SPEC SHEET

BA-4000 Bit Analyzer

800G BIT ERROR RATE (BER) TESTER

- Electrical BER tester supporting NRZ and PAM4 coding, with advanced FEC tools and with testing capabilities up to 800G.

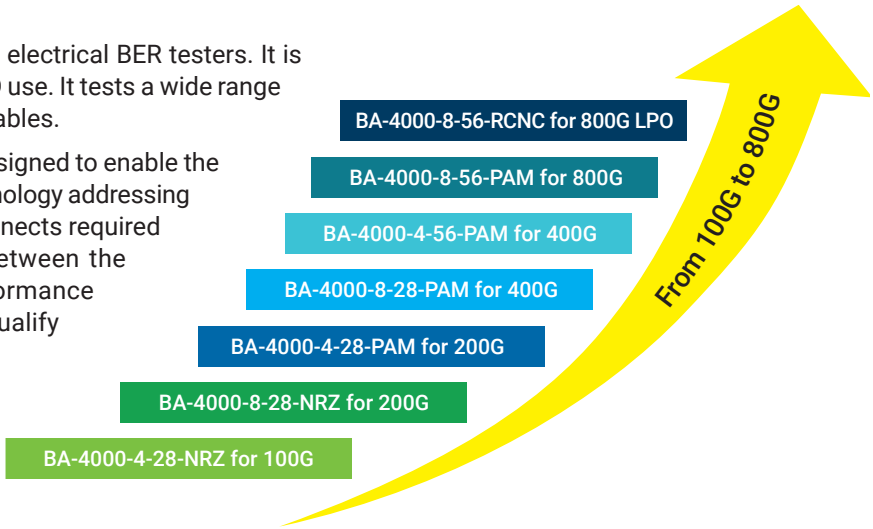
KEY FEATURES

- Supports NRZ and PAM4
- Supports PRBS 7/9/11/13/15/23/31/13Q/31Q, SSPRQ
- Advanced FEC tools
- Supports RS-FEC Scrambled Idle Pattern
- Channel simulator
- Burst/random error injection
- O-SMPM connection
- Channel histogram
- Channel mapping
- Powerful and user-friendly GUI
- Automation: API support
- LPO testing supported by RCNC model

BA-4000 READY FOR 800G TESTING

The BA-4000 is a world-class series of 100G/800G electrical BER testers. It is designed for production line quality control and R&D use. It tests a wide range of devices from components to transceivers and cables.

The BA-4000-RCNC model has been specifically designed to enable the testing of linear-drive pluggable optics (LPO), a technology addressing the need of high bandwidth and low power interconnects required by AI/ML applications. The strong correlation between the BA-4000-RCNC test results and real-switch performance reduces uncertainty, allowing manufacturers to qualify transceivers with confidence and efficiency.



POWERFUL AND SIMPLIFIED USER INTERFACE

The BA-4000 graphical user interface (GUI) provides simplified and real-time test results per channel. It requires an external Windows-based PC with Ethernet capability to run the GUI and API.

FEC SIMULATION

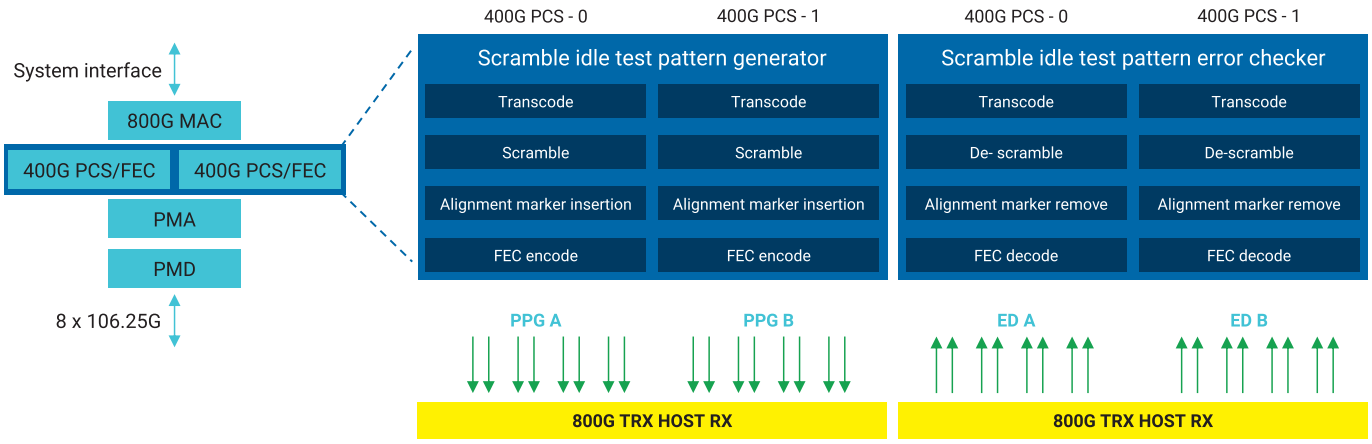
The BER tester includes FEC simulation capabilities. This provides powerful burst error analysis.

