# Cisco NCS 2000 200-Gbps Multirate DWDM Line Card

As a network operator, you need greater capacity to meet ever-increasing bandwidth demands. And you need greater agility and programmability to rapidly respond to an increasingly dynamic network environment. The Cisco® Network Convergence System 2000 (NCS 2000) delivers all this and more by harnessing nLight ROADM, silicon, and multilayer control technologies. The Cisco NCS 2000 200-Gbps Multi-Rate dense wave division multiplexing (DWDM) Line Card uses nLight Silicon to combine multimodulation capability with soft-decision forward error correction to flexibly trade off transmission rate versus reach, with exceptional optical performance.

## Product Features and Benefits

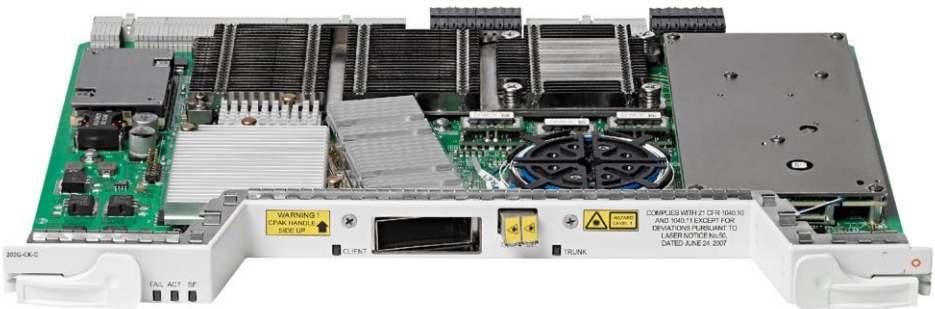
The Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line Card (Figure 1) is a module for the Cisco NCS 2000 Series, which transports 200, 100, or 50 gigabits per second across metro, regional, long-haul, and ultra-long-haul DWDM optical networks.

The card features a Cisco CPAK™ pluggable client interface, which can be mapped to a single DWDM line interface directly or in combination with optional tributary line cards, providing transponder or muxponder capabilities. It supports a software-configurable coherent modulation scheme over a single optical carrier.

The line card is capable of three modulation formats:

- 200-Gbps coherent polarization-multiplexed 16-state quadrature amplitude modulation (16-QAM)
- 100-Gbps coherent polarization-multiplexed differential quadrature phase shift keying (CP-DQPSK)
- 50-Gbps coherent polarization-multiplexed binary phase shift keying (CP-BPSK)

**Figure 1.** Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line Card



The Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line Card provides the following benefits:

- Transport of 50-, 100-, or 200-Gbps wavelengths over fully uncompensated networks
- Transport over very-low-quality fiber with very high Polarization Mode Dispersion (PMD)
- Support for 128 channels at 37.5-GHz channel spacing, or up to 150 channels at minimal spacing
- Support for different card configurations (transponder, muxponder, or regenerator) and modulation formats (CP-BPSK, CP-QPSK, or CP-16QAM) through software provisioning
- Software configurable Hard Decision (HD) or Soft Decision (SD) Forward Error Correction (FEC) algorithms for maximum optical performance and backward compatibility with existing Cisco 100-Gbps DWDM line cards

## Enhanced Forward Error Correction Capability

The Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line Card supports multiple FEC mechanisms on its trunk and client interfaces. The trunk port supports three FEC modes:

- Soft-Decision FEC with 20-percent overhead
- Hard-Decision Generic FEC with 7-percent overhead – Standards-based ITU-T G.975
- Hard-Decision High-Gain FEC with 7-percent overhead

The SD FEC employs an advanced differential encoding and cycle slip-aware algorithm offering excellent performance and robustness against high cycle slip rates. The HD FEC is fully interoperable with previous generations of Cisco NCS 2000 and Cisco ONS 15454 MSTP 100-Gbps DWDM trunk cards. The client port supports the ITU-T G.975 FEC algorithm when configured as an OTU-4, which can be enabled or disabled through software configuration.

