

# A Switchable-Gain Optical Amplifier functioning in the flexible spectrum of C-Band for the Cisco NCS 2000 Platform

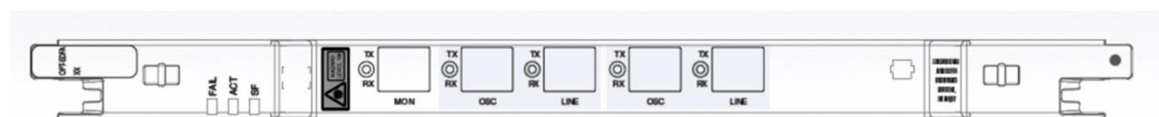
The Cisco® NCS 2000 platform provides a comprehensive, intelligent Dense Wavelength-Division Multiplexing (DWDM) solution for expanding metropolitan (metro), regional, and long-haul bandwidth. The platform supports a host of ROADMs, amplifiers, transponders and node software to manage all of them. This is the datasheet for the latest hardware to be added to the list: an all-new EDFA (Erbium Doped Fiber Amplifier) that is capable of functioning in dual gain ranges while also extending the supported gain to a maximum of 35dB.

## Product Overview

The Cisco NCS 2000 offers an enhanced optical amplifier card (Figure 1) operating in the C-band region of the optical spectrum to extend the reach and capacity of a metro, regional, or long-haul network. The optical amplifier cards are part of the Cisco NCS 2000 intelligent DWDM architecture engineered to reduce DWDM complexity and speed the deployment of next-generation networking solutions.

The Cisco NCS 2000 enhanced optical amplifier card is a plug-in module that takes advantage of the proven Cisco NCS 2000 carrier-class features. This card delivers the reach and optical performances to support a single DWDM channel all the way to 96 channels today, to meet the requirements of service provider and enterprise networks. The NCS 2000 platform is also a pioneer in the industry to support the cutting-edge technology of Flexible Spectrum on the C-Band. This new optical amplifier is able to function seamlessly in this fluid spectrum DWDM world. Table 1 outlines the C-band optical amplifier plug-in card types available for the Cisco NCS 2000 with the applications they are designed to support.

**Figure 1.** Cisco NCS 2000 Switchable gain Flex Spectrum Optical Amplifier (EDFA-35)



## Features and Benefits

The EDFA-35 takes advantage of the latest in amplifier technology, variable optical attenuators, photo diodes, and extensive software to facilitate a high degree of automation for simplified operations. The EDFA-35 features low-noise-gain blocks for C-band optical amplification requirements. The EDFA will be one of the earliest solutions in the market that offer the below features:

- 1) Dual gain blocks for either directions in the same module that still fits in a 1 RU space in the NCS 2000 chassis.
- 2) Dual gain ranges that allow noise figure of the amplifier to be more optimized to the range adopted by the user.
- 3) Support amplification of channels in a fluid (grid-less) Flex Spectrum world.
- 4) Support EDFA based amplification method up to 35dB of gain in the flex spectrum world, as an alternative option to Raman amplification methods.

Taking off from point 1 above, the amplifier can be used either as a pre-amplifier or as a booster amplifier or both (each block working as a booster or pre-amplifier) or a pair of booster or pre amplifiers. This functionality is consequent to the two individual gain blocks for either directions in the Hardware module. When used as a booster amplifier, the integrated OSC splitting and combining capability allows the TNC (Controller) unit to provide visibility and manageability of all the nodes of the network.