Main features include:

- PRBS error check and correction
- Pre-FEC and Post-FEC BER
- KP4/KR4 and low latency FEC protocols
- FEC lane striping function
- FEC symbol error distribution plot: codewords vs symbol errors
- FEC margin auto-calculation

FEC encoded scrambled idle

With the FEC Generator and Checker (FGC) option, the BA-4000 addresses RS-FEC scrambled idle pattern for testing 53 GBd host side interfaces as part of the development of new-generation 800G optics, including optical transceivers, DAC, etc.



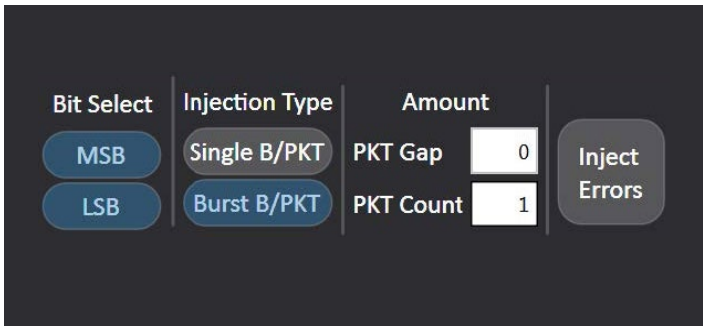
800G function flow structure

FGC option
BA-4000-FGC4/8

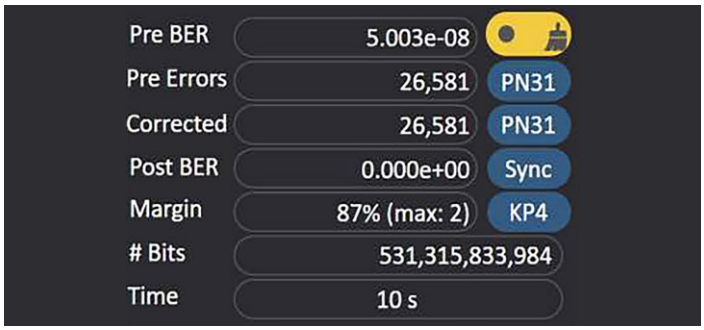
- Codeword error ratio
- Corrected codeword
- Uncorrected codeword
- FLR-64oct
- FEC margin
- Total codewords

