SDM-9000 Adjacent Carrier Performance

Application Note

One key measure of a modem's performance is its operation in the presence of adjacent carriers. A typical transponder loaded with three carriers is shown in Figure 1. Notice there is spectral overlap from the adjacent carriers into the desired carrier. At the demodulator, this unwanted energy acts as increased noise, reduces the effective E_b/N_0, and degrades the BER.

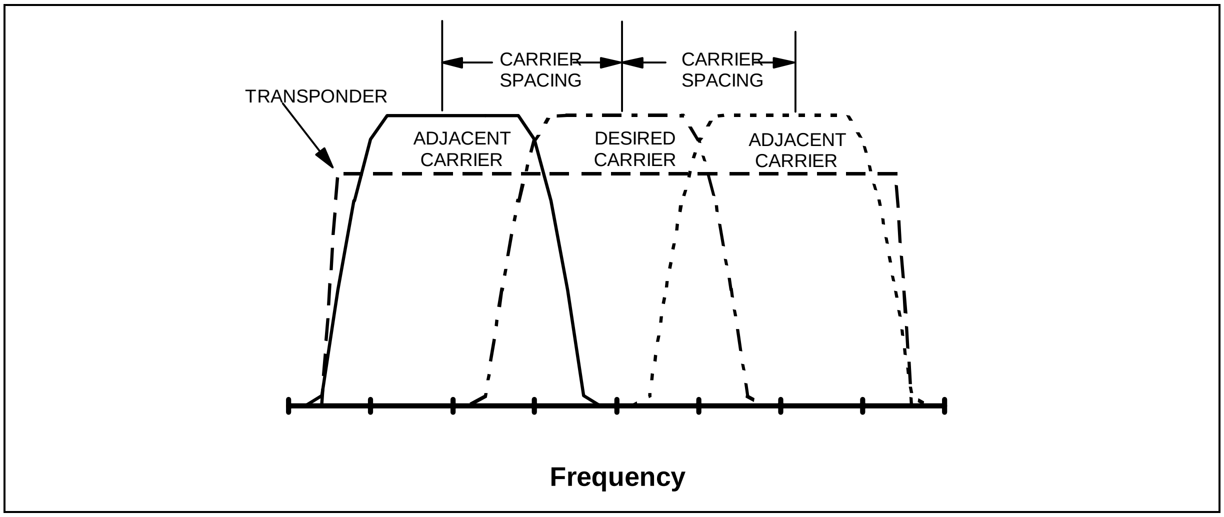

Figure 1. Adjacent Carriers and Transponder

A question often arises about the allowable spacing between carriers. This amounts to asking how much spectral overlap degrades modem performance as spacing is decreased. The specification for a typical modem permits an additional 0.5 dB E_b/N_0 to meet its BER requirement when adjacent carriers are present. Usually, the desired carrier is surrounded by two like modulated carriers, each 10 dB greater in power than the desired carrier, and separated in frequency from the desired carrier by 1.3 times the symbol rate.

For test purposes, a single adjacent carrier is sufficient to characterize the E_b/N_0 degradation of a desired carrier, and the results are valid for 1 or 2 carriers with the proper scaling of the adjacent carrier level. Two adjacent carriers, each 3 dB less in power than a single adjacent carrier, produce the same impact on the desired carrier.

The carrier configuration for the test is shown in Figure 2 with a single adjacent carrier placed next to a desired carrier. The carrier spacing is normalized to the symbol rate because data taken in this way is generic and applies to the modem operating at other symbol rates and with the same modulation and coding scheme.

During the test, the power of the adjacent carrier is adjusted relative to the power of the desired to characterize modem performance under a number of representative adjacent carrier conditions.

Initially, the modem is set up with noise to establish a reference E_b/N_0 and BER with no adjacent carrier present. Then, an adjacent carrier is enabled and the E_b/N_0 degradation measured as the adjacent carrier is moved closer to the desired carrier.

A family of data is produced when the measurements are repeated with different adjacent carrier power levels relative to the desired carrier. A diagram of the test setup is shown in Figure 3.