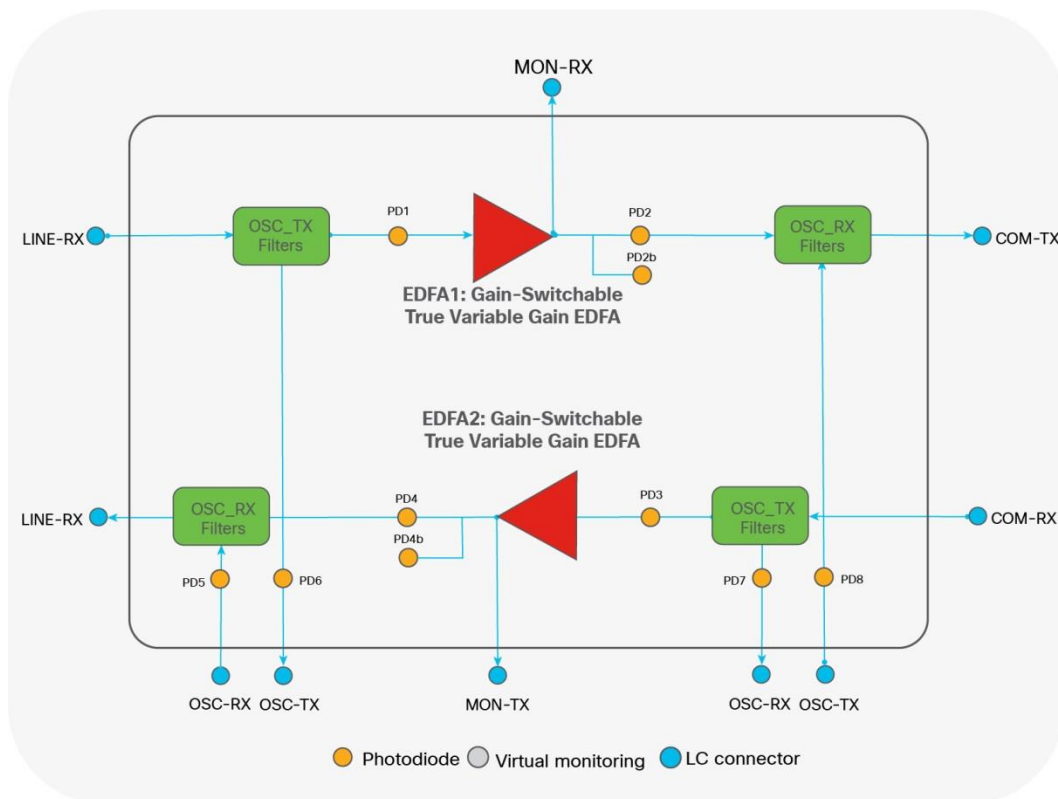
Taking off from point 2 above, the amplifier will be an industry pioneer to support 2 Software selectable gain ranges on the same Hardware module. It supports 2 gain ranges: 12-24dB and 20-35dB (with tilt control) and noise figure optimized to each of the specified gain ranges. In the real world, the fiber parameters could drastically change between the planning and installation phases of the network. Many organizations have faced the pain of having to run down truck rolls to change or add amplifiers. But the ability to obtain fiber data much in advance and more so the ability to guarantee that no change will occur to the same in the future, still remains a distant possibility, anyone would agree. This problem is completely alleviated by the EDFA-35 switchable gain amplifier. This unit supports 2 different gain ranges and thus can handle a wide range of fiber parameter changes that could be incurred. It is significant to note that there are amplifiers in the market that support ranges from say 5 to 35dB; but their noise figure is often traded off to support this wide gain range. But with the EDFA-35, the ability to switch to different gain ranges is the critical difference and that allows the optimization of the noise figure on either range: a unique capability.

Taking off from point 3 above, the amplifier is able to support amplification of signals in the all new fluid (grid-less) Flex Spectrum world. Nevertheless, it can also function just the same in the traditional "grided" DWDM world of fixed sized channels.

Taking off from point 4 above, the amplifier is able to support up to 35dB of maximum gain (with tilt control) in the second gain range. Forsaking the control over tilt on a rare occasion, one can function beyond this barrier as well. This is therefore a significant addition to the Cisco NCS 2000 portfolio that had Raman amplification solutions beyond 24dB in the Flex spectrum world. It is also worthwhile to note that the EDFA-35 can be a perfect alternative for customers that would prefer the same over Raman amplification methods for spans below but around 35dB. The Raman amplification method definitely has its own advantages and is still the recommended method to amplify when gain requirements are beyond 35dB.

The amplifier also provides a fast-transient suppression to respond quickly to network changes without adding impairments and degradation. It also allows a programmable tilt and possess a non-distorting low-frequency transfer function. Each card integrates software-controllable Variable Optical Attenuators (VOAs) along with extensive optical monitoring with photo diodes, to provide nodal- and network-based automatic power-level management. Extensive optical safety algorithms provide user safety when operating the network. The EDFA-35 also incorporate faceplate-mounted LEDs to provide a quick visual check of the operational status at the card. Printed on each of the faceplates is an icon, an orange circle, which corresponds to shelf-slot icons located on the shelf assembly; it indicates the shelf slot where the cards can be inserted. The card is supported by the integrated Cisco Transport Controller, a craft manager, which provides the user access for Operations, Administration, Maintenance, and Provisioning (OAM&P) for the system.

