Multi-Carrier Performance of the CST-5000 Terminal with the SDM-8000 Modem

Application Note

Performance data for an RF terminal is normally recorded with continuous wave (CW) carriers to standardize testing and ensure repeatable conformance to specifications. However, the units are commissioned for the transmission of modulated carriers resulting in a gap between test conditions and actual use. Providing additional Radio Frequency Terminal (RFT) characterization data based upon modulated carriers fills in the gap and simplifies the task of system designers who must establish the operating limits for the links they design.

Additional characterization testing was conducted on a 40W CST-5000 C-band terminal in conjunction with the SDM-8000 modem to supply typical performance information under operating conditions. Testing includes:

- Output (vs) Input backoff characteristic curve for the RFT with a single CW, single modulated carrier, and two CW tones.
- Spectral re-growth of carriers as saturation is approached for both single and multiple modulated carriers.
- Residual E_b/N_0 effects for single and multiple modulated carriers near compression.
- CW two tone 3rd order intermodulation products (vs) versus input backoff.

The modulated carrier tests were conducted with three types of carriers: QPSK, 8PSK, and 16QAM.

DETAILS

The item tested is a 40W CST-5000 RFT. Because transmit chain of the RF terminals is designed so that the output amplifier determines saturation performance, the data is also typical of terminals with different power ratings. Refer to Figure 1 for a diagram of the test setup.

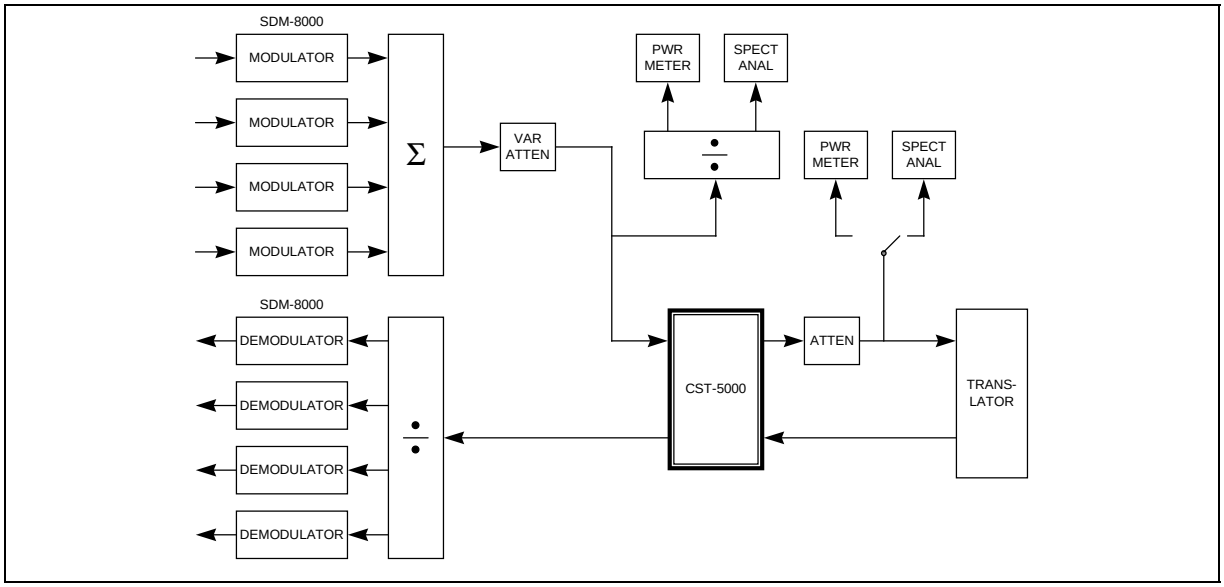

Figure 1. Test Setup

Test Comments

The modem is configured to operate with an IDR carrier at a data rate of 2048 + 96 (OH) = 2144 kbit/s (SDM-8000). Testing is conducted for several modulation and coding schemes:

1. The 1 dB compression point of the RF Terminal is calibrated using a sine wave and noting the corresponding input power level to establish the 0 dB input backoff reference point. The operating power level for either 1 or 4 modulated carriers is set as follows:

   The total Tx power into the RF terminal is set to the same 0 dB reference level and all measurements are taken relative to that point by varying the input backoff.

