Transmit

Silicon DSP Corporation

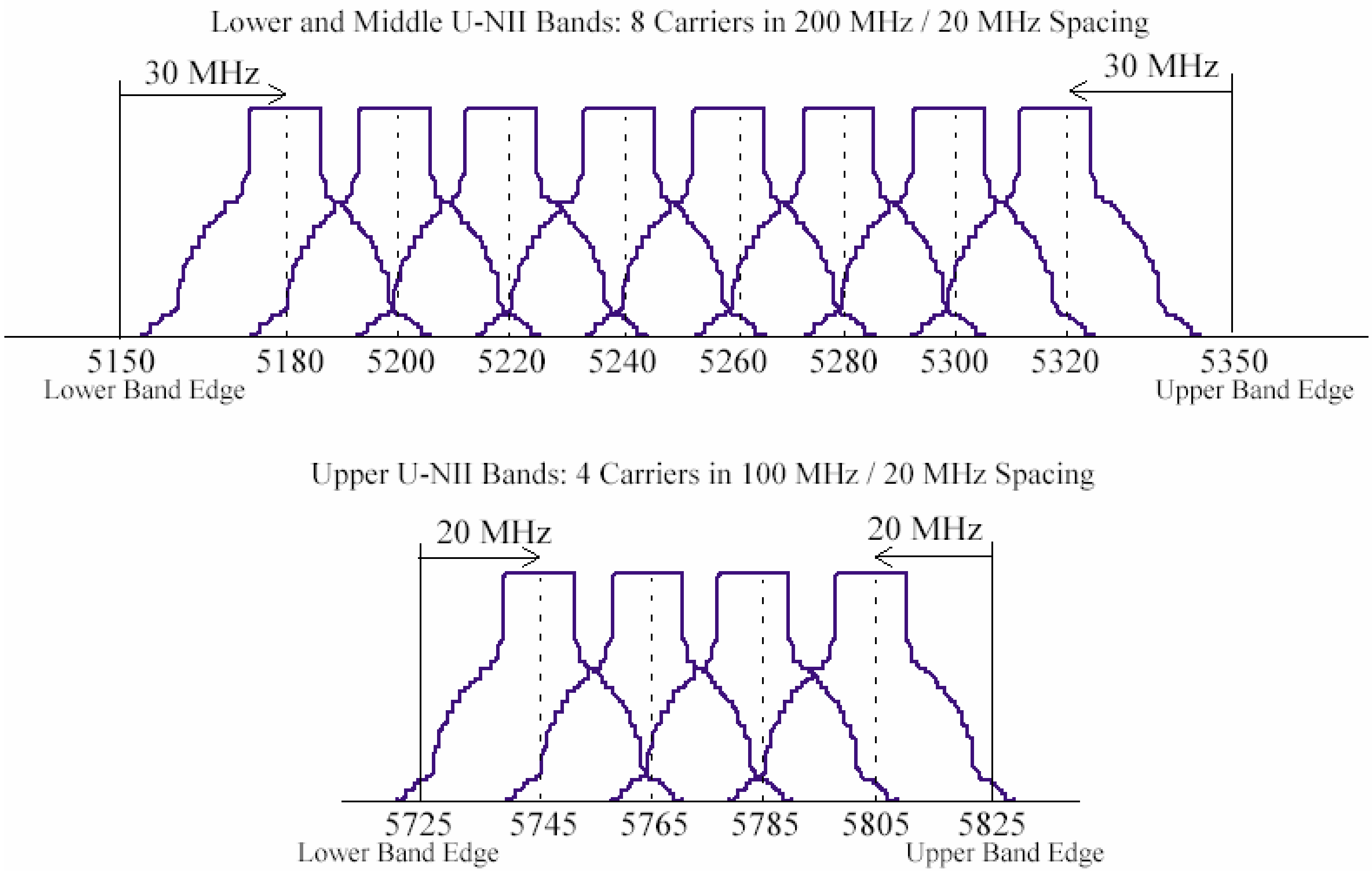


Figure 119—OFDM PHY frequency channel plan for the United States

Table 89—Transmit power levels for the United States

Frequency band (GHz)	Maximum output power with up to 6 dBi antenna gain (mW)
5.15–5.25	40 (2.5 mW/MHz)
5.25–5.35	200 (12.5 mW/MHz)
5.725–5.825	800 (50 mW/MHz)