FEC encoded scramble idle metrics in the GUI

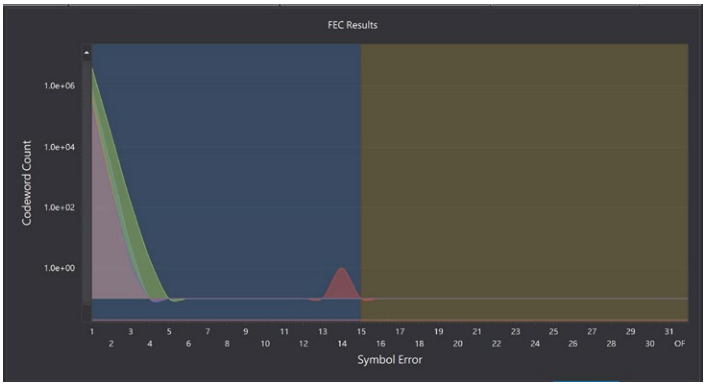
WITH PAM4 CODING, A SIMPLE BER TEST IS NOT ENOUGH



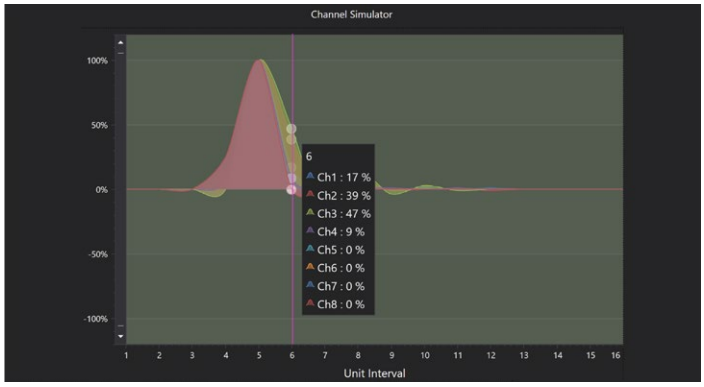
Burst and random error injection



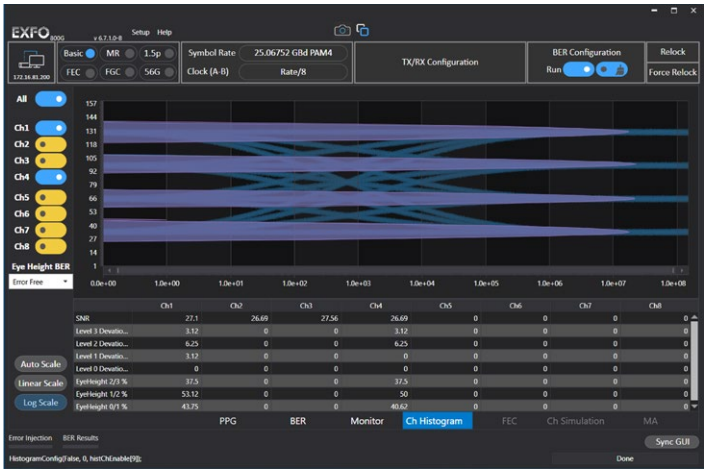
FEC symbol error margin



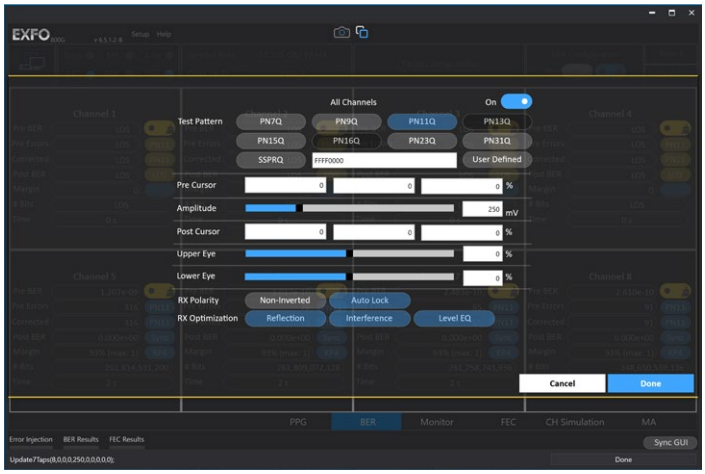
FEC symbol error distribution plot



Channel response simulation



Channel histogram



7-tap mode

All specifications are typical, at 23 °C ± 2 °C unless otherwise specified.

