TQD029-TUNC-SO

QSFP-DD 400G Ultra Long Haul Coh Tunable Flexgrid CMIS5.3 LC

OVERVIEW

The TQD029-TUNC-SO is an QSFP-DD form-factor (type 2a) DWDM transceiver conforming to the OpenZR+ and OpenROADM MSA for 400Gbps Ethernet applications. The transceiver has the option to transport 400Gbps with a DP-QPSK modulated signal, resulting in a better OSNR performance compared to DP-16QAM modulated signals. The transceiver also has options to modulate the signal with a proprietary probabilistic constellation shaping (PCS).

While the 400G DP-QSPSK signal results in a better optical performance it also increases the optical bandwidth (FWHM) to 113GHz making it compatible with 150GHz spaced filters.

The OpenZR+ MSA provides a flexible solution for operators having routers that not yet have migrated to 400G services. The TQD029-TUNC-SO can as an example be used in the Smartoptics DCP-404 Muxponder to combine up to 4x100G/2x200G/1x400G flows to a 400G OpenZR+ signal to be transported over an optical network.

The below table lists the Host and NTWK modes supported by TQD029-TUNC-SO.

Host framing	Network Frame	Payload	Modulation	Line Symbol Baud Rate	Channel spacing	Media code[1)]	MSA format	NTWK Mode description
1x 400GAUI-8 2x 200GAUI-4 4x 100GAUI-2	FlexO-4(e)	400G	DP-QPSK	118.2GBd	150GHz	0x64	FLEXO-4e-DO-QPSK	OpenROADM 400G QPSK
1x 400GAUI-8 2x 200GAUI-4 4x 100GAUI-2	FlexO-4(e)	400G	PCS-66	65.7GBd	75GHz	0xC0	FlexO-4e-MPCS066-OS [2)]	400G PCS-66
1x 400GAUI-8 2x 200GAUI-4 4x 100GAUI-2	FlexO-4(e)	400G	PCS-75	75.0GBd	87.5GHz	0xC2	FlexO-4e-MPCS075-OS [2)]	400G PCS-75
1x 400GAUI-8 2x 200GAUI-4 4x 100GAUI-2	FlexO-4(e)	400G	PCS-87	87.4GBd	100GHz	0xC9	FlexO-4e-MPCS087-OS [2)]	400G PCS-87
1x 400GAUI-8 2x 200GAUI-4 4x 100GAUI-2	FlexO-4(e)	400G	PCS-98	97.9GBd	112.5GHz	0xD8	FlexO-4e-MPCS098-OS [2)]	400G PCS-98
4xFOIC1.2	FlexO-4	400G	PCS-101	100.8GBd	125GHz	0xDC	FlexO-4-MPCS101-OS [2)]	400G PCS-101 (OTN)
4xFOIC1.2	FlexO-4	400G	PCS-79	78.9GBd	87.5GHz	0xC4	FlexO-4-MPCS079-OS [2)]	400G PCS-79 (OTN)
4xFOIC1.2	FlexO-4	400G	PCS-69	69.1GBd	75GHz	0xC1	FlexO-4-MPCS069-OS [2)]	400G PCS-69 (OTN)
4xFOIC1.2	FlexO-4	400G	PCS-87	87.3GBd	100GHz	0xCA	FlexO-4-MPCS087-OS [2)]	400G PCS-87 (OTN)
1x 400GAUI-8 2x 200GAUI-4 4x 100GAUI-2	OpenZR400	400G	DP-16QAM	60.1GBd	75GHz	0xC6	OpenZR+, MSA, Enhanced	OpenZR+ 400G 16QAM (Enhanced mode)
1x 400GAUI-8 2x 200GAUI-4 4x 100GAUI-2	OpenZR400	400G	DP-16QAM	60.1GBd	75GHz	0x46	ZR400-OFEC-16QAM	OpenZR+ 400G 16QAM
1x 400GAUI-8 2x 200GAUI-4 4x 100GAUI-2	OpenZR400	400G	DP-16QAM	60.1GBd	75GHz	0x36	ZR400-OFEC-16QAM-HB	OpenZR+ 400G 16QAM-HB

1) The media code is defined through the reference code tables listed in SFF-8024.
2) Non-MSA compliant code.