Transmit Spectrum Mask

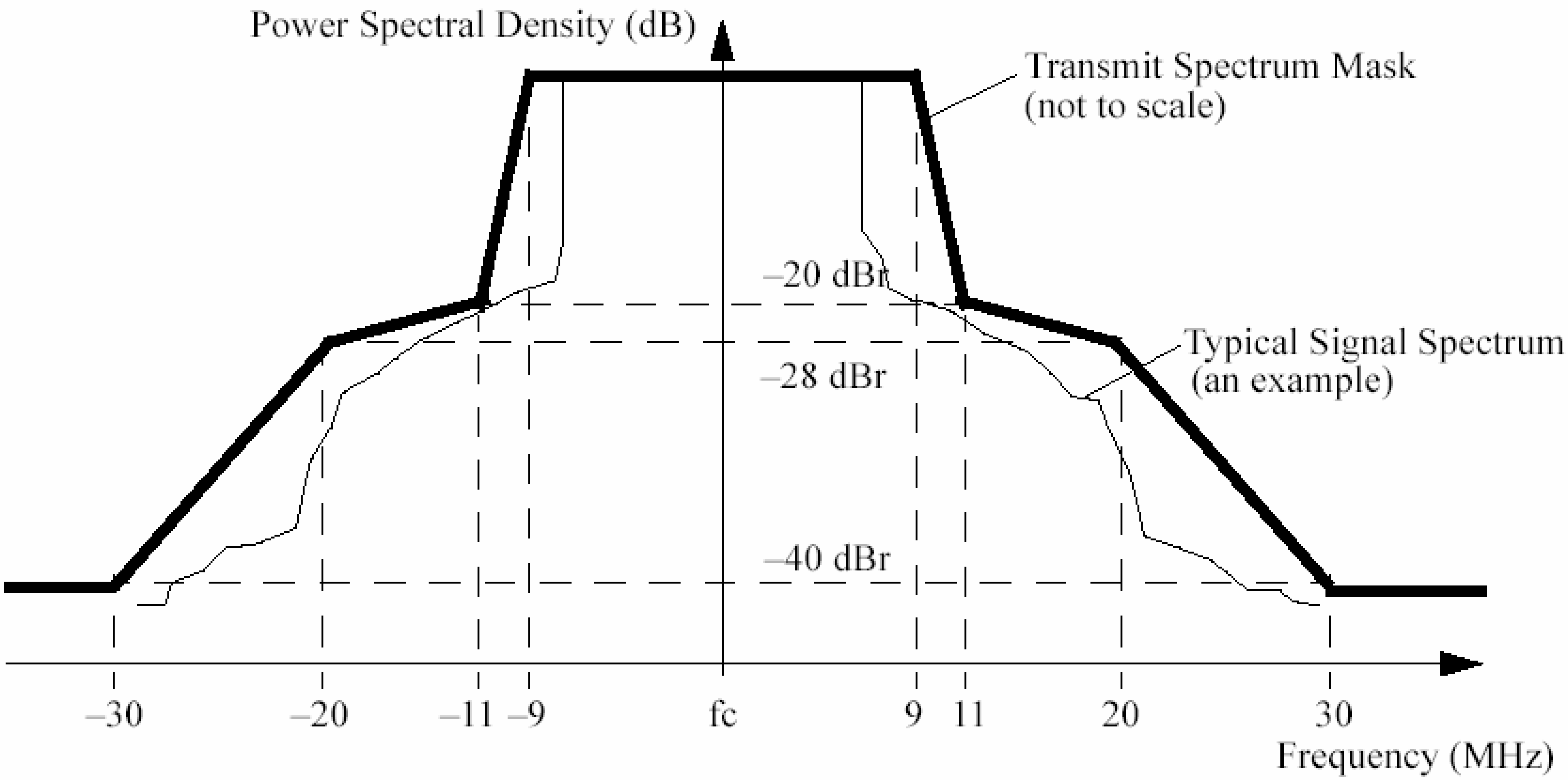
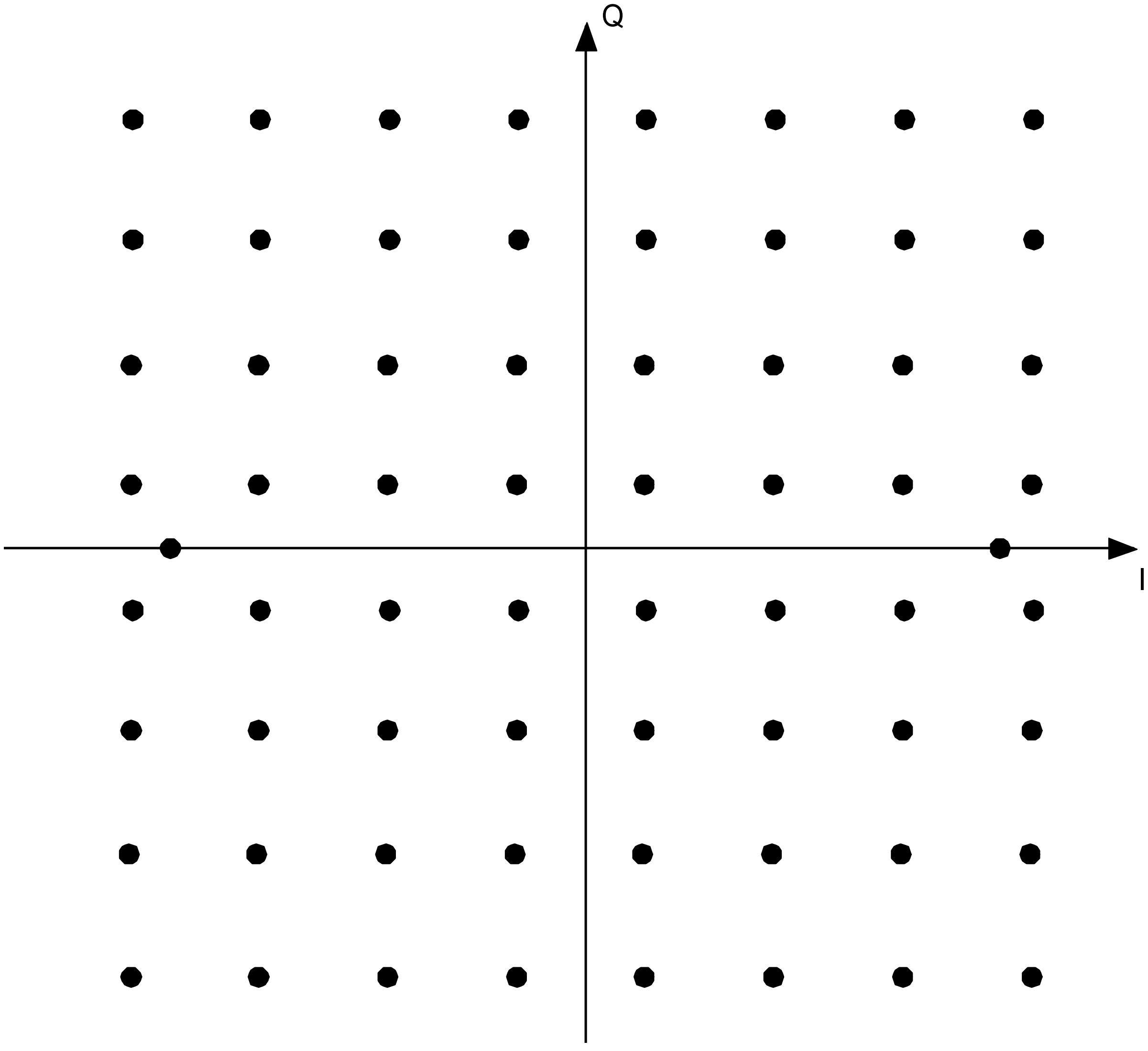


