Exercise of Electronics for Communication Systems Prof. C. Abbate, G. Busatto - A.A. 2018/2019

06 – Experimental Verification of a Low Noise Amplifier for FM receivers

08/11/2018 – Diego Tuzi – 50435 – diego.tuzi@studentmail.unicas.it

BIAS VERIFICATION

Insert a resistor R8 = 1kΩ, corresponding to a current Ic≈2.2mA. Feed the circuit with Vcc = 12V through the Red (+) and Black (-) bushes. Check the correct operating point of transistors Q1 and Q2 with the aid of the oscilloscope or the multimeter.

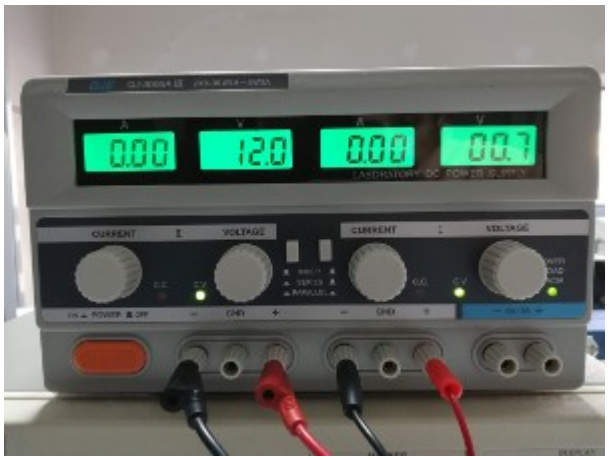
Description	Value	Unit	Measured/Calculated
V_{BEQ1}	0.48	V	Measured
V_{BEQ2}	0.71	V	Measured
V_{CEQ1}	4.80	V	Measured
V_{CEQ2}	4.80	V	Measured
V_{R_8}	2.38	V	Measured
$I_c = \frac{V_{R_8}}{R_8}$	2.38	mA	Calculated

Operating point is verificated as you can see from the previous table.

TUNING OF THE AMPLIFIER WITH THE NETWORK ANALYZER

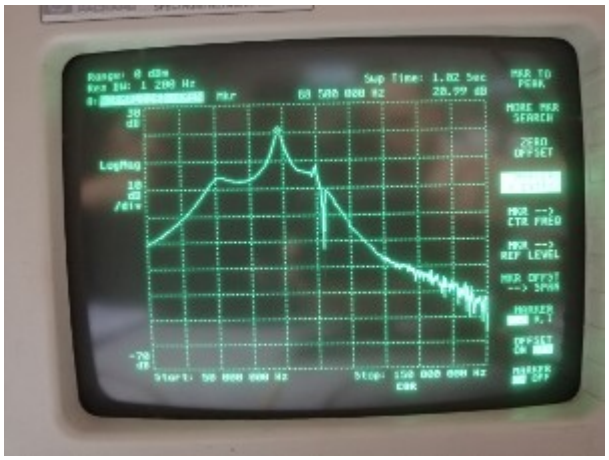
Apply a tuning voltage, variable between 0 and 12V, on the bush “+Sint”. For this purpose use a second power supply or second section of the previous one. Set the output signal of the network analyzer to -40dBm and perform the instrument calibration. Afterword set the output signal of the network analyzer to -50dBm and connect input and output of the circuit to the Source and Input connectors of the instrument, respectively. For this purpose use BNC cables.

Set the tuning voltage to Vsint=1V and measure amplitude and frequency of the resonance peak. Regulate in sequence the nucleus of the transformer T2 and the capacitor C14 in such a way to obtain f ris1 =88MHz for Vsint=1V. Afterward, regulate T1 and C18 to obtain the maximum selectivity and the minimum harmonic content. and, respectively.



