QPSK, OQPSK, and MSK Spectral Regrowth and PA Efficiency

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- QPSK, OQPSK, and MSK were evaluated for spectral regrowth and power amplifier efficiency.
- Each waveform was synthesized at baseband using a dual channel arbitrary waveform generator and then upconverted using a quadrature modulator to the ISM band.
- The resulting signal was passed through a Class AB solid state power amplifier (SSPA).
- The power consumption of the SSPA was measured at various input drive levels and efficiency computed.
- Power spectrum for each waveform was then plotted at the 1 dB compression point and with the output saturated.
SSPA Characterization

QPSK Compression / Efficiency
QPSK Spectrum (11 Mchips/s)

OQPSK Compression / Efficiency
OQPSK Spectrum (11 Mchips/s)

MSK Compression / Efficiency
MSK Spectrum (11 Mchips/s)

Summary

<table>
<thead>
<tr>
<th>Waveform</th>
<th>Peak (dBm)</th>
<th>Eff @ Peak (%)</th>
<th>For gr 1 dB Gc (dBm)</th>
<th>Eff @ 1 dB Gc (dB)</th>
<th>Eff @ 1 dB Gc (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPSK</td>
<td>24.5</td>
<td>24.0</td>
<td>22.9</td>
<td>1.6</td>
<td>18.0</td>
</tr>
<tr>
<td>OQPSK</td>
<td>24.7</td>
<td>24.0</td>
<td>22.4</td>
<td>2.3</td>
<td>17.0</td>
</tr>
<tr>
<td>MSK</td>
<td>24.8</td>
<td>24.0</td>
<td>21.7</td>
<td>3.1</td>
<td>15.0</td>
</tr>
</tbody>
</table>

• Based on lab data, QPSK must be operated at 1.5 - 2.0 dB more OBO than OQPSK.

• For an output power of 24.5 dBm, OQPSK requires about 1.2 W (24% eff) and QPSK would require about 1.6 W (18% eff).

• This is a 33% increase in power required for the PA. Or about 80 ma at 5VDC.
Conclusions

• OQPSK is slightly more power efficient than QPSK

• The increase in power efficiency must be traded against a added complexity in the DFE and slightly degraded performance due to more complex equalizer training.

• The power advantage of OQPSK is not substantial enough to warrant adoption without further study of receiver issues.