Figure 120—Transmit spectrum mask

Transmit EVM

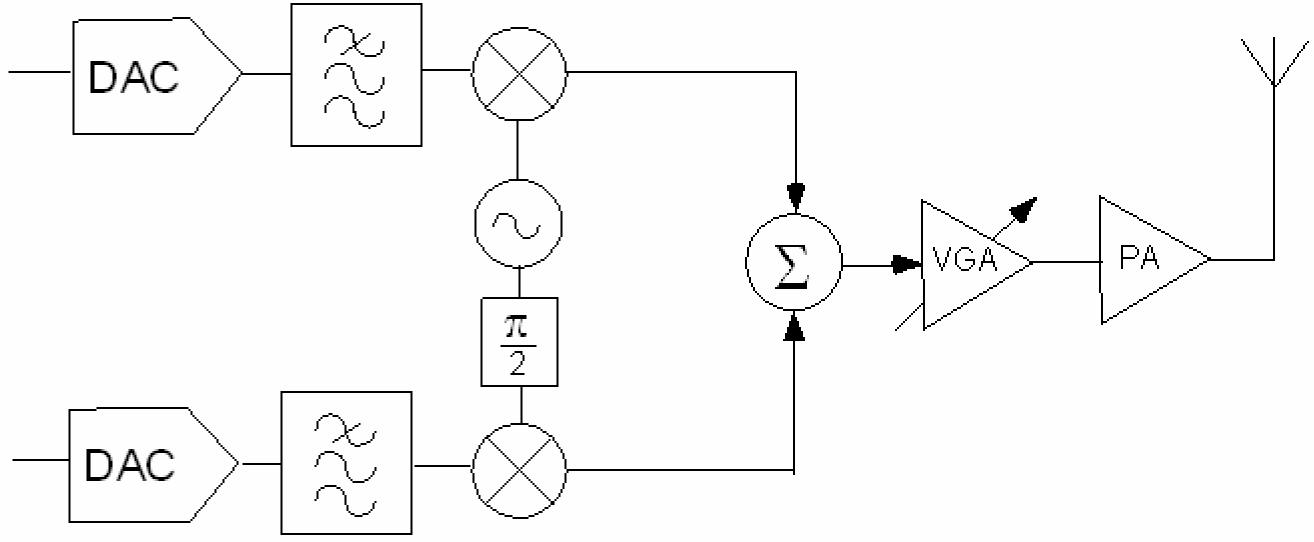
Table 90—Allowed relative constellation error versus data rate

Data rate (Mbits/s)	Relative constellation error (dB)
6	–5
9	–8
12	–10
18	–13
24	–16
36	–19
48	–22
54	–25