Power supply

Vcc=12V; Vcontr=0,7V



Network analyzer

Resonance frequency=87,5 MHz; Gain=23.9 dB

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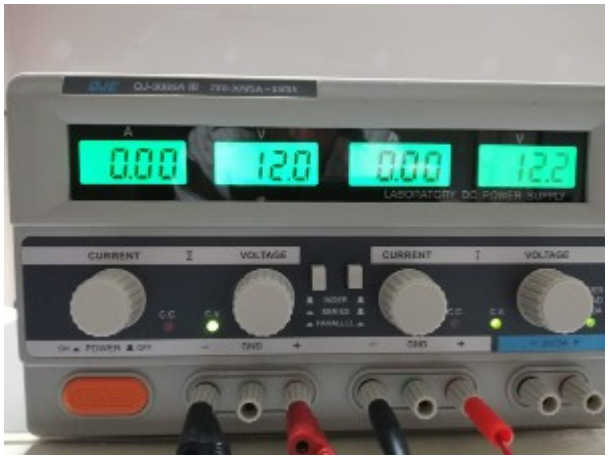
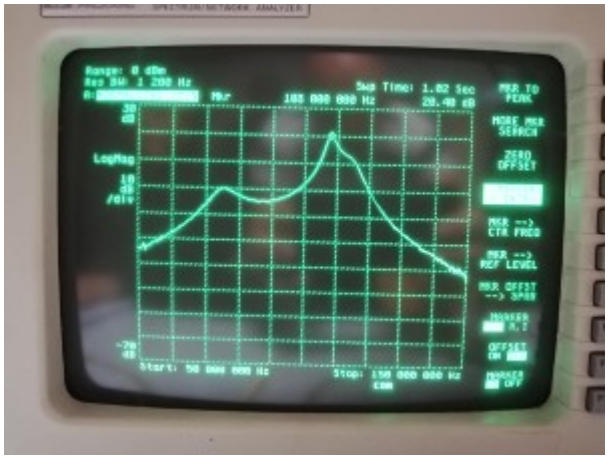
Regulate in sequence the nucleus of the transformer T2 and the capacitor C14 in such a way to obtain f ris2 >108MHz for Vsint=12V. Afterward, regulate T1 and C18 to obtain the maximum selectivity and the minimum harmonic content.

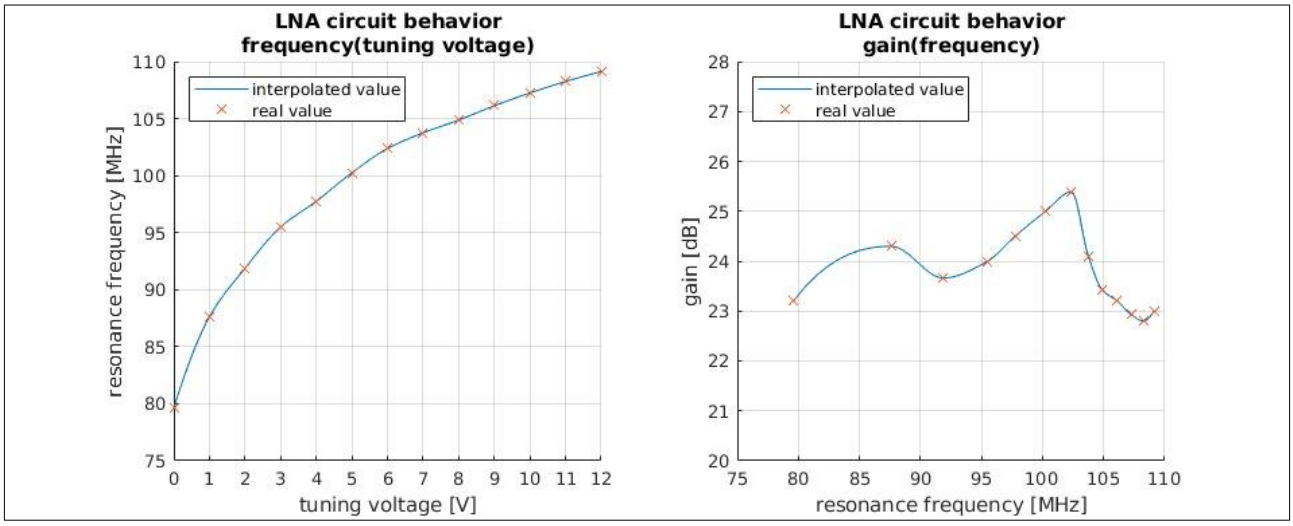


Power supply
Vcc=12V; Vcontr=12,2V



Network analyzer
Resonance frequency=109,2 MHz; Gain=23 dB

Measure the resonance frequency varying the tuning voltage between 0 and 12V with steps of 1V. Report the resonance frequency vs. the tuning voltage in an x-y plot.