TQD029-TUNC-SO will automatically configure the above via the Host and NTWK modes. For 400G applications, the TQD029-TUNC-SO asynchronously (GMP) maps an Ethernet signal from a switch/router to an intermediate 400ZR/FlexO frame structure, then adapts the frame structure to the selected FEC engine. The encoded signal is subsequently DSP framed and modulated for transmission as a coherent Dual Polarity signal.

TECHNICAL DATA

The optical characteristics are into Generic and Application code sections. The *Generic* section defines the common characteristics, independent of the selected application modes. The *NTWK/Media* code section defines application code based optical characteristics.
The performance is compliant with the respective specifications but can exceed the minimum requirements on some parameters.

GENERIC

Parameter	Value
Technology	DWDM QSFP-DD type 2a
Transmission media	SM (2x LC)
Nominal wavelengths	191.25 - 196.1THz (tunable) 6.25GHz Grid
Interface standards	400G OpenZR+/OpenROADM
Operating temperature	+15^{O}C to +75^{O}C [1)]
Storage temperature	-40^{O}C to +85^{O}C
DDM functions	Total received power
	Coherent channel power
	OSNR, eSNR, PDL, dispersion, DGD
	Case temperature

Parameter	Value
MSA	QSFP-DD MSA's, CMIS5.3
Misc	Sync-E support, LLDP, RMON
Power consumption, EOL	See Section below.
Tx Power	Min 1dBm [2)]
Tx In-band OSNR	37dB
Tx Out-Of-Band OSNR	TBD
Receiver turn-up	Max 30ms from warm start
	Max 125s from cold start
Absolute max conditions	Rx signal input power: +1dBm
	Rx total input power: 15dBm

[1)] The module will turn up from cold start at ambient temperature as low as -5C and will reach specifications after self-heating up to min temperature.

[2)] The module transmit power can be provisioned up to the maximum available TX power. If the TX power is not provisioned by the host, the module TX power will default to the maximum available power. The provisional Tx power range of the module is 10dB.

Safety/regulatory compliance:
TUV/UL/FDA (contact Smartoptics for latest certification information)
RoHS compliance

OPTICAL SPECIFICATION – NTWK/MEDIA CODES

The table below lists the primary optical parameters for each supported application code.

Media code	Line rate	Network frame	Modulation	Tx Power[1])	Rx sens @ OSNR > 36dB	Rx @ OSNR [2)]	Rx OSNR @~1dB penalty [2)]	Default CDC range [ps/nm]	Maximum CDC search range
0x64	400G	FlexO-4(e)	DP-QPSK	1dBm	-27.0dBm	17.9dB@ -12dBm	18.7dB@ -22dBm	58 000	58 000
0xC0	400G	FlexO-4(e)	PCS-66	1dBm	-24.5dBm	21.2dB@ -12dBm	22.0dB@ -20dBm	42 000	150 000
0xC2	400G	FlexO-4(e)	PCS-75	1dBm	-25.5dBm	20.6dB@ -12dBm	21.4dB@ -20dBm	37 000	125 000
0xC9	400G	FlexO-4(e)	PCS-87	1dBm	-25.5dBm	19.5dB@ -12dBm	20.3dB@ -21dBm	52 000	100 000
0xD8	400G	FlexO-4(e)	PCS-98	1dBm	-26.0dBm	19.2dB@ -12dBm	20.0dB@ -21dBm	35 000	70 000
0xDC	400G	FlexO-4	PCS-101	1dBm	-26.0dBm	19.7dB@ -14dBm	20.4dB@ -21dBm	34 000	68 000
0xC4	400G	FlexO-4	PCS-79	1dBm	-25.0dBm	20.5dB@ -14dBm	21.2dB@ -20dBm	58 000	100 000
0xC1	400G	FlexO-4	PCS-69	1dBm	-24.0dBm	21.5dB@ -14dBm	22.2dB@ -20dBm	80 000	150 000
0xCA	400G	FlexO-4	PCS-87	1dBm	-25.5dBm	20.1dB@ -14dBm	20.8dB@ -20dBm	52 000	100 000
0xC6	400G	OpenZR400	DP-16QAM	1dBm	-22.5dBm	22.9dB@ -12dBm	23.6dB@ -18dBm	23 000	175 000
0x46	400G	OpenZR400	DP-16QAM	1dBm	-22.5dBm	23.1dB@ -12dBm	23.8dB@ -18dBm	23 000	175 000
0x36	400G	OpenZR400	DP-16QAM	1dBm	-22.5dBm	23.1dB@ -12dBm	23.8dB@ -18dBm	23 000	175 000

1) Minimum Tx power without attenuation. The module Tx power can be attenuated with 10dB from the maximum available Tx power. If the Tx power is not provisioned by the host, the module Tx power will default to the maximum available power.
2) Specified as [Min OSNR Value @ Min Rx power for the OSNR value].
3) maximum provisionable CD search range. Increasing the search range will increase the power consumption of the transceiver.