SPECIFICATIONS

BA-4000	x-28-NRZ	x-28-PAM x-28-PAM-FECx	x-56-PAM-FECx x-56-PAM-FGCx-FECx	x-56-HP-FECx x-56-HP-FGCx-FECx	x-56-RCNC-FECx
Number of channels	4 (x = 4) or 8 (x = 8)	4 (x = 4) or 8 (x = 8)	4 (x = 4) or 8 (x = 8)	4 (x = 4) or 8 (x = 8)	8 (x = 8)
Modulation	NRZ only	NRZ/PAM4	NRZ/PAM4	NRZ/PAM4	PAM4 only
Data rate per lane (GBd) [a, k]	8.5, 9.95328, 10, 10.3125, 10.709, 11.3176, 12, 12.5, 14.025, 21.0, 24.33024, 24.8832, 25, 25.06752, 25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9	24.8832, 25, 25.06752, 25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 29.0625	24.8832, 25, 25.06752, 25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 29.0625, 49.765, 49.7664, 50, 50.13504, 51.5625, 53.125, 55.9, 55.90747, 56.125, 56.25, 57.8, 58.125, 59.375	24.8832, 25, 25.06752, 25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 29.0625, 49.765, 49.7664, 50, 50.13504, 51.5625, 53.125, 55.9, 55.90747, 56.125, 56.25, 57.8, 58.125, 59.375	n/a
Data rate per lane (GBd) [k] under FEC mode	n/a	24.8832, 25.0, 25.06752, 25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 29.0625	24.8832, 25, 25.06752, 25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 29.0625, 49.765, 49.7664, 50, 50.13504, 51.5625, 53.125, 55.9, 55.90747, 56.125, 56.25, 57.8, 58.125, 59.375	24.8832, 25, 25.06752, 25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 29.0625, 49.765, 49.7664, 50, 50.13504, 51.5625, 53.125, 55.9, 55.90747, 56.125, 56.25, 57.8, 58.125, 59.375	26.5625, 53.125
Data rate per lane (GBd) under FGC mode	n/a	n/a	25.78125, 26.5625 (support NRZ and PAM4), 51.5625, 53.125 (support PAM4)	25.78125, 26.5625 (support NRZ and PAM4), 51.5625, 53.125 (support PAM4)	n/a
Data rate adjustment (ppm)	0 to ±300	0 to ±300	0 to ±1000	0 to ±1000	n/a
Pattern supported by PPG and ED	PRBS 7/9/15/23/31 and user-defined pattern	PRBS 7/9/11/13/15/23/31 PRBS 7Q/9Q/11Q/13Q/15Q/23Q/31Q Only PPG supports PRBS16Q, SSPRQ, user-defined pattern	PRBS 7/9/11/13/15/23/31 PRBS 7Q/9Q/11Q/13Q/15Q/23Q/31Q Only PPG supports PRBS16Q, SSPRQ, user-defined pattern	PRBS 7/9/11/13/15/23/31 PRBS 7Q/9Q/11Q/13Q/15Q/23Q/31Q Only PPG supports PRBS16Q, SSPRQ, user-defined pattern	n/a
Pattern supported by PPG and ED under FEC mode	n/a	PRBS 7/9/11/15/23/31 PRBS 7Q/9Q/11Q/15Q/23Q/31Q [l]	PRBS 7/9/11/15/23/31 PRBS 7Q/9Q/11Q/15Q/23Q/31Q [l]	PRBS 7/9/11/15/23/31 PRBS 7Q/9Q/11Q/15Q/23Q/31Q [l]	Tx: PRBS 13Q/15Q/31Q, SSPRQ, user-defined pattern Rx: PRBS 15Q/31Q [l]
Maximum amplitude (mV_{ppd})	800 [b, c]	800 [c, e, j]	800 [f, j]	800 [f, j]	800 [f, j]
Rise/fall time (20% to 80%) (ps)	16.5/16.5 [c]	11/11 [c]	10/10 [e] (53.125G) 10/10 [c] (25.78125G)	10/10 [e] (53.125G) 10/10 [c] (25.78125G)	n/a
PAM4 eye width (zero hit) (ps)	n/a	23 [d]	5.5 [f] (53.125G) 23 [d] (26.5625G)	5.5 [f] (53.125G) 23 [d] (26.5625G)	6 [g] (53.125G) 23 [d] (26.5625G)
Jitter RMS (fs)	750 [c]	450 [c]	500 [e] (53.125G) 450 [c] (25.78125G)	500 [e] (53.125G) 450 [c] (25.78125G)	n/a
Sensitivity (mV_{ppd}) [h]	100 (NRZ 25.78125G)	200 (PAM4 26.5625G)	250 [i] (PAM4 53.125G)	200 [i, m] (PAM4 53.125G)	150 [i] (PAM4 53.125G)
CTLE (dB)	0 to 7	0 to 8	n/a	n/a	Auto-adaptive
ED damage level (mV_{ppd})	1200	1200	1200	1200	900
Clock ratio (clock frequency / symbol rate)	/8, /16	/2, /4, /8, /16, /32, /64	/2, /4, /8, /16, /32, /64	/2, /4, /8, /16, /32, /64	/8, /16, /32, /64
Connector type	O-SMPM connector (up to 67 GHz bandwidth)				
BER monitor	Supported	Supported	Supported	Supported	Supported
FEC plot	n/a	Support (FEC option required)	Supported	Supported	Supported
Channel histogram	n/a	Supported	Supported	Supported	Supported
Channel simulation	n/a	Support (FEC option required)	Supported	Supported	Supported
Error injection	Supported	Supported	Supported	Supported	n/a

a. Fixed rate.

