—	dBm
Dispersion (all rates)	0	—	1600	ps/nm
Reflectance	—	—	-27	dB
<b>Rx characteristics for OSNR <math>\geq</math> 30 dB @ 1e-12</b>				
GbE, OC48, 1XFC, 2XFC				
0 ps/nm	-28	—	—	dBm
1600 ps/nm	-26	—	—	dBm
4XFC				
0 ps/nm	-24	—	—	dBm
1600 ps/nm	-21	—	—	dBm

## 11.4.7 DWDM SFPs

This section covers the following topics:

- [11.4.7.1, “Multirate DWDM ER SFP optical specifications”](#)
- [11.4.7.2, “4G DWDM SFP specifications”](#)

### 11.4.7.1 Multirate DWDM ER SFP optical specifications

**Table 11-13 Multirate DWDM ER SFP BP3AM1DE optical specifications**

Parameter	Min	Typ	Max	Units
Bit rate	125	—	2.67	Mb/s
<b>Transmitter</b>				
Laser source	single-mode			
Tx center wavelength	1529.55	—	1560.61	nm
Tx center wavelength accuracy	-0.1	—	+0.1	nm
Average operating power	0	—	4	dBm
Spectral width (-20 dB)	—	—	0.3	nm
Side mode suppression ratio	30	—	—	dB
Extinction ratio	8.2	—	—	dB
<b>Receiver</b>				
Rx operating wavelength	1260	—	1580	nm
Rx overload	-8	—	—	dBm
Dispersion	—	—	2100	ps/nm
<b>Receiver characteristics for OSNR <math>\geq</math> 30 dB<sup>1</sup></b>				
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-28	—	-9	dBm

Table 11-13 Multirate DWDM ER SFP BP3AM1DE optical specifications (Continued)

Parameter	Min	Typ	Max	Units
Optical path penalty	—	—	2	dB
Receiver characteristics for OSNR ≥ 20 dB				
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-24	—	-12	dBm
Optical path penalty	—	—	2	dB
Receiver characteristics for OSNR ≥ 18 dB				
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-22	—	-12	dBm
Optical path penalty	—	—	2	dB
Reflectance	—	—	-27	dB
Other				
Connector/Latch type	LC/Bail			
DWDM SFP MSA, GR 253 and SFF 8472 compliant				
<sup>1</sup> Optical Path Penalty needs to be applied to Rx Sensitivity only.				

### 11.4.7.2 4G DWDM SFP specifications

Table 11-14 4G DWDM SFP BP3AM2DL optical specifications

Parameter	Min	Typ	Max	Units
<b>Bit rate</b>				
GbE	—	1.25	—	Gb/s
OC48	—	2.48832	—	Gb/s
1XFC	—	1.062	—	Gb/s
2XFC	—	2.12	—	Gb/s
4XFC	—	4.24	—	Gb/s
<b>Transmitter</b>				
Tx center wavelength	1530.33	—	1559.79	nm
Tx center wavelength accuracy	-0.1	—	0.1	nm
Channel Spacing	—	100	—	GHz
Average operating power	0	—	4	dBm
Spectral width (-20 dB)	—	—	0.3	nm
Side mode suppression ratio	40	—	—	dB
<b>Extinction ratio</b>				
GbE, OC48, 1XFC, 2XFC	—	—	8.2	dB
4XFC	—	—	6	dB
<b>Receiver</b>				
Rx operating wavelength	1520	—	1570	nm
<b>Rx overload</b>				
GbE, OC48, 1XFC, 2XFC	-7	—	—	dBm

**Table 11-14 4G DWDM SFP BP3AM2DL optical specifications (Continued)**

Parameter	Min	Typ	Max	Units
4XFC	-9	—	—	dBm
Dispersion				
GbE, OC48, 1XFC, 2XFC	0	—	4000	ps/nm
4XFC	0	—	1600	ps/nm
Reflectance	—	—	-27	dB
<b>Rx characteristics for OSNR <math>\geq</math> 30 dB @ 1e-12</b>				
GbE, OC48, 1XFC, 2XFC				
0 ps/nm	-28	—	—	dBm
2100 ps/nm	-26	—	—	dBm
4XFC				
0 ps/nm	-25	—	—	dBm
1600 ps/nm	-22	—	—	dBm
<b>Rx characteristics for OSNR <math>\geq</math> 25 dB @ 1e-12</b>				
4XFC, 1600 ps/nm	-22	—	—	dBm
<b>Rx characteristics for OSNR <math>\geq</math> 20 dB @ 1e-12</b>				
GbE, OC48, 1XFC, 2XFC, 2100 ps/nm	-24	—	—	dBm
<b>Rx characteristics for OSNR <math>\geq</math> 18 dB @ 1e-12</b>				
GbE, OC48, 1XFC, 2XFC, 2100 ps/nm	-22	—	—	dBm

## 11.4.8 Copper SFPs

This section covers the following topics:

- [11.4.8.1, “Copper SFP BP3AD3ES specifications”](#)
- [11.4.8.2, “Copper SFP BP3AE2ES specifications”](#)

### 11.4.8.1 Copper SFP BP3AD3ES specifications

**Table 11-15 Copper SFP BP3AD3ES specifications**

Parameter	Min	Typ	Max	Units
Data rate (10/100/1000Base-T)	0.0125	—	1.25	Gbps
Reach (CAT 5 cable)	100	—	—	m
Clock Tolerance	-50	—	50	ppm
Rise/fall time (20%-80%)	—	175	—	ps
Power dissipation	—	—	1.3	W
Latency	—	—	1	$\mu$ s
Regulatory compliance	Class A EMI GR1089 lightning protection: Type 2 (intra-building) from NEBS-3, unshielded cable			

Table 11-15 Copper SFP BP3AD3ES specifications

Parameter	Min	Typ	Max	Units
IEEE 802.3				

### 11.4.8.2 Copper SFP BP3AE2ES specifications

Table 11-16 Copper SFP BP3AE2ES specifications

Parameter	Min.	Typical	Max.	Units
Data rate (1000Base-T)	—	1.25	—	Gb/s
Reach (CAT 5 cable)	100	—	—	m
Clock Tolerance	-50	—	50	ppm
Rise/fall time (20%-80%)	—	175	—	ps
Power dissipation	—	—	1.3	W
Latency	—	—	1	μs
Regulatory compliance	Class A EMI; GR1089 lightning protection: Type 2 (intra-building) from NEBS-3, unshielded cable; IEEE 802.3			

## 11.5 XFP specifications

**Note** Optical performance has been characterized for SM fiber.

### 11.5.1 850 nm XFP specifications

Table 11-17 850 nm XFP BP3AM4SS optical specifications

Parameter	Min	Typ	Max	Units
Bit rate	9.953	—	10.7	Gb/s
Transmitter				
Tx operating wavelength	840	850	860	nm
Average operating power	-4.4	—	-1.1	dBm
Spectral width (rms)	—	—	0.45	nm
Extinction ratio	3	—	—	dB
Optical Return Loss Tolerance	—	—	12	dB
Receiver				
Rx operating wavelength	840	850	860	nm
Stressed Rx sensitivity (BER = 1e-12)	-7.5	—	—	dBm
Rx overload	—	—	-1.0	dBm
Optical Path Penalty	—	—	3.9	dB
Reflectance	—	—	-12	dB
50/125 μm Cable Specifications (multimode 850 nm)				
Length @ 2000 MHz-km	2	—	300	m
Length @ 500 MHz-km	2	—	82	m
62.5/125 μm Cable Specifications (multimode 850 nm)				
Length @ 200 MHz-km	2	—	33	m
Other				
Connector/Latch type	LC/Lever			
IEEE 802.3 ae and XFP MSA compliant				

