

Low Latency LDPC

FastLink LDPC is a new low-latency Low Density Parity Code FEC from Paradise designed specifically for latency-sensitive applications.

The performance of traditional forward error correction schemes represents a trade-off between latency and coding gain. **FastLink** LDPC has been designed by Paradise engineers from the ground up to optimize latency and throughput while giving coding gain that is close to the theoretical limits.

FastLink LDPC has better or comparable latency and coding gain performance relative to conventional LDPC and TPC, meaning potentially that no other FEC may ever be required, *particularly as it is available on all Evolution and all Quantum modems at all data rates*. All Evolution and Quantum modems using **FastLink** will therefore interoperate up to the maximum data rate for each model.

Performance

A wide range of modulation and FEC rate options have been designed to give optimal Es/No performance when charted against spectral efficiency. Typically these offer improved coding gains of around 1dB when compared to TPC and are similar to the coding gains of conventional LDPC. They also reduce latency when compared to conventional LDPC by up to 90%. **FastLink** LDPC is therefore well balanced, giving extremely good all round performance.

For particularly demanding applications you can choose to optimise latency or BER performance even further, unlike other low-latency LDPC FECs that are available.

Two optimisation settings are available. *Low Latency* mode is designed to give lower or comparable latency relative to industry-standard TPC while giving BER performance that is no worse and in many instances significantly better. If latency is not an issue, BER can be optimised instead in *Low BER* mode to be comparable with industry-standard conventional LDPC. This gives unparalleled flexibility designed to meet the needs of even the most demanding applications.

Options

FastLink LDPC is available as a combined hardware add-on and Software Activated Feature (SAF) option:

- ▶ Operation up to 1Mbps (provided free with add-on hardware).
- ▶ SAF upgrade to 2.5Mbps.
- ▶ SAF upgrade to 5Mbps.
- ▶ SAF upgrade to 10Mbps.
- ▶ SAF upgrade to 20Mbps (PD20 only).
- ▶ SAF upgrade to 25Mbps.
- ▶ SAF upgrade to 55Mbps (Evolution) or 60Mbps (Quantum).
- ▶ SAF upgrade to 100Mbps (Quantum).

BPSK, (O)QPSK, 8PSK, 8QAM, 16APSK, 16QAM, 32APSK and 64QAM modulations are all supported.

An Adaptive Coding and Modulation (ACM) option uses a feedback path from the receiver to the transmitter to respond to changes in channel conditions to optimise throughput by dynamically varying the modulation and FEC rate to convert unused link margin into useful throughput.

FastLink LDPC is fully compatible with Paired Carrier.

Availability

- ▶ **FastLink** LDPC requires a hardware add-on card along with **FastLink** LDPC software.
- ▶ Available as a field hardware/software upgrade on all existing Quantum modems.
- ▶ Available as a field hardware/software upgrade on some existing Evolution modems and as a factory upgrade in all other cases.
- ▶ An ACM whitepaper is available (under 'White Papers') from the Paradise web site at <http://www.paradisedata.com>.
- ▶ The outstanding performance of **FastLink** LDPC has resulted in Paradise's conventional LDPC being discontinued.

BER Performance Summary Table

The table below shows FastLink LDPC performance in the three available modes:

- **Low BER**, where performance is optimized to give the best possible BER performance at the expense of extra latency. This mode is useful on high data rate links and where applications are not especially latency sensitive.
- **Balanced**, where latency and BER performance are given equal weight, giving good all-round performance. This is the recommended mode for most applications.
- **Low Latency**, where performance is optimized to give the lowest possible latency at the expense of a small increase in the Eb/No required to achieve a particular BER. This mode is for applications that require a real-time response.

FastLink Modulation	Code Rate	Eb/No for 5e-8 (Guaranteed)			Latency (ms) at 64kbps		
		Low BER	Balanced	Low Latency	Low BER	Balanced	Low Latency
BPSK	0.499	2.1	2.9	3.4	514	34	18
(O)QPSK	0.532	2.2	2.6	2.9	516	67	35
(O)QPSK	0.639	2.4	2.8	3.2	516	67	35
(O)QPSK	0.710	2.7	3.3	3.7	516	67	35
(O)QPSK	0.798	3.3	3.9	4.4	516	67	35
8PSK	0.639	See Note 1			517	133	69
8PSK	0.710	Note 2	5.5	5.9	517	133	69
8PSK	0.778	5.7	6.1	6.6	517	133	69
8QAM	0.639	4.5	4.8	5.1	517	133	70
8QAM	0.710	5	5.4	5.7	517	133	70
8QAM	0.778	5.6	5.9	6.3	517	133	70
16APSK	0.726	See Note 3			520	134	73
16APSK	0.778	See Note 3			520	134	73
16APSK	0.828	7.7	8.2	8.5	520	134	73
16APSK	0.851	8	8.5	8.9	520	134	73
16QAM	0.726	Note 4	7.5	7.7	519	136	70
16QAM	0.778	7	7.6	7.9	519	136	70
16QAM	0.828	7.5	8.0	8.2	519	137	71
16QAM	0.851	7.8	8.2	8.6	519	137	72
32APSK	0.778	9.4	9.9	10.3	520	137	71
32APSK	0.828	10.1	10.7	11.2	520	137	71
32APSK	0.886	11.1	11.6	12.2	520	137	72
32APSK	0.938	12.9	13.5	14.3	520	137	72