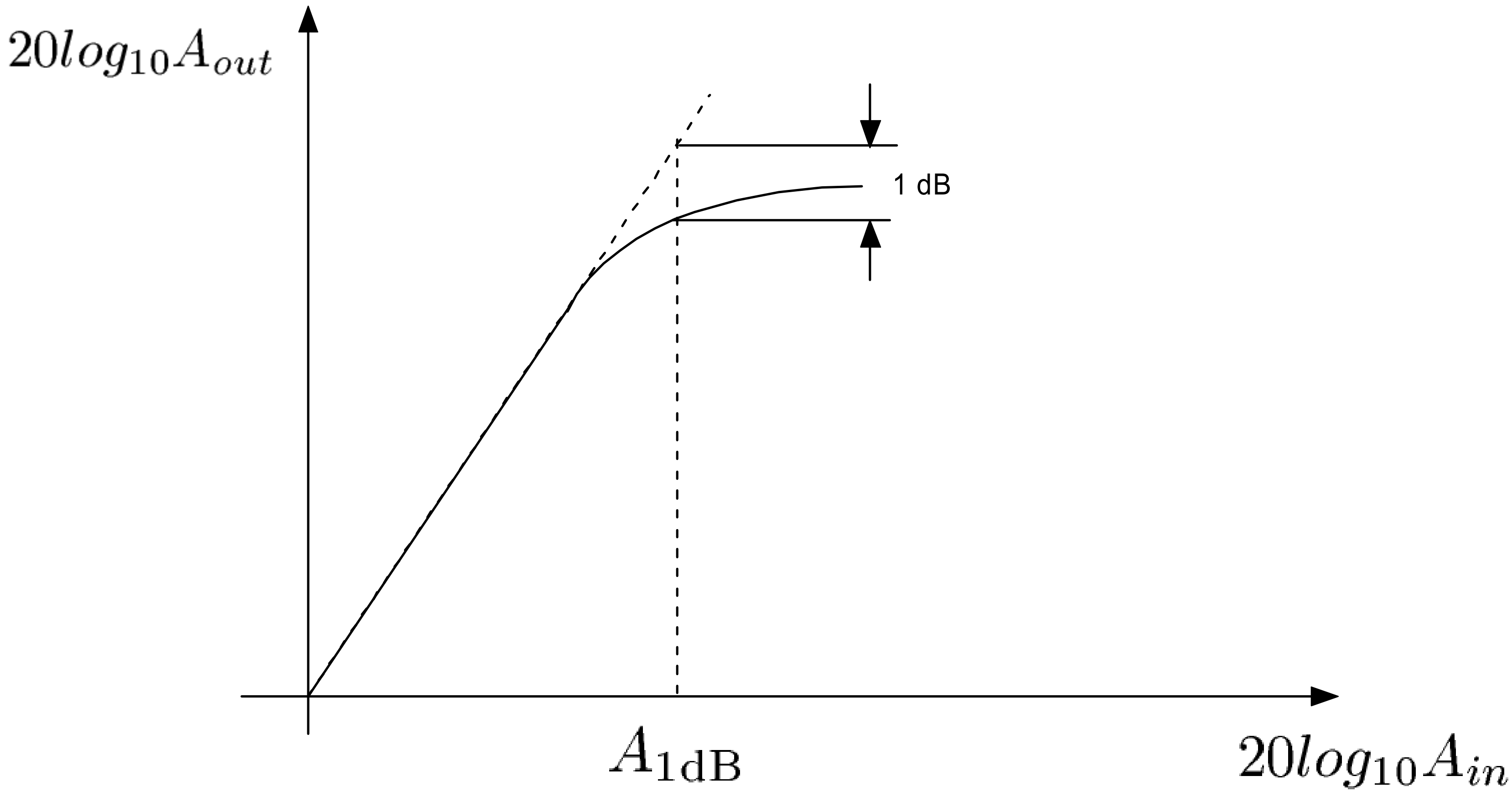
Q
I

RF Transmitter

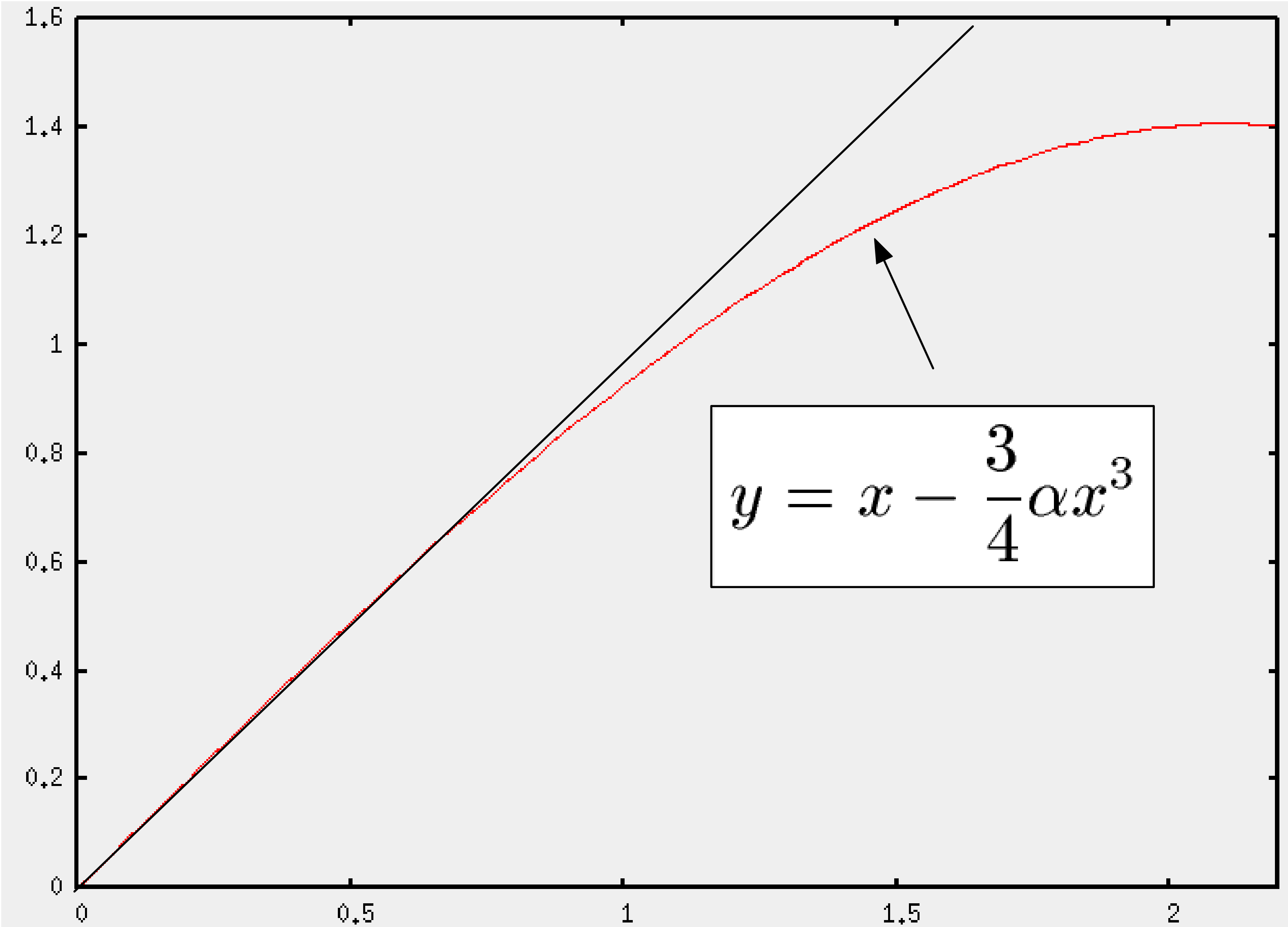


- The linearity of the PA is a key parameter as it is closely related to power consumption and to distortion, hence BER.

- The PA is quantified by its input-referred third-order intercept point IIP3 or 1 dB-compression point for a given average RF input power.



$$y(t) = G\left(x(t) - \alpha x^3(t)\right)$$



$$\alpha = 0.1$$

$$y(t) = G\left(x(t) - \alpha x^3(t)\right)$$

$$y(t) = G(A\cos\omega t - \alpha A^3 \cos^3 \omega t)$$

$$\cos^3 \alpha = \frac{1}{4}(\cos 3\alpha + 3\cos\alpha)$$

$$y(t) = G(A\cos\omega t - \alpha A^3 \frac{3}{4}\cos\omega t + ...)$$

$$y(t) \approx AG(1 - \frac{3}{4}\alpha A^2)\cos\omega t$$

$$\text{Gain} = G(1 - \frac{3}{4}\alpha A^2)$$

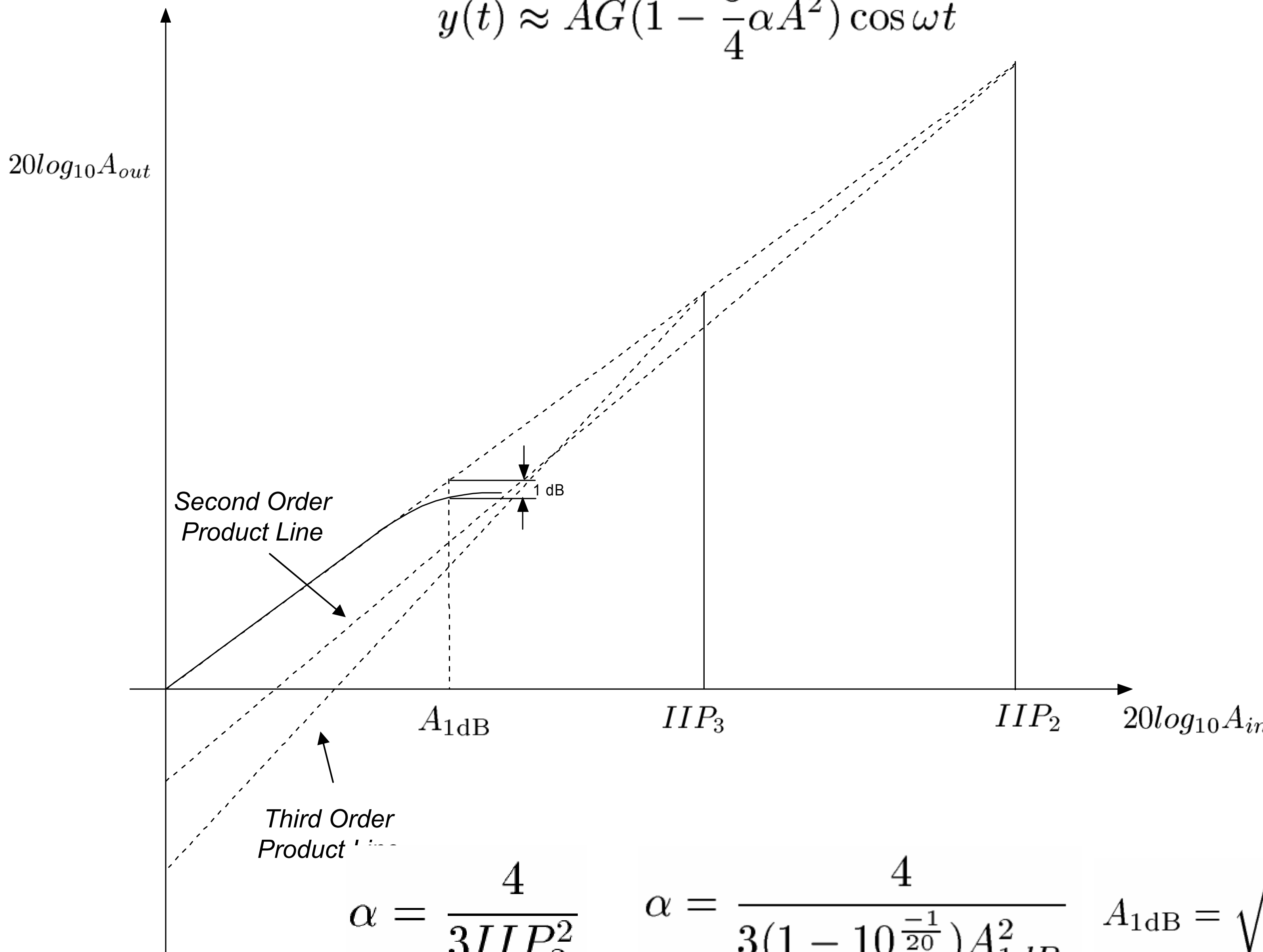
$$A_{1\text{dB}} = \sqrt{0.145|\frac{1}{\alpha}|}$$

