White Paper

"Datum 8QAM Advantage"

8QAM/8PSK Performance Comparison

All M7 and PSM-500 Series Modems

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Introduction

Presented here is a brief comparison of Datum Systems' 8QAM Modulation, a leading Competitive Technology "CT" 8QAM design and the Industry Standard 8PSK Constellations types through a Norsat 1010XRT 1 watt Ku band BUC. Keep in mind; different modulation formats have different peak-to-average power ratios. Generally therefore, the lower the peak-to-average power ratio the more power at RF

Datum's 8-QAM has been optimized for the best BER and power performance. The optimal 8-QAM modulation constellation configuration is dependent on Es/No which is unique to 8QAM and a select group of other modulation formats. Therefore three 8-QAM constellations were created A, B and C to each cover a specific range of Es/No to best match each FEC mode offered by Datum. The optimum 8-QAM constellation is selected automatically by the modem based on the FEC mode selected.
For Example:

Datum 8-QAM-A is used by the following FEC modes:

- LDPC 256 – 16k Block, Code Rate 1/2
- LDPC 512 – 16k Block, Code Rate 2/3
- LDPC 1k – 16k Block, Code Rate 3/4
- LDPC 8k – 16k Block, Code Rate 14/17
- TPC Advanced 0.453-16k
- TPC Advanced 1/2-4k, 1/2-16k
- TPC Advanced 3/4-4k, 3/4-16k

Datum 8-QAM-B is used by the following FEC modes:

- LDPC 256 Block, Code Rate 2/3
- LDPC 256 – 512 Block, Code Rate 3/4
- LDPC 512 – 4k Block, Code Rate 14/17
- LDPC 1k – 16k Block, Code Rate 7/8
- LDPC 1k – 16k Block, Code Rate 10/11
- LDPC 4k – 16k Block, Code Rate 16/17
- TPC Advanced 7/8-4k, 7/8-16k
- TPC Advanced 0.922-16k
- TPC CT Code Rate 3/4
- TPC CT Code Rate 7/8

Datum 8-QAM-C is used by the following FEC modes:

- LDPC 256 Block, Code Rate 14/17
- LDPC 256 – 512 Block, Code Rate 7/8
- LDPC 256 – 512 Block, Code Rate 10/11
- LDPC 256 – 2k Block, Code Rate 16/17
- TPC Advanced 0.950-4k
- TPC CT Code Rate 0.95

Performance Comparisons

Relative Peak-to-Average Power Ratios of Modulation Constellation Points

Standard 8PSK	0.00 dB
Datum 8-QAM-A	1.42 dB
Datum 8-QAM-B	1.37 dB
Datum 8-QAM-C	1.80 dB
CT 8-QAM	2.55 dB

The data below was collected with a PSM-500 using LDPC FEC, 16k data block size and a code rate of 3/4 at 10 Mbps. 10 Mbps was used to speed BER testing.

Industry Standard 8PSK

Output Power	Spectrum Growth (Power 1 Side)	BER Degradation
360 mW	-40 dBc	< 0.05 dB
850 mW	-30 dBc	< 0.1 dB
1000 mW	-27 dBc	≈ 0.1 dB

Datum's 8-QAM

Output Power	Spectrum Growth (Power 1 Side)	BER Degradation
280 mW	-40 dBc	< 0.05 dB
650 mW	-30 dBc	< 0.1 dB
800 mW	-27 dBc	≈ 0.1 dB

Competitive Technology 8-QAM

Output Power	Spectrum Growth (Power 1 Side)	BER Degradation
240 mW	-40 dBc	< 0.1 dB
580 mW	-30 dBc	≈ 0.1 dB
745 mW	-27 dBc	≈ 0.5 dB

Conclusion

With 8PSK, the full power of the BUC is available with about 0.1 dB of BER degradation. With Datum's 8-QAM, a back off of about 1 dB is required to produce both similar BER degradation and spectral growth as 8PSK. With "CT" 8-QAM a back off of about 2.4 dB is required to produce similar BER degradation compared to 8PSK. Therefore Datum's 8-QAM can output about 1.4 dB more power out of the transmit BUC for similar BER degradation as compared to "CT" 8-QAM.

It takes about 1.3 dB of BUC power back off for "CT" 8-QAM to have similar spectral growth but it incurs an additional 0.4 dB BER performance reduction in doing so. Therefore overall the effective output power is reduced by an additional 0.4 dB, or 0.7 dB overall, compared to Datum's 8-QAM.

1.3 dB "CT" Required 8-QAM back off (for similar spectral growth)
- 1.0 dB Datum Required 8-QAM back off
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0.3 dB Difference
+ 0.4 dB "CT's" Reduced BER Performance due to reduced back off
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0.7 dB "CT's" Overall Reduced Effective Power for Similar Spectral Growth

This has the additional penalty of increasing the power on the satellite by 0.4 dB with no corresponding improvement in BER when using "CT's" 8-QAM with 1.3 dB of back off. Increasing the back off on "CT's" 8-QAM to 2.4 dB eliminates the excess satellite power but reduces the BUC's available output power by 1.4 dB compared to Datum's 8-QAM. Datum's 8-QAM clearly performs better in every way saving the link operator money at each step of the way.