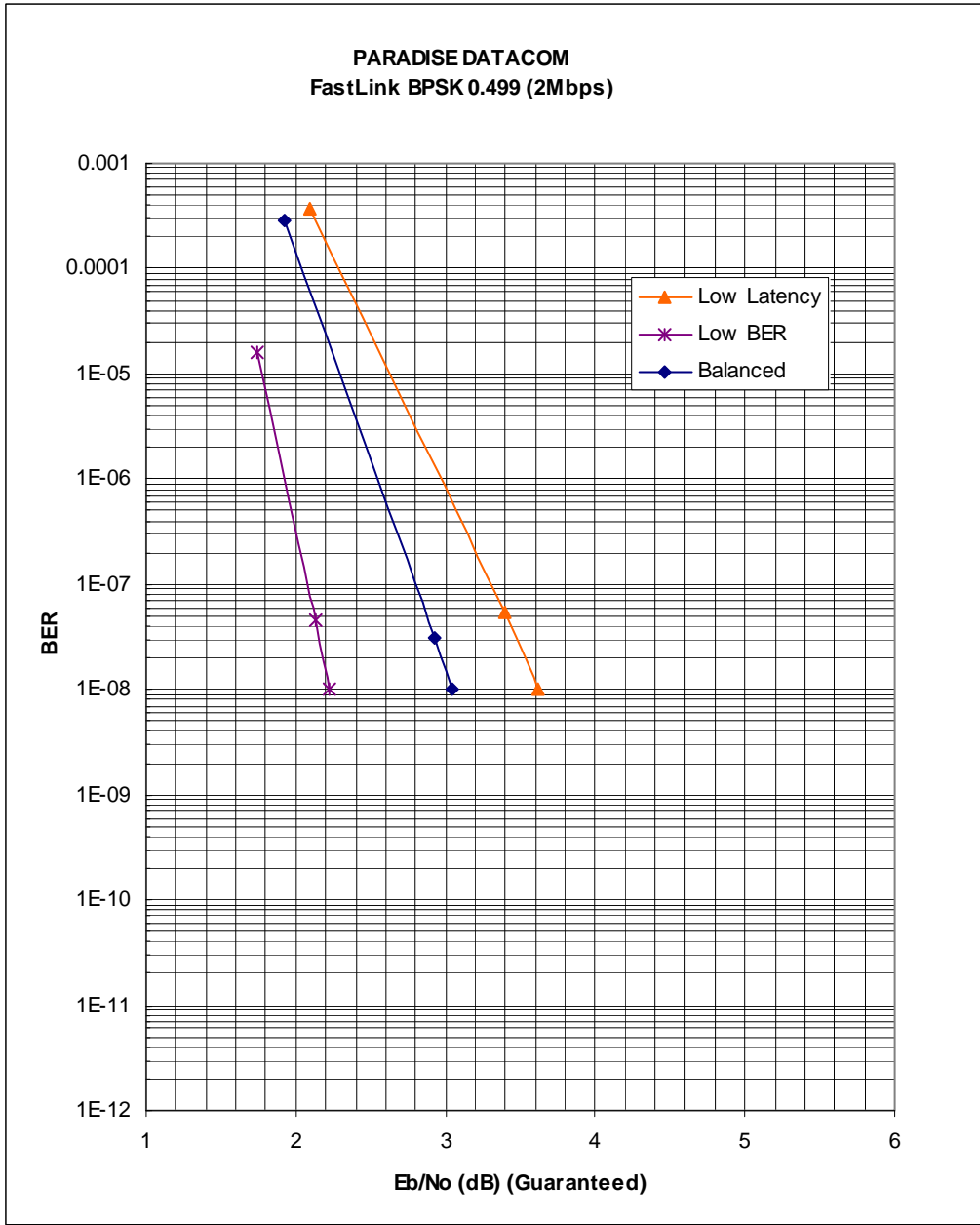
► **Note 1:** 8PSK rate 0.639 operates at a BER QEF point of 1e-12 only, with Eb/No (guaranteed) as follows:
 Low BER mode: 5.9dB
 Balanced mode: 6.2dB
 Low Latency mode: 6.7dB

► **Note 2:** 8PSK rate 0.710 can be used in a Low BER mode at a BER QEF point of 1e-12 only, with Eb/No of 5.9dB (guaranteed).

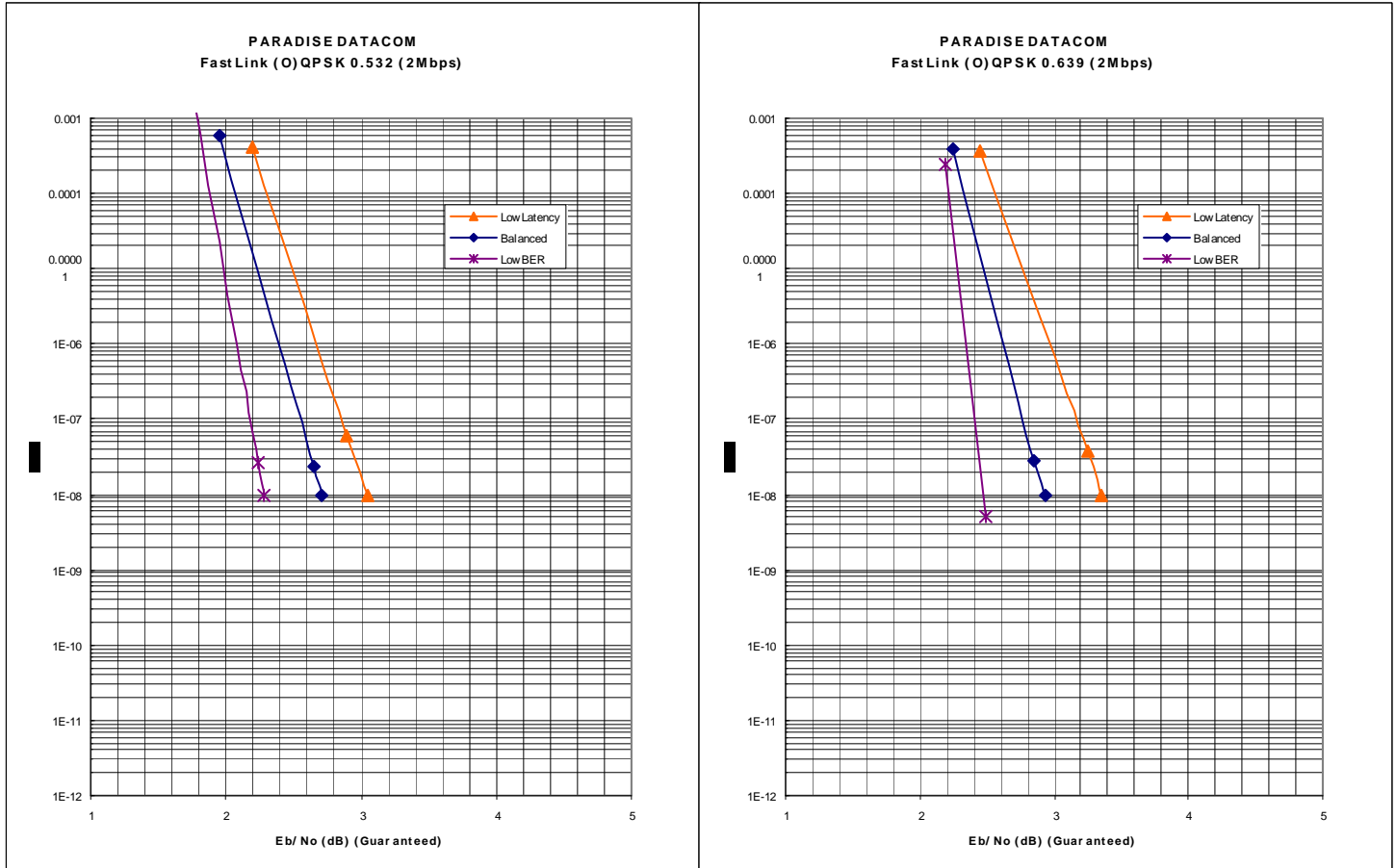
► **Note 3:** BER performance for this FEC rate is to be announced.