$$\frac{\text{Gain}}{G} = (1 - \frac{3}{4}\alpha A^2)$$

$$20log_{10}(1 - \frac{3}{4}\alpha A^2_{1dB}) = -1\ \text{dB}$$

IIP3=input-referred third-order intercept point

$$y(t) \approx AG(1 - \frac{3}{4}\alpha A^2)\cos\omega t$$



$$\alpha = \frac{4}{3IIP_3^2} \quad \alpha = \frac{4}{3(1-10^{\frac{-1}{20}})A_{1dB}^2} \quad A_{1\mathrm{dB}} = \sqrt{0.145|\frac{1}{\alpha}|}$$

Reference

“Impact of front-end non-idealities on Bit Error Rate performance of WLAN-OFDM transceivers”, Come, et. Al, IMEC, IEEE 2000.

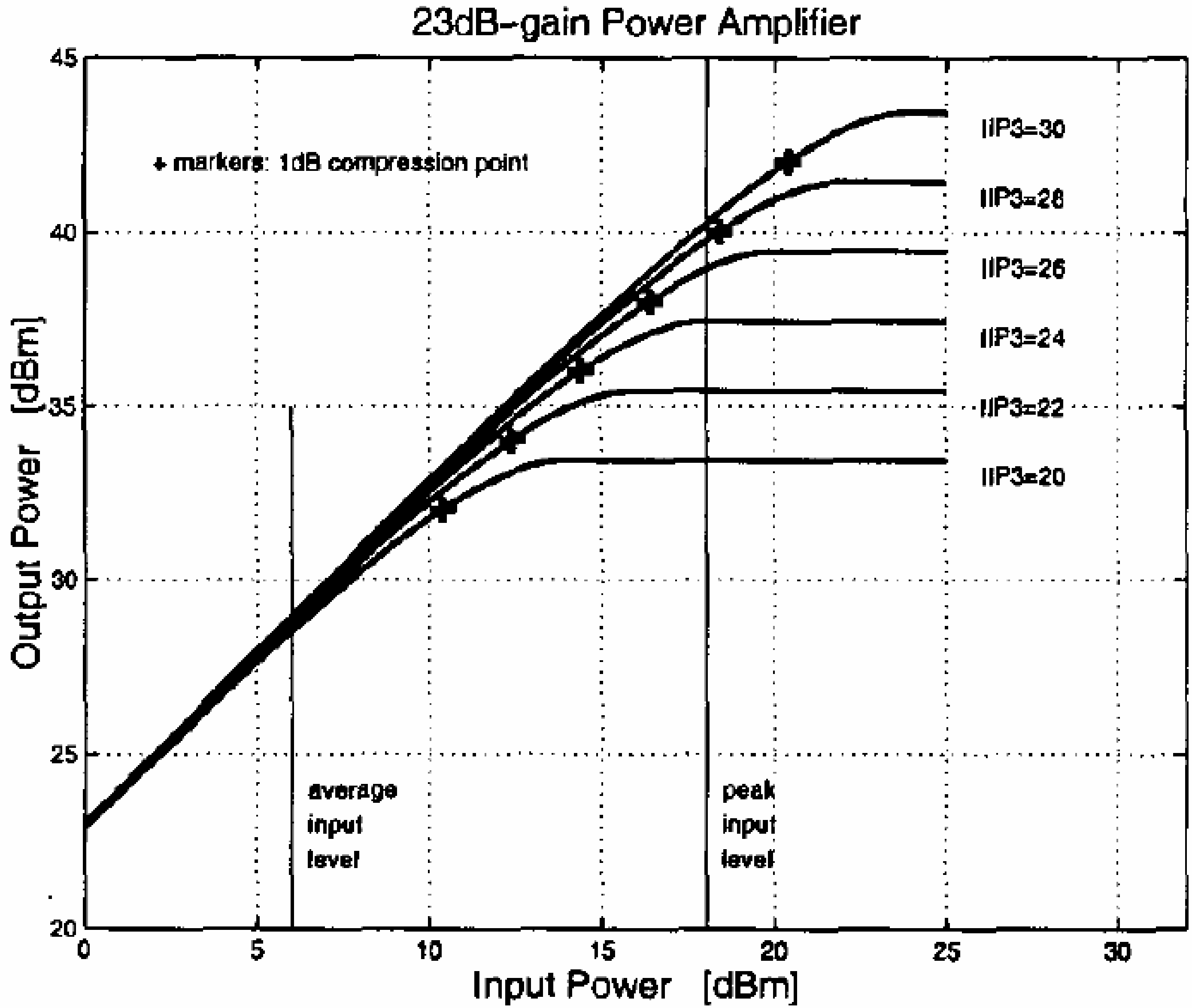


Figure 4: For an input signal clipped at 4σ and with +6dBm average power, the power amplifier is driven up to the limit of saturation for IIP3 < +24dBm.