2. The data is taken relative to input backoff because this is more readily controlled in practice. The 0 dB input backoff corresponds to actual 1 dB compression point (46.9 dBm) of the 40W SSPA, not its rated power (46 dBm). Three plots of output versus input backoff are shown for a single CW carrier:

   a. For a signal modulated carrier in Figures 2.a and 2.b.
   b. For two CW tones in Figure 2.c.

3. Carrier spacing is 1.4 x Symbol Rate as indicated below:

Modulation and Code Rate	Symbol Rate (SR) Ksym/s	Carrier Spacing (KHz)
QPSK R3/4 + RS	1429.3	2000
8PSK R2/3 + RS	1168.0	1624
16QAM R3/4 + RS	778.7	1090

   Figure 3 illustrates the shoulder level for each of these modulation schemes for both a single carrier case and a four carrier configuration.

   Note: The shoulder levels for the different modulation types are virtually indistinguishable in the multiple carrier case. Figures 6 through 9 show the shoulders as they appear on a spectrum analyzer.

4. The residual E_b/N_0 measures the effect off compression on the modem with no noise present. This E_b/N_0 is the value read from the modem when it is locked to the carrier from the SSPA and represents the degradation caused by the carrier intermodulation products. There is no degradation (E_b/N_0 > 16 dB) when the test is conducted with a single carrier. The residual E_b/N_0 is shown in Figure 4.

5. The level of 3rd order intermodulation products as a function of input backoff is depicted in Figure 5. The 0 dB input level represents to two equal power CW carriers whose total combined input power produces the 1 dB output compression point.

The attached spectral plots show the regenerated “shoulders” observed at the output of the CST-5000 SSPA at the 1 dB compression point.