► **Note 4:** 16QAM rate 0.726 can be used in a Low BER mode at a BER QEF point of 1e-12 only, with Eb/No of 7.6dB (guaranteed).

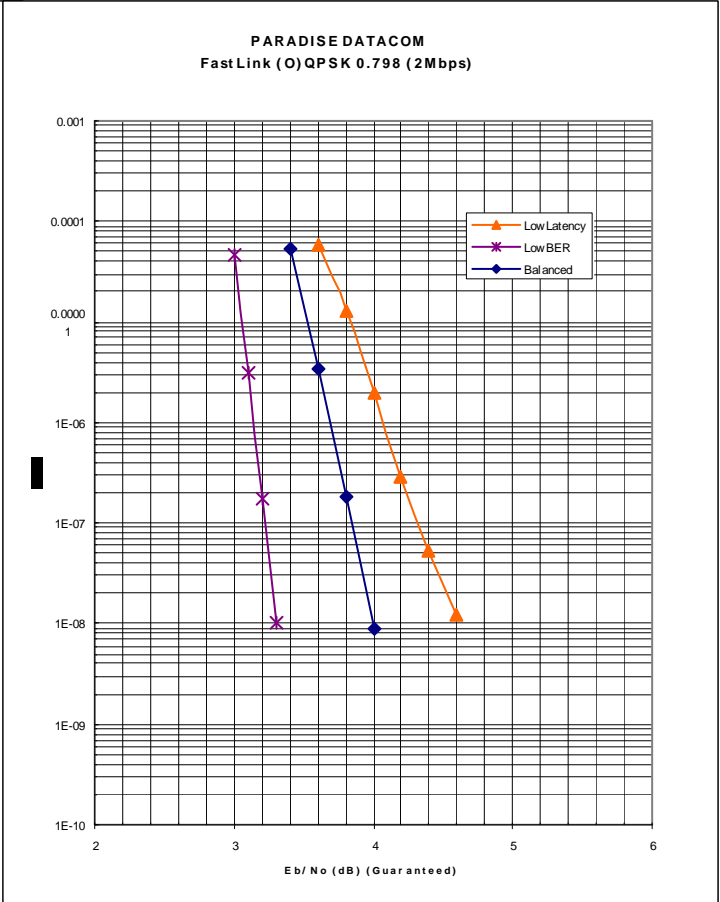
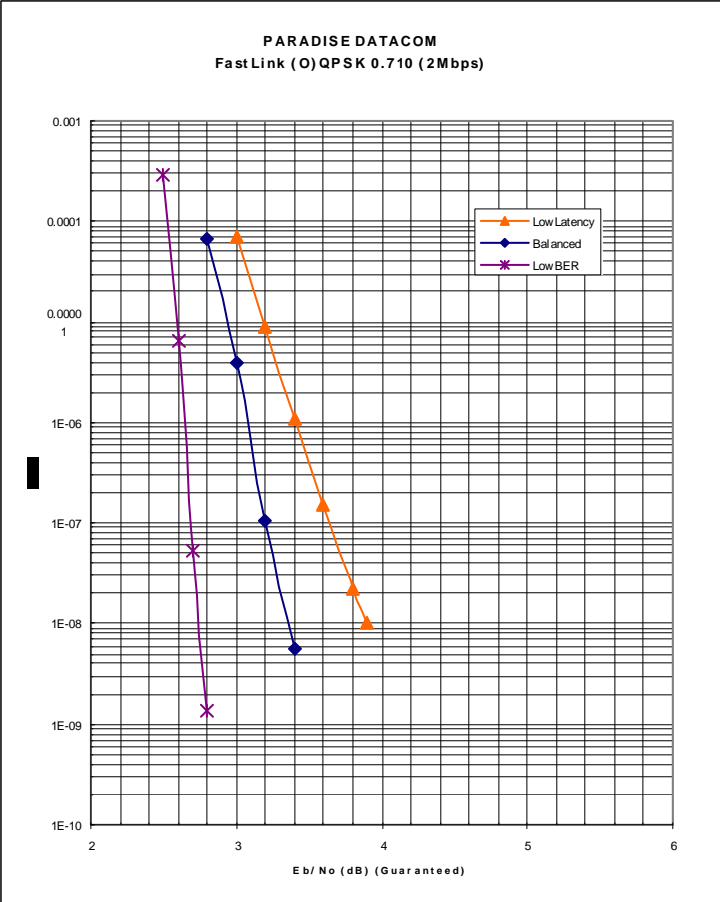
BER Performance Curves: BPSK



