Exercise #7, TUE, 19-jan-2016; Deadline: MO, 18-jan-2016, 10:00

Problem. 7.1 VU RF Techniques 2015/2016 19-jan-2016

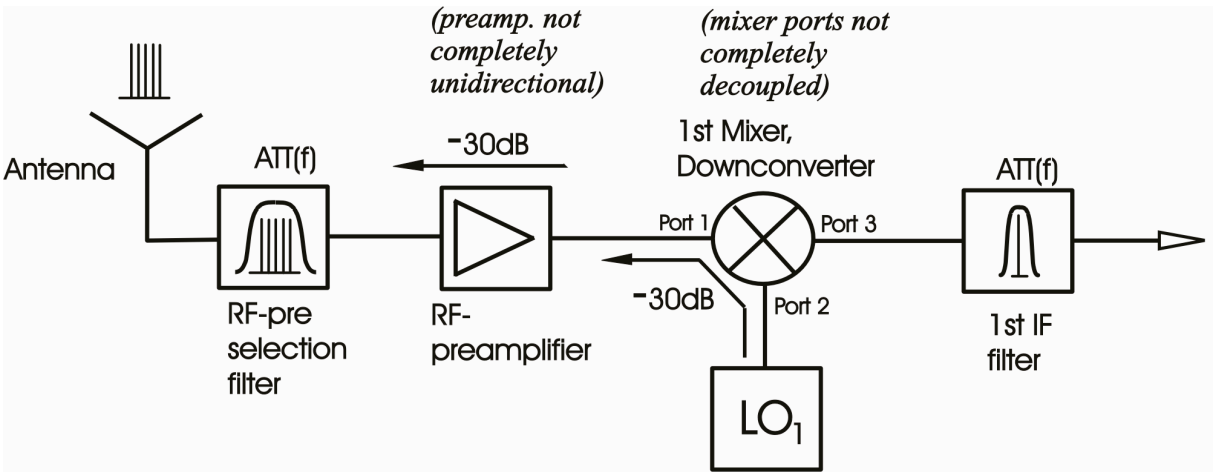
VHF-Broadcast (Analog-FM radio): the RF-input tuning range is 87 MHz …… 107 MHz, the intermediate frequency is f_{IF} = 10,7 MHz.

a) Give the tuning ranges of the local oscillator for two different cases: $f_{LO} > f_{RF}$, and $f_{LO} < f_{RF}$, respectively.
b) For both cases: calculate the ranges of the „mirror" frequencies.
c) Which parts of the LO-tuning ranges fall into the RF-input tuning ranges?

Draw sketches of the frequency map in a), b) und c).

Problem. 7.2 VU RF Techniques 2015/2016 19-jan-2016

DECT (Digital European Cordless Telephone) superheterodyne receiver:
first intermediate frequency, f_{IF1} = 110,6 MHz
Frequency conversion from RF to IF lets the channels appear in **regular shape.**
RF input frequencies: f_{IN} = 1897 MHz - nΔf n = 0, ... 9
Mirror frequency range: 1660 – 1677 MHz.
The sketch describes the front end of the DECT (also: **D**igital **E**nhanced **C**ordless **T**elecommunications) receiver. Frequency characteristics of the RF preselection filter, and of the IF / channel selection filter, respectively are given in the data sheets.



a) Draw the frequency map of the RF-input carrier frequencies. Set the LO1 frequency to select channel n=0 and calculate the range of all other 1st IF frequencies.
b) Estimate the Q-factors of both filters.
c) Give the tuning range of the local oscillator LO1.
d) Estimate the mirror frequency attenuation of the RF preselection filter. Estimate the LO1 attenuation of the RF preselection filter. LO1 power is +10 dBm. LO1 radiation from antenna must not exceed 2 nW. Is the LO1-attenuation of the path from LO via mixer, preamplifier, and RF preselection filter sufficient to fulfill this requirement?
e) Estimate the channel selection of the 1st intermediate frequency filter.
f) There are two interferers of equal power at the antenna input at frequencies like this: "Nutzkanal" (desired channel) at f_1, Interferer 1 at $f_1 + \Delta f$, and interferer 2 at $f_1 + 2\Delta f$. Estimate the attenuation of third order products, i.e. intermodulation products at the IF1-filter output.

Problem. 7.3 VU RF Techniques 2015/2016 19-jan-2016

The channel spacing in a wireless communication system is 0,5 MHz,
the channel bandwidth is 800kHz (i.e. +/- 400kHz around the carrier center frequency).
Active carriers with channels at the following frequencies:

f1 = **950**MHz, f2 = **951**MHz, f3 = **957**MHz, f4 = **959**MHz, f5 = **960**MHz

The channel power of all five channels shall be monitored simultaneously by use of a cheap spectrum analyzer (0 – 10 MHz) via simple frequency conversion and IF-filtering, irrespective of regular shape or reversed (flipped) shape.
Mixer: ideal multiplier producing difference and sum frequencies
Local Oscillator : 0 – 1 GHz max, (f_{LO} tunable within steps of 0,5MHz)
IF-filter: *total bandwidth:* **6 MHz,** Pass Band from lower limit (**1,5 MHz**) to upper limit (**7,5 MHz)**

a) find the proper oscillator frequency to completely resolve the five channels simultaneously without any overlapping.