### 11.5.2 1310 nm SR XFP optical specifications

Table 11-18 1310 nm SR XFP BP3AM4MS optical specifications

Parameter	Min	Typ	Max	Units
Bit rate	9.953	—	10.7	Gb/s
<b>Transmitter</b>				
Tx operating wavelength	1290	1310	1330	nm
Average operating power	-6	—	-1	dBm
Spectral width (-20dB)	—	—	1	nm



Table 11-18 1310 nm SR XFP BP3AM4MS optical specifications (Continued)

Parameter	Min	Typ	Max	Units
Side mode suppression ratio	30	—	—	dB
Extinction ratio	6	7	—	dB
Optical Return Loss Tolerance	—	—	12	dB
Receiver				
Rx operating wavelength	1260	—	1355	nm
Stressed Rx sensitivity (BER = 1e-12)	-10.3	—	—	dBm
Rx overload	—	—	+0.5	dBm
Optical path penalty (@ 6.6 ps/nm)	—	—	1.2	dB
Reflectance	—	—	-14	dB
Reach				
SONET	—	—	7	km
Ethernet/FC	—	—	10	km
Other				
Connector/Latch type	LC/Lever			
GR 253, ITU-T G.957, IEEE 802.3 ae and XFP MSA compliant				

### 11.5.3 1550 nm IR XFP optical specifications

Table 11-19 1550 nm IR XFP BP3AM4LI optical specifications

Parameter	Min	Typ	Max	Units
Bit rate	9.953	—	10.7	Gb/s
Transmitter				
Tx operating wavelength	1530	—	1565	nm
Average operating power	-1	—	+2	dBm
Side mode suppression ratio	30	—	—	dB
Extinction ratio	8.2	—	—	dB
Receiver				
Rx operating wavelength	1270	—	1600	nm
Stressed Rx sensitivity (BER = 1e-12)	-11.3	—	—	dBm
Rx overload	—	—	-1	dBm
Optical path penalty (at 800 ps/nm)	—	—	2	dB
Reflectance	—	—	-27	dB
Other				
Connector/Latch type	LC/Lever			
GR 253, ITU-T G.957, IEEE 802.3 ae and XFP MSA compliant				

## 11.5.4 CWDM XFP BP3AM4CL optical specifications

Table 11-20 CWDM XFP BP3AM4CL optical specifications

Parameter	Min	Typ	Max	Units
Bit rate	9.953	—	10.7	Gb/s
Transmitter				
Tx center wavelength	1471	—	1611	nm
Tx center wavelength accuracy	-6.5	—	+6.5	nm
Average operating power	0	—	4	dBm
Spectral width (-20dB)	—	—	1	nm
Side mode suppression ratio	30	—	—	dB
Extinction ratio	9	—	—	dB
Receiver				
Rx operating wavelength	1460	—	1620	nm
Rx reflectance	—	—	-27	dB
Other				
Connector/Latch type	LC/Lever			
Compliant to XFP MSA and GR 253				

Table 11-21 CWDM XFP Rx Optical Performance Specifications

Bit Rate (Gb/s)	Dispersion (ps/nm)	Receiver Sensitivity (dBm)	BER
9.953/10.312/10.5	0	-21 to -9	1e-12
	1400	-20.5 to -9	
10.7 with FEC	0	-25 to -9	1e-4
	1400	-24.5 to -9	
10.7 with EFEC	0	-26 to -9	1e-3
	1400	-25.5 to -9	

## 11.5.5 DWDM XFP optical specifications

Table 11-22 DWDM XFP BP3AM4DL optical specifications

Parameter	Min	Typ	Max	Units
Bit Rate	9.953	—	10.7	Gb/s
<b>Transmitter</b>				
Tx operating wavelength	1529.55	—	1560.61	nm
Average operating power	-1	—	+3	dBm
Spectral width (-20dB)	—	—	0.3	nm
Side mode suppression ratio	30	—	—	dB
Extinction ratio	8.2	—	—	dB

Table 11-22 DWDM XFP BP3AM4DL optical specifications (Continued)

Parameter	Min	Typ	Max	Units
Receiver				
Rx operating wavelength	1528	—	1565	nm
Reflectance	—	—	-27	dB
Other				
Connector/Latch type	LC/Lever			
Compliant to XFP MSA				

Table 11-23 DWDM XFP Rx Optical Performance Specifications

Bit Rate (Gb/s)	Dispersion (ps/nm)	OSNR (dB)	Receiver Sensitivity (dBm)	BER
9.95/10.3	0	≥30	-24 to -7	1e-12
		≥25	-18 to -7	
	1200	≥30	-23 to -7	
		≥27	-18 to -7	
	1600	≥30	-22 to -7	
		≥28	-18 to -7	
10.5	0	≥30	-23 to -7	1e-12
		≥26	-18 to -7	
	1200	≥30	-22 to -7	
		≥28	-18 to -7	
	1600	≥30	-18 to -7	
10.7/ with FEC	0	≥30	-26 to -7	1e-4
		≥18	-18 to -7	
	1200	≥30	-25 to -7	
		≥18	-18 to -7	
	1600	≥30	-24 to -7	
		≥19	-18 to -7	
10.7/ with EFEC	0	≥30	-27 to -7	1e-3
		≥16	-18 to -7	
	1200	≥30	-26 to -7	
		≥16	-18 to -7	
	1600	≥30	-25 to -7	
		≥17	-18 to -7	

## 11.5.6 Tunable DWDM LR XFP optical specifications

**Table 11-24 Tunable DWDM LR XFP BP3AM4TL, BP3AM4TF, BP3AM4TB-Bnn, BP3AM4TC-Bnn optical specifications**

Parameter	Min	Max	Units
Bit Rate	9.953	10.7	Gb/s
Transmitter			
Tx operating wavelength:			
BP3AM4TL <sup>1</sup>	1529.55	1560.61	nm
BP3AM4TF	1528.77	1566.72	nm
BP3AM4TB-Bnn	See Table 11-25.		
BP3AM4TC-Bnn	See Table 11-26.		
Average operating power	-1	+3	dBm
Spectral width (-20dB)	—	0.3	nm
Side mode suppression ratio	30	—	dB
Extinction ratio	8.2	—	dB
Receiver			
Rx operating wavelength	1528.77	1566.72	nm
Reflectance	—	-27	dB
Other			
Connector/Latch type	LC/Lever		
Compliant to XFP MSA			

<sup>1</sup>This transceiver is manufacture discontinued. Use BP3AM4TF instead.

**Note** The BP3AM4TC-Bnn is intended for 50 GHz spacing applications only.

**Table 11-25 100 GHz sub-band tunable (BP3AM4TB-Bnn) transmit frequencies**

Part Number	Sub-band	Min	Max	Units
BP3AM4TB-B01	1	192.10	193.00	THz
BP3AM4TB-B02	2	193.10	194.00	THz
BP3AM4TB-B03	3	194.10	195.00	THz
BP3AM4TB-B04	4	195.10	196.00	THz

**Table 11-26 50 GHz sub-band tunable (BP3AM4TC-Bnn) transmit frequencies**

Part Number	Sub-band	Min	Max	Units
BP3AM4TC-B01	1	191.35	191.80	THz
BP3AM4TC-B02	2	191.85	192.30	THz
BP3AM4TC-B03	3	192.35	192.80	THz
BP3AM4TC-B04	4	192.85	193.30	THz
BP3AM4TC-B05	5	193.35	193.80	THz

**Table 11-26 50 GHz sub-band tunable (BP3AM4TC-Bnn) transmit frequencies (Continued)**

Part Number	Sub-band	Min	Max	Units
BP3AM4TC-B06	6	193.85	194.30	THz
BP3AM4TC-B07	7	194.35	194.80	THz
BP3AM4TC-B08	8	194.85	195.30	THz
BP3AM4TC-B09	9	195.35	195.80	THz
BP3AM4TC-B10	10	195.85	196.10	THz