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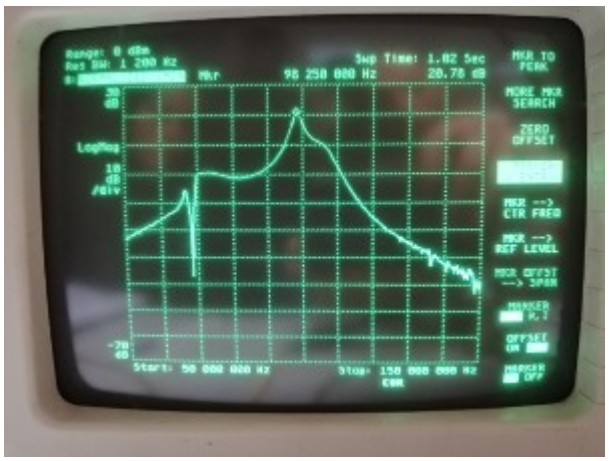
Measure Q of the tuned amplifier at 98MHz and acquire its harmonic response.

Power supply

Vcc=12V; Vcontr=3,6V



Network analyzer

Resonance frequency=98,25 MHz; Gain=24,78 dB

$$Q = \frac{f_0}{BW} \simeq \frac{98{,}25\ MHz}{3\ MHz} \simeq 32{,}6$$

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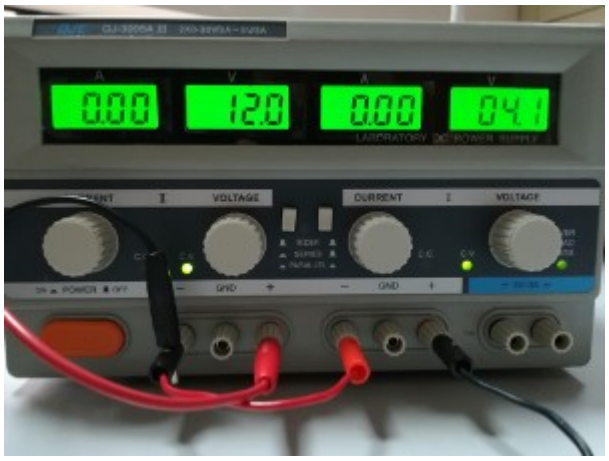
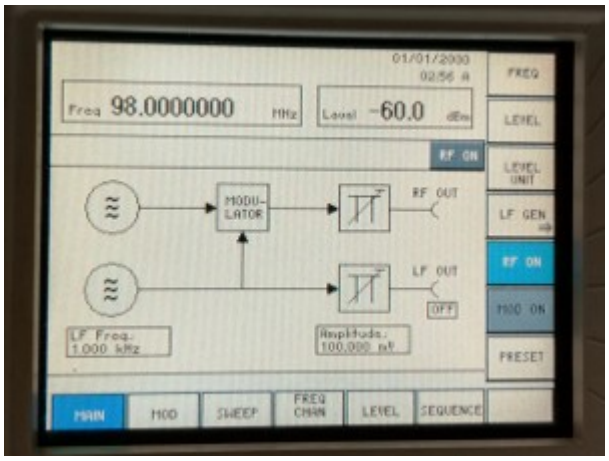
MEASURE OF THE AMPLIFIER GAIN

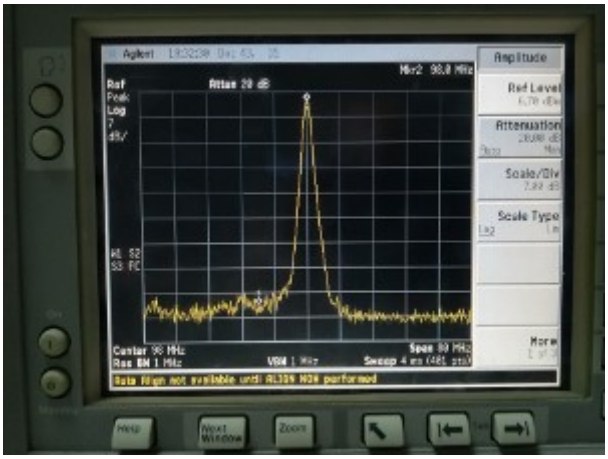
Use the RF signal generator to supply the amplifier with a sinusoidal signal having amplitude=-60dBm and frequency=98MHz. Measure the output voltage with the spectrum analyzer or with the oscilloscope. Set the tuning voltage to the value required for obtaining f ris =98MHz (use the results of the previous point) adjusting the tuning voltage for obtaining the maximum amplitude of the output voltage. If spurious signals would appear on the output voltage, trim T1 and C18 to obtain the minimum harmonic content of the output voltage. In the conditions of the best tuning (maximum output signal), measure the amplifier gain. Acquire the spectrum of the output signal.