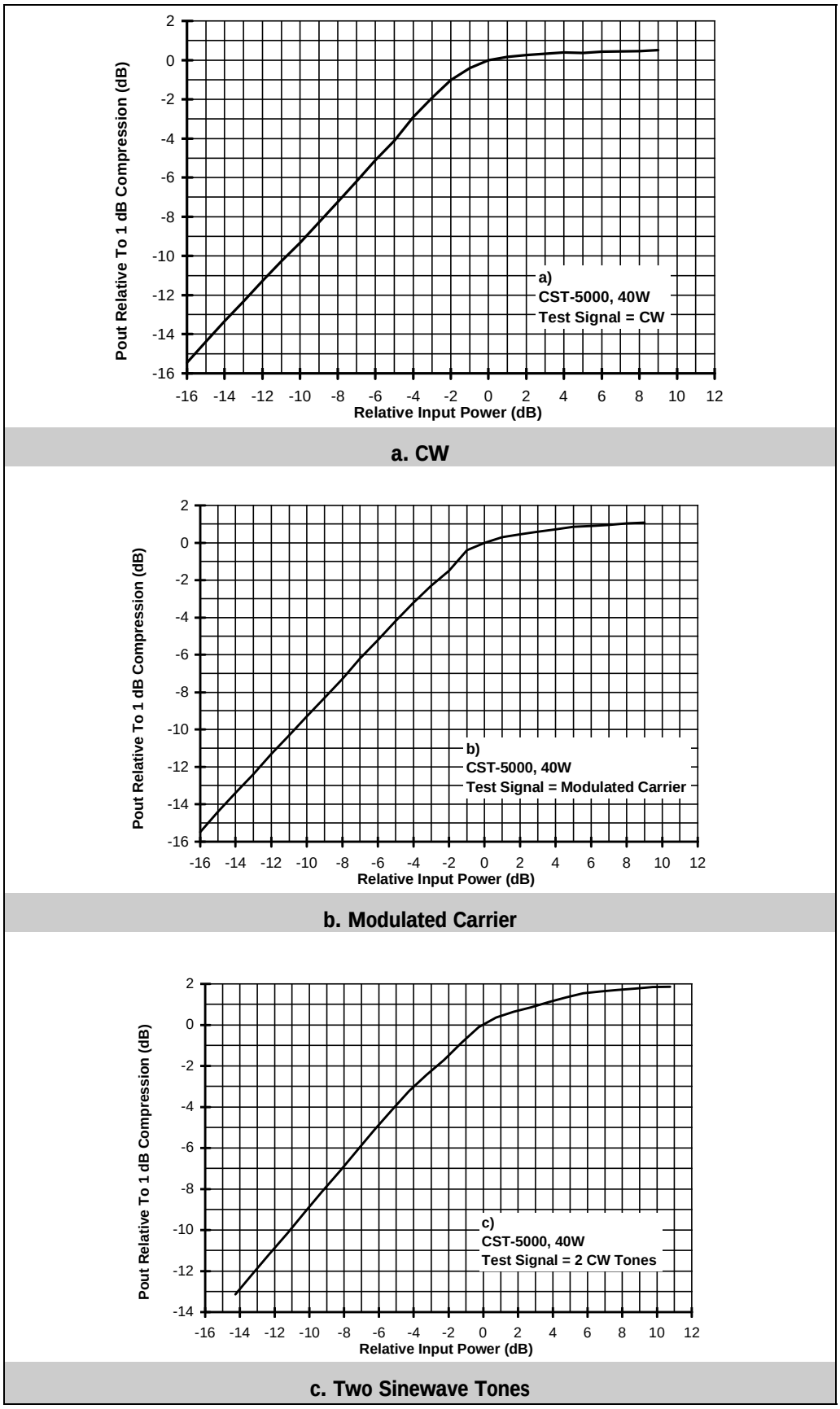

Figure 2. Output Backoff (vs) Input Backoff

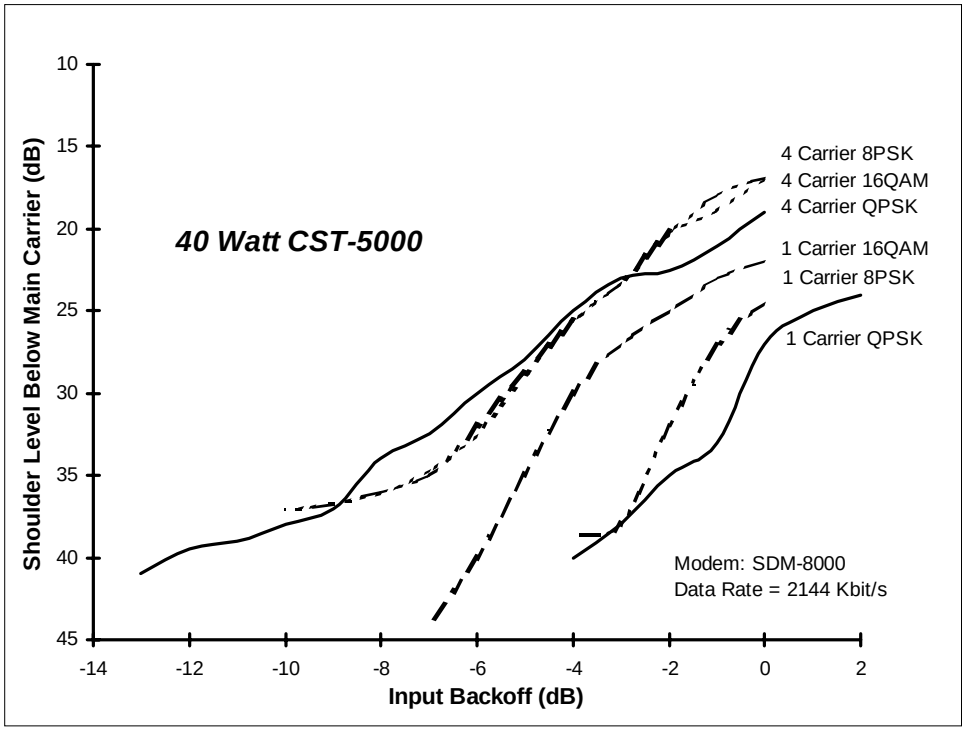