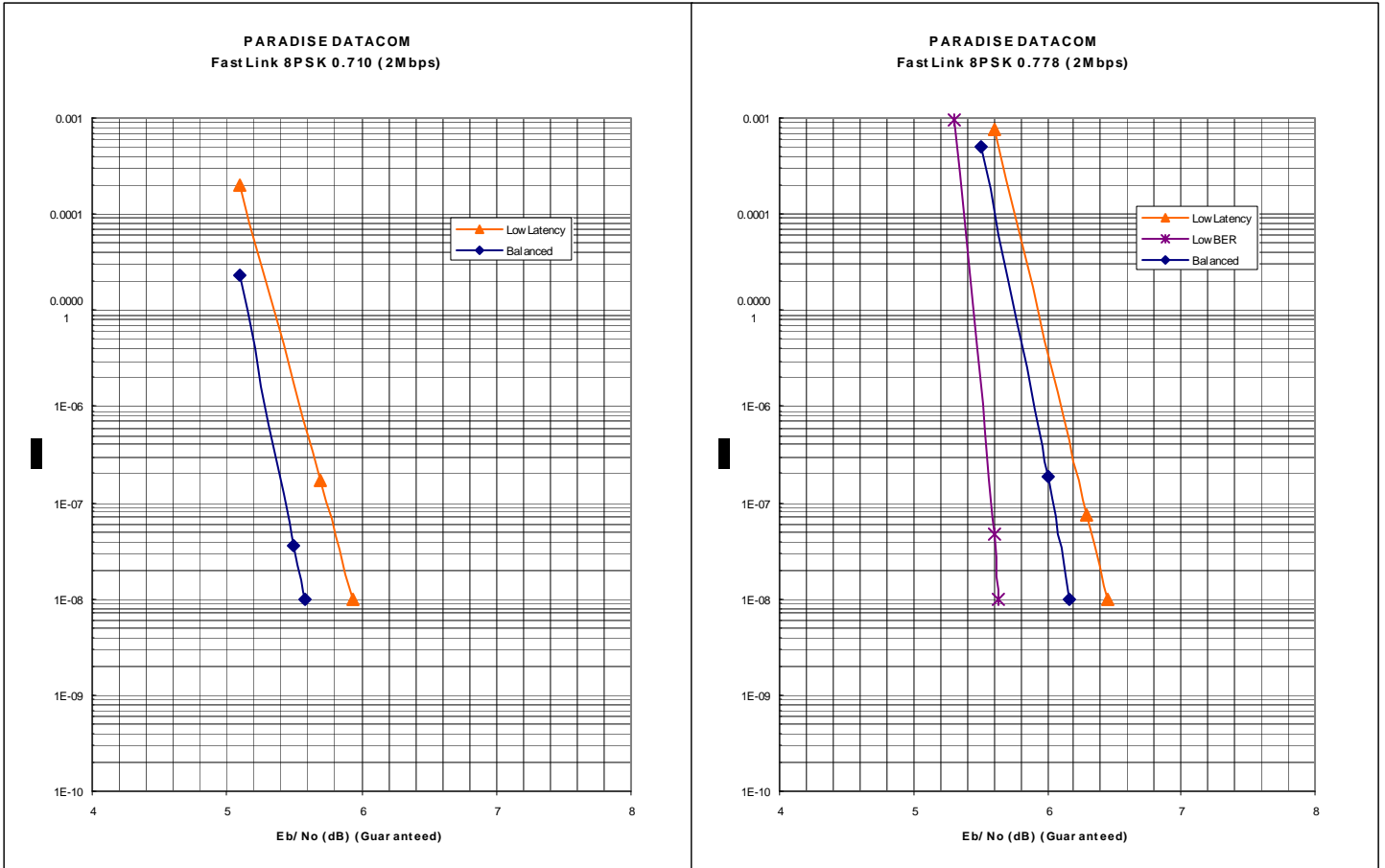
BER Performance Curves: (O)QPSK



BER Performance Curves: (O)QPSK (continued)



BER Performance Curves: 8PSK

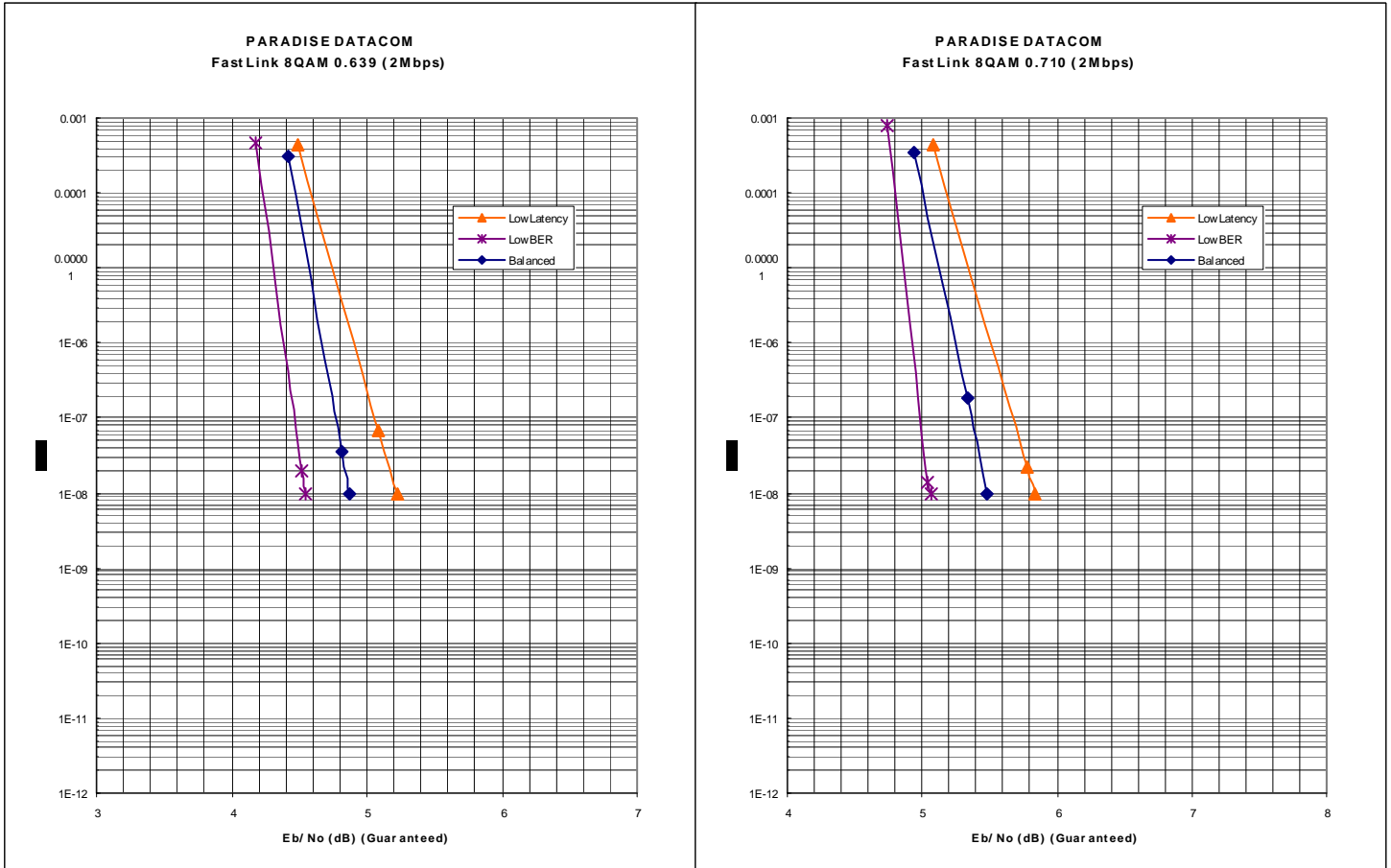


Note: 8PSK rate 0.639 is also available but operates at a BER QEF point of 1e-12 only, with Eb/No (guaranteed) as follows:

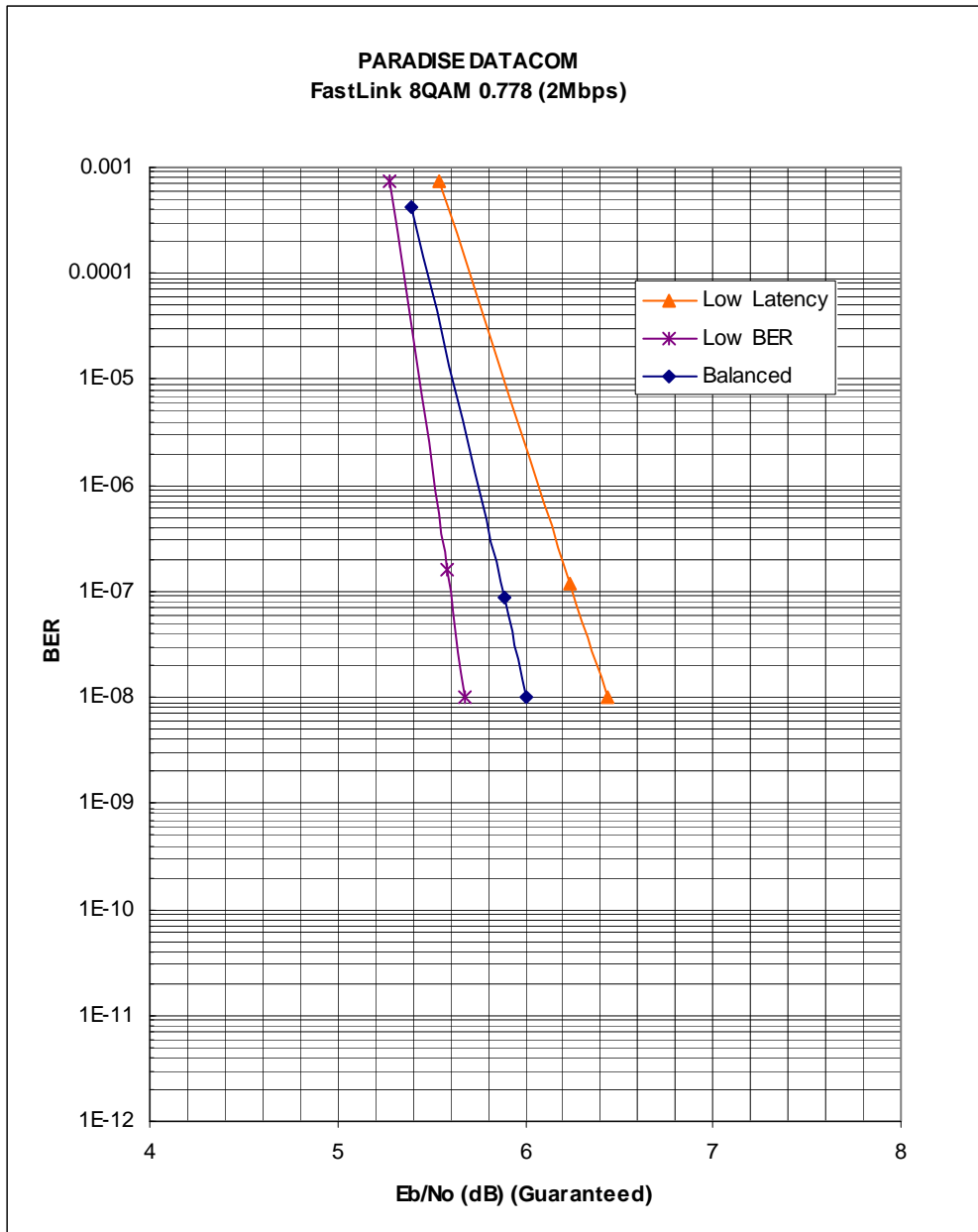
- Low BER mode: 5.9dB
- Balanced mode: 6.2dB
- Low Latency mode: 6.7dB

Note: 8PSK rate 0.710 can also be used in a Low BER mode but at a BER QEF point of 1e-12 only, with Eb/No of 5.9dB (guaranteed).