b. Amplitude step is 200 mV_{ppd}

c. NRZ 25.78125 GBd signal measured by 50 GHz bandwidth scope with 40 GHz 2.92 mm, 15 cm RF cable.

d. PAM4 26.5625 GBd signal measured by 50 GHz bandwidth scope with 40 GHz 2.92 mm, 15 cm RF cable.

e. NRZ 53.125 GBd signal measured by 50 GHz bandwidth scope with 50 GHz 2.4 mm, 15 cm RF cable. Post-cursor is −2%.

f. PAM4 53.125 GBd signal measured by 50 GHz bandwidth scope with 50 GHz 2.4 mm, 15 cm RF cable. Post-cursor is −2%.

g. PAM4 53.125 GBd signal measured by 50 GHz bandwidth scope with 50 GHz 2.4 mm, 15 cm RF cable. Post-cursor is 0%.

h. Measured by direct loopback from PPG to ED with 40 GHz O-SMPM, 20 cm RF cable.

i. BER ≤ 10^{-10}

j. Support overdrive 900 mV_{ppd}

k. Use GUI version 6.17 or newer.

l. Under FEC mode, no support of PRBS13Q, PRBS16Q, SSPRQ, and user-defined pattern at ED.

m. Receiving range is up to 500 mV_{ppd} and BER ≤ 10^{-10}

GENERAL SPECIFICATIONS		
Size (H x W x D)		103 mm x 442 mm x 300 mm (4.1 in x 17.4 in x 11.8 in)
Weight		≤ 10 kg (22 lb)
Temperature	Operating Storage	5 °C to 40 °C (41 °F to 104 °F) −20 °C to 70 °C (−4 °F to 158 °F)
Relative humidity		20% to 80%
Power		100 Vac to 240 Vac (47 Hz to 63 Hz) 60 W typical / 80 W max.

COMPARISON TABLE

	BA-4000-8-56-PAM-FEC8	BA-4000-8-56-RCNC-FEC8
Description	8×56 GBd NRZ/PAM4 BERT, FEC simulator included BA-4000-8-56-PAM-FEC8	8×53 GBd PAM4 BERT (reflection cancellation, noise cancellation), FEC simulator included
Applications	DSP-based transceivers and cables	LPO and DSP-based transceivers
Modulation	NRZ/PAM4	PAM4 only
Data rate per lane (GBd) under FEC mode	24.8832, 25, 25.06752, 25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 29.0625, 49.765, 49.7664, 50, 50.13504, 51.5625, 53.125, 55.9, 55.90747, 56.125, 56.25, 57.8, 58.125, 59.375	26.5625, 53.125
Data rate adjustment (ppm)	0 to ±1000	n/a
Pattern supported by PPG and ED under FEC mode	PRBS 7/9/11/15/23/31 PRBS 7Q/9Q/11Q/15Q/23Q/31Q Only PPG supports PRBS16Q, SSPRQ, and user-defined pattern	PPG: PRBS 13Q/15Q/31Q, SSPRQ, user-defined pattern ED: PRBS 15Q/31Q
Eye width (zero hit) (ps)	5.5 (PAM4 53.125G) 23 (PAM4 26.5625G)	6 (PAM4 53.125G) 23 (PAM4 26.5625G)
Sensitivity (mV_{ppd}) @ BER ≤ e-10	250 (PAM4 53.125G)	150 (PAM4 53.125G)
CTLE (dB)	n/a	Auto-adaptive
FFE taps	16	20
RCNC (reflection cancellation, noise cancellation)	n/a	Supported
ED damage level (mV_{ppd})	1200	900
Clock output amplitude (mV_{ppd})	400	300
Clock ratio (clock frequency / symbol rate)	/2, /4, /8, /16, /32, /64	/8, /16, /32, /64
Error injection	Supported	n/a