## Multiple Modulation Schemes

The Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line Card features a software configurable modulation scheme, allowing the operator to customize the spectral efficiency and reach characteristics of individual wavelengths. Compared to 100-Gbps CP-QPSK, CP-16QAM modulation doubles the spectral efficiency, transmitting 200 Gbps per wavelength at the same baud rate while reducing unregenerated reach. Conversely, CP-BPSK halves the spectral efficiency compared to 100-Gbps CP-QPSK while greatly extending the reach. Supported modulation formats are detailed in Table 1.

**Table 1.** Supported Modulation Formats

| Modulation Type | Bits/Symbol | Symbol Rate (GBaud) | | Bit Rate (Gbps) | | Approximate Reach (km) |
|---|---|---|---|---|---|---|
| | | 7% FEC | 20% FEC | 7% FEC | 20% FEC | |
| **CP-BPSK** | 2 | 27.952 | 31.241 | 55.904 | 62.482 | 10000 |
| **CP-QPSK** | 4 | 27.952 | 31.241 | 111.809 | 124.964 | 5000 |
| **CP-16-QAM** | 8 | 27.952 | 31.241 | 223.616 | 249.928 | 1200 |

## Wavelength Tunability

The line interface supports software-provisionable tunability across the full C band, covering 96 channels on the 50-GHz grid or 128 channels Nyquist shaped and 33-GHz spaced. Continuous tunability in increments of 0.1 GHz provides the ability to create multicarrier superchannels over flex spectrum reconfigurable optical add/drop multiplexers (ROADMs).

## Protection Mechanisms

The line card supports multiple protection mechanisms commonly used in optical transport networks. Table 2 outlines the available protection options and the associated service-level agreements (SLAs) that can be provided.

**Table 2.** Protection Formats

| Protection Type | Capabilities |
|---|---|
| **1 + 1** | Client signal is transported transparently over diverse unprotected optical paths. Protection is provided for the client interface, transponder card, and DWDM line through client-based protocols. |
| **Optical Channel (OCH) trail** | A single trunk interface is passively split across two diverse paths using the Protection Switch Module. Protection is provided for the DWDM line signal only. |
| **Y-Cable** | Client interfaces are passively split into two client-facing cards using an external module. Protection is provided for the DWDM line, the muxponding client card, and the DWDM trunk card. |

## Flow-Through Timing

The Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line FEC allows timing to flow through from client to line optical interface. The received timing from the client interface is used to time the line transmitter interface. This flow-through timing allows multiple trunk cards in the same shelf to be independently timed, independent of the network element timing.

## Management

The Cisco NCS 2000 provides comprehensive management capabilities to support operations, administration, maintenance, and provisioning (OAM&P) capabilities through the integrated Cisco Transport Controller craft interface with support from the Cisco Prime™ optical element management system. The trunk card features provisionable digital wrapper (G.709) functions, providing per-wavelength performance-management capabilities, especially for services transported transparently across the network. The generic communication channel (GCC) of the digital wrapper provides a separate communications channel on a per-wavelength basis to be used by the platform when transparent signals are transported. The GCC allows the Cisco NCS 2000 to extend its advanced network autodiscovery capabilities to DWDM-based services.

## Far-End-Laser-Off Behavior

The Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line Card can provision the far-end-laser-off behavior when SONET/SDH payloads are present. The remote client can be configured to squelch or to send an Alarm Indication Signal (AIS) following a fault condition. For 100 Gigabit Ethernet signals, the default behavior is squelching.

## Performance Monitoring

The Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line Card supports both transparent and nontransparent signal transport performance monitoring. The digital-wrapper channel is monitored according to G.709 Optical Transport Network (OTN) and G.8021 standards. Performance monitoring of optical parameters on the client and DWDM line interface includes Loss of Signal (LOS), laser bias current, and transmit and receive optical power. Calculation and accumulation of the performance-monitoring data are supported in 15-minute and 24-hour intervals as per G.7710.

Physical system parameters measured at the wavelength level, such as mean polarization mode dispersion, accumulated chromatic dispersion, and received optical signal-to-noise ratio (SNR) are also included in the set of performance-monitoring parameters. These parameters can greatly simplify troubleshooting operations and enhance the set of data that can be collected directly from the equipment.

The trunk card incorporates faceplate-mounted LEDs to provide a quick visual check of the operational status of the card.