Figure 3. Shoulder Level (vs) Input Backoff

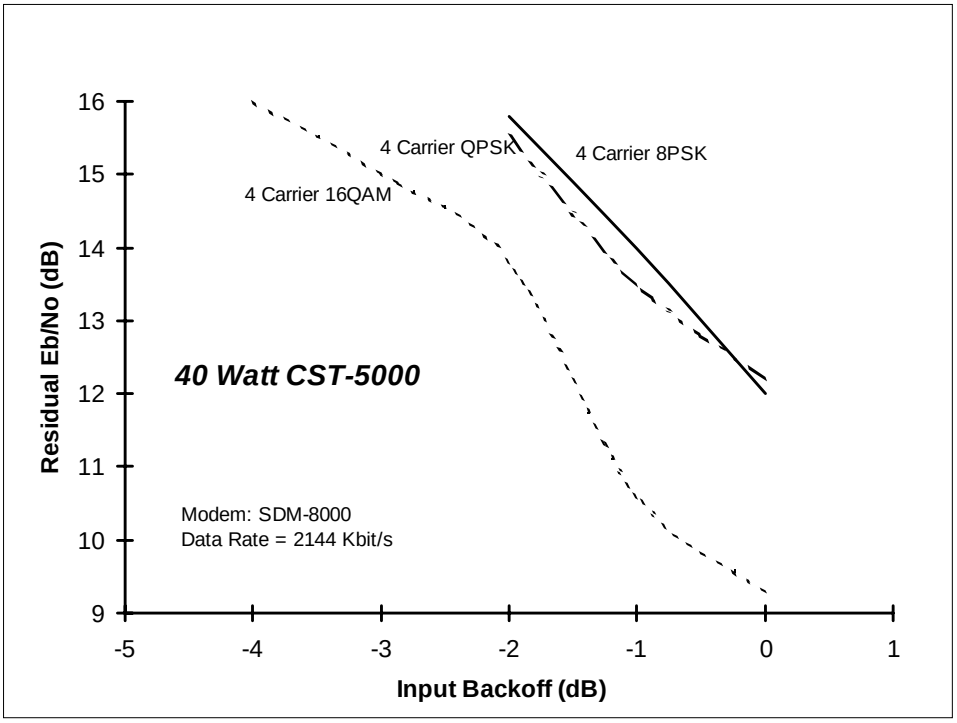

Figure 4. Residual E_b/N_0 (vs) Input Backoff