Power supply
Vcc=12 V; Vcontr=4,1V



RF generator
Freq=98 MHz; Level=-60 dBm



Spectrum Analyzer
LNA output level=-35.4 dBm; Gain=-35,4-(-60) = 24,6 dB

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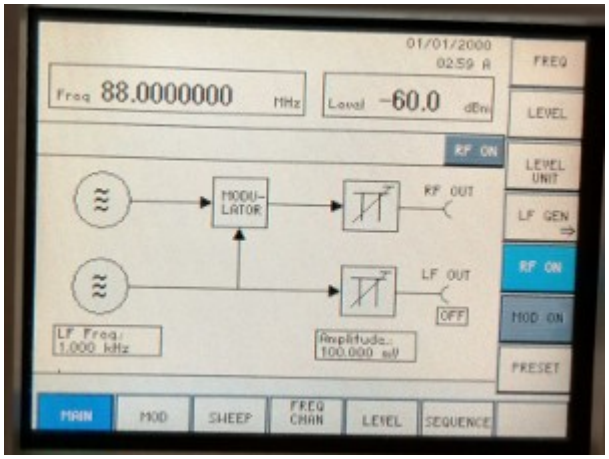
Repeat the measure of the gain at f min=88 MHz varying the frequency of the RF generator. Adjust the tuning voltage to obtain the maximum value of the output voltage.

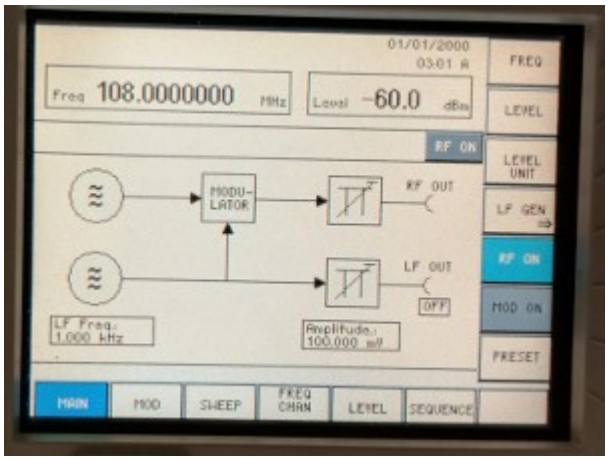
<table>
<tr>
<td> 

Power supply
Vcc=12 V; Vcontr=2,0 V</td>
<td> 

RF generator
Freq=88 MHz; Level=-60 dBm</td>
</tr>
<tr>
<td colspan="2">Spectrum Analyzer
LNA output level=-40 dBm; Gain=-35,73-(-60) = 20 dB</td>
</tr>
</table>

Repeat the measure of the gain at f min=108 MHz varying the frequency of the RF generator. Adjust the tuning voltage to obtain the maximum value of the output voltage.

<table>
<tr>
<td> 

Power supply
Vcc=12 V; Vcontr=11,2 V</td>
<td> 

RF generator
Freq=108 MHz; Level=-60 dBm</td>
</tr>
<tr>
<td colspan="2">Spectrum Analyzer
LNA output level= - 37 dBm; Gain=-37-(-60)=23 dB</td>
</tr>
</table>

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MEASURE OF CP 1DB AND IIP3-OIP3

Use signal generator, Spectrum Analyzer and the procedure described in the previous point for measuring the first harmonic gain of the amplifier at 98MHz. Use increasing values of the input signal starting from -50dBm. Create a Cartesian plot of the above quantity and determine CP 1dB. For determining IIP3 use the graphical method described during the lecture.