## Protocol Transparency

The Cisco NCS 200-Gbps Multi-Rate DWDM Line Card can transparently deliver 100-Gbps point-to-point services over a 100-Gbps or 200-Gbps wavelength. Table 3 shows transponder client configurations and mapping.

**Table 3.** Client Configurations and Mapping

| Client | Rate (Gbps) | Mapping |
|---|---|---|
| **100GE LAN-PHY** | 103.125 | Bit transparent through standard G.709v3 mapping |
| **OTU-4** | 111.809 | Transparent G.709 standard |

## 100-Gbps Transponder Functions

The Cisco NCS 200-Gbps Multi-Rate DWDM Line Card provides high-density single-slot 100-Gbps transponder functions using its integrated CPAK pluggable interface. Both 100GBASE-LR4 and 100GBASE-SR10 pluggable modules are available, supporting 100 Gigabit Ethernet or OTU-4 data rates.

## 200-Gbps Muxponder Functions

The Cisco NCS 200-Gbps Multi-Rate DWDM Line Card can efficiently aggregate two 100-Gbps client signals onto a single 200-Gbps carrier using the integrated CPAK client interface in combination with a second CPAK interface residing on the Cisco NCS 2000 100-Gbps Multi-Rate Muxponder Line Card, placed in an adjacent slot and paired through the chassis backplane.

In addition to 100-Gbps signals, the Cisco NCS 200-Gbps Multi-Rate DWDM Line Card can transport 10- and 40-Gbps client signals through muxponder client cards placed in an adjacent slot and paired through the chassis backplane.

The 100-Gbps Multi-Rate Muxponder Line Card includes two SFP+ ports, two QSFP+ ports, and one CPAK port for aggregation of 10-, 40-, and 100-Gbps signals into a 100- or 200-Gbps DWDM trunk. Please refer to the Cisco NCS 2000 100-Gbps Multi-Rate Muxponder Line Card data sheet for additional information.

The Cisco ONS 15454 10-Port 10-Gbps Line Card can also be paired with the 200-Gbps Multi-Rate DWDM Line Card for aggregation of ten 10-Gbps clients. Please refer to the Cisco ONS 15454 10-Port 10 Gbps Line Card data sheet for more information.

Table 4 lists the allowable combinations of the two supported muxponder cards and the integrated CPAK client for 200-Gbps muxponding on the 200-Gbps Multi-Rate DWDM Line Card.

**Table 4.** 200-Gbps Muxponding Client Configurations

| Configuration | 10x10-Gbps Line Card | 100-Gbps Multirate Muxponder | Integrated CPAK Client |
|---|---|---|---|
| **Configuration 1** | 1 | 1 | 0 |
| **Configuration 2** | 0 | 2 | 0 |
| **Configuration 3** | 0 | 1 | 1 |

## Feature Licensing

The Cisco NCS 2000 200-Gbps Multi-Rate DWDM Line Card offers a feature licensing scheme, allowing users to purchase only the functions they require. The line card is available in two versions: an unlicensed version that includes all functions, and a licensed version that includes a subset of functions, and is upgradable with feature-specific licenses.

The licensed version of the card supports the following functions:

- G-FEC capability (standards-based G.975)
- Muxponder capability (must be paired with a client card)
- 100-Gbps wavelength support
- 50-GHz tunability

Additional functions are offered through feature licenses; for example:

- Cisco CPAK client license: Enables the Cisco CPAK client
- Flex-Spectrum license: Allows continuous tuning of the transmit laser at 0.1-GHz granularity
- 7-percent HD HG-FEC: High-gain HD-FEC compatible with previous versions of 100-Gbps line cards
- Soft-Decision FEC: Allows the use of soft-decision FEC at both 7 percent and 20 percent for 100-Gbps wavelengths
- 200-Gbps 16-QAM: Enables 200-Gbps wavelength with 16-QAM modulation, including SD-FEC for 200-Gbps mode
- 50-Gbps BPSK: Enables 50-Gbps wavelength with 16-QAM modulation, including SD-FEC for 50-Gbps mode

For convenience in ordering, a version of the card (part number NCS2K-100G-CK-LIC=) is available preloaded with licenses for the CPAK client, Flex Spectrum, HG-FEC, and SD-FEC.

