

Cisco Network Convergence System 1004 C-Band 1.2T Transponder Line Card

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Video traffic continues to grow rapidly. It would take more than 5 million years to watch the amount of video that will cross global IP networks each month in 2021. Every second, a million minutes of video content will cross the network. Content Delivery Networks (CDNs) will carry 71 percent of Internet traffic by 2021. Content providers will need to scale their networks at speed to keep up with the demand for more video. Networks needs to be designed with “web-scale” in mind. A web-scale network needs to scale at deployment speed while being operationally simple. Network Convergence System 1004 uses state of the art silicon along with complete automation and real-time visibility to deliver a universal transponder solution that provides best-in-class performance for metro, long-haul and submarine applications while being simple to deploy and manage.

Product features and benefits

NCS1004 1.2T transponder can provide up to 12 100Gbe/OTU4 client ports. The client ports map to two trunk ports operating any rate between 100G and 600G in 50G increments. The baud-rate, modulation format and FEC of each trunk port is software-configurable per slice, where each slice is a combination of a sequence of 6 client ports.

The trunk ports are capable of several line rates with fine control of modulation format, baud-rate and forward error correction allowing the solution to be used for metro, terrestrial long-haul or submarine applications:

- The baud-rate can be controlled between 28Gbd/s and 72Gbd/s.
- The modulation format can be controlled between BPSK, QPSK, 8-QAM, 16QAM, 32QAM and 64QAM.
- Hybrids between modulation formats can be configured to achieve 0.001 bits/symbol of granularity.
- Forward Error Correction (FEC) of 27% and 15% overhead.
- Trunk line rate from 50G to 600G in 100G increments.



Figure 1.
Cisco NCS 1004 1.2T C band line card

The Cisco NCS 1004 system provides the following hardware benefits:

- Transport of any trunk rate between 100 and 600-Gbps wavelengths on the same platform through software provisioning.
- Support of granular control of baud-rate and modulation format to maximize spectral efficiency.
- One universal transponder that is performance optimized for metro, long-haul and submarine applications.
- Support for up to 350,000 ps/nm of residual chromatic dispersion compensation.
- Transport of 100GE, OTU4 and 400GE on the same platform through software provisioning.
- 600G DWDM provides unparalleled scale and density. With 64 channels of 600G at 75Ghz, the NCS 1004 provides 38.4Tbps in 16RU.

- State of the art AES-256 Encryption at scale – 4.8Tbps of encrypted trunk capacity per 2RU.
- Non-Linear Compensation for maximum performance on compensated legacy subsea cables and for non-linear terrestrial fibers.
- SOP tracking speed of up to 10 million rad/s for aerial fiber applications.

Modulation schemes

The Cisco NCS 1004 1.2T transponder features a software configurable modulation scheme per slice, allowing the operator to customize the spectral efficiency and reach characteristics of individual wavelengths. Supported modulation formats are detailed in Table 1.

Table 1. Supported modulation formats

Capacity	Baud Rate	Modulation Scheme
100Gbps	24.02 to 69.4Gbaud in 0.3Gbd increments	1 to 2.890625 bits/symbol in 0.008 bits/symbol increments
150Gbps	24.02 to 71.6Gbaud in 0.3Gbd increments	1.453125 to 3.9375 bits/symbol in 0.008 bits/symbol increments
200Gbps	24.02 to 71.8Gbaud in 0.3Gbd increments	1.7578125 to 5.25 bits/symbol in 0.008 bits/symbol increments
250Gbps	26.27 to 72Gbaud in 0.3Gbd increments	2.4140625 to 6 bits/symbol in 0.008 bits/symbol increments
300Gbps	31.52 to 72Gbaud in 0.3Gbd increments	2.8984375 to 6 bits/symbol in 0.008 bits/symbol increments
350Gbps	36.78 to 72Gbaud in 0.3Gbd increments	3.0703125 to 6 bits/symbol in 0.008 bits/symbol increments
400Gbps	46.3 to 72Gbaud in 0.3Gbd increments	3.859375 to 6 bits/symbol in 0.008 bits/symbol increments
450Gbps	47.2 to 72Gbaud in 0.3Gbd increments	3.945 to 6 bits/symbol in 0.008 bits/symbol increments
500Gbps	52.5 to 71.8Gbaud in 0.3Gbd increments	4.3828125 to 6 bits/symbol in 0.008 bits/symbol increments
550Gbps	57.8 to 71.8Gbaud in 0.3Gbd increments	4.8203125 to 6 bits/symbol in 0.008 bits/symbol increments
600Gbps	71.8Gbaud	5.27 bits/symbol

Wavelength tunability

The line interface supports software-provision able tunability across the full C band, covering 96 channels across 191.25 to 196.10 THz (1528.77 to 1566.72 nm). Grid-less tuning support allows for continuous tunability in increments of 0.1 GHz and the ability to create multicarrier super-channels over flex spectrum line systems.