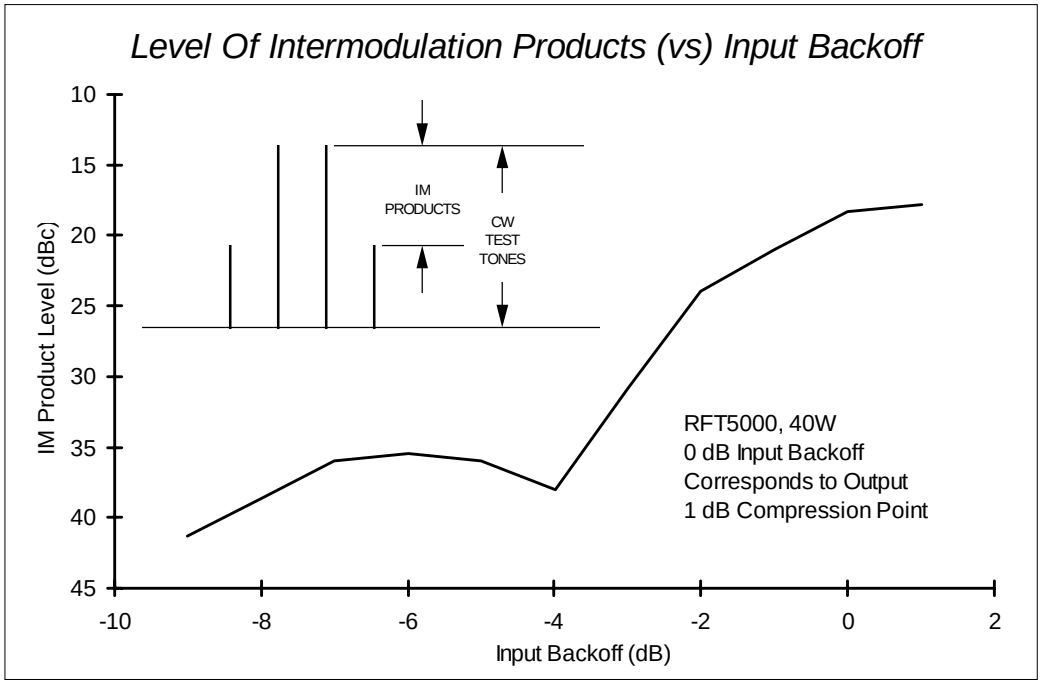

Figure 5. Intermodulation Products (vs) Input Backoff

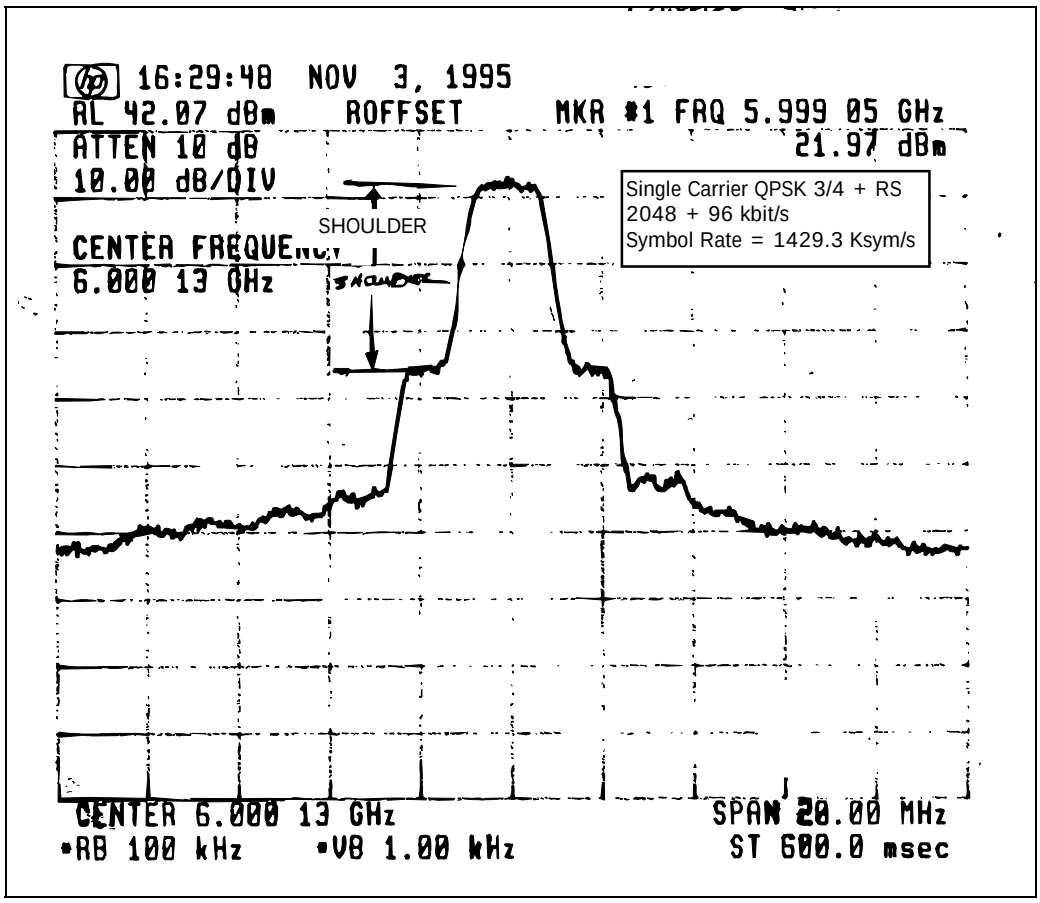

Figure 6. Single Carrier QPSK

