# **BA-4000 Bit Analyzer**

100G/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 7/9/11/13/15/23/31/130/310, SSPR0

Advanced FEC tools

**Channel simulator** 

Burst/random error injection

Supports linear / gray mapping

**O-SMPM** connection

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## BA-4000 READY FOR 800G TESTING The BA-4000 is a world-class series of 100G/800G electrical BER testers (either 4 or 8 channels) supporting PAM4 or NRZ coding. BA-4000-8-28-PAM - 400G BA-4000-4a-28-PAM - 200G BA-4000-8-28-NRZ - 200G BA-4000-4-28-NRZ - 100G

## POWERFUL AND SIMPLIFIED USER INTERFACE

The BA-4000 user interface provides simplified and real-time test results per channel.

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EXFO	v 5.3.2.1 Setu	up Help			Ó	G					
	MultiRate 1.5Vpp		Symbol Rate 26.5625 GBd PAM4				BER Configuration		Relock		
172.16.81.65	FEC SE	G	Clock (A-B)	Rate/8			X/RX Configuration		Run		Force Relock
	-						-1 -1 -				
D== 050	Channel 1			Channel 2		D DED (	Channel 3		D-1 050 C	Channel 4	
	8.737e-09			2.372e-09			3.636e-05			3.834e-0	09
Pre Errors	4,696	PN31	Pre Errors	1,279	PN31	Pre Errors	19,674,924	PN31	Pre Errors	2,08	82 PN31
Corrected	4,696	PN31	Corrected	1,279	PN31	Corrected	19,674,924	PN31	Corrected	2,01	82 PN31
Post BER	0.000e+00	Sync	Post BER	0.000e+00	Sync	Post BER	0.000e+00	Sync	Post BER	0.000e+0	00 Sync
Margin	80% (max: 3)	KP4	Margin	80% (max: 3)	KP4	Margin	40% (max: 9)	KP4	Margin	80% (max:	3) KP4
# Bits	537,460,2	65,600	# Bits	539,295,8	04,160	# Bits	541,134,1	26,592	# Bits	542,96	8,437,504
Time	10 s		Time	10 s		Time	10 s		Time	10 s	
	Channel 5			Channel 6			Channel 7			Channel 8	
Pre BER	3.671e-11	•	Pre BER	3.489e-06	•	Pre BER	2.545e-05	•	Pre BER	1.976e-0	06 💌 🏓
Pre Errors	20	PN31	Pre Errors	1,907,057	PN31	Pre Errors	13,961,536	PN31	Pre Errors	1,052,8	89 PN31
Corrected	20	PN31	Corrected	1,907,057	PN31	Corrected	13,961,536	PN31	Corrected	1,052,8	89 PN31
Post BER	0.000e+00	Sync	Post BER	0.000e+00	Sync	Post BER	0.000e+00	Sync	Post BER	0.000e+0	00 Sync
Margin	80% (max: 3)	KP4	Margin	80% (max: 3)	KP4	Margin	60% (max: 6)	KP4	Margin	80% (max:	3) KP4
# Bits	544,804,9	21,728	# Bits	546,644,1	41,824	# Bits	548,487,2	45,696	# Bits	532,76	9,596,416
Time	10 s		Time	10 s		Time	10 s		Time	10 s	
				PPG		BER	Monitor	FEC	CH Sim	nulation N	1A
Error Injection	BER Results FEC Resu	ilts									
UpdateTaps(0,0	1,800,0,0,0);								2	Done	



### **FEC SIMULATION**

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

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

## WITH PAM4 CODING, SIMPLE BER TEST IS NOT ENOUGH



Pre BER	5.003e-08	•
Pre Errors	26,581	PN31
Corrected	26,581	PN31
Post BER	0.000e+00	Sync
Margin	87% (max: 2)	KP4
# Bits	531,315,8	33,984
Time	10 s	

Burst and random error injection

FEC symbol error margin



FEC symbol error distribution plot



Channel response simulation



All specifications are typical, at 23 °C  $\pm$  2 °C unless otherwise specified.