Protocol transparency

The Cisco NCS 1004 1.2T transponder can transparently deliver 100Gbe and OTU4 clients over 2x 100G-600G.

Fine Control of Coherent DWDM interface

The Cisco NCS 1004 1.2T transponder provides the ability to modify baud-rate and modulation format with fine control to meet capacity and reach requirements for a range of use-cases as shown in Figure 2.

- Use 69Gbaud/s line rates to maximize capacity at lowest price per bit for Metro and Long-Haul networks.
- Use real-time network bandwidth and performance data to maximize line rate capacity on coherent DWDM interface.
- Support line rates that can maximize capacity for bandwidth constrained 50Ghz and 100Ghz spaced legacy ROADMs networks.
- Maximize spectral efficiency on submarine cable line system for the target Q-margin.

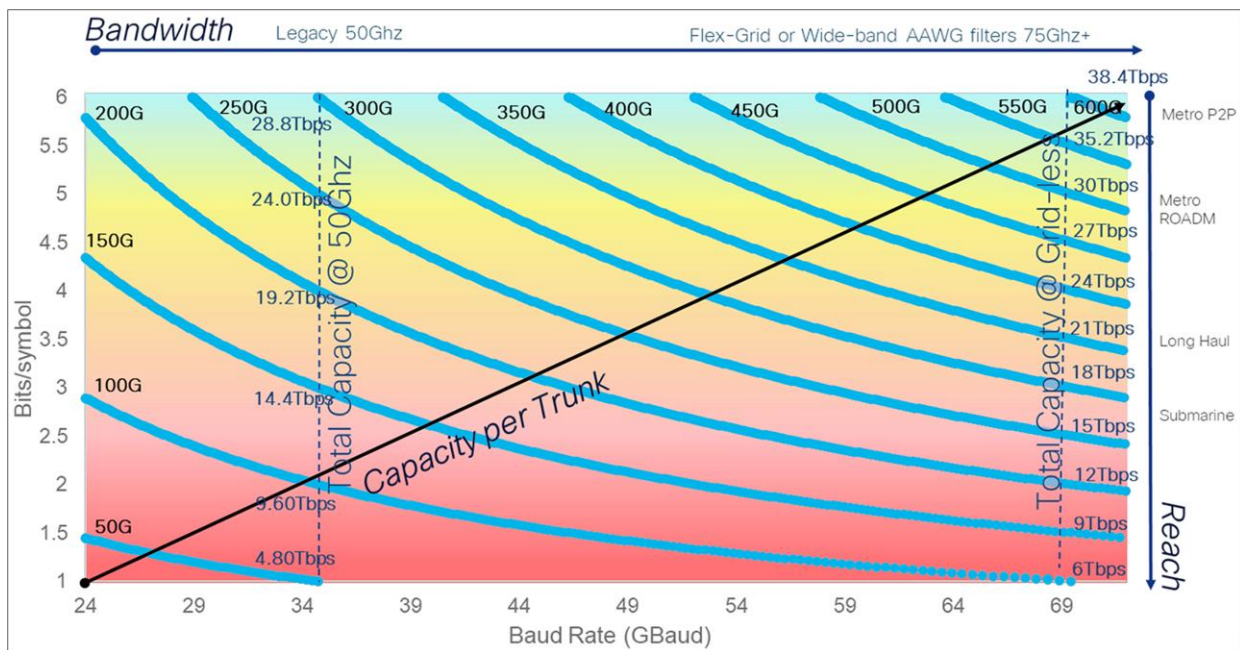


Figure 2.