**Table 11-27 Tunable XFP Rx Optical Performance Specifications**

Bit Rate (Gb/s)	Dispersion (ps/nm)	OSNR (dB)	Receiver Sensitivity (dBm)	BER
9.95/10.3	0	$\geq 30$	-24 to -7	1e-12
		$\geq 25$	-18 to -7	
	1200	$\geq 30$	-23 to -7	
		$\geq 27$	-18 to -7	
	1600	$\geq 30$	-22 to -7	
		$\geq 28$	-18 to -7	
10.5	0	$\geq 30$	-23 to -7	1e-12
		$\geq 26$	-18 to -7	
	1200	$\geq 30$	-22 to -7	
		$\geq 28$	-18 to -7	
	1600	$\geq 30$	-18 to -7	
10.7/ with FEC	0	$\geq 30$	-26 to -7	1e-4
		$\geq 18$	-18 to -7	
	1200	$\geq 30$	-25 to -7	
		$\geq 18$	-18 to -7	
	1600	$\geq 30$	-24 to -7	
10.7/ with EFEC	0	$\geq 30$	-27 to -7	1e-3
		$\geq 16$	-18 to -7	
	1200	$\geq 30$	-26 to -7	
		$\geq 16$	-18 to -7	
	1600	$\geq 30$	-25 to -7	
		$\geq 17$	-18 to -7	

## 11.5.7 Wavelengths supported on Tunable XFP BP3AM4TL

**Note** This transceiver is manufacture discontinued. Use BP3AM4TF instead.

**Table 11-28 DWDM Wavelength Plan**

Wavelength (nm)	BTI Channel Numbers	Wavelength (nm)	BTI Channel Numbers
1529.55	E8	1545.32	E4
1530.33	32	1546.12	16
1531.12	31	1546.92	15
1531.90	30	1547.72	14
1532.68	29	1548.51	13
1533.47	28	1549.32	12
1534.25	27	1550.12	11
1535.04	26	1550.92	10
1535.82	25	1551.72	9
1536.61	E7	1552.52	E3
1537.40	E6	1553.33	E2
1538.19	24	1554.13	8
1538.98	23	1554.94	7
1539.77	22	1555.75	6
1540.56	21	1556.55	5
1541.35	20	1557.36	4
1542.14	19	1558.17	3
1542.94	18	1558.98	2
1543.73	17	1559.79	1
1544.53	E5	1560.61	E1

## 11.5.8 Wavelengths supported on Tunable XFP BP3AM4TF

**Table 11-29 96-channel DWDM Wavelength Plan**

DOLChannel Numbers	Frequency (THz)	Wavelength (nm)
610	196.10	1528.77
605	196.05	1529.16
600	196.00	1529.55
595	195.95	1529.94
590	195.90	1530.33
585	195.85	1530.72
580	195.80	1531.12
575	195.75	1531.51
570	195.70	1531.90
565	195.65	1532.29
560	195.60	1532.68
555	195.55	1533.07

Table 11-29 96-channel DWDM Wavelength Plan (Continued)

DOLChannel Numbers	Frequency (THz)	Wavelength (nm)
550	195.50	1533.47
545	195.45	1533.86
540	195.40	1534.25
535	195.35	1534.64
530	195.30	1535.04
525	195.25	1535.43
520	195.20	1535.82
515	195.15	1536.22
510	195.10	1536.61
505	195.05	1537.00
500	195.00	1537.40
495	194.95	1537.79
490	194.90	1538.19
485	194.85	1538.58
480	194.80	1538.98
475	194.75	1539.37
470	194.70	1539.77
465	194.65	1540.16
460	194.60	1540.56
455	194.55	1540.95
450	194.50	1541.35
445	194.45	1541.75
440	194.40	1542.14
435	194.35	1542.54
430	194.30	1542.94
425	194.25	1543.33
420	194.20	1543.73
415	194.15	1544.13
410	194.10	1544.53
405	194.05	1544.92
400	194.00	1545.32
395	193.95	1545.72
390	193.90	1546.12
385	193.85	1546.52
380	193.80	1546.92
375	193.75	1547.32
370	193.70	1547.72
365	193.65	1548.11

**Table 11-29 96-channel DWDM Wavelength Plan (Continued)**

<b>DOLChannel Numbers</b>	<b>Frequency (THz)</b>	<b>Wavelength (nm)</b>
360	193.60	1548.51
355	193.55	1548.91
350	193.50	1549.32
345	193.45	1549.72
340	193.40	1550.12
335	193.35	1550.52
330	193.30	1550.92
325	193.25	1551.32
320	193.20	1551.72
315	193.15	1552.12
310	193.10	1552.52
305	193.05	1552.93
300	193.00	1553.33
295	192.95	1553.73
290	192.90	1554.13
285	192.85	1554.54
280	192.80	1554.94
275	192.75	1555.34
270	192.70	1555.75
265	192.65	1556.15
260	192.60	1556.55
255	192.55	1556.96
250	192.50	1557.36
245	192.45	1557.77
240	192.40	1558.17
235	192.35	1558.58
230	192.30	1558.98
225	192.25	1559.39
220	192.20	1559.79
215	192.15	1560.20
210	192.10	1560.61
205	192.05	1561.01
200	192.00	1561.42
195	191.95	1561.83
190	191.90	1562.23
185	191.85	1562.64
180	191.80	1563.05
175	191.75	1563.45



**Table 11-29 96-channel DWDM Wavelength Plan (Continued)**

<b>DOLChannel Numbers</b>	<b>Frequency (THz)</b>	<b>Wavelength (nm)</b>
170	191.70	1563.86
165	191.65	1564.27
160	191.60	1564.68
155	191.55	1565.09
150	191.50	1565.50
145	191.45	1565.91
140	191.40	1566.31
135	191.35	1566.72

## 11.6 Physical PMs

**Table 11-30 Physical PMs (gauges)**

PM (montype)	Supported transceivers
<b>Optical Power Received</b> (OPR MIN, OPR MAX, OPR AVG) Optical Power Received measures the minimum, maximum, and average optical power (dBm) received. Measurements are accurate to $\pm 3.0$ dBm for SFPs; to $\pm 2.0$ dBm for XFPs.	Noncopper SFPs All XFPs
<b>Optical Power Transmitted</b> (OPT MIN, OPT MAX, OPT AVG) Optical Power Transmitted measures the minimum, maximum, and average optical power (dBm) transmitted. Measurements are accurate to $\pm 3.0$ dBm for SFPs; to $\pm 2.0$ dBm for XFPs.	Noncopper SFPs All XFPs
<b>Supply Voltage</b> Supply Voltage measures the supply voltage on the 3.3V supply for SFPs; on the 5.0V supply for XFPs. This PM is not supported on all XFPs and the PM line will contain "NA" instead of "CMPL" or "PRTL".	Noncopper SFPs All XFPs
<b>Supply Voltage 2</b> Supply Voltage 2 measures the supply voltage on the 3.3V supply. This PM is not supported on all XFPs and the PM line will contain "NA" instead of "CMPL" or "PRTL".	All XFPs
<b>Temperature</b> Temperature measures the temperature ( $^{\circ}\text{C}$ ) of the transceiver.	All SFPs All XFPs
<b>Tx Bias current</b> Laser Bias Current measures the laser bias current (mA).	Noncopper SFPs All XFPs

**Note** Physical PMs are not supported on SFPs on SCP modules and Expansion Shelf Interface ports.

## 12.0 Remote management

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This section provides information about the options available for remote management of BTI 7000 Series network elements.