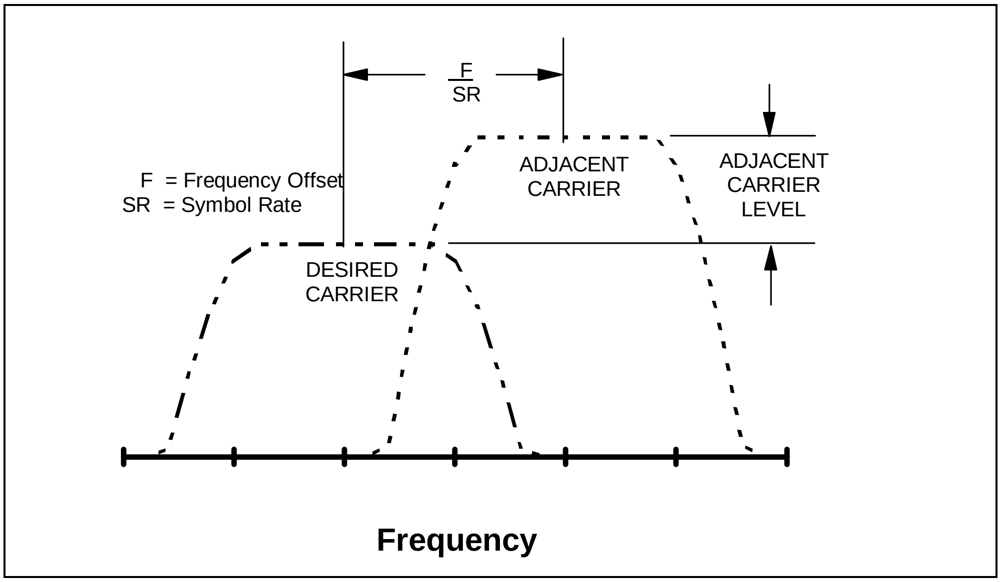

Figure 2. Normalized Carrier Spacing and Level

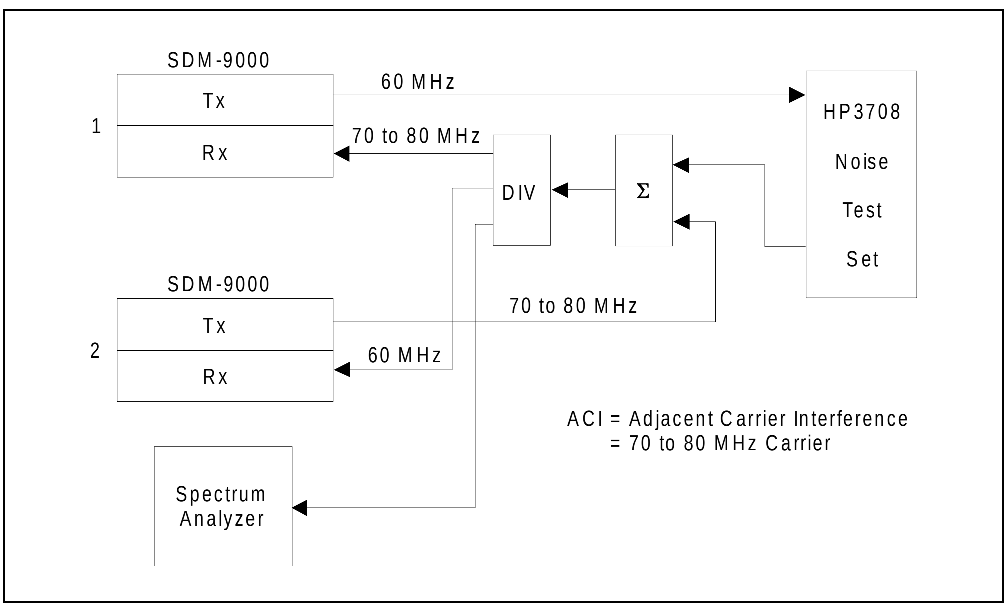

Figure 3. Adjacent Carrier Test Setup

Key Test Considerations

1. Degradation is measured relative to a reference point, not the specification limit. This is important because modem performance is typically 0.5 dB better than specification, so, usually 1 dB or more of degradation accrues from the reference point before the specification limit is reached.

2. The test is conducted with the modems connected through test equipment at IF.

3. The E_b/N_0 measurement for degradation was based upon the modems internal E_b/N_0 indicator. This is done in the interest of making timely measurements, and because this indicator shows good correlation with other methods.

4. Two SDM-9000 modems with 70/140 MHz IF and 34.368 Mbit/s data rate, G.703 interface, and no IDR (Intelsat IESS-308) overhead was used for the test with the following modulation and coding parameters:

   a. 8PSK R5/6 + 192/208 RS (i.e., concatenated 5/6 Viterbi decoding and 192/208 Reed-Solomon)
   b. 16QAM R3/4 + 192/208 RS.

   The interleaving depth in both cases is 4 per IDR. The remaining parameters are shown in Figures 4 and 5.

Interpretation of Degradation

Refer to Figures 4 and 5.

1. One or two adjacent carriers: Two adjacent carriers each operating at 0 dB relative to the desired carrier (similar to Figure 1) exhibit the same performance as one adjacent carrier operating on the curve labeled 3 dB in the figures. Similarly, a single adjacent carrier at 10 dB greater than the desired carrier corresponds to two adjacent carriers each 7 dB greater than the desired carrier.

