S-26.2350 Parts of Radiocommunications Systems

Examination 7.3.2011, at 9–12, room S1 (A102)

Maximum points in part A 3×5 = 15
Maximum points in part B 3×5 = 15

Part A, at 9:00–10:30
Use of literature or own notes is *not* allowed in part A!

1. Explain briefly the following terms:
a) polarisation diversity
b) *k*-factor
c) OFDM

2. Compare the suitability of the frequency bands around 30 MHz, 1 GHz and 30 GHz for different radio communications systems. I.e. explain why some frequencies are more suitable for certain radio communication systems.

3. How do we (typically) model non-linearity of components in radio systems, how does the non-linearity appear, and what problems does is cause in radio systems? How can the non-linearity be taken advantage of?

You can start part B already at 10:00 if you wish.

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Part B, at 10:30–12:00
Use of literature and own notes is allowed in part B.

1. Let's consider a 16QAM signal.
   a) Two symbols are transmitted, one with the largest possible and one with the smallest possible symbol power. What is the power ratio between these two?
   b) What is the average power P_{ave} of the 16QAM signal? What is the minimum required ratio of P_{ave} and an interfering signal, to realize a data transfer without error. (*Hint:* You need to consider only one quarter of the constellation diagram.)

2. Two amplifiers are connected in series with an attenuator between them (Fig. 1a). The 3rd-order intermodulation (IM) product (measured at the antenna port) shall be 40 dB below the signal level (Fig. 1b). The output power of the first amplifier is (fixed) P_{out} = +5 dBm, and the first amplifier is assumed ideal. For the second amplifier we have OIP_3 = 40 dBm and G = 20 dB.
   a. Determine the required attenuation L to ensure the given 3rd-order IM level.
   b. How much below the 1-dB compression point is the amplifier operating (in *a.*)?

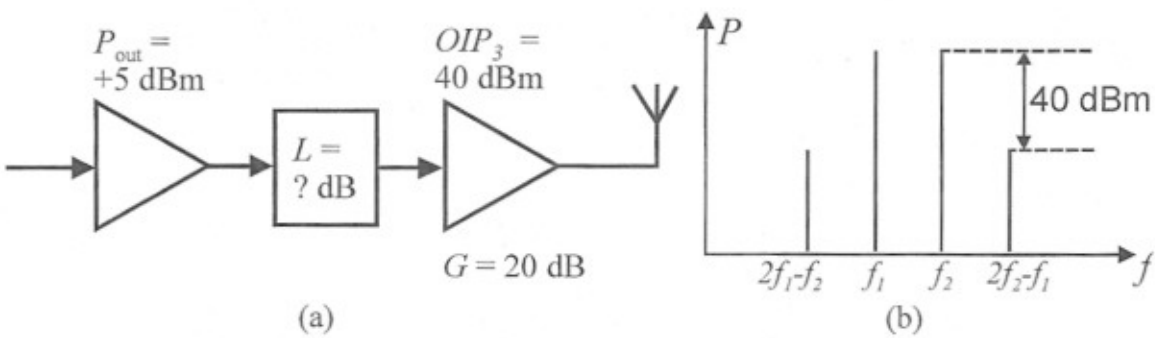

Figure 1: (a) Transmitter circuit, (b) 3rd-order IM level at antenna port

3. The transmit power of a digital link operating at 58 GHz is 10 mW and the gain of each of the parabolic antennas is 42 dB. The receiver sensitivity is −78 dBm (for $BER = 10^{-3}$). You can ignore losses from RF cables and power dividers.
   a) Calculate the available fading margin as a function of link span and present the result in a graph (with link span on the horizontal, and fading margin on the vertical axis).
   b) What is the maximum link span when the link has to operate also in case of strong rain with 50 mm/h?