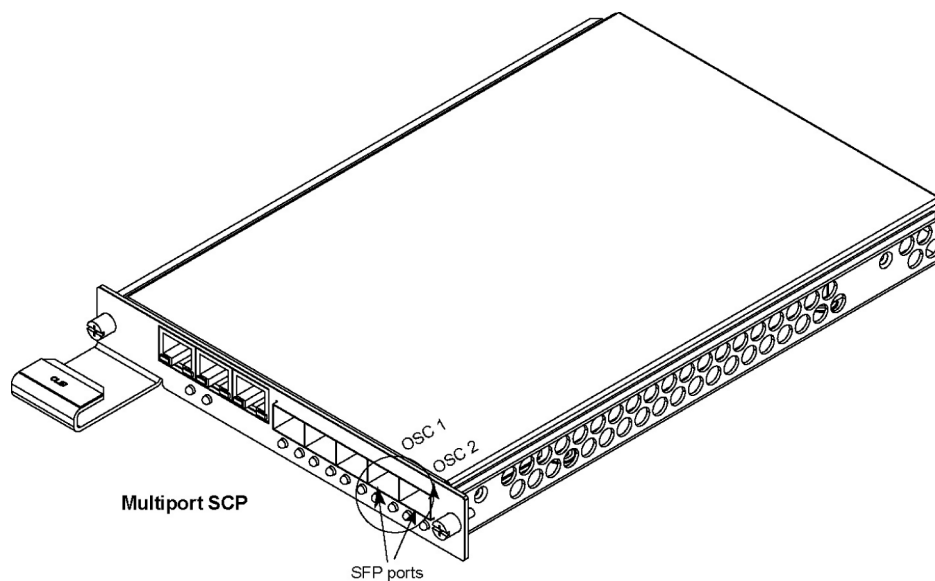
- 12.1, “Optical Supervisory Channel integrated on the System Control Processor”
- 12.2, “OSC Coupler/Splitter ”
- 12.3, “Management Communication Channels”
- 12.4, “Supported MCC network configurations”
- 12.5, “Management communication channel selection criteria”
- 12.6, “Management interfaces supported by the MCC”

## 12.1 Optical Supervisory Channel integrated on the System Control Processor

The System Control Processor (SCP) provides Optical Supervisory Channel (OSC) functionality for remote management of a BTI 7000 Series shelf. The SCP has two SFP-based OSC ports supporting 1511 channels. The OSC integrated on the SCP must be combined with a separate Coupler/Splitter module for full functionality.

**Note** For OSC applications using the 1511 SFP, use the 1-Channel or Double 1-Channel CWDM OADM/OSC Coupler Splitter, Channel 6 (1511 nm) Optical Coupler / Splitter Single Direction or Optical Coupler / Splitter Dual Direction module.

The following figure shows the OSC ports on the SCP.



This section covers the following topics:

- [12.1.1, “1510 XR SFP \(for OSC\) specifications”](#)
- [12.1.2, “CWDM ER SFP \(for OSC\) specifications”](#)
- [12.1.3, “Multimode 1310 SR SFP optical specifications ”](#)

### 12.1.1 1510 XR SFP (for OSC) specifications

The following table provides specifications for the 1510 XR SFP (for OSC) supported for use in the OSC ports on the SCP.

**Table 12-1 1510 XR SFP (for OSC) BP3AE1CX specifications**

Parameter	Min	Typ	Max	Units
Bit rate <sup>1</sup>	—	156	—	Mb/s

**Table 12-1 1510 XR SFP (for OSC) BP3AE1CX specifications (Continued)**

Parameter	Min	Typ	Max	Units
Transmitter				
Laser source	single-mode			
Tx center wavelength	1500	1511	1520	nm
Average operating power	1	—	5	dBm
Spectral width (-20 dB)	—	—	1	nm
Side mode suppression ratio	30	—	—	dB
Extinction ratio	10	—	—	dB
Receiver				
Rx operating wavelength	1100	—	1600	nm
Max Input (BER=1x10 <sup>-10</sup> )	-7	—	—	dBm
Rx sensitivity (BER=1x10 <sup>-10</sup> )	-43	—	—	dBm
Optical Return Loss	25	—	—	dB
Other				
Connector/Latch type	LC/Bail			
<sup>1</sup> Data rate ranges from 50 Mb/s to 266 Mb/s. However, device performance is not guaranteed.				

## 12.1.2 CWDM ER SFP (for OSC) specifications

The following table provides specifications for the CWDM ER SFP (for OSC) supported for use in the OSC ports on the Multiport SCP.

**Table 12-2 CWDM ER SFP (for OSC) BP3AE1CE specifications**

Parameter	Min	Typ	Max	Units
Bit rate	50	156	266	Mb/s
<b>Transmitter</b>				
Laser source	single-mode			
Tx center wavelength	1511	—	1611	nm
Tx center wavelength accuracy	-6.5	—	6.5	nm
Average operating power	0	—	5	dBm
Spectral width (-20 dB)	—	—	1	nm
Side mode suppression ratio	30	—	—	dB
Extinction ratio	10	—	—	dB
<b>Receiver</b>				
Rx operating wavelength	1100	—	1620	nm
Max Input (BER=1x10 <sup>-10</sup> )	-7	—	—	dBm
Rx sensitivity (BER=1x10 <sup>-10</sup> )	-34	-37	—	dBm
Optical Return Loss	25	—	—	dB
<b>Other</b>				

**Table 12-2 CWDM ER SFP (for OSC) BP3AE1CE specifications (Continued)**

Parameter	Min	Typ	Max	Units
Connector/Latch type	LC/Bail			

### 12.1.3 Multimode 1310 SR SFP optical specifications

The following table provides specifications for the Multimode 1310 SR SFP supported for multishelf use.

**Table 12-3 Multimode 1310 SR SFP BP3AE1MM optical specifications**

Parameter	Min	Typ	Max	Units
Bit rate	—	125	—	Mb/s
<b>Transmitter</b>				
Laser source	multimode			
Tx operating wavelength	1270	—	1380	nm
Average operating power	-20	—	-14	dBm
Spectral width (-20 dB)	—	—	200	nm
Extinction ratio	10	—	—	dB
<b>Receiver</b>				
Rx operating wavelength	1100	—	1600	nm
Max input (BER=2.5x10 <sup>-10</sup> )	-14	—	—	dBm
Rx sensitivity (BER=1x10 <sup>-10</sup> )	-30	—	—	dBm
Rx sensitivity (BER=1x10 <sup>-12</sup> )	-29	—	—	dBm
<b>Other</b>				
Connector/Latch type	LC/Bail			

## 12.2 OSC Coupler/Splitter

The OSC Coupler/Splitter module allows the OSC channel to be decoupled from the incoming C-band optical signals. It also allows the OSC channel to be combined with C-band optical signal channels and launched into the fiber. Both the Single and Double Coupler/Splitter modules are used for either adding or dropping the OSC channel.

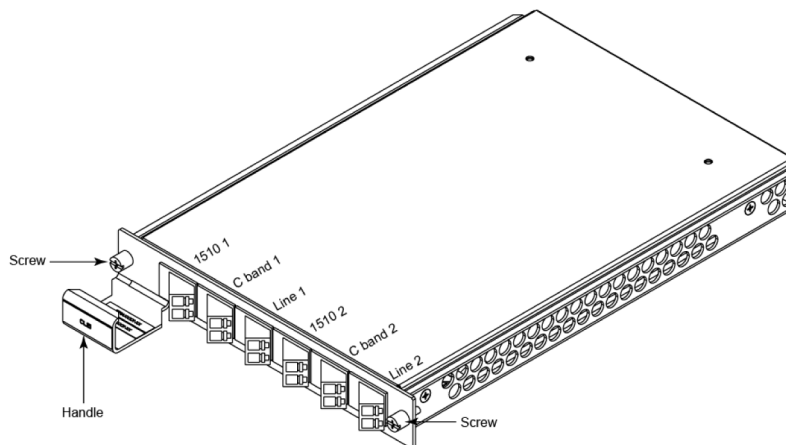
Two standalone OSC Coupler/Splitter modules are available:

- 1-Channel CWDM OADM/OSC Coupler Splitter, Channel 6 (1511 nm)
- Double 1-Channel CWDM OADM/Double OSC Coupler Splitter, Channel 6 (1511 nm)

**Note** The OSC Coupler/Splitter module is used in conjunction with the OSC functionality on the System Control Processor (SCP).