AVAILABLE OPTIONS

BA-4000	FEC4	FEC8	FGC4	FGC8
4-28-NRZ				
8-28-NRZ				
4-28-PAM	✓			
8-28-PAM		✓		
4-56-PAM-FEC4			✓	
8-56-PAM-FEC8				✓
4-56-HP-FEC4			✓	
8-56-HP-FEC8				✓
8-56-RCNC-FEC8				

ORDERING INFORMATION

BA-4000-XX-XX

Models
4-28-NRZ = 4×28 GBd NRZ BERT with O-SMPM connector
8-28-NRZ = 8×28 GBd NRZ BERT with O-SMPM connector
4-28-PAM = 4×28 GBd NRZ/PAM4 BERT with O-SMPM connector
8-28-PAM = 8×28 GBd NRZ/PAM4 BERT with O-SMPM connector
4-56-PAM-FEC4 = 4×56 GBd NRZ/PAM4 BERT with O-SMPM connector and FEC simulator included
8-56-PAM-FEC8 = 8×56 GBd NRZ/PAM4 BERT with O-SMPM connector and FEC simulator included
4-56-HP-FEC4 = 4×56 GBd NRZ/PAM4 BERT (better sensitivity, narrower receiving range) with O-SMPM connector and FEC simulator included
8-56-HP-FEC8 = 8×56 GBd NRZ/PAM4 BERT (better sensitivity, narrower receiving range) with O-SMPM connector and FEC simulator included
8-56-RCNC-FEC8 = 8×53 GBd PAM4 BERT (reflection cancellation, noise cancellation) with O-SMPM connector and FEC simulator included

Options
FEC4 = FEC simulator software 4CH [a]
FEC8 = FEC simulator software 8CH [b]
FGC4 = FEC pattern generator and checker 4CH [c]
FGC8 = FEC pattern generator and checker 8CH [d]

Example: BA-4000-8-56-PAM-FGC8-FEC8

a. Available for BA-4000-4-28-PAM.
b. Available for BA-4000-8-28-PAM.
c. Available for BA-4000-4-56-PAM-FEC4 and BA-4000-4-56-HP-FEC4.
d. Available for BA-4000-8-56-PAM-FEC8 and BA-4000-8-56-HP-FEC8.

MODEL LIST

FULL MODEL NO.	DESCRIPTION
BA-4000-4-28-NRZ	4×28G NRZ BERT
BA-4000-8-28-NRZ	8×28G NRZ BERT
BA-4000-4-28-PAM	4×28G NRZ/PAM4 BERT
BA-4000-4-28-PAM-FEC4	4×28G NRZ/PAM4 BERT with FEC simulator
BA-4000-8-28-PAM	8×28G NRZ/PAM4 BERT
BA-4000-8-28-PAM-FEC8	8×28G NRZ/PAM4 BERT with FEC simulator
BA-4000-4-56-PAM-FEC4	4×56G NRZ/PAM4 BERT with FEC simulator
BA-4000-4-56-PAM-FGC4-FEC4	4×56G NRZ/PAM4 BERT with FEC pattern generator and checker and FEC simulator
BA-4000-8-56-PAM-FEC8	8×56G NRZ/PAM4 BERT with FEC simulator
BA-4000-8-56-PAM-FGC8-FEC8	8×56G NRZ/PAM4 BERT with FEC pattern generator and checker and FEC simulator
BA-4000-4-56-HP-FEC4	4×56G NRZ/PAM4 BERT (better sensitivity, narrower receiving range) with FEC simulator
BA-4000-4-56-HP-FGC4-FEC4	4×56G NRZ/PAM4 BERT (better sensitivity, narrower receiving range) with FEC pattern generator and checker, and FEC simulator
BA-4000-8-56-HP-FEC8	8×56G NRZ/PAM4 BERT (better sensitivity, narrower receiving range) with FEC simulator
BA-4000-8-56-HP-FGC8-FEC8	8×56G NRZ/PAM4 BERT (better sensitivity, narrower receiving range) with FEC pattern generator and checker, and FEC simulator
BA-4000-8-56-RCNC-FEC8	8×53G PAM4 BERT (reflection and noise cancellation) with FEC simulator

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