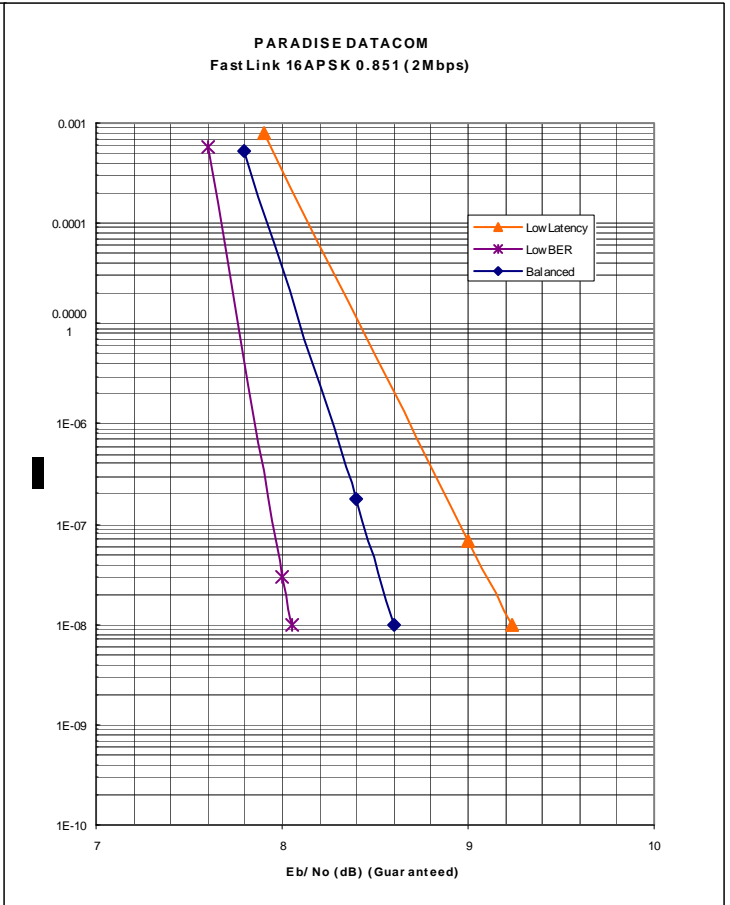
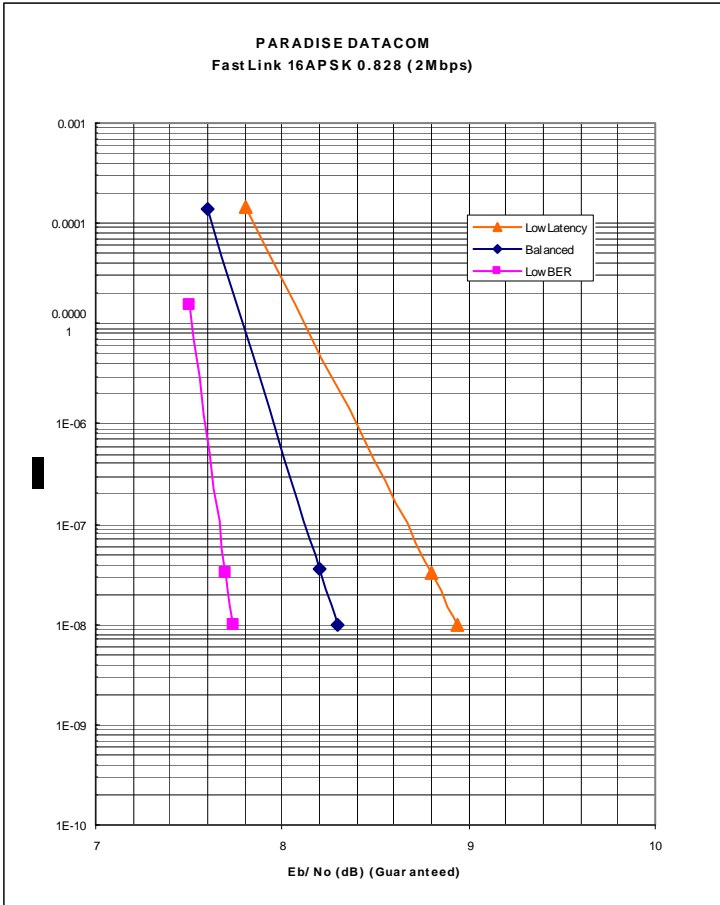
BER Performance Curves: 8QAM



BER Performance Curves: 8QAM (continued)