Backoff

$$b = 20log_{10}\left(\frac{U_{1\mathrm{dB}}}{\overline{\overline{U}}_{in,mag,av}}\right)$$

- Influences the Transmit signal spectrum
- Influences the Efficiency of the Power Amplifier
- Backoff Should be as Low as Possible in Order to Maximize Efficiency
- Example 5 dB
- Run Simulations with BER versus SNR

Transmit Spectrum Mask

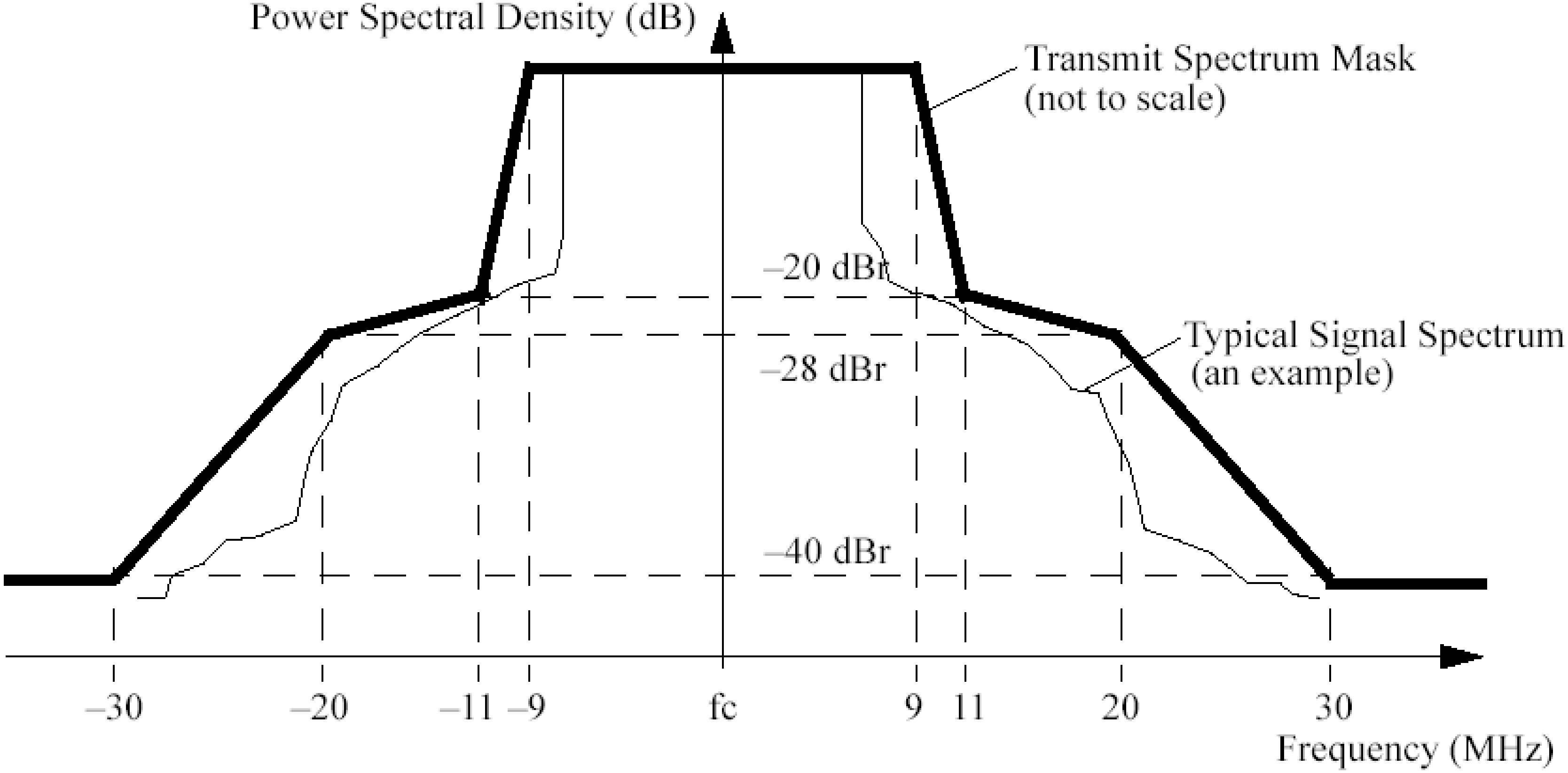
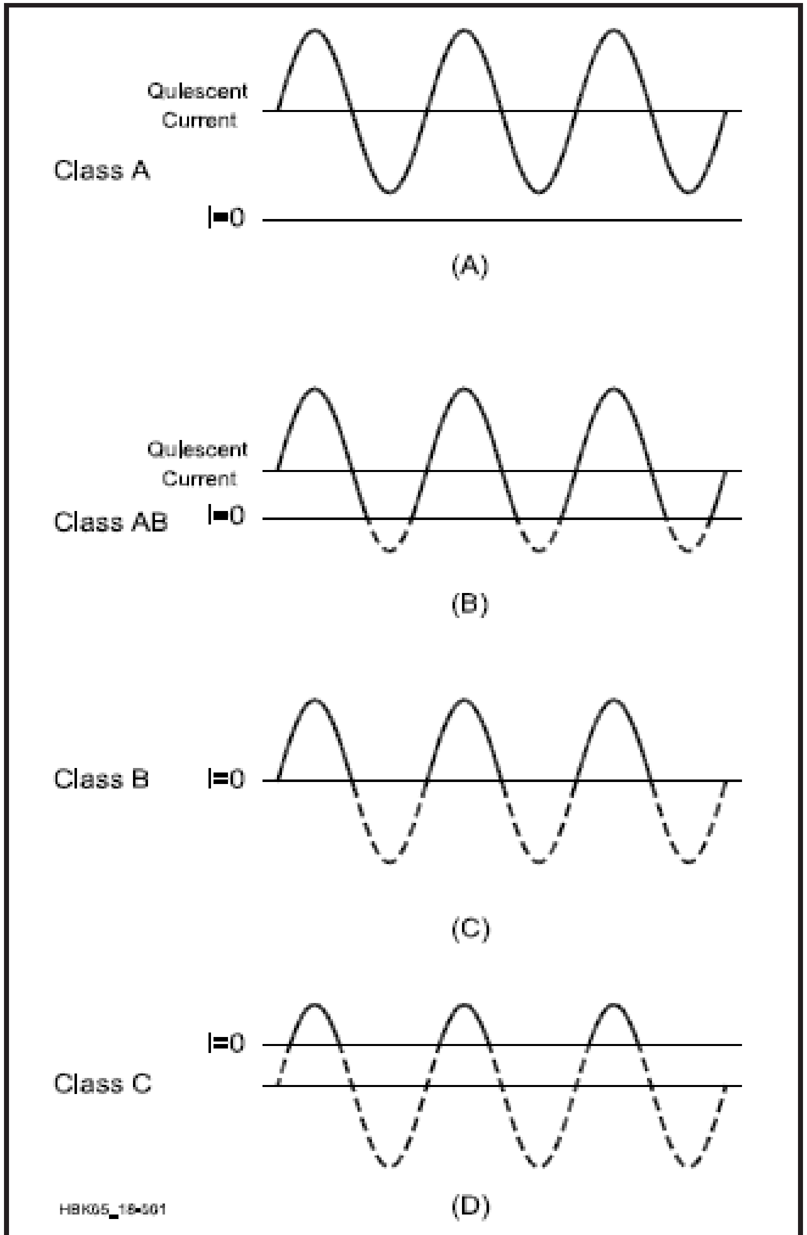