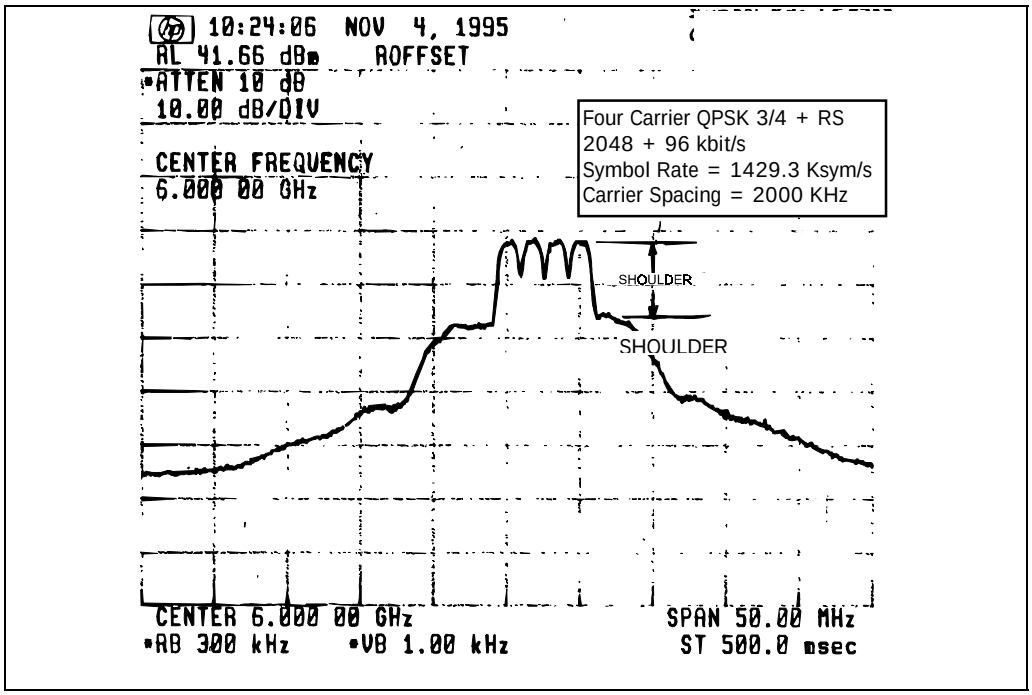

Figure 7. Four Carrier QPSK

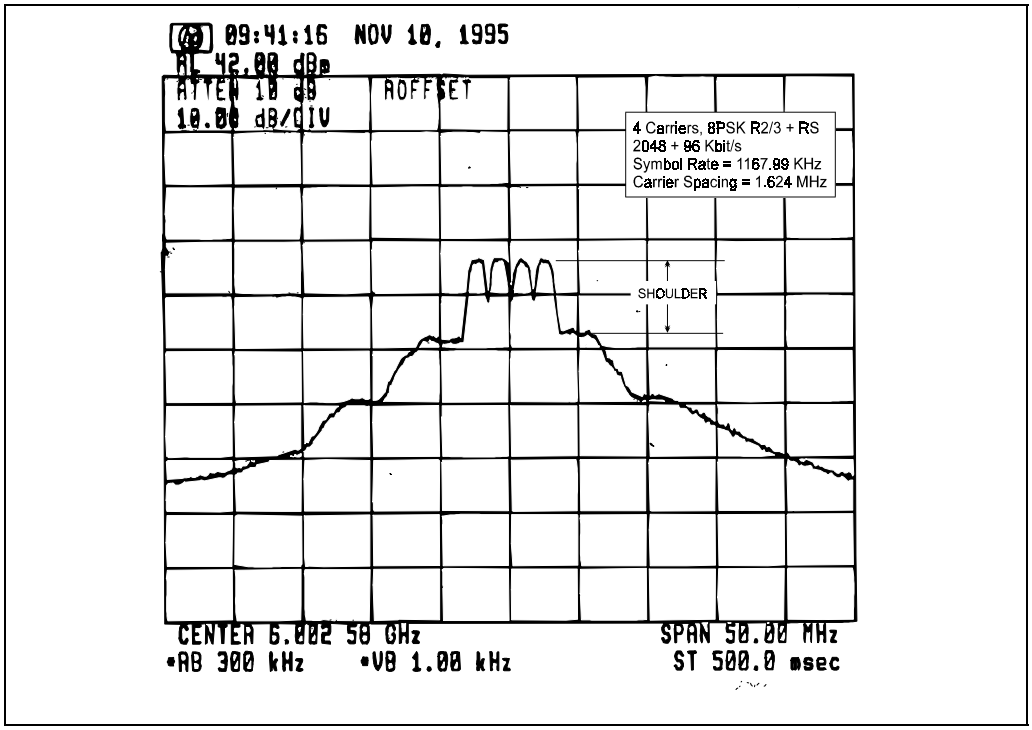