The following figure shows the key physical features of the Double 1-Channel CWDM OADM/Double OSC Coupler/Splitter.

**Double 1-Channel CWDM OADM/Double OSC Coupler/Splitter**





## 12.3 Management Communication Channels

The Management Communication Channels (MCC) solution supported on the BTI 7000 Series allows network providers to remotely manage network elements using the General Communications Channel (GCC), the Optical Data Communications Channel (ODCC) on DOL modules, and the ODCC on the Optical Supervisory Channel (OSC) ports on the SCP.

The GCC, ODCC on DOL, and ODCC on SCP OSC support point-to-point and ring configurations. For more information refer to [12.4, “Supported MCC network configurations”](#).

The GCC, ODCC on DOL, and ODCC on SCP OSC are open communications channels that provide IP connectivity to BTI 7000 Series network elements, allowing network-management applications to be used for:

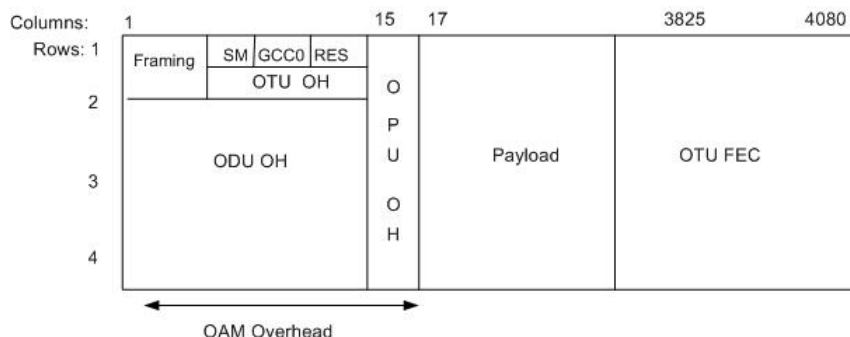
- Remote provisioning and inventory
- Network surveillance, including detection of link failures and equipment alarms
- Remote backup and restore of the configuration database
- Remote upgrade of system software
- Remote performance monitoring

### 12.3.1 GCC

The BTI 7000 Series uses the GCC (defined in ITU-T standard G.709-2003) to form an IP-based network for management communications.

Service Providers can use the GCC to manage their networks without impacting customer bandwidth, or using another wavelength on their fibers. The GCC0 bytes defined in the OTU1/OTU2 overhead are used to form a 333 kilobits/second channel for the 8-Port Multiprotocol Muxponder - SDH.

**Figure 12-2 GCC in the OTN OTU2 frame structure**



### 12.3.2 GCC support on BTI 7000 Series modules

The following table lists the BTI 7000 Series modules that support GCC.

**Table 12-4 Supported GCC modules**

<b>Module</b>	<b>PEC</b>
10G Multiprotocol Transponder	BT7A49AB
Dual 10G Multiprotocol Transponder	BT7A49AA
	BT7A49AA-I02
8-Port Multiprotocol Muxponder - SONET	BT7A47JA
8-Port Multiprotocol Muxponder - SDH	BT7A47KA
8-Port Multiprotocol Muxponder - SDH CCAT	BT7A47MA
10-Port Multiprotocol Muxponder - SONET	BT7A48AA, BT7A48AA-I02
10-Port Multiprotocol Muxponder - SDH	BT7A48BA, BT7A48BA-I02
10-Port Multiprotocol Muxponder - SDH CCAT	BT7A48DA
packetVX Integrated Packet Services Module - 12/2	BT7A81AA
packetVX Integrated Packet Services Module - 24/2	BT7A81BA
packetVX Integrated Packet Services Module - 24/4	BT7A81CA

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## 12.4 Supported MCC network configurations

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BTI offers the following Management Communication Channels solution options:

- GCC
- ODCC on DOL
- ODCC on SCP OSC

### 12.4.1 GCC and ODCC on DOL supported configurations

The BTI 7000 Series supports the following configurations for GCC and ODCC on DOL:

- [12.4.1.1, “Point-to-point configuration for GCC and ODCC on DOL”](#)
- [12.4.1.2, “Ring configuration for GCC and ODCC on DOL”](#)
- [12.4.1.3, “Management VLAN configuration for GCC”](#)

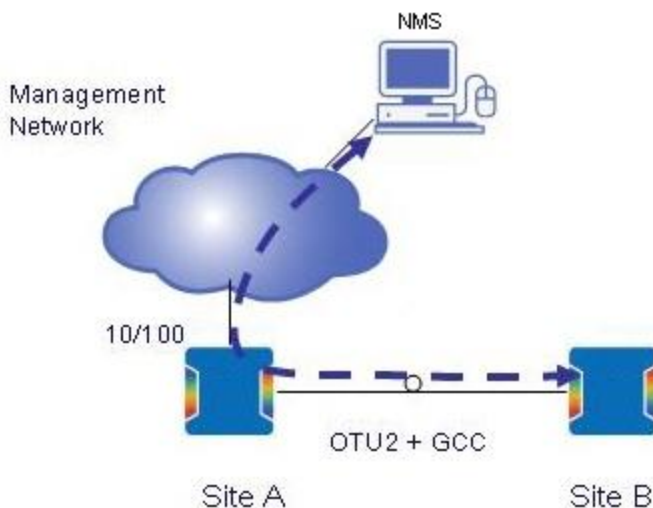
#### 12.4.1.1 Point-to-point configuration for GCC and ODCC on DOL

In a point-to-point configuration, each network element must include a minimum of one GCC- or one ODCC- capable port.

- **For GCC:** The port(s) must have the supported OTU line protocol and GCC overhead enabled.
- **For ODCC on DOL:** ODCC must be enabled on a DOL module.

The following example shows a GCC point-to-point network configuration. Site A connects to the management network through the management LAN port (10/100BaseT port on the MSI). Communication to site B is through site A and the GCC. Site A and Site B each have a unique IP address (on the different subnets) assigned allowing the management station to connect.

<b>Note</b>	For an ODCC configuration, Sites A and B are connected by DOL (dynamic optical layer) line ports.
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**Figure 12-3 Example point-to-point configuration for GCC**

#### 12.4.1.2 Ring configuration for GCC and ODCC on DOL

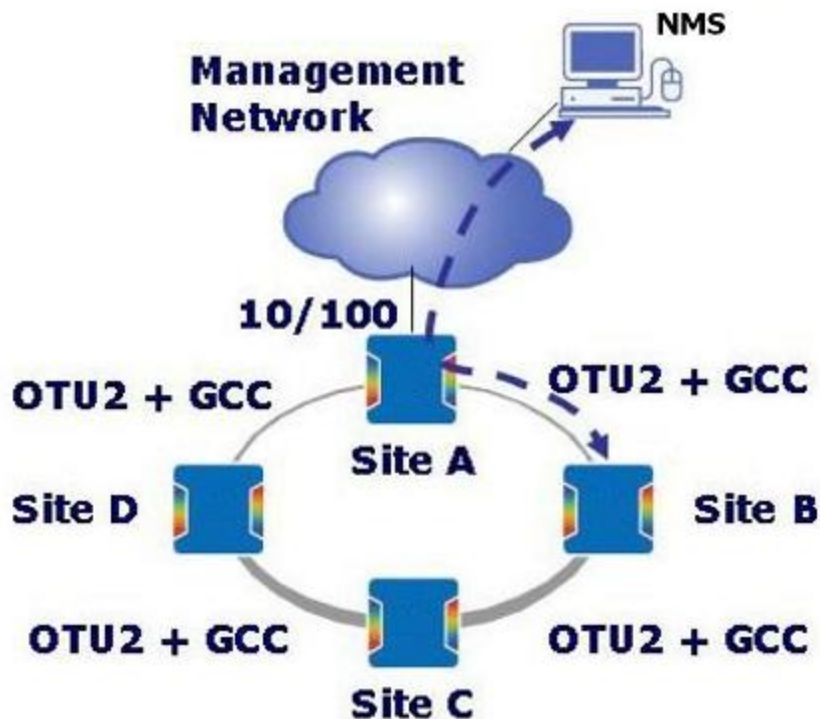
In a ring network configuration, each network element (NE) must include a minimum of two GCC-capable ports, or one ODCC-capable port.