Controlling baud-rate and bits/symbol for line rates from 50G to 600G to meet reach and capacity needs with NCS 1004 1.2Tbps line card

Encryption

With increasing asks for data privacy and data protection across the globe, encryption of any data that leaves the Data Center facility is becoming an important requirement for cloud operators. The NCS 1004 1.2T line card provides AES256 based OTN-Sec encryption for 100GE and OTU4. IKEv2 is used for authentication of the devices in an encryption session and the protocol provides pre-shared keys, certificates or 802.1X based authentication options. Elliptical Curve Diffie Hillman (ECDH) Key Exchange protocol runs over a GCC (Generic Communication Channel) between two NCS1004 1.2T line card nodes.

Management

The Cisco NCS 1004 1.2T line card supports all management feature as mentioned in the NCS 1004 system datasheet.

Performance monitoring

The Cisco NCS 1004 1.2T line card supports performance monitoring of optical parameters on the client and DWDM line interface including laser bias current, transmit and receive optical power. Ethernet RMON statistics for the client ports and OTN error counters for the trunk are also available. 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, pre-FEC Bit Error Rate and received Optical Signal-to-Noise Ratio (OSNR) are also included in the set of performance-monitoring parameters. These parameters can greatly simplify troubleshooting operations.

Table 2. Client and Trunk PM parameters

Port	PM Parameters
Client	<ul style="list-style-type: none">LBC, OPT, OPR, FREQ_OFF
Trunk	<ul style="list-style-type: none">LBC, OPT, OPR, CD, DGD, SOPMD, OSNR, PDL, PCR, RX_SIG, FREQ_OFF, PREFEC BER, POSTFEC BER, Q,Q_ Margin

The NCS 1004 1.2T line card provides a set of port and system LEDs for a quick visual check of the operational status. The various LEDs are described in detail in Table 8.

Licensed NCS 1004 1.2T Transponder

The licensed NCS 1004 1.2T line card provides pay as grow model with 4x 100G of unencrypted client capacity day-1 that the user can build on. User can purchase 100G incremental licenses to grow to 12x 100G capacity per card.

Pre- IOS X.R release 7.3.2 behavior:

Trunk port of licensed 1.2T line card supports 400G and above rates only i.e. 400-600G. Capacity of 4x 100GE/OTU4 unencrypted available to the user day-1 per line card. 100G incremental client licenses available to grow from 4x100G to full 12x 100G capacity for unencrypted cases and 0 to 12x100G capacity for encrypted cases.

IOS X.R release 732 and later:

Trunk port of licensed 1.2T licensed line card supports all line rates i.e. 100-600G. Capacity of 4x 100GE/OTU4 unencrypted available to the user day-1 per line card at 16QAM and higher modulation formats. 100G incremental client licenses available to grow from 4x100G to full 12x 100G capacity for unencrypted cases and 0 to 12x100G capacity for encrypted cases. Customer also needs to buy long haul and subsea licenses as required to enable corresponding modulation formats and special settings. The long-haul license is required to enable QPSK and 8QAM modes. The subsea license is available to enable BPSK and subsea specific controls (extended chromatic dispersion, special non-linear compensation settings etc.)

IOS X.R release 7.10.1 and later:

The licensed line card supports a generic licensing scheme from 7.10.1 XR SW release. The trunk port of licensed 1.2T licensed line card supports all line rates i.e. 100-600G. Capacity of 4x 100GE/OTU4 unencrypted available to the user day-1 per line card at 16QAM and higher modulation formats. 100G universal incremental client licenses S-NCS1K4-ULIC-100= are available to grow from 4x100G to full 12x 100G capacity for unencrypted cases and 0 to 12x100G capacity for encrypted cases using S-NCS1K4-LIC-100X=. Any existing user with licensed line card shall upgrade to 7.10.1 release using a zero dollar upgrade PID S-NCS1K4-UPG-100=. The universal client licenses are supported across 1.2T transponder, 1004 OTN transponder and 800G QSFP-DD transponder. Customer also needs to buy long haul and subsea licenses as required to enable corresponding modulation formats and special settings. The long-haul license is required to enable QPSK and 8QAM modes. The subsea license is available to enable BPSK and subsea specific controls (extended chromatic dispersion, special non-linear compensation settings etc.)

Feature summary

The following table summarizes the features of the NCS 1004.