ELECTICAL CHARACTERISTICS

The table below lists the worst case power consumption for each media code. The power consumption will also increase based on the host interface

Media code	Line rate	Network frame	Modulation	Worst case power consumption	If non-Muxponder mode[1)]	Additional Max CD range[2)]
0x64	400G	FlexO-4(e)	DP-QPSK	24.0W	TBD	TBD
0xC0	400G	FlexO-4(e)	PCS-66	23.5W	TBD	TBD
0xC2	400G	FlexO-4(e)	PCS-75	24.0W	TBD	TBD
0xC9	400G	FlexO-4(e)	PCS-87	24.0W	TBD	TBD
0xD8	400G	FlexO-4(e)	PCS-98	25.0W	TBD	TBD
0xDC	400G	FlexO-4	PCS-101	24.5W	TBD	TBD
0xC4	400G	FlexO-4	PCS-79	24.0W	TBD	TBD
0xC1	400G	FlexO-4	PCS-69	23.5W	TBD	TBD
0xCA	400G	FlexO-4	PCS-87	24.5W	TBD	TBD
0xC6	400G	OpenZR400	DP-16QAM	22.5W	TBD	TBD
0x46	400G	OpenZR400	DP-16QAM	22.5W	TBD	TBD
0x36	400G	OpenZR400	DP-16QAM	22.5W	TBD	TBD

1) The power consumption figures are listed with the transceiver multiplexing the host streams. If the transceiver is running a 400GBASE-R stream, the transceiver shall remove the power consumption according to the numbers listed in the table..
2) The power consumption figures are listed with the default chromatic dispersion compensation range. For maximum dispersion compensation, the transceiver shall add the power consumption figures according to the numbers listed in the table.

ORDERING INFORMATION

Ordering code	Item Name
TQD029-TUNC-SO	QSFP-DD 400G ULH Coh-T SM C5.3

GENERAL DEFINITIONS

Parameter	Description
Technology	Grey; Transceiver type for non-WDM applications. Electrical or optical. CWDM; Transceiver type for CWDM applications using G.694.2 channel grid. DWDM; Transceiver type for DWDM applications using G.694.1 channel grid. BiDi; Transceiver pair using two different wavelength channels operating on a single-fiber.
Transmission Media	Type of fiber, e.g. Multimode (MM) or Singlemode (SM). Number of and connector type within brackets (e.g. 2x LC, 1x MPO).
Typical reach	Nominal distance performance based on typical fiber dispersion, fiber loss and power budget properties, i.e. w/o dispersion compensation and optical amplification. Actual distance is dependent on actual optical path loss and dispersion properties.
Bit rate range	Supported bit rate range in Gigabit or Megabit per second (Gbps or Mbps).
Protocols	Protocols within supported bit rate range.
Nominal wavelength	Typical wavelength(s) from transmitter.
Interface standards	Referenced interface standards or MSA's, e.g. IEEE 802.3 standard for 10GbE services or 100G 4WDM-10 etc.
Power budget	Min and max power budget between Transmitter and Receiver w/o optical path penalties.
Dispersion tolerance/penalty	Maximum amount of tolerated dispersion and required reduction of power budget to maintain stipulated Bit Error Rate (BER) and at a given bit rate.
Temperature range	Max operating case temperature range. Standard temperature range (C-temp): 0°C to +70°C (32°F to +158°F) Extended temperature range (E-temp): typically -20°C to +75°C (-4°F to +167°F) Industrial temperature range (I-temp): -40°C to +85°C (-40°F to +185°F)
Power consumption	Worst case power consumption. Will vary over temperature.
Transmitter Output power	Average output power. Provided in min and max values.
Receiver minimum input power	Minimum average input power at specified BER, normally $1E^{-12}$. Note that some protocols require FEC to achieve sufficient BER.
Receiver max input power	Maximum average input power giving a BER, normally $1E^{-12}$.
DDM	Digital Diagnostic Monitoring functionality as defined in e.g. SFF-8472 MSA.