- **For GCC:** The port(s) must have the supported OTU line protocol and GCC overhead enabled.
- **For ODCC on DOL:** ODCC must be enabled on the dynamic optical layer DOL module.

The following example shows a ring network configuration for GCC. In this example network configuration, site A connects to the management network through the management LAN port (10/100Base-T port on the MSI). Communication to sites B, C and D is through site A and the GCC. Each site has a unique IP address assigned allowing the management station to connect. OSPF routing protocol is used between BTI 7000 Series network elements to determine the optimal path to reach a specific NE. If a network element or link fails, management traffic is re-routed automatically.

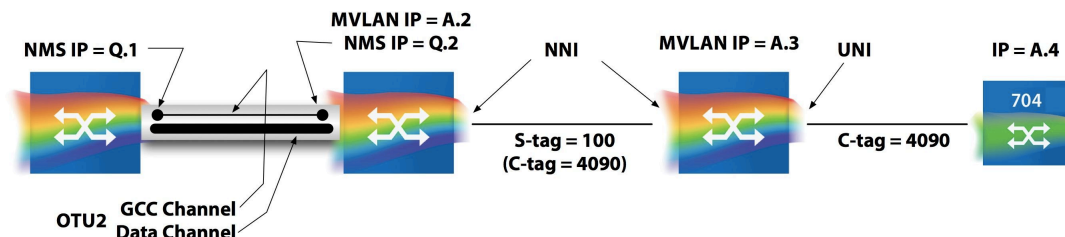
**Note** For an ODCC configuration, communication to sites B, C and D is through site A and the ODCC service.

Figure 12-4 Ring configuration for GCC



### 12.4.1.3 Management VLAN configuration for GCC

This section describes GCC to Management VLAN routing, as shown in the following figure.



In this scenario, traffic from a GCC link is routed across the Management VLAN with an ultimate destination of a NE on a customer VLAN on NE A.2. The GCC link is provisioned on interface tenGig 1/1/1 and routed over an NNI on port tenGig 1/1/2 which is part of the Management VLAN service.

## 12.4.2 ODCC on SCP OSC supported configurations

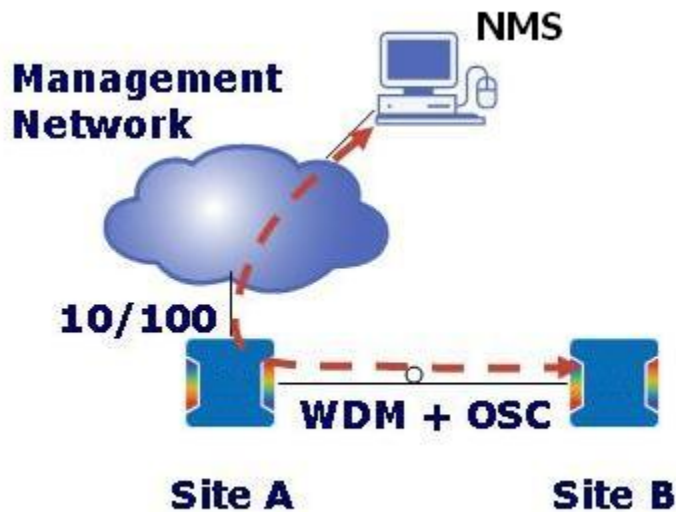
The BTI 7000 Series supports the following configurations for ODCC on SCP OSC:

- Point-to-point
- Ring

### 12.4.2.1 Point-to-point configuration for ODCC on SCP OSC

The following figure shows an example point-to-point configuration. In point-to-point network configurations, each NE must include an OSC SFP and coupler/splitter. Each NE must also have the OSC enabled through software. Site A is connected to the management network through the management LAN port (10/100 BaseT port on the MSI). Communication to site B is through site A and the OSC. Site A and Site B each have a unique IP address (on the same subnet) assigned allowing the management station to connect.

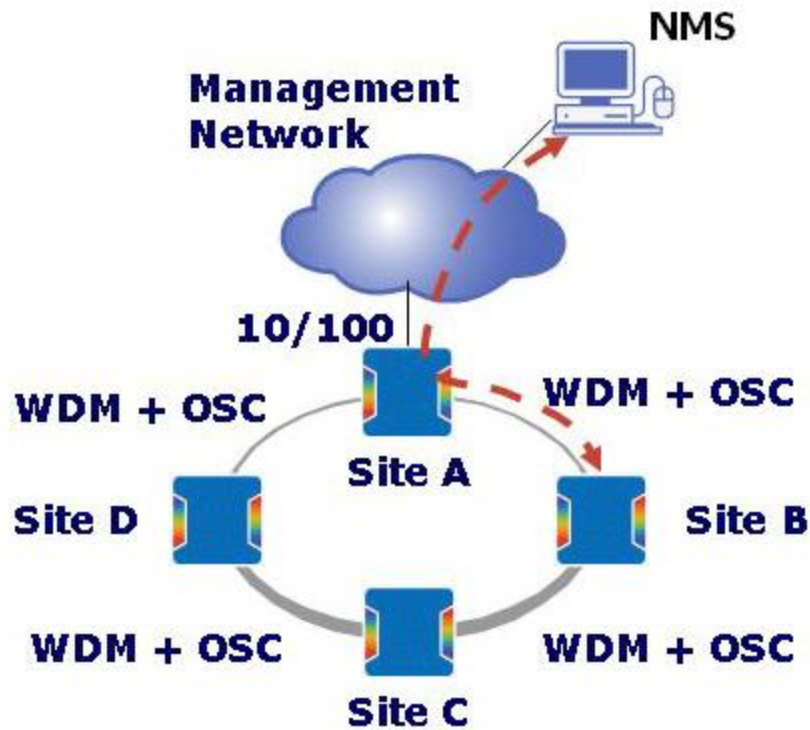
**Figure 12-5 Point-to-point configuration for OSC**



### 12.4.2.2 Ring configuration for ODCC on SCP OSC

The following figure shows an example ring configuration. In a ring configuration, each NE must include two OSC SFPs and a coupler/splitter. Each NE must also have both OSC ports enabled through software. Site A is connected to the management network through the management LAN port (10/100 BaseT port on the MSI). Communication to sites B, C and D is through site A and the OSC. Each site has a unique IP address assigned allowing the management station to connect. In the event of a network element or link failure, management traffic is switched along an alternate path automatically using STP protocol.