SPECIFICATIONS				
BA-4000	x-28-NRZ	x-28-PAM	x-56-PAM	x-56-PAM-FGC
Number of channels	4 (x = 4) 8 (x = 8)	4 (x = 4) 8 (x = 8)	4 (x = 4) 8 (x = 8)	4 (x = 4) 8 (x = 8)
Modulation	NRZ	NRZ/PAM4	NRZ/PAM4	NRZ/PAM4
Data rate per lane ª (GBd)	9.95328, 10, 10.3125, 10.709, 11.3176, 12.5, 14.025, 24.33024, 25, 25.78125, 26.5625, 27.95, 28.05, 28.125	25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9	25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 49.765, 53.125, 57.8	25.78125, 26.5625, 27.95, 28.05, 28.125, 28.9, 49.765, 53.125, 57.8
Data rate adjustment (ppm)	0 to ±300	0 to ±300	0 to ±300	0 to ±300
PAM4 coding	n/a	Linear code / Gray code	Linear code / Gray code	Linear code / Gray code
Pattern supported by PPG and ED	PRBS 7/9/15/23/31	PRBS 7/9/11/13/15/23/31 PRBS 7Q/9Q/11Q/13Q/ 15Q/23Q/31Q Only PPG supports PRBS16Q, SSPRQ, 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, 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, and user-defined pattern Scrambled Idle at FGC mode (with option FGCx)
Maximum amplitude (mV <sub>ppd</sub> )	800 <sup>b, c</sup> (typical)	800 <sup>c, e</sup> (typical)	800 <sup>f</sup> (typical)	800 <sup>f</sup> (typical)
Rise time/fall time (20% to 80%) (ps)	15/15 ° (typical)	11/11 º (typical)	9.5/9.5 d (53.125G) 10/10 d (25.78125G)	9.5/9.5 <sup>d</sup> (53.125G) 10/10 <sup>d</sup> (25.78125G)
PAM4 eye width (zero hit) (ps)	n/a	23 ° (typical)	5.5 <sup>f</sup> (53.125G) 23 <sup>f</sup> (26.5625G)	5.5 <sup>f</sup> (53.125G) 23 <sup>f</sup> (26.5625G)
Jitter RMS (fs)	750 ° (typical)	450 ° (typical)	400 ° (53.125G) 450 ° (25.78125G)	400 ° (53.125G) 450 ° (25.78125G)
Sensitivity <sup>g</sup> (mV <sub>ppd</sub> )	100 (NRZ 25.78125G)	200 (PAM4 26.5625G) 150 (NRZ 25.78125G)	200 <sup>h</sup> (PAM4 53.125G) 200 (PAM4 26.5625G) 150 (NRZ 25.78125G)	200 <sup>i</sup> (PAM4 53.125G) 200 (PAM4 26.5625G) 150 (NRZ 25.78125G)
CTLE (dB)	0 to 7	0 to 8	n/a	n/a
Clock output amplitude (mV <sub>ppd</sub> )	300	400	400	400
Clock ratio	/8, /16 (Clock frequency / Symbol rate)	/2, /4, /8, /16, /32, /64 (Clock frequency / Symbol rate)	/2, /4, /8, /16, /32, /64 (Clock frequency / Symbol rate)	/2, /4, /8, /16, /32, /64 (Clock frequency / Symbol rate)
Connector type	O-SMPM connector (up to 67 GHz bandwidth)	O-SMPM connector (up to 67 GHz bandwidth)	O-SMPM connector (up to 67 GHz bandwidth)	O-SMPM connector (up to 67 GHz bandwidth)

#### 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 humidi	ty	20% to 80%	
Power <sup>i</sup>		100/120 Vac (50/60/400 Hz) 220/240 Vac (50/60 Hz) 60 W typical/80 W max.	

a. Fixed rate.

b. Amplitude step is 200  $\mathrm{mV}_{_{\mathrm{ppd}}}$ 

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

d. 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%.

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

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

h. BER ≤ 10<sup>-10</sup> i. BER ≤ 10<sup>-9</sup>



EXFO

#### **OPTION AVAILABLE**

BA-4000	FEC4	FEC8	FGC4	FGC8
4-28-NRZ				
8-28-NRZ				
4-28-PAM	~			
8-28-PAM		~		
4-56-PAM	~		~	
8-56-PAM		$\checkmark$		~