Table 3. Feature summary

Feature	Description
Software Compatibility	<ul style="list-style-type: none">• IOS-XR 7.0.1 or later with NC1004 system
Port Density	<ul style="list-style-type: none">• 48 /QSFP28 client-side ports• 8 DWDM line/trunk ports
OTN feature summary	<ul style="list-style-type: none">• Alarm reporting for Loss Of Signal (LOS), Loss Of Frame (LOF), Loss Of Multi-frame (LOM), Alarm Indication Signal (AIS), Backward Defect Indicator (BDI)• OTUk, ODUk, OPUk Performance Monitoring• Threshold Crossing Alerts (TCAs)• Local (internal) and line (network) loopbacks• Trunk Trace Identifier, Generic Communication Channel• L1 AES-256 encryption
Optical Feature Summary	<ul style="list-style-type: none">• 50GHz and flex-grid (0.1GHz) tunable lasers• Nyquist shaping• Non-Linear Equalization• Electronically compensated CD and PMD• Performance Monitoring and Threshold Crossing Alerts (TCAs)• Tx and Rx power monitoring
Ethernet Feature Summary	<ul style="list-style-type: none">• Alarms and Performance Monitoring• Squelch and Local Fault Propagation• LLDP Snooping• Performance Monitoring and Threshold Crossing Alerts (TCAs)• Local (internal) and line (network) loopbacks

Feature	Description
Network Management	<ul style="list-style-type: none"> • iPXE and Zero Touch Provisioning (ZTP) • IOS XR CLI • SNMP • Streaming Telemetry including event driven telemetry • NETCONF, RESTCONF, gRPC with YANG data models
Physical Dimensions (NCS 1004)	<ul style="list-style-type: none"> • 1.59" tall x 7.55" wide x10.90" deep • Weight: 3.2Kg
Power	<ul style="list-style-type: none"> • Max:230W, Typ:215W (without client optics).

Regulatory compliance

Table 4 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 that are not listed below.

Table 4. Regulatory compliance

ANSI System	ETSI System
Countries and Regions Supported	
<ul style="list-style-type: none"> • Canada • United States • Korea • Japan • European Union 	<ul style="list-style-type: none"> • European Union • Africa • CSI • Australia • New Zealand • China • Korea • India • Saudi Arabia • South America
<ul style="list-style-type: none"> • EMC (Emissions) 	<ul style="list-style-type: none"> • FCC 47CFR15, Class A • AS/NZS CISPR 32, Class A • CISPR 32, Class A • CISPR 22, Class A • EN55032, Class A • ICES-003, Class A • VCCI, Class A • KN 32, Class A • KN61000-3-2 • KN61000-3-3 • CNS-13438, Class A

ANSI System	ETSI System
<ul style="list-style-type: none"> • EMC (Immunity) 	<ul style="list-style-type: none"> • IEC/EN61000-4-2 Electrostatic Discharge Immunity • IEC/EN61000-4-3 Radiated Immunity • IEC/EN61000-4-4 EFT-B Immunity • IEC/EN61000-4-5 Surge AC Port • IEC/EN61000-4-6 Immunity to Conducted Disturbances • IEC/EN61000-4-11 Voltage Dips, Short Interruptions, and Voltage Variations • KN 35
<ul style="list-style-type: none"> • EMC (ETSI/EN) 	<ul style="list-style-type: none"> • EN 300 386 Telecommunications Network Equipment (EMC) • EN55032 Electromagnetic Compatibility of Multimedia Equipment- Emission Requirements • EN55022 Information Technology Equipment (Emissions) • EN55035 Electromagnetic Compatibility of Multimedia Equipment- Immunity Requirements • EN55024 Information Technology Equipment (Immunity) • EN61000-6-1/EN61000-6-2 Generic Immunity Standard • EN61000-3-2 Power Line Harmonics • EN61000-3-3 Voltage Changes, Fluctuations, and Flicker
Safety	
<ul style="list-style-type: none"> • CSA C22.2 #60950-1 - Edition 7, March 2007 • UL 60950-1 - Edition 2, 2014 	<ul style="list-style-type: none"> • IEC 60950-1 Information technology equipment Safety Part 1: General requirements - Edition 2, 2005 + Amendment 1 2009 + Amendment 2 2013 • EN 60950-1: Edition 2 (2006) Information technology equipment - Safety - Part 1: General requirements + A11:2009 + A1:2010 + A12:2011 + A2:2013 • CE Low Voltage Directive (LVD): 2014/35/EC
Laser	
<ul style="list-style-type: none"> • 21CFR1040 (2008/04) (Accession Letter and CDRH Report) Guidance for Industry and FDA Staff (Laser Notice No. 56), May 2019 	<ul style="list-style-type: none"> • IEC 60825-1: 2014-05 Ed. 3.0 Safety of laser products Part 1: Equipment classification, requirements and users guide • IEC60825-2 Ed.3.2 (2010) Safety of laser products Part 2: Safety of optical fibre communication systems
Optical	
<ul style="list-style-type: none"> • ITU-T G.691 	<ul style="list-style-type: none"> • ITU-T G.975
Quality	
<ul style="list-style-type: none"> • TR-NWT-000332, Issue 4, Method 1 calculation for 20-year Mean Time Between Failure (MTBF) 	