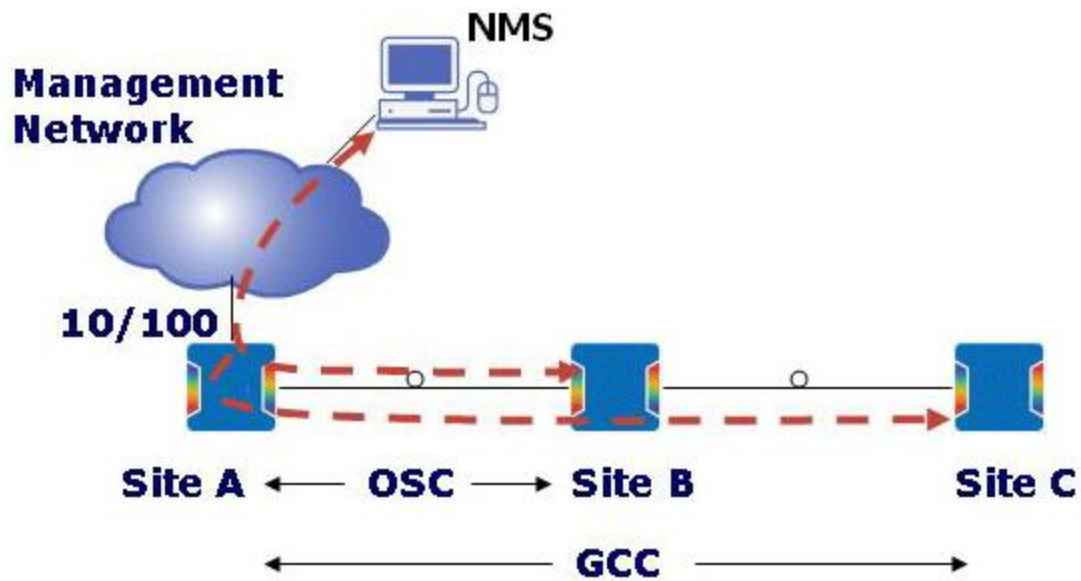
Figure 12-6 Ring configuration for OSC



### 12.4.3 Supported configurations for combined GCC and OSC

The BTI 7000 Series also supports network configurations that combine GCC and OSC. The following figure shows an example point-to-point configuration. In this configuration, Site A and Site C both have GCC-supported modules, but Site B does not. Therefore, connectivity from Site A to Site B is provided by OSC, and connectivity from Site A to Site C is provided by GCC. See [12.5, “Management communication channel selection criteria”](#) for information on deploying GCC and OSC in your network configuration.

Figure 12-7 GCC and OSC configuration





## 12.5 Management communication channel selection criteria

The following table lists the channel selection criteria to consider when choosing a management communications option.

**Note** The channel options are listed in the order recommended.

**Table 12-5 MCC selection criteria**

Criteria		MVLAN	ODCC on SCP OSC	ODCC on DOL	GCC
Topology	Point-to-point	Y	Y	Y	Y
	Ring	Y	Y	Y	Y
	Mesh	Y	N	Y	Y
	Star (>2 legs)	Y	N	Y	Y
Module types in the network element (NE)	packetVX (PVX)	Y <sup>1</sup>	Y <sup>2</sup>	N	Y <sup>1</sup>
	dynamic optical layer (DOL)	N	N	Y	N
	OTU2	N	Y <sup>2</sup>	N	Y
	SCP	N	Y <sup>2</sup>	N	N
Forwarding	Bridging	Ethernet with STP	Ethernet with STP	not applicable	not applicable
	Routing	IP/OSPF	IP/OSPF	IP/OSPF	IP/OSPF
Speed	-	Up to 1Gb/s <sup>3</sup>	100Mb/s	1.3 Mb/s	1.3 Mb/s
Physical complexity	Additional components required	N	OSC SFPs Coupler/ Splitter	N	N
Fan-out	1-port	Y	Y	Y	Y
	2-ports	Y	Y	Y	Y
	> 2 ports	Y <sup>4</sup>	N	Y	Y

<sup>1</sup>With PVX modules present, either MVLAN or GCC can be run.

<sup>2</sup>OSC ports on SCP modules are available on all nodes regardless of card lineup.

<sup>3</sup>OSC is bandwidth dedicated to management traffic. MVLAN can be up to 1Gb/s ingressing on a PVX client-port UNI, or up to 100Mb/s ingressing on IP-NMS, but is subject to bandwidth sharing.

<sup>4</sup>MVLAN fanning out via > 2 ports requires four line ports, therefore a PVX 24/4 must be used.

<sup>5</sup>Applicable when configured for the OSI protocol.

## 12.6 Management interfaces supported by the MCC

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Management Communication Channels can be configured and managed using the following interfaces:

MCC Channel	Supported Interface
GCC (General Communications Channel)	proNX 900 Node Controller
	SNMP
	TL1
	CLI
ODCC (Optical Data Communications Channel) on DOL	proNX 900 Node Controller
	SNMP
	TL1
ODCC (Optical Data Communications Channel) on SCP OSC	proNX 900 Node Controller
	SNMP
	TL1
Management VLAN	proNX 900 Node Controller
	SNMP
	CL1

## 13.0 Standard and protocol compliance

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This section describes the standards and protocols to which the BTI 7000 Series complies.

- [13.1, “Relevant standards and protocol conformance”](#)
- [13.2, “Metro Ethernet Forum MEF Certification”](#)
- [13.3, “Brocade Certification”](#)

## 13.1 Relevant standards and protocol conformance

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This section provides information about the primary standards and protocols supported by the BTI 7000 Series and covers the following topics:

- 13.1.1, “Telcordia standards”
- 13.1.2, “Telcordia TL1”
- 13.1.3, “Telcordia physical electrical requirements”
- 13.1.4, “Telcordia outside plant requirements”
- 13.1.5, “European Telecommunications Standards Institute”
- 13.1.6, “ITU Telecommunication standardization”
- 13.1.7, “Internet Engineering Task Force (IETF) RFCs”
- 13.1.8, “Safety certifications”

### 13.1.1 Telcordia standards

The BTI 7000 Series conforms to Telcordia GR-1312-CORE, Generic Requirements for Optical Fiber Amplifiers and Proprietary Dense Wavelength-Division Multiplexed Systems.

### 13.1.2 Telcordia TL1

**Table 13-1 Supported Telcordia TL1 standards**

Standard	Description
GR-831-CORE	Operations Application Messages - Language for Operations Application Messages
GR-1093-CORE	Generic State Requirements for Network Elements
GR-199-CORE	Operations Application Messages - Memory Administration Messages
GR-833-CORE	Operations Application Messages - Network Maintenance: Network Element and Transport Surveillance Messages
GR-834-CORE	Operations Application Messages - Network Maintenance: Access and Testing Messages
TR-NWT-000835	Operations Application Messages - Network Element and Network System Security Administration Messages

### 13.1.3 Telcordia physical electrical requirements

The system is tested to the following Telcordia standards:

**Table 13-2 Telcordia physical standards**

Standard	Description
GR-63-CORE	Physical Protection; identifies minimum generic spatial and environmental criteria

**Table 13-2 Telcordia physical standards (Continued)**

Standard	Description
GR-1089-CORE	Electromagnetic Compatibility and Electrical Safety Generic Criteria for Network Telecommunications Equipment; identifies the minimum generic criteria for Electromagnetic Compatibility (EMC) and electrical safety
TR-NWT-000078	Generic Physical Design Requirements for Telecommunications Products and Equipment; identifies the minimum generic physical design criteria

### 13.1.4 Telcordia outside plant requirements

The BTI 7000 Series passive CWDM mux/demux modules, and OADM's comply with Telcordia GR-3108-CORE Generic Requirements for Network Equipment in the Outside Plant (OSP).