Figure 8. Four Carrier 8PSK

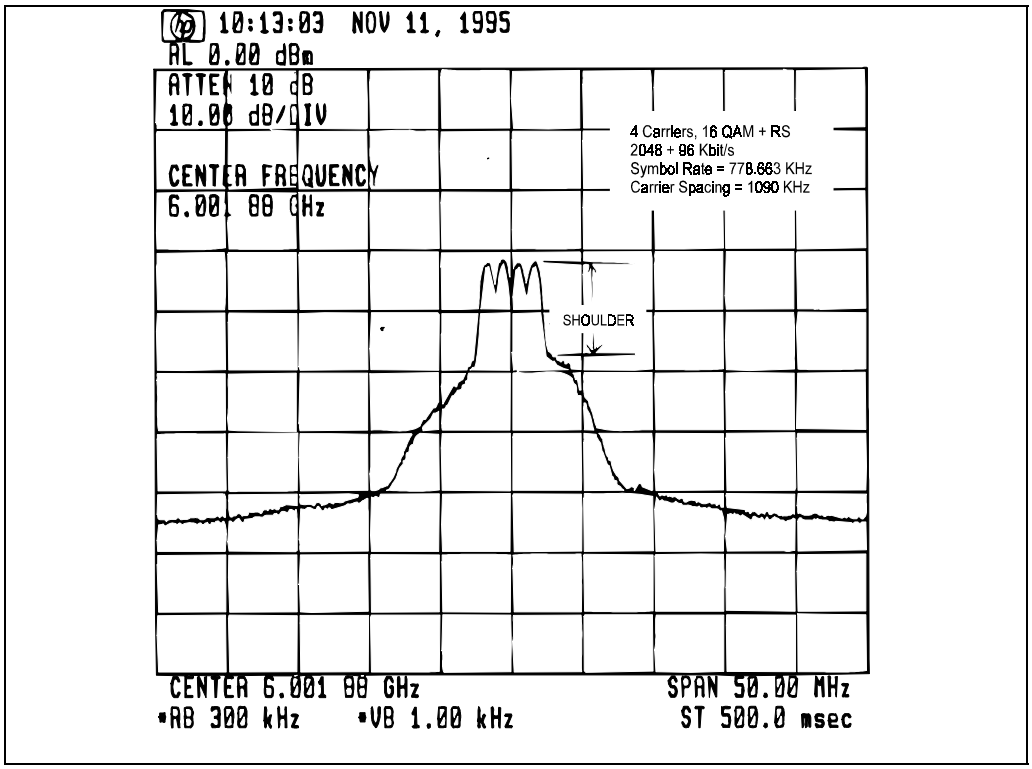

Figure 9. Four Carrier 16QAM

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