Table 5 provides the DWDM specifications, Table 5 details receive-side optical performances, Table 6 lists performance-monitoring parameters, Table 7 provides card specifications, Table 8 gives ordering information.

Table 5. DWDM specifications

Parameter	Value
Baud rate	24 to 72Gbaud/s
Automatic laser shutdown and restart	ITU-T G.664 (06/99)
Nominal wavelengths (λ_{Tnom})	Fully tunable between 1528.77 and 1566.72 nm
Connector type (TX/RX)	LC, duplex (shuttered)
Optical Transmitter	
Type	PM-BPSK modulation format PM-QPSK modulation format PM-8QAM modulation format PM-16QAM modulation format PM-32QAM modulation format PM-64QAM modulation format Hybrids of adjacent modulation allowing 1 to 6 bits/symbol in 0.001 bits/symbol increments.
Output power	+3 to -10 dBm in 0.01 dBm increments
Required optical return loss, minimum (ORLmin)	24 dB
Laser safety class	1
Optical Receiver	
Frequency range	191.25 to 196.10 THz (1528.77 to 1566.72 nm)
Input Power Range (64QAM)	-8 to +5 dBm
Input Power Range (32QAM)	-15 to +5 dBm
Input Power Range (16QAM)	-17 to +5 dBm
Input Power Range (8QAM, QPSK)	-22 to +5 dBm
Power accuracy	+/- 1 dBm
Optical Return Loss	27 dB
PMD tolerance @ 69Gbaud/s	64ps max DGD
Chromatic Dispersion tolerance @	+/- 100,000 ps for QPSK/8QAM

Parameter	Value
0.5db penalty	+/-80,000 ps for 16QAM +/-15,000 ps for 32QAM +/-10,000 ps for 64QAM
Chromatic Dispersion tolerance @ 1db penalty	+/-350,000 ps for BPSK, QPSK, 1.5bits/sym, 2.5 bits/sym +/-280,000 ps for 8QAM +/-200,000 ps for 3.5 bits/sym +/-150,000 ps for 16QAM
State of Polarization change tolerance	100,000 rad/s for QPSK/8QAM 50,000 rad/s for 16QAM, 32QAM, 64QAM

Table 6. DWDM receive-side optical performances

Modulation Type	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	CD Tolerance	DGD	Required worst case OSNR (0.1 nm RBW)
PM-BPSK (100G)	SD-FEC (27% overhead)	<3.75x10E (-2)	<10E (-15)	0 to -16 dBm	0 ps/nm	–	10.5 dB
					+/- 100,000 ps/nm	64 ps	11 dB
					+/- 350,000 ps/nm	64 ps	11.7 dB
PM-QPSK (200G)	SD-FEC (27% overhead)	<3.75x10E (-2)	<10E (-15)	0 to -16 dBm	0 ps/nm	–	13.5 dB
					+/- 100,000 ps/nm	64 ps	14 dB
					+/- 350,000 ps/nm	64 ps	14.7 dB
PM-8QAM (300G)	SD-FEC (27% overhead)	<3.75x10E (-2)	<10E (-15)	0 to -13 dBm	0 ps/nm	–	17.5 dB
					+/- 100,000 ps/nm	64 ps	18 dB
					+/- 280,000 ps/nm	64 ps	18.7 dB
PM-16QAM (400G)	SD-FEC (27% overhead)	<3.75x10E (-2)	<10E (-15)	0 to -10 dBm	0 ps/nm	–	21 dB
					+/- 80,000 ps/nm	64 ps	21.5 dB
					+/- 150,000 ps/nm	64 ps	22.2 dB
PM-32QAM	SD-FEC	<3.75x10E (-2)	<10E (-15)	0 to -9 dBm	0 ps/nm	-	25.4 dB