### 13.1.5 European Telecommunications Standards Institute

**Table 13-3 ETSI compliance**

Standard	Description
ETSI 300 119	European telecommunication standard for equipment practice
ETSI 300 019	Environmental conditions and environmental tests for telecommunications equipment
ETSI 300 019-2-2:1994	Transportation (Class T2.3 Public Transportation)
	IEC 60068-2-1: Public Transportation, Temperature Low
	IEC 60068-2-2: Public Transportation, Air Temperature High
	IEC 60068-2-56: Public Transportation, Humidity, High
ETSI EN300 019	Equipment Engineering(EE); Environmental Conditions and Environmental Tests for Telecommunications Equipment: 2-1, Class T1.2-Storage; 2-2, Class T2.3-Public Storage; 2-3, Class T3.1&3.1E
ETSI EN 300 019-2-1	IEC 60068-2-1: Storage, Air Temperature Low - covered by NEBS testing.
	IEC 60068-2-1: Storage, Air Temperature High - covered by NEBS testing.
	IEC 60068-2-6: Storage, Sinusoidal Vibration - covered by NEBS testing.
	IEC 60068-2-56: Storage, Humidity, High - covered by NEBS testing.
	IEC 60068-2-64: Storage, Random Vibration - covered by Public Transportation testing below.
ETSI 300 019-2-2:1994	Transportation (Class T2.3 Public Transportation)
	IEC 60068-2-14 - Public Transportation, Air Temperature, Change Evaluated in the BTI 7060 Chassis
ETSI 300 019-2-2:1994	Transportation (Class T2.3 Public Transportation)
	IEC 60068-2-30: Public Transportation, Rapid Temperature Change Evaluated in the BTI 7060 Chassis
ETSI 300 019-2-2:1994	Transportation (Class T2.3 Public Transportation)
	IEC 60068-2-64: Public Transportation, Random Vibration - (\$800) Evaluated in the BTI 7060 Chassis
ETSI 300 019-2-2:1994	Transportation (Class T2.3 Public Transportation)

**Table 13-3 ETSI compliance (Continued)**

Standard	Description
	IEC 60068-2-29: Public Transportation, Shocks Evaluated in the BTI 7060 Chassis
ETSI 300 019-2-2:1994	Transportation (Class T2.3 Public Transportation)
	IEC 60068-2-32: Public Transportation, Free Fall
ETSI 300 019-2-3:1994	In use Weather Protected (Class T3.IE Temperature Controlled)
	IEC 60068-2-1: Stationary Use, Air Temperature Low
	IEC 60068-2-2: Stationary Use, Air Temperature High
ETSI 300 019-2-3:1994	In use Weather Protected (Class T3.IE Temperature Controlled)
	IEC 60068-2-14: Stationary Use, Air Temperature Change
ETSI 300 019-2-3:1994	In use Weather Protected (Class T3.IE Temperature Controlled)
	IEC 60068-2-14: Stationary Use, Air Temperature Change
ETSI 300 019-2-3:1994	In use Weather Protected (Class T3.IE Temperature Controlled)
	IEC 60068-2-56: Stationary Use, High Humidity Evaluated in the BTI 7060 Chassis
ETSI EN 300 386-2	Issued: 01/01/2000 Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Telecommunication Network Equipment; ElectroMagnetic Compatibility (EMC) Requirements; Part 2: Product Family Standard V1.2.1.
ETSI 300 019-2-3:1994	In use Weather Protected (Class T3.IE Temperature Controlled) -
	IEC 60068-2-27: Stationary Use, Mechanical Tests, Shocks Evaluated in the BTI 7060 Chassis

## 13.1.6 ITU Telecommunication standardization

**Table 13-4 ITU-T compliance for CWDM and DWDM wavelengths**

Standard	Description
G.694.1	Spectral grids for WDM applications: DWDM frequency grid
G.694.2	Spectral grids for WDM applications: CWDM wavelength grid
G.709.Y.133	Interfaces for the Optical Transport Network (OTN)

## 13.1.7 Internet Engineering Task Force (IETF) RFCs

**Table 13-5 Supported IETF RFCs**

Protocol	RFC number	Description
IP	RFC 791	Internet Protocol
TCP	RFC 793	Transmission Control Protocol
UDP	RFC 768	User Datagram Protocol
ICMP	RFC 792	Internet Control Message Protocol
Telnet	RFC 854	Telnet Protocol Specification
	RFC 855	Telnet Option Specification

**Table 13-5 Supported IETF RFCs (Continued)**

Protocol	RFC number	Description
TFTP	RFC 1350	Trivial File Transfer Protocol
SNMPv1	RFCs 1155, 1157, 1212, 1213, and 1215	Simple Network Management Protocol
SNMPv2c	RFCs 1901 through 1907	Simple Network Management Protocol
OSPF	RFC 2328	Open Shortest Path First
PPP	RFC 1172	PPP initial configuration options
	RFC 1570	PPP LCP Extensions
	RFC 1662	PPP in HDLC-like Framing

### 13.1.8 Safety certifications

The following safety standards are supported by the BTI 7000 Series network element:

- IEC60950/UL safety compliance
- IEC60825, part 1 and 2, laser safety

## 13.2 Metro Ethernet Forum MEF Certification

### Carrier Ethernet certification

Iometrix, the networking industry's leading testing authority, has certified that the following BTI 7000 Series modules deliver services compliant with the Metro Ethernet Forum MEF 9 and MEF 14 technical specifications.

**Table 13-6 MEF 9- and MEF 14-certified modules**

Module	Protocol	MEF 9			MEF 14		
		EVP	EVPL	E-LAN	EVP	EVPL	E-LAN
2-Port GbE Muxponder	GbE	X	—	—	—	—	—
8-Port Multiprotocol Muxponder	GbE	X	—	—	—	—	—
10-Port Multiprotocol Muxponder	GbE	X	—	—	—	—	—
Dual 1G/2.5G Multiprotocol Transponder	GbE	X	—	—	—	—	—
Dual 4G Multiprotocol Transponder	GbE	X	—	—	—	—	—
Dual 10G Multiprotocol Transponder/Lite	10GbE	X	—	—	—	—	—
10G Multiprotocol Transponder	10GbE	X	—	—	—	—	—
packetVX 12/2, 24/2, 24/4	—	X	X	X	X	X	X

For BTI customers, MEF 9 and MEF 14 certification assures the following:

- The time and expense required to diligently test interoperability and, in turn, time-to-market and installation costs, are dramatically reduced.
- Service providers are able to offer standardized services over a single 2.5G or 10G line.
- The review of product capabilities through independent validation of function and conformance, as well as performance and behavior benchmarks.

The following Web sites provide detailed information about Metro Ethernet Forum, Carrier Ethernet, and the MEF 9 and MEF 14 Certification Programs:

- <http://metroethernetforum.org>
- [www.iometrix.com](http://www.iometrix.com)



## 13.3 Brocade Certification

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### Data Center Ready Certification

BTI is a member of Brocade's Developer Program. BTI 7000 Series product lines are currently certified, including the following BTI 7000 Series solutions:

- 1G, 2G, 4G, and 10G Fibre Channel solutions
- Dual 1G Multiprotocol Transponder
- Dual 2.5G Multiprotocol Transponder
- Dual 4G Multiprotocol Transponder
- Dual 10G Multiprotocol Transponder
- Dual 10G Multiprotocol Transponder Lite
- 10G Multiprotocol Transponder
- 10-Port 10G/OTU2 Multiprotocol Muxponder

BTI platforms were tested with the following Brocade switches, directors, and Fabric Extension & Routing elements

- Switches: 5000, 4900, 4100, 4024, 4018/4020, 4012/4016, 200E
- Director: 48000
- Fabric Extension & Routing: 7500/7500E

### Networked Solution Validation

BTI equipment is deployed in Brocade's San Jose facility for ongoing customer solution validation and development testing.

More information about the Brocade Data Center Ready certification, consult the DCR Compatibility Matrix available at the following web site:

<http://www.brocade.com/partnerships/index.page>





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