**Figure 2.** Depicts the Functional Block Diagram of the EDFA-35.



## Product Specifications

Table 1 gives regulatory compliance, Table 2 gives system requirements, Table 3 provides card specifications and tables 4, 5, 6 provide optical specifications for the Cisco NCS 2000 Switchable Gain Optical Amplifier.

**Table 1.** Regulatory Compliance<sup>1</sup>

NCS 2000 System	
<b>Supported Countries</b>	
<ul style="list-style-type: none"> <li>• Canada</li> <li>• United States</li> <li>• Korea</li> </ul>	<ul style="list-style-type: none"> <li>• Europe</li> <li>• Latin America</li> <li>• Japan</li> <li>• Asia Pacific</li> <li>• Middle East and Africa</li> </ul>
<b>EMC (Class A)</b>	
<ul style="list-style-type: none"> <li>• ICES-003 Issue 4 (2004)</li> <li>• GR-1089-CORE, Issue 4 (Type 2 and Type 4 equipment)</li> <li>• GR-1089-CORE – Issue 03 (Oct 2002) (Objective O3-2 – Section 3.2.1 – Radiated Emissions requirements with all doors open)</li> <li>• FCC 47CFR15, Class A subpart B (2006)</li> </ul>	<ul style="list-style-type: none"> <li>• EN 300 386 v1.3.3 (2005) and v1.4.1 (2007)</li> <li>• CISPR 22 – Fifth edition (2005-04) Class A and the amendment 1 (2005-07)</li> <li>• CISPR 24 – First edition (1997-09) and amendment 1 (2001-07) and amendment 2 (2002-10).</li> <li>• EN 55022:1998 Class A – CENELEC Amendment A2:2003</li> <li>• EN 55024:1998 – CENELEC Amendment A1:2001 and Amendment A2:2003</li> <li>• Resolution 237 (Brazil)</li> <li>• VCCI V-3/2006.04</li> <li>• EN 61000-6-1:2001</li> <li>• EN 61000-6-2:1999</li> </ul>
<b>Safety</b>	
<ul style="list-style-type: none"> <li>• UL/CSA 60950 -1 First Edition (2003)</li> <li>• GR-1089-CORE, Issue 4 (Type 2 and Type 4 equipment)</li> </ul>	<ul style="list-style-type: none"> <li>• UL/CSA 60950 -1 First Edition (2003)</li> <li>• IEC 60950 -1 (2001-01) First Edition/EN60950 -1 (2001), First Edition (with all country deviations)</li> <li>• Non TAA</li> </ul>
<b>Laser</b>	
<ul style="list-style-type: none"> <li>• UL/CSA 60950 -1 First Edition (2003)</li> <li>• IEC 60950 -1 (2001-01) First Edition/EN60950 -1 (2001), First Edition</li> <li>• IEC 60825-2 (2004-06) Third Edition</li> <li>• IEC 60825-1 +Am.1+ Am.2 (2001)</li> <li>• CDRH (Accession letter and report)</li> </ul>	
<b>Environmental</b>	
<ul style="list-style-type: none"> <li>• GR-63-CORE, Issue 2 and Issue 3</li> </ul>	<ul style="list-style-type: none"> <li>• ETS 300-019-2-1 V2.1.2 (Storage, Class 1.1)</li> <li>• ETS 300-019-2-2 V2.1.2 (Transportation, Class 2.3)</li> <li>• ETS 300-019-2-3 V2.1.2 (Operational, Class 3.1E)</li> <li>• EU WEEE regulation</li> <li>• EU RoHS regulation</li> </ul>
<b>Optical</b>	
<ul style="list-style-type: none"> <li>• EN or IEC-60825-2 Third edition (2004-06)</li> <li>• EN or IEC 60825-1 Consol. Ed. 1.2 – incl. am1+am2 (2001-08)</li> <li>• 21CFR1040 (2004/04) (Accession Letter and CDRH Report)</li> <li>• IEC-60825-2 Third edition (2004-06)</li> <li>• ITU-T G.664 (2006)</li> </ul>	

<sup>1</sup> All compliance testing and documentation may not be completed at release of the product. Check with your sales representative for countries outside of Canada, the United States, and the European Union.