Modulation Type	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	CD Tolerance	DGD	Required worst case OSNR (0.1 nm RBW)
(500G)	(27% overhead)				+/- 15,000 ps/nm	64 ps	26.4 dB
PM-64-QAM (600G)	SD-FEC (27% overhead)	<3.75x10E (-2)	<10E (-15)	0 to -6 dBm	0 ps/nm	-	30 dB
					+/- 10,000 ps/nm	64 ps	30.5 dB

Table 7. Trunk Performance-monitoring parameters

Area	Parameter Name	Description
OTUk Monitoring (Near-end, Far-end, OTUk-SM, ODUk-PM)	BBE	Number of background block errors
	BBER	Background block error ratio
	ES	Number of errored seconds
	ESR	Errored seconds ratio
	SES	Number of severely errored seconds
	SESR	Severely errored seconds ratio
	UAS	Number of unavailable seconds
	FC	Number of failure counts
FEC	Bit errors	Number of corrected bit errors
	Uncorrectable words	Number of uncorrectable words
	Q	Q-factor
	Q-Margin	Q-factor margin
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

Area	Parameter Name	Description
	PDL	Polarization Dependent Loss (PDL) Estimation

Table 8. NCS 1004 1.2T line card specifications

Management	
Attention LED	Blue
Client and DWDM port LEDs	
<ul style="list-style-type: none"> No alarms Minor alarms Critical and Major alarms 	Green Amber Red
Storage temperature	-40°C to 85°C (-40°F to 185°F)
Operating temperature	
<ul style="list-style-type: none"> Normal 	0°C to 40°C (32°F to 104°F)
Relative humidity	
<ul style="list-style-type: none"> Normal Short-term¹ 	5% to 85%, noncondensing 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).	

Table 9. Ordering information

Part Number	Description
NCS1K4-1.2T-K9=	NCS1K4 12x QSFP28 2 Trunk C-Band DWDM card
NCS1K4-1.2T-L-K9=	NCS1K4 12x QSFP28 2 Trunk C-Band DWDM card - Licensed
S-NCS1K4-LIC-100G=	NCS1K4 smart license - one QSFP28 client
E-NCS1K4-LIC-100G=	NCS1K4 electronic license - one QSFP28 client
S-NCS1K4-LIC-100X=	NCS1K4 smart license - one QSFP28 client with encryption
E-NCS1K4-LIC-100X=	NCS1K4 electronic license - one QSFP28 client with encryption
XR-NCS1K4-731K9	NCS 1004 IOS XR Software Release 7.3.1 RTU- USB key
SF-NCS1K4-R731K9	NCS 1K - R7.3.1 SW, NCS1004-No RTU
S-NCS1K4-LIC-LH=	NCS1K4 smart license - enables 2-4 bps
E-NCS1K4-LIC-LH=	NCS1K4 e-delivery - enables 2-4 bps

Part Number	Description
S-NCS1K4-LIC-SEA=	NCS1K4 smart license - enables 1-4 bps and subsea parameters
E-NCS1K4-LIC-SEA=	NCS1K4 e-delivery - enables 1-4 bps and subsea parameters
NCS1K4-1.2T-CW-K9=	NCS1K4 12x QSFP28 2 Trunk C-Band DWDM card
NCS1K4-1.2TLCW-K9=	NCS 1004 1.2T Licensed Line Card - C-band
S-NCS1K4-ULIC-100=	NCS 1004 Universal 100G Client Smart License
E-NCS1K4-ULIC-100=	NCS 1004 Universal 100G Client E-delivery License
S-NCS1K4-UPG-100=	NCS 1004 Universal 100G Client Upgrade Smart License

Warranty

The following are the warranty:

- Hardware warranty duration: 5 years.
- Software warranty duration: 1 year.
- Hardware replacement, repair, or refund procedure: Cisco or our service center will use commercially reasonable efforts to ship a replacement part for delivery within 15 working days after receipt of the defective product at Cisco's site. Actual delivery times of replacement products may vary depending on customer location.

Your formal warranty statement appears in the Cisco Information Packet that accompanies your Cisco product.

Product warranty terms and other information applicable to Cisco products are available at:

<https://www.cisco.com/go/warranty>.

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Document history

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