## Feature Availability

Availability of features is dependent upon software release. Please refer to the Cisco NCS 2002 and NCS 2006 Line Card Configuration Guide for specific feature availability.

## Regulatory Compliance

Table 5 lists regulatory compliance information for the trunk card. Note that all compliance documentation may not be completed at the time of product release. Please check with your Cisco sales representative for countries other than Canada, the United States, and the European Union.

**Table 5.** Regulatory Compliance

| ANSI System | ETSI System |
|---|---|
| **Countries and Regions Supported** | |
| • Canada<br>• United States<br>• Korea<br>• Japan<br>• European Union | • European Union<br>• Africa<br>• CSI<br>• Australia<br>• New Zealand<br>• China<br>• Korea<br>• India<br>• Saudi Arabia<br>• South America |
| **EMC (Class A)** | |
| • ICES-003, 2004<br>• GR-1089-CORE Issue 4, NEBS EMC and Safety, June 2006<br>• FCC 47CFR15, 2007 | • ETSI EN 300 386 V1.4.1 (2008-04) Telecommunication network equipment EMC requirements (Note: EMC-1)<br>• CISPR22:2008 and EN55022:2006/A1:2007 Information Technology Equipment (Emissions) (EMC-2)<br>• CISPR24: 1997/ A1:2001/A2:2002 and EN55024:1998/A1:2001/A2:2003: Information Technology Equipment – Immunity characteristics - Limits and Methods of Measurement (test levels) |
| **Safety** | |
| • CSA C22.2 #60950-1 - Edition 7, March 2007<br>• UL 60950-1 - Edition 2, December 2011<br>• GR-1089-CORE Issue 6, NEBS EMC and Safety, May 2011 | • IEC 60950-1 Information technology equipment Safety Part 1: General requirements - Edition 2, 2005 + Amendment 1 2009<br>• EN 60950-1: Edition 2 (2006) Information technology equipment - Safety - Part 1: General requirements + A11:2009 + A1:2010 + A12:2011<br>• CE Safety Directive: 2006/95/EC |
| **Laser** | |
| • 21CFR1040 (2008/04) (Accession Letter and CDRH Report) Guidance for Industry and FDA Staff (Laser Notice No. 50) , June 2007 | • IEC 60825-1: 2007 Ed. 2.0 Safety of laser products Part 1: Equipment classification, requirements and users guide<br>• IEC60825-2 Ed.3.2 (2010) Safety of laser products Part 2: Safety of optical fibre communication systems |
| **Environmental** | |
| • GR-63-CORE Issue 4, Network Equipment Building Standards (NEBS) Physical Protection, April 2012 | • ETS 300-019-2-1 V2.1.2 (Storage, Class 1.1)<br>• ETS 300-019-2-2 V2.1.2 (1999-09): Transportation, Class 2.3<br>• ETS 300-019-2-3 V2.2.2 (2003-04):Operational, Class 3.1E |
| **Optical** | |
| • GR-253-CORE – Issue 04<br>• ITU-T G.691 | • ITU-T G.709<br>• ITU-T G.975 |
| **Quality** | |
| • TR-NWT-000332, Issue 4, Method 1 calculation for 20-year mean time between failure (MTBF) | |
| **Miscellaneous** | |
| • GR-1089-CORE Issue 6 May 2011, NEBS EMC and Safety<br>• GR-63-CORE Issue 4 April 2012, NEBS Physical Protection<br>• ATT-TP-76200: 2008<br>• ANSI T1.315-2001<br>• GR-499: 2004 Transport Systems Generic Requirements (TSGR): Common Requirements | |

## Other Specifications

Table 6 lists system requirements for the Cisco NCS 2000 200-Gbps Coherent DWDM Trunk Card. Table 7 provides the DWDM specifications, Table 8 details receive-side optical performances, Table 9 lists performance-monitoring parameters, Table 10 provides card specifications, Table 11 gives ordering information, and Table 12 lists the supported pluggables.