NCS 2000 System	
<b>Quality</b>	
<ul style="list-style-type: none"> <li>• TR-NWT-000332, Issue 4, Method 1 calculation for 20-year Mean Time Between Failure (MTBF)</li> </ul>	
<b>Miscellaneous</b>	
<ul style="list-style-type: none"> <li>• Acoustic noise</li> <li>• GR-63-CORE, Issue 3 (2006)</li> <li>• ETS 300 753 ed.1 (1997-10)</li> <li>• Rain, sand, dust, and moisture proofing</li> <li>• AS 1939-1990, 4.2, IP 53</li> <li>• Mechanical shock and bumps</li> <li>• AS1099- 2.27</li> <li>• Customer-specific requirements</li> <li>• AT&amp;T Network Equipment Development Standards (NEDS) Generic Requirements, AT&amp;T 802-900-260</li> <li>• SBC TP76200MP</li> <li>• Verizon SIT.NEBS.NPI.2002.010</li> </ul>	

**Table 2.** System Requirements

Component	NCS 2000
<b>Processor</b>	TNCS-O, TNCS, TNC, TNC-E
<b>Cross-connect</b>	All (not required)
<b>Shelf assembly</b>	NCS2006, NCS2015, NCS2002 shelf assembly
<b>System software</b>	NCS 2000 Release 10.8 or later
<b>Slot compatibility</b>	Any slot on NCS2006, NCS2002 and NCS2015 chassis.

**Table 3.** Card Specifications

Specification	Value
<b>Management</b>	
<b>Card LEDs</b>	
<ul style="list-style-type: none"> <li>• Failure (FAIL)</li> <li>• Active/standby (ACT/STBY)</li> <li>• Signal Fail (SF)</li> </ul>	Red Green/yellow Yellow
<b>General Specifications</b>	
<b>Card power draw</b>	
<ul style="list-style-type: none"> <li>• Typical</li> <li>• Maximum</li> </ul>	55W 75W
<b>Weight (not including clam shell)</b>	< 2Kg
<b>Optical connectors</b>	LC
<b>Size</b>	1 slot
<b>Reliability</b>	
<b>Predicted MTBF</b>	300,000 hrs
<b>Operating Environment</b>	
<b>Temperature</b>	23 to 131°F (-5 to 55°C)
<b>Humidity</b>	5 to 95% noncondensing
<b>Storage Environment</b>	
<b>Temperature</b>	-40 to 158°F (-40 to 70°C)
<b>Humidity</b>	5 to 95% noncondensing
<b>Transportation Environment</b>	

Specification	Value
Temperature	-40 to 158°F (-40 to 70°C)
Humidity	5 to 95% noncondensing

**Table 4.** Optical Specifications – Gain Range 1

Specification	Value
Channel Gain Range	12 to 24 dB
Input power range	-32 to 11 dBm (full channel load) -21 to -9 dBm (single channel)
Channel signal-spontaneous noise figure (Maximum)	6 dB at gain = 24 dB 9.3 dB at gain = 12 dB

**Table 5.** Optical Specifications – Gain Range 2

Specification	Value
Channel Gain Range	20 to 35 dB
Input power range	-45 to 3 dBm (full channel load) -32 to -17 dBm (single channel)
Channel signal-spontaneous noise figure (Maximum)	5.8 dB at gain = 35 dB 7.5 dB at gain = 20 dB

**Table 6.** Common Optical Specifications – Gain ranges 1 and 2

Specification	Value
Channels allocation	1528.3 – 1567.3 nm
Channel output power range	-5 to 23 dBm
Maximum total output power	23 dBm
Input reflectance	40 dB
Output reflectance	40 dB
Pump leakage to input/output	-20 dBm
Gain ripple @ Target Gain and Tilt = 0 dB	+/- 0,6 dB
Gain set resolution	0.1 dB
Gain and Power regulation settling time	5ms (Minimum) 1S (Maximum)
Gain and Gain tilt short term stability	+/- 0.1 dB
Polarization Mode Dispersion (PMD)	0.5 ps
Polarization dependent gain	0.35 dB (Maximum)

## Ordering Information

Tables 7 gives ordering information for the Cisco NCS 2000 Enhanced C-Band Optical Amplifier card.

**Table 7.** Ordering Information

Part Number	Description
NCS2K-OPT-EDFA-35=	NCS2000 - Optical Amplifier, C Band, Switchable Gain

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