Figure 120—Transmit spectrum mask



Class A: The conduction angle is 360º. DC bias and RF drive level are set so that the device is not driven to output current cutoff at any point in the driving-voltage cycle, so some device output current flows throughout the complete 360º of the cycle .

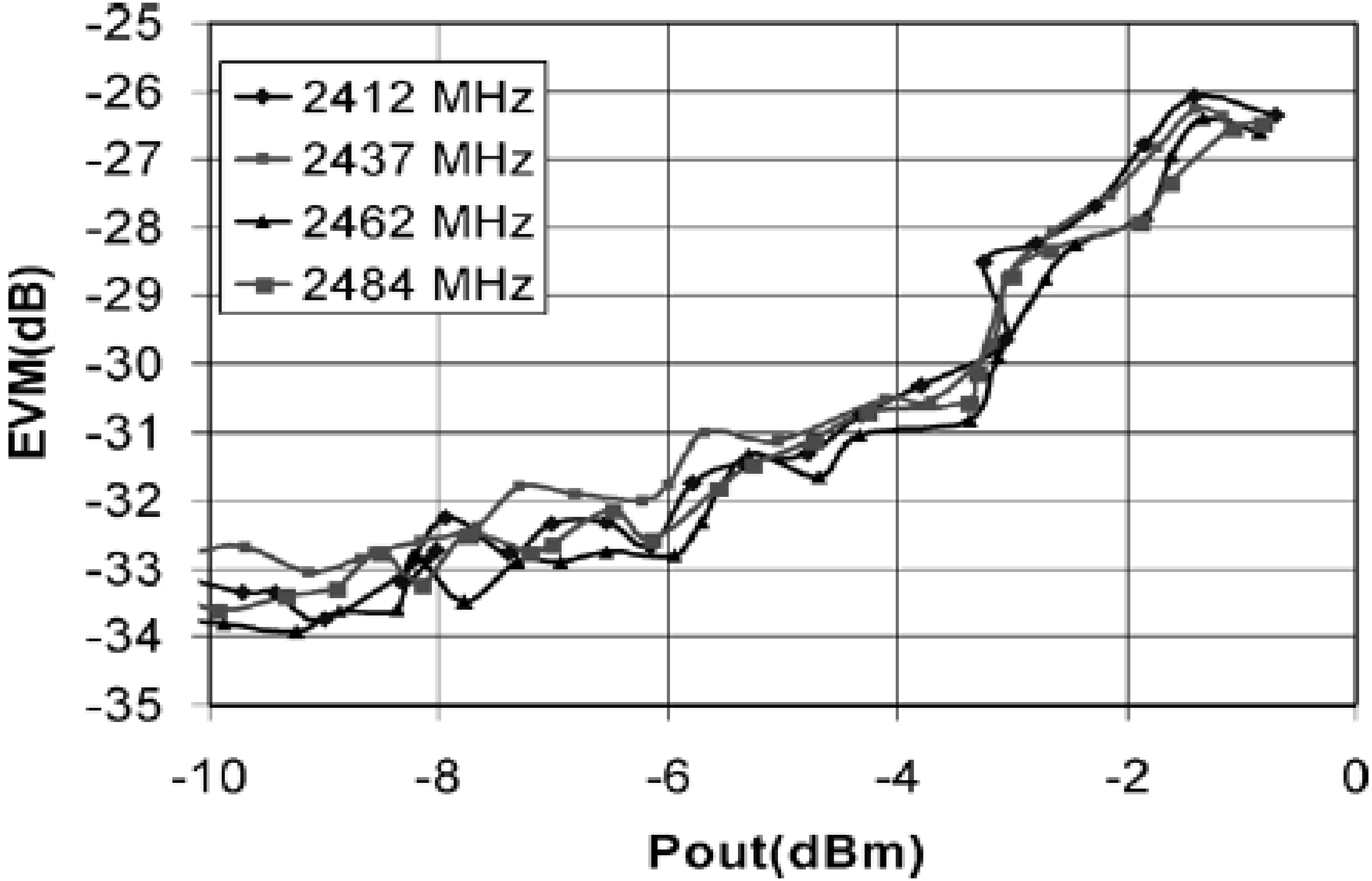
Maximum linearity and gain are achieved in a Class A amplifier, but the efficiency of the stage is low. Maximum theoretical efficiency is 50%, but 25 to 30% is more common in practice.

Class AB: The conduction angle is greater than 180º but less than 360º . In other words, dc bias and drive level are adjusted so device output current flows during appreciably more than half the drive cycle, but less than the whole drive cycle.