**Table 6.** System Requirements

| Component | Cisco NCS 2006 or ONS 15454 M6 | Cisco NCS 2002 or ONS 15454 M2 |
|---|---|---|
| **Processor** | 15454-M-TNCE, 15454-M-TSCE, 15454-M-TSC, 15454-M-TNC | 15454-M-TNCE, 15454-M-TSCE, 15454-M-TSC, 15454-M-TNC |
| **Shelf Assembly** | NCS2006-SA, 15454-M6-SA | NCS2002-SA, 15454-M2-SA |
| **Shelf Door** | NCS2006-DDR, 15454-M6-DDR | NCS2002-DDR, 15454-M2-DDR |
| **Fan Tray** | 15454-M6-FTA2, NCS2006-FTA | 15454-M2-FTA2, NCS2002-FTA |
| **Power Supply** | NCS2006-DC40, NCS2006-DC, NCS2006-DC20<br>NCS2006-AC, 15454-M6-AC2, 15454-M6-AC | NCS2002-DC, NCS2002-DC-E<br>15454-M2-DC, 15454-M2-DC–E |
| **System Software** | Release 10.3 or later | Release 10.3 or later |
| **Slot Compatibility** | 2 through 7 | 2 through 3 |

**Table 7.** DWDM Specifications

| Parameter | Value |
|---|---|
| **Baud rate** | 27.952 Gbaud ±20 ppm (FEC 7% OH)<br>31.241 Gbaud ±20 ppm (FEC 20% OH) |
| **Automatic laser shutdown and restart** | ITU-T G.664 (06/99) |
| **Nominal wavelengths ($\lambda_{Tnom}$)** | Fully tunable between 1528.77 and 1566.72 nm in 0.1-nm increments |
| **Connector type (TX/RX)** | LC, duplex (shuttered) |
| **Optical Transmitter** | |
| **Type** | CP-BPSK modulation format<br>CP-DQPSK modulation format<br>CP-16QAM modulation format |
| **Output power (PTmin)** | -10 to -1.5 dBm in 0.01dBm increments |
| **Required optical return loss, minimum (ORLmin)** | 22 dB |
| **Laser safety class** | 1 |
| **Optical Receiver** | |
| **Chromatic dispersion tolerance ($DLR_{max}$)** | +/- 94,000 ps/nm with CP-DQPSK<br>+/- 20,000 ps/nm with 16-QAM |
| **Overload** | 0 dBm |
| **Receiver reflectance (maximum)** | 30 dB |
| **Input wavelength bandwidth ($\lambda_{c\_rx}$)** | Between 1528.77 and 1566.72 nm |

**Table 8.** DWDM Receive-Side Optical Performances

| Modulation Type | FEC Type | Pre-FEC BER | Post-FEC BER | Input Power Sensitivity | CD Tolerance | DGD | OSNR (0.5 nm RBW) |
|---|---|---|---|---|---|---|---|
| **CP-DQPSK** | SD-FEC (20% overhead) | <4x10E (–2) | <10E (-15) | 0 to -16 dBm (-20 dBm with 0.2 dB OSNR penalty) | 0 ps/nm | - | 5.1 dB |
| | | | | | +/- 70,000 ps/nm | 180 ps | 6.6 dB |
| | | | | | +/- 94,000 ps/nm | 180 ps | 7.6 dB |
| | G-FEC (7% overhead) | <1.0x10E (-5) | <10E (-15) | 0 to -14 dBm (- 16 dBm with 0.4 dB OSNR penalty) (-20 dBm with 0.8 dB OSNR penalty) | 0 ps/nm | - | 13.5 dB |
| | | | | | +/- 20,000 ps/nm | 100 ps | 14.5 dB |
| **CP-16-QAM** | SD-FEC (20% overhead) | <2.4x10E (–2) | <10E (-15) | 0 to -14 dBm (-16 dBm with 0.5 dB OSNR penalty) (-20 dBm with 1.5 dB OSNR penalty) | 0 ps/nm | - | 14.3 dB 13.5 dB (Typical) |
| | | | | | +/- 20,000 ps/nm | 100 ps | 15.8 dB 15.0 dB (Typical) |