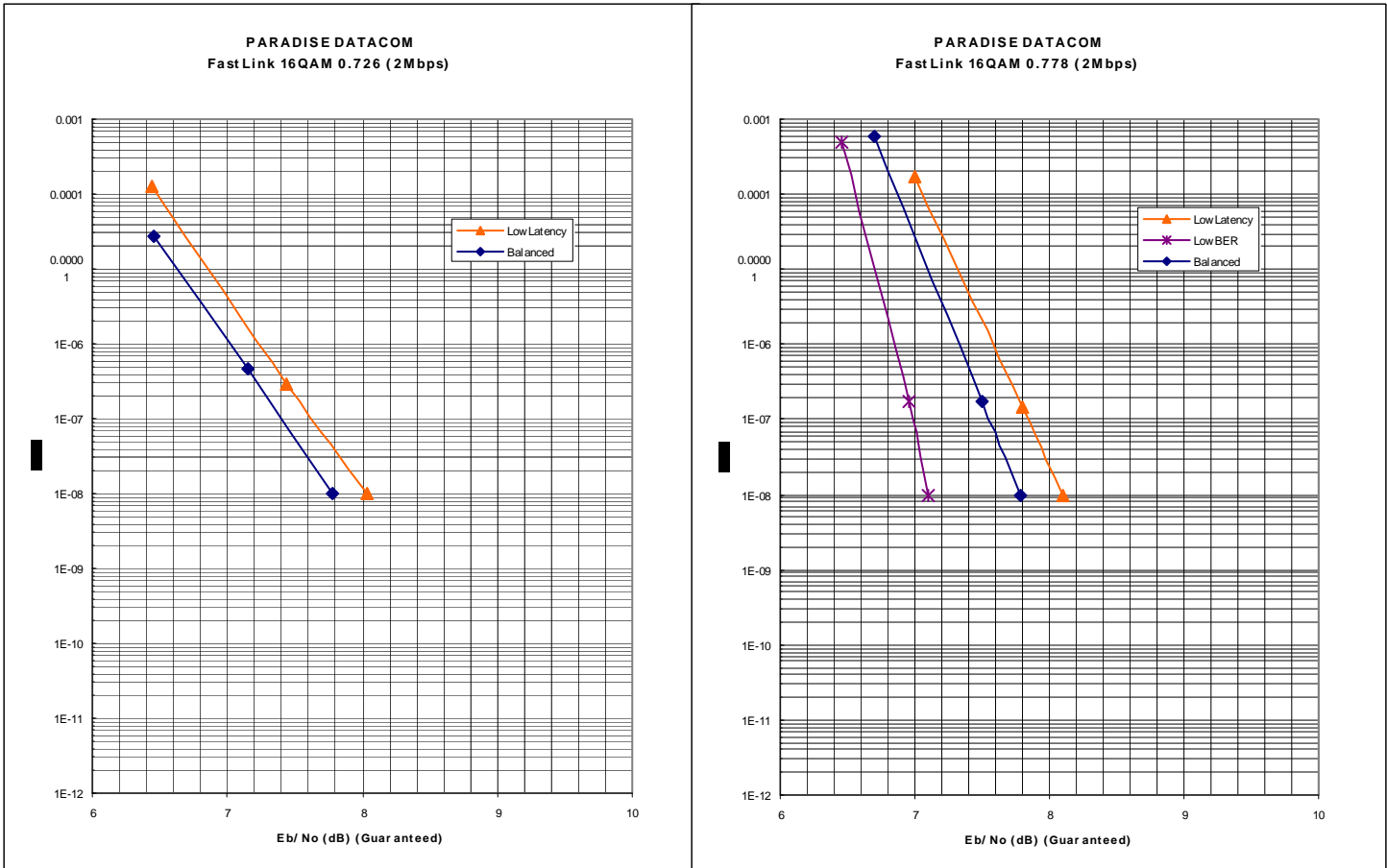


BER Performance Curves: 16APSK



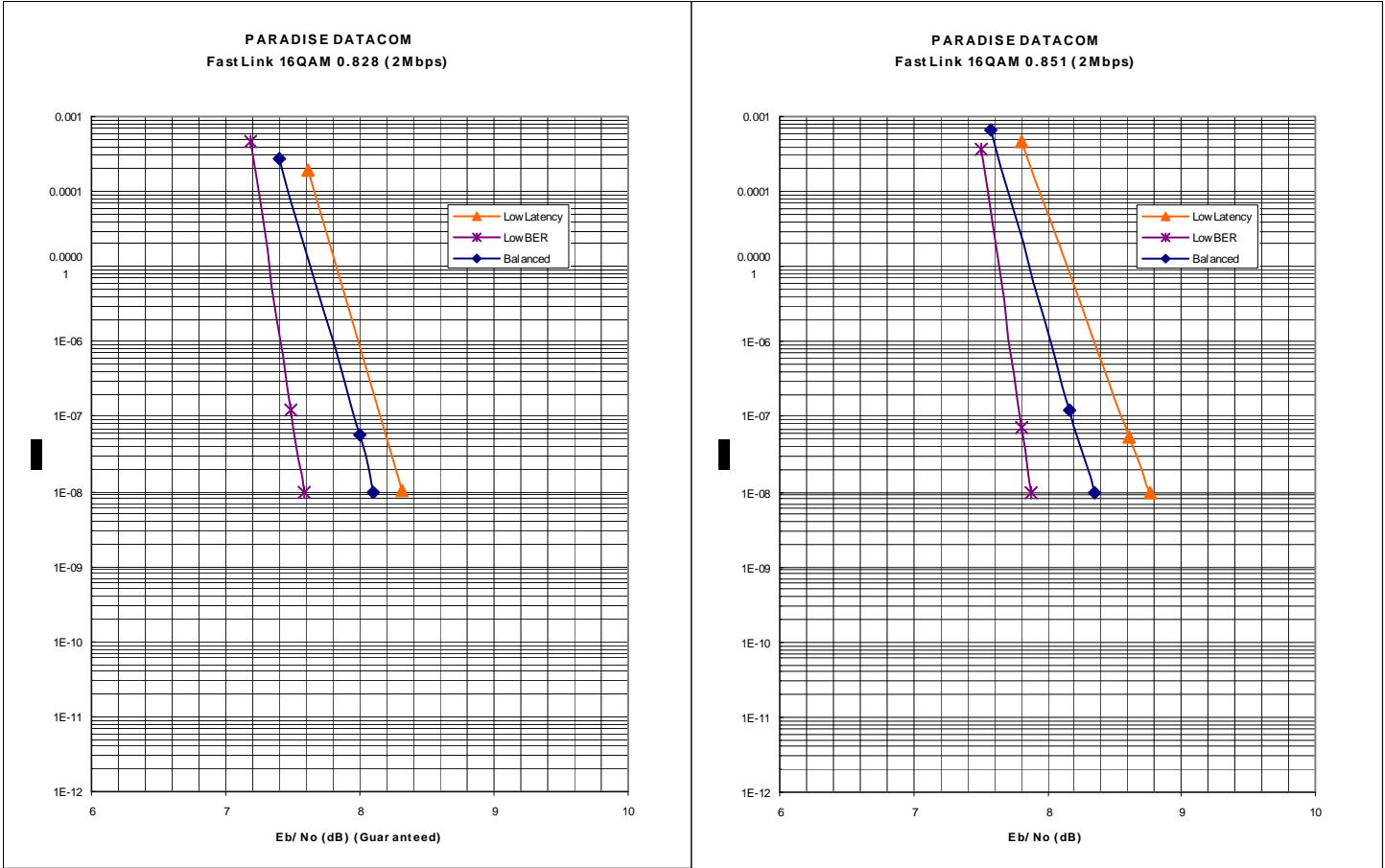
Note: Performance for two other 16APSK rates (0.726 and 0.778) is to be announced.