Efficiency is much better than Class A, typically reaching 50-60% at peak output power. Class AB linearity and gain are not as good as that achieved in Class A

SRC: ARRL Handbook 2006

EVM vs Output Power

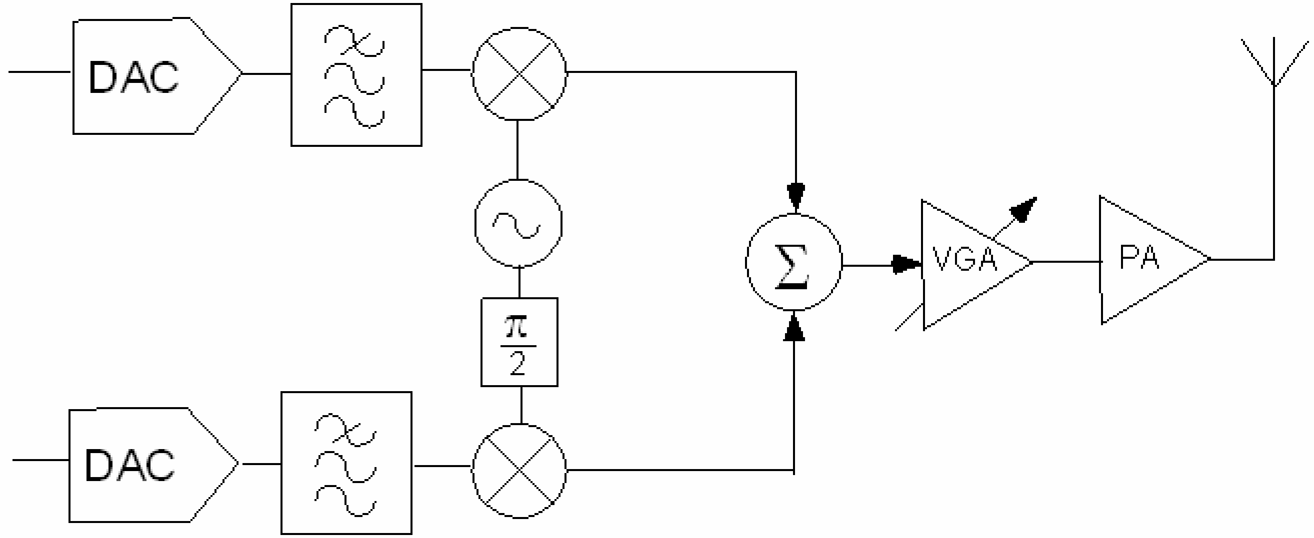


“An 802.11g WLAN SoC”, Srenik S. Mehta,et. Al.,IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 36, NO. 11, NOVEMBER 2001

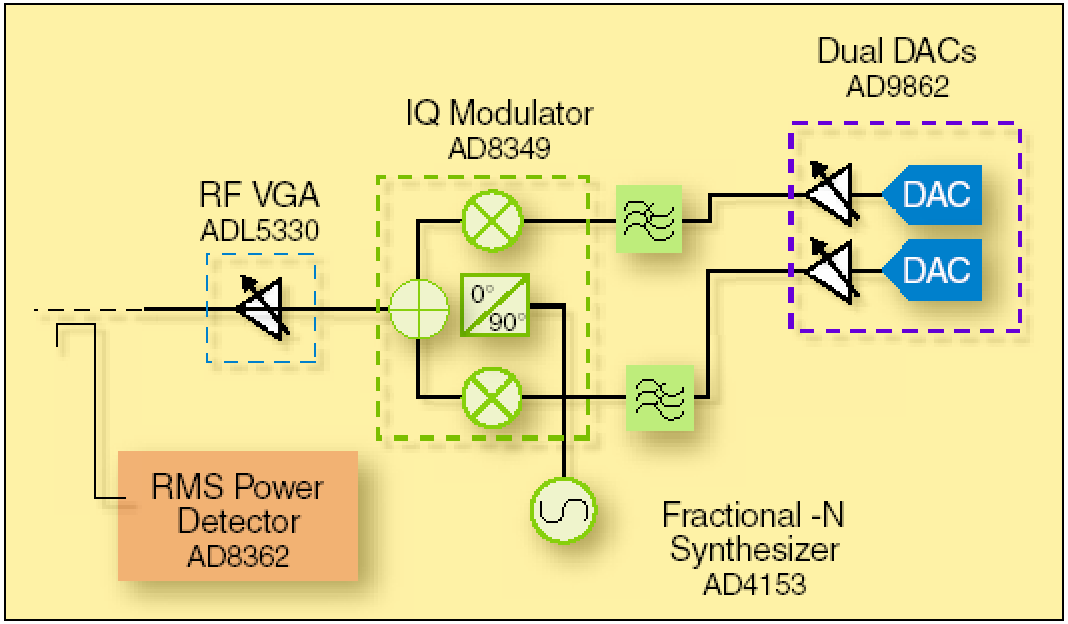
I/Q imbalance results from two effects:

- Gain mismatch between I and Q paths
- Non-perfect quadrature generation

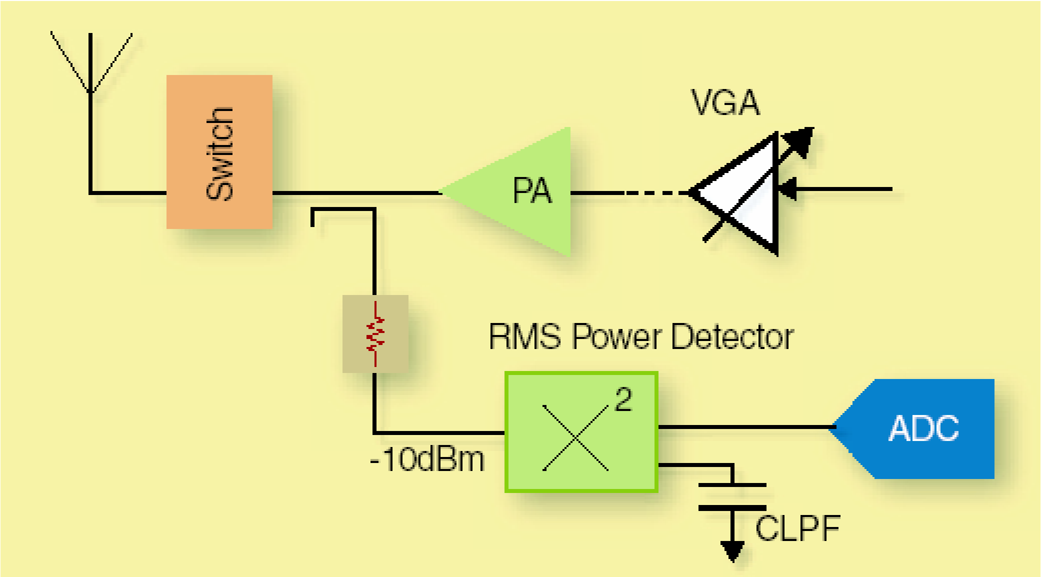
RF Transmitter



A Direct-Conversion Transmitter for WiMAX and WiBro Applications



Cecile Masse, A direct-conversion transmitter for WiMAX and WiBro applications, www.rfdesign.com January 2006



Switch
PA
VGA
RMS Power Detector
2
-10dBm
ADC
CLPF