**Table 9.** Performance-Monitoring Parameters

| Area | Parameter Name | | Description |
|---|---|---|---|
| **OTN** | **OTUk SM** | **ODUk PM** | |
| | BBE-SM | BBE-PM | Number of background block errors |
| | BBER-SM | BBER-PM | Background block error ratio |
| | ES-SM | ES-PM | Number of errored seconds |
| | ESR-SM | ESR-PM | Errored seconds ratio |
| | SES-SM | SES-PM | Number of severely errored seconds |
| | SESR-SM | SESR-PM | Severely errored seconds ratio |
| | UAS-SM | UAS-PM | Number of unavailable seconds |
| | FC-SM | FC-PM | Number of failure counts |
| **FEC** | Bit errors | | Number of corrected bit errors |
| | Uncorrectable words | | Number of uncorrectable words |
| **Trunk optical performance monitoring** | OPT | | Transmitter optical power |
| | LBC | | Transmitter laser bias current |
| | OPR | | Receiver optical power |
| | RCD | | Residual chromatic dispersion |
| | PMD | | Mean polarization mode dispersion |
| | OSNR | | Optical signal-to-noise ratio, calculated with 0.5-nm RBW |
| | SOPMD | | Second Order PMD (SOPMD Estimation |
| | SOPCR | | Polarization Change Rate Estimation |
| | PDL | | Polarization Dependent Loss (PDL) Estimation |

**Table 10.** Card Specifications

| **Management** | | |
|---|---|---|
| **Card LEDs**<br>• Failure (FAIL)<br>• Active/standby (ACT/STBY)<br>• Signal fail (SF) | <br>Red<br>Green/yellow<br>Yellow | |
| **Client port LEDs (per port)**<br>• Active input signal | <br>Green | |
| **DWDM port LEDs**<br>• Active input signal<br>• Output wavelength | <br>Green<br>Green | |
| **Power (including pluggable, 25C, and -48V)** | **100G Mode** | **200G Mode** |
| • Typical<br>• Maximum | 127W<br>143W | 151W<br>163W |
| **Physical** | | |
| Dimensions | Occupies 1 slot | |
| Weight | 4 lb (1.8 kg) | |
| **Reliability and availability** | | |
| Mean time between failures (MTBF) | 116,052 hr | |
| **Latency (end to end, CPAK client port)** | | |
| • SD-FEC - 20%<br>• GFEC - 7% | 9 microseconds<br>4 microseconds | |
| Storage temperature | -40ºC to 70ºC (-40ºF to 158ºF) | |
| Operating temperature<br>• Normal<br>• Short-term[1] | <br>0ºC to 40°C (32°F to 104°F)<br>-5ºC to 55ºC (23ºF to 131ºF) | |
| Relative humidity<br>• Normal<br>• Short-term[1] | <br>5% to 85%, noncondensing<br>5% to 90% but not to exceed 0.024 kg water/kg of dry air | |

[1] Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in 1 year (a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period). The values shown are valid for M6 or M2 chassis.

**Table 11.** Ordering Information

| Part Number | Description |
|---|---|
| **NCS2K-200G-CK-C=** | 50G/100G/200G CPAK Multi Rate Line Card - SD FEC C Band |
| **NCS2K-200G-CK-LIC=** | CPAK MR Line Card - C-Band - Licensed |
| **NCS2K-100G-CK-LIC=** | 100G CPAK MR SD-FEC Line Card - C-Band - Licensed (includes Client, FS, HG FEC and SD FEC) |
| **L-NCS2K-CK-CL=** | SW license - CPAK Client |
| **L-NCS2K-FS=** | SW license - Flex-Spectrum on WDM Trunk port |
| **L-NCS2K-DQPSK-LH=** | SW license - HG-FEC on 100G CP-DQPSK WDM Trunk port |
| **L-NCS2K-SD-FEC=** | SW license - Soft-Decision FEC on WDM Trunk port |
| **L-NCS2K-SFEC-BPSK=** | SW license - SD-FEC & BPSK on 50G WDM Trunk port |
| **L-NCS2K-SFEC-16Q=** | SW license - SD-FEC & 16-QAM on 200G/250G WDM Trunk port |

**Table 12.** Supported Pluggables

| Part Number | Description |
|---|---|
| **ONS-CPAK-LR4=** | 100GE/OTU4 Multi-Rate CPAK Pluggable - LR4 |
| **ONS-CPAK-SR10=** | 100GE/OTU4 Multi-Rate CPAK Pluggable - SR10 |

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