2. The figures typify a transponder loaded with two high rate carriers. In actual operation, both carriers are set to the same power level, so the 0 dB curve in the figures is representative of expected performance excluding the effects of the transponder which include:

   a. Non-linear compression effects due to the transponder operating near saturation.

   b. Increased degradation due to transponder bandwidth limitations and the impact of its band edge amplitude and phase distortion on the transmitted spectrum as it passes through the transponder’s frequency muxes. Impairment increases as the transmitted spectrum is moved closer to the edge of the transponder.

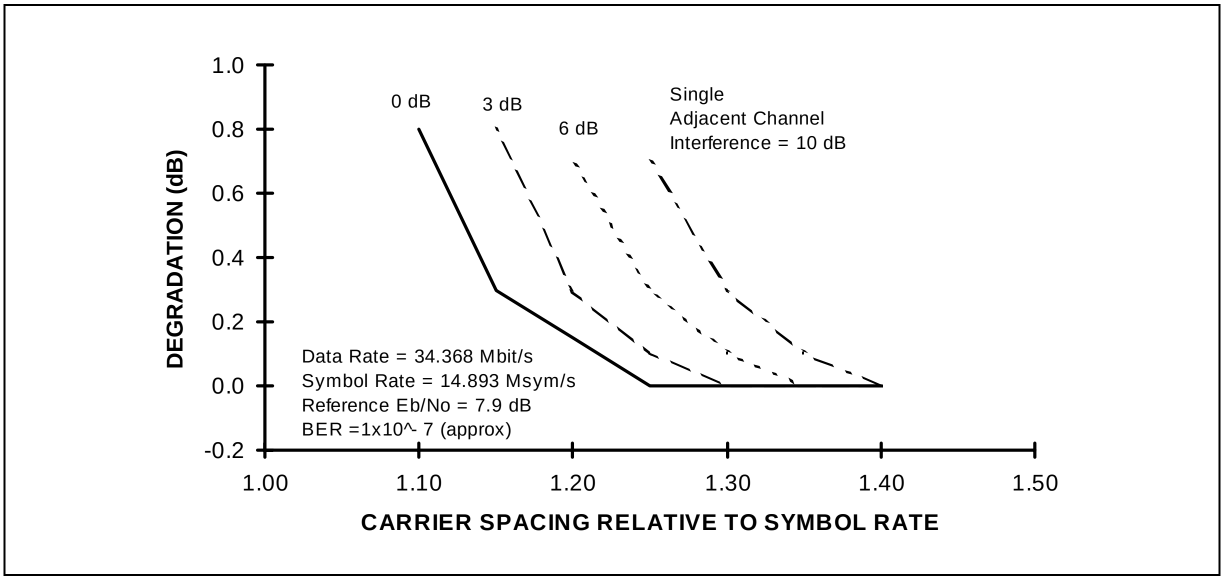

Figure 4. E_b/N_0 Degradation (vs) Relative Carrier Spacing
SDM-9000 8PSK, R5/6 + 192/208 RS

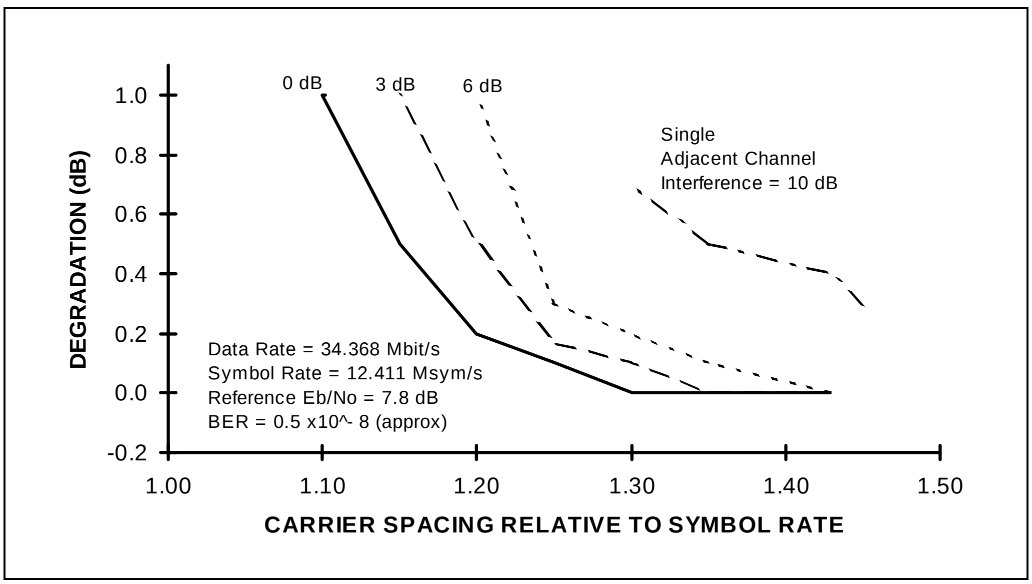

Figure 5. E_b/N_0 Degradation (vs) Relative Carrier Spacing
SDM-9000 16QAM, R3/4 + 192/208 RS

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