BER Performance Curves: 16QAM

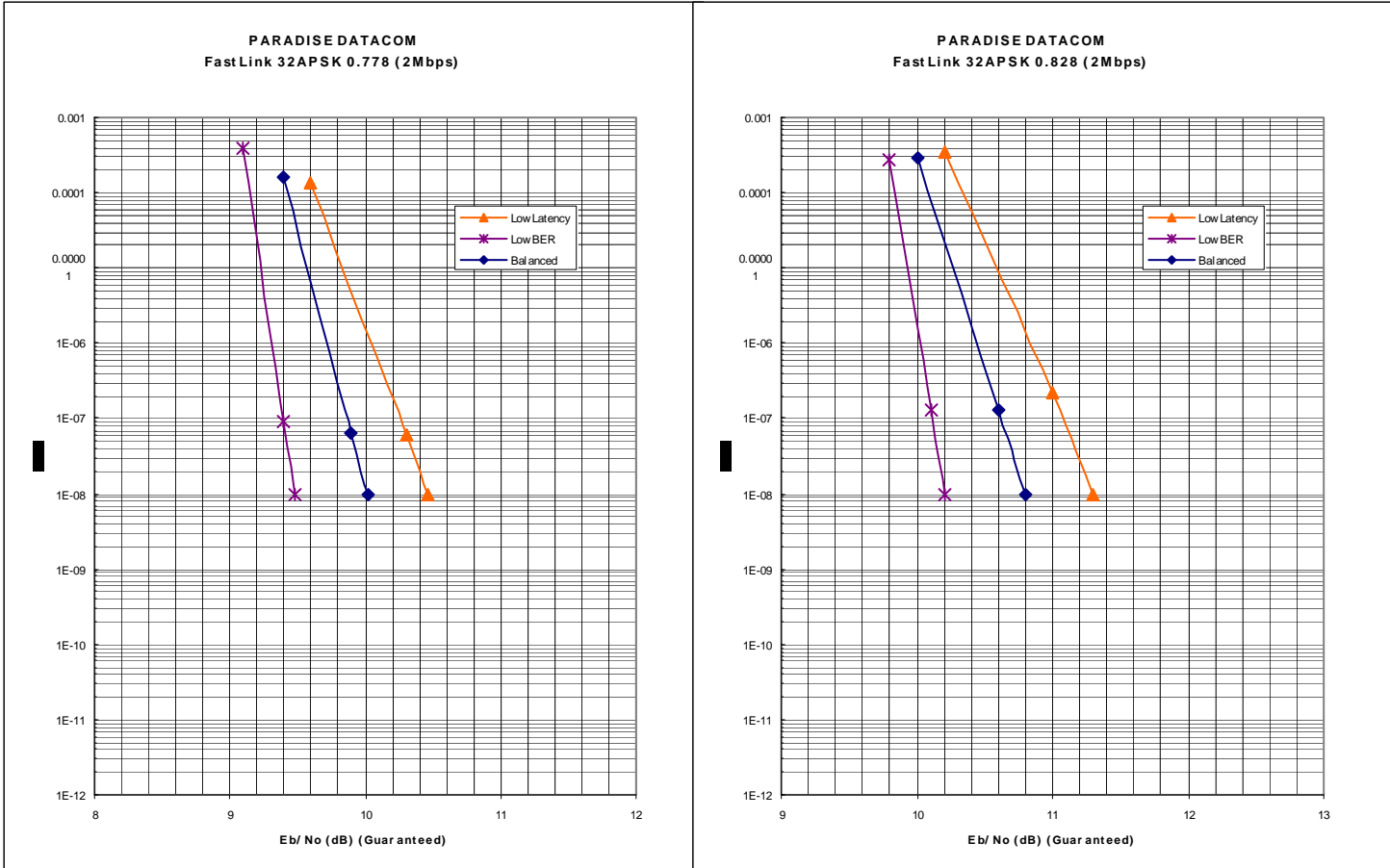


Note: 16QAM rate 0.726 can also be used in a Low BER mode but at a BER QEF point of 1e-12 only, with Eb/No of 7.6dB (guaranteed).

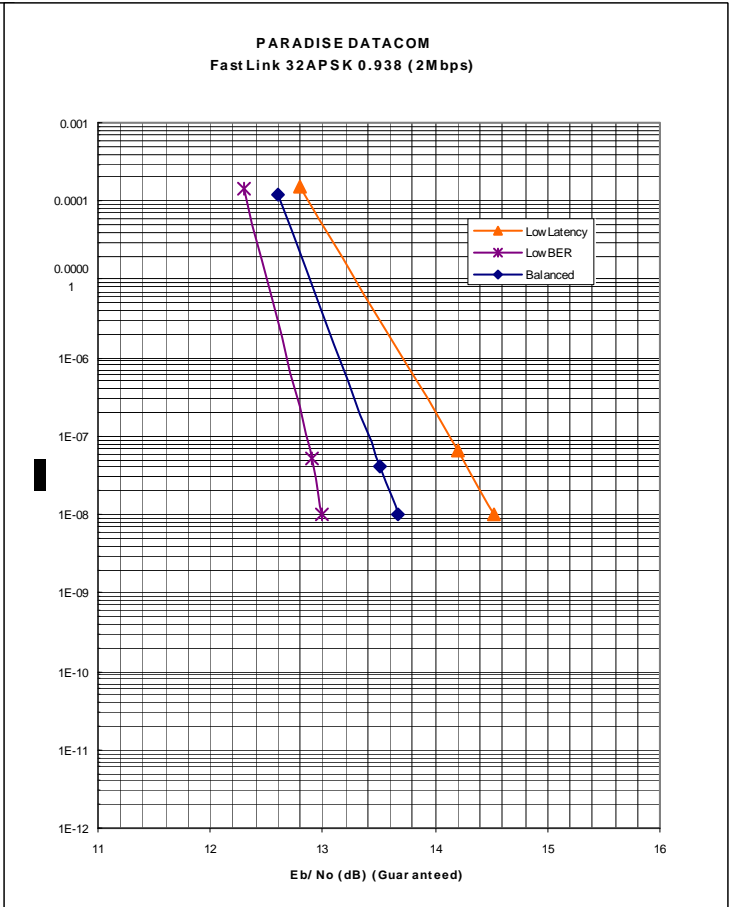
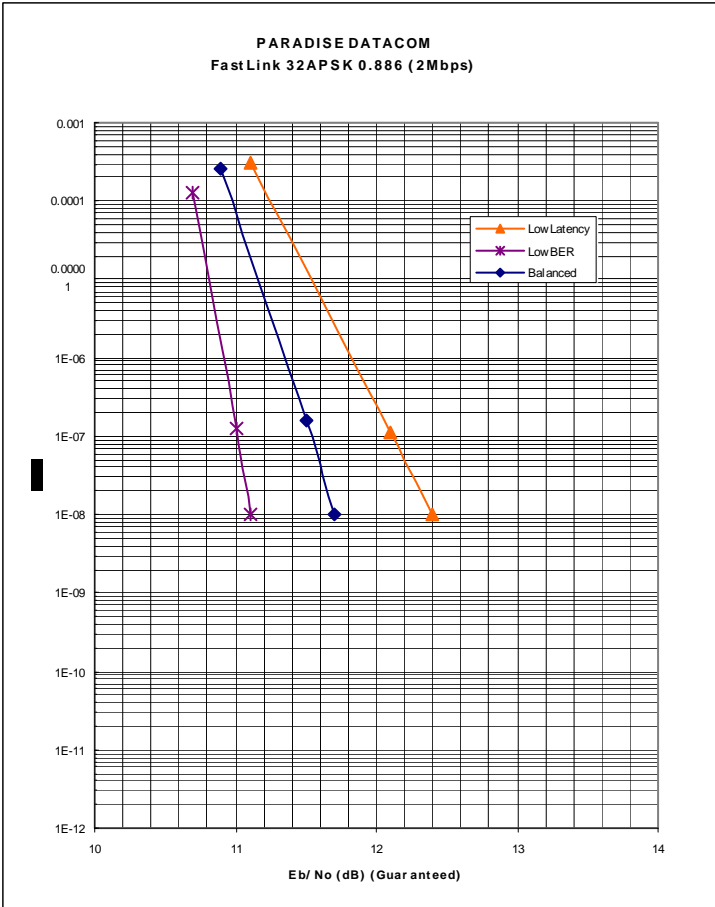
BER Performance Curves: 16QAM (continued)



BER Performance Curves: 32APSK



BER Performance Curves: 32APSK (continued)



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