Problem. 7.4 VU RF Techniques 2015/2016 19-jan-2016

Vienna Ground Station MOST (**M**icrovariability and **O**scillation of **ST**ars):
Microwave link low orbit satellites to earth: transceiver with two spatially separated antennas. Transmitter antenna (uplink earth to SAT) and receiver antenna (downlink SAT to earth) in close vicinity, distance between the antennas approx. 1m. Cross talk from TX-antenna to RX-antenna.
MOST uplink TX frequency: 2.055 MHz
MOST downlink RX frequency: 2.232 MHz
MOST RX LO frequency: 2.372.MHz
MOST RX IF frequency: 140 MHz

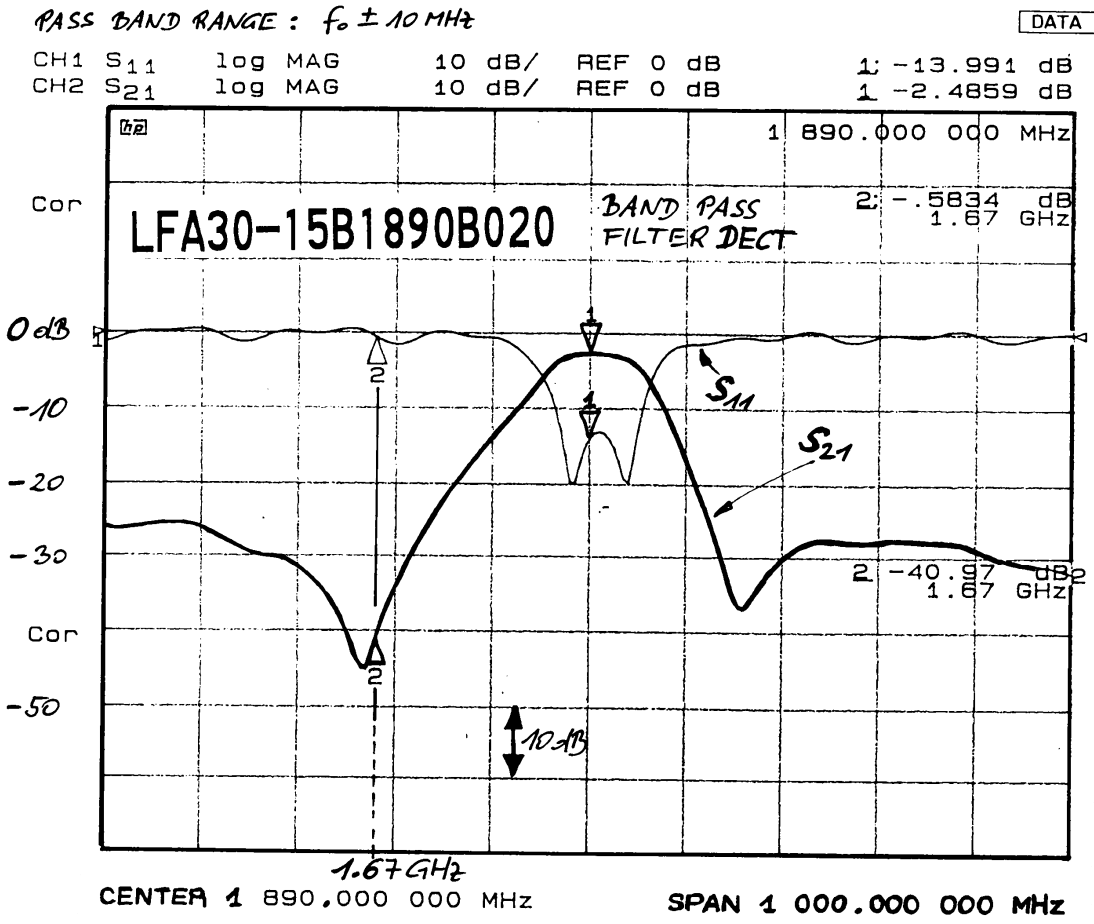
Next frequencies in this frequency range: GSM-1800 downlink band: 1.805 MHz ……. 1.880 MHz

MOST-receiver: the **MOST uplink** carrier and **GSM-1800 downlink channels** may produce 3rd order products (= intermodulation) in the MOST receiver preamplifier.

a) MOST receiver, preamplifier output: draw an RF frequency map (1st order, and 3rd order products).