#### **ORDERING INFORMATION**

BA-4000-XX-XX-	XX
Models 4-28-NRZ = 4x28 GBd NRZ BERT with O-SMPM connector 8-28-NRZ = 8x28 GBd NRZ BERT with O-SMPM connector 4-28-PAM = 4x28 GBd NRZ/PAM4 BERT with O-SMPM connector 8-28-PAM = 8x56 GBd NRZ/PAM4 BERT with O-SMPM connector 8-56-PAM = 8x56 GBd NRZ/PAM4 BERT with O-SMPM connector <b>Options</b> FEC4 = 26G PAM4 FEC simulator software 4CH <sup>a</sup> FEC8 = 26G PAM4 FEC simulator software 8CH <sup>b</sup> FGC4 = FEC pattern generator and checker 4CH <sup>c</sup> FGC8 = FEC pattern generator and checker 8CH <sup>d</sup>	<ul> <li>Accessories         ICBOS-KM-7 = 40 GHz, 1x8 O-SMPM to K(male) cable, 7 cm         ICBOS-KM-15 = 40 GHz, 1x8 O-SMPM to K(male) cable, 15 cm         ICBOS-KM-30 = 40 GHz, 1x8 O-SMPM to K(male) cable, 30 cm         ICBOS-KM-60 = 40 GHz, 1x8 O-SMPM to K(male) cable, 60 cm         ICBOS-QM-7 = 50 GHz, 1x8 O-SMPM to 2.4 mm (male) cable, 7 cm         ICBOS-QM-15 = 50 GHz, 1x8 O-SMPM to 2.4 mm (male) cable, 15 cm         ICBOS-QM-30 = 50 GHz, 1x8 O-SMPM to 2.4 mm (male) cable, 30 cm         ICBOS-QM-60 = 50 GHz, 1x8 O-SMPM to 2.4 mm (male) cable, 30 cm         ICBOS-QM-60 = 50 GHz, 1x8 O-SMPM to 2.4 mm (male) cable, 60 cm         ICBOS-SMPM-7 = 50 GHz, 1x8 O-SMPM to SMPM (female) cable, 7 cm         ICBOS-SMPM-15 = 50 GHz, 1x8 O-SMPM to SMPM (female) cable, 7 cm         ICBOS-SMPM-15 = 50 GHz, 1x8 O-SMPM to SMPM (female) cable, 7 cm         ICBOS-SMPM-30 = 50 GHz, 1x8 O-SMPM to SMPM (female) cable, 7 cm         ICBOS-SMPM-30 = 50 GHz, 1x8 O-SMPM to SMPM (female) cable, 30 cm         ICBOS-SMPM-60 = 50 GHz, 1x8 O-SMPM to SMPM (female) cable, 60 cm         ICBOS-OS-20 = 50 GHz, 1x8 O-SMPM to O-SMPM cable, 20 cm         ICBOS-OS-60 = 50 GHz, 1x8 O-SMPM to O-SMPM cable, 30 cm         ICBOS-OS-60 = 50 GHz, 1x8 O-SMPM to O-SMPM cable, 60 cm         ICBOS-VM-15 = 67 GHz, 1x8 O-SMPM to 1.85 mm (male) cable, 15 cm         ICBOS-VM-30 = 67 GHz, 1x8 O-SMPM to 1.85 mm (male) cable, 30 cm         ICBOS-VM-50 = 67 GHz, 1x8 O-SMPM to 1.85 mm (male) cable, 60 cm         ICBOS-VM-60 = 67 GHz, 1x8 O-SMPM to 1.85 mm (male) cable, 60 cm         ICBOS-VM-60 = 67 GHz, 1x8 O-SMPM to 1.85 mm (male) cable, 60 cm         ICBOS-VM-60 = 67 GHz, 1x8 O-SMPM to 1.85 mm (male) cable, 60 cm         ICBOS-VM-60 = 67 GHz, 1x8 O-SMPM to 1.85 mm (male) cable, 60 cm         ICBOS-VM-60 = 67 GHz, 1x8 O-SMPM to 1.85 mm (male) cable, 60 cm         ICBOS-VM-60 = 67</li></ul>
Exemple: BA-4000-8-56-PAM-FGC8-FEC8	ICBOS-VF-15 = 67 GHz, 1x8 O-SMPM to 1.85 mm (female) cable, 15 cm ICBOS-VF-30 = 67 GHz, 1x8 O-SMPM to 1.85 mm (female) cable, 30 cm ICBOS-VF-60 = 67 GHz, 1x8 O-SMPM to 1.85 mm (female) cable, 60 cm

a. Available for BA-4000-4-28-PAM and BA-4000-4-56-PAM.

b. Available for BA-4000-8-28-PAM and BA-4000-8-56-PAM.

c. Available for BA-4000-4-56-PAM. Must be ordered with FEC4 software option.

d. Available for BA-4000-8-56-PAM. Must be ordered with FEC8 software option.

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