b) MOST receiver, mixer output: draw the IF frequency map (1st order, and 3rd order products). 3rd order IF products will be observed in regular or in reversed (flipped) position?

ad) Problem 7.2, Datasheets



RF-preselection filter of a DECT-receiver

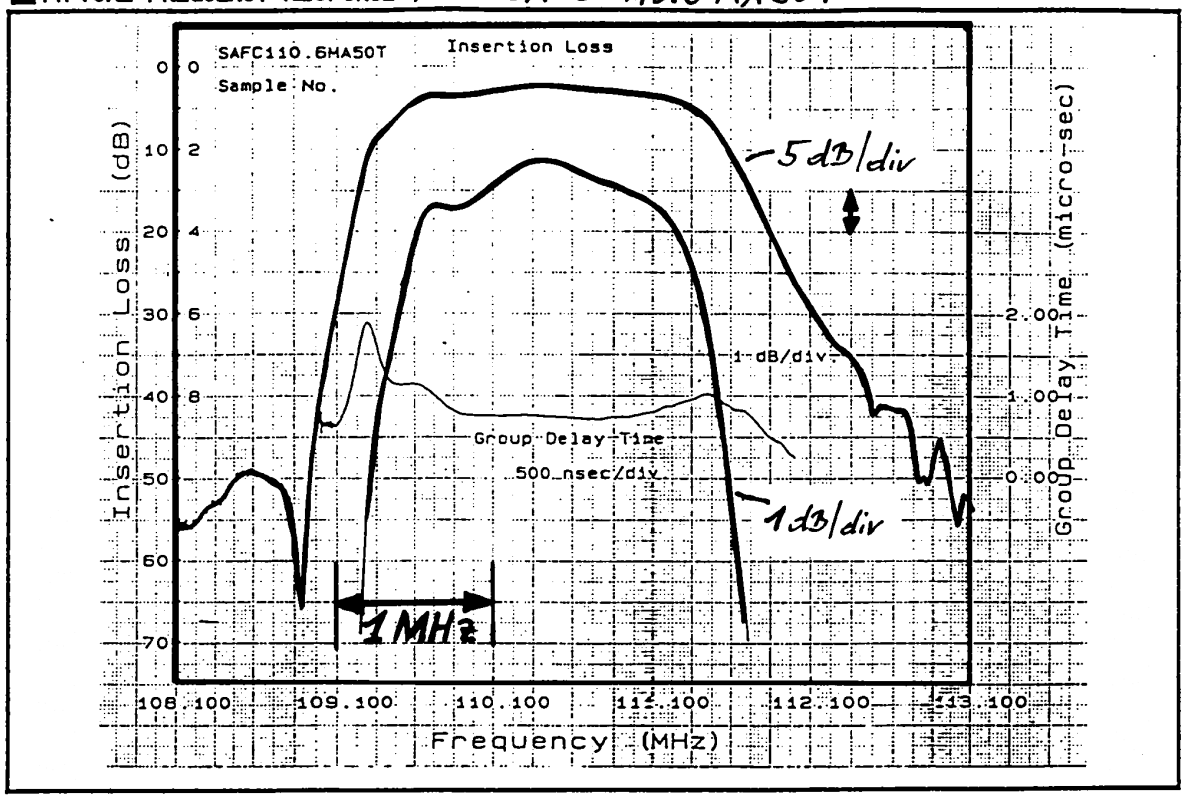
murata PIEZO PRODUCT FOR COMMUNICATION

TYPE: SAW FILTER FOR DECT 1st-IF (110.6MHz)

■SPECIFICATIONS (0℃ to +40℃)

Part Number	SAFC110.6MA50T-TC (SMD) SAF110.6MA40T (Lead)	
Item	Specification	Typical (at 20℃)
Nominal Center Frequency(fo)	110.592 MHz	←
3dB Bandwidth (from fo)	± 576 KHz min.	1.87 MHz(Total B.W.)
Insertion Loss (at peak level)	4.0 dB max.	2.5 dB
Stop Band Attenuation (from peak level)		
at fo − 3×f△	50 dB min.	
at fo − 2×f△	44 dB min.	52 dB
at fo − f△	31 dB min.	35 dB
at fo + f△	20 dB min.	28 dB
at fo + 2×f△	42 dB min.	44 dB
at fo + 3×f△	42 dB min.	
f△=1.728MHz (Channel spacing)		
Group Delay Time Deviation within fo ± 576 KHz	0.7 μsec. max.	0.45 μsec. (0 to +40°C)
Input / Output Impedance (at fo)	150 Ω // 0 pF	
Package	SMD: SC713, Lead: SF-712	

■TYPICAL FREQUENCY RESPONSE-1 SAFC 110.6 MA 50T



DECT-receiver, IF-filter at the first intermediate frequency