Semester project

TTT4201 - Radio System Design and

RF/Microwave Measurement Techniques

Design of a RF power amplifier

- Discrete transistor by MACOM (Wolfspeed/Cree)
- Part1: Design of the RF power amplifier with the help of Advanced Design Systems (ADS)
- Part2: Measurements of your designed RF power amplifier at the department's microwave laboratory
- Part3: Hand in a full report
  - The report should, as a minimum, include the design process for your design, and a comparison of your simulated and measured results, followed by a discussion and a conclusion. **The length of the report should not exceed 15 pages, including the appendix**.

Device technology and components

- The transistor you will be using in the design is a packaged, discrete transistor by MACOM, CG2H40010 (10W)
- The CAD-model for the transistor is provided in Blackboard/Teams. After installation of the CAD-model in ADS, you will find the transistor in the **Cree_Wlfspd_ADS_v2p5** library. The name of the component is **CG2H40010F**
- **Microstrip substrate**: standard FR-4 substrate with parameters as summarized in table 1. These parameters should be entered into the **MSUB** component found in the **TLines-Microstrip** library in ADS

H	Er	Mur	Cond	T	TanD
1.52×10^{-3} m	4.4	1.0	5.96×10^{7}	35×10^{-6} m	0.02

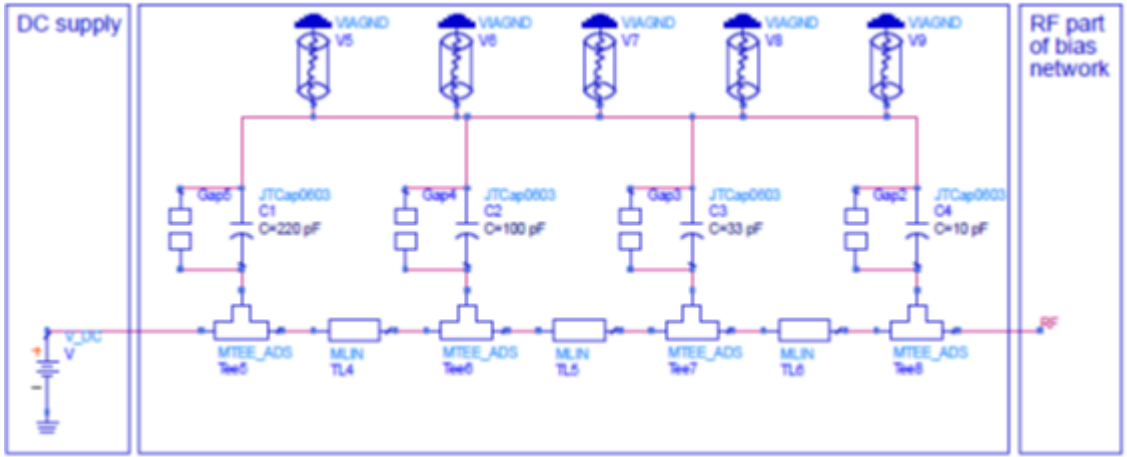
Passive components,

- Resistors: use the standard, ideal resistors found in the Lumped-Components library in ADS (E12-series)
- Capacitors: CAD-models provided on Blackboard, Johanson RF capacitors and Murata for decoupling.
- Inductors: Johanson library (if you need)

Table 2: Available component values for the R14S capacitors in pico farad.

0.3	0.5	0.8	1.0	1.2	1.5	1.8	2.2	2.7	3.3	3.6	3.9	4.7
5.6	6.8	7.5	8.2	9.1	10	12	15	18	20	22	24	27
30	33	36	39	43	47	56	68	82				

Bias network



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Design restrictions

- The frequency of operation (f_c) is 2.4 GHz.
- The device must be biased with a drain voltage (V_D) of 28 V.
- The drain current (I_D) should be no less than 50 mA. This implies that gate voltages (V_G) below approximately −3.0 V cannot be used.

Small-signal specifications

- The device must be unconditionally stable, e.g. the stability factor (μ) must be greater than unity for all frequencies.
- The small-signal bandwidth (f_{bw}) should be at least 100 MHz within 1dB.
- The small-signal gain (S_{21}) should be at least 14 dB throughout the bandwidth (2.35 GHz to 2.45 GHz).

Large-signal specifications

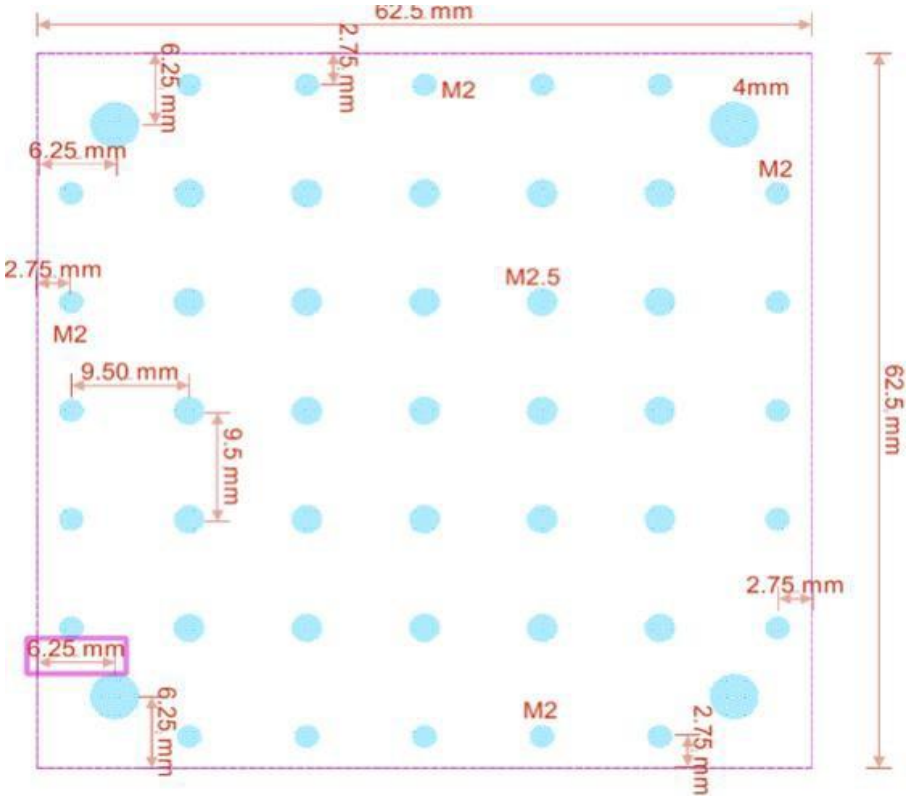
- The device should produce an output power (P_{out}) of at least 39 dBm with a maximum single-tone input power (P_{in}) of 27 dBm.
- For a two-tone peak output power of 38 dBm, the intermodulation distortion (IMD) should be as little as possible. The tone spacing should be 5 MHz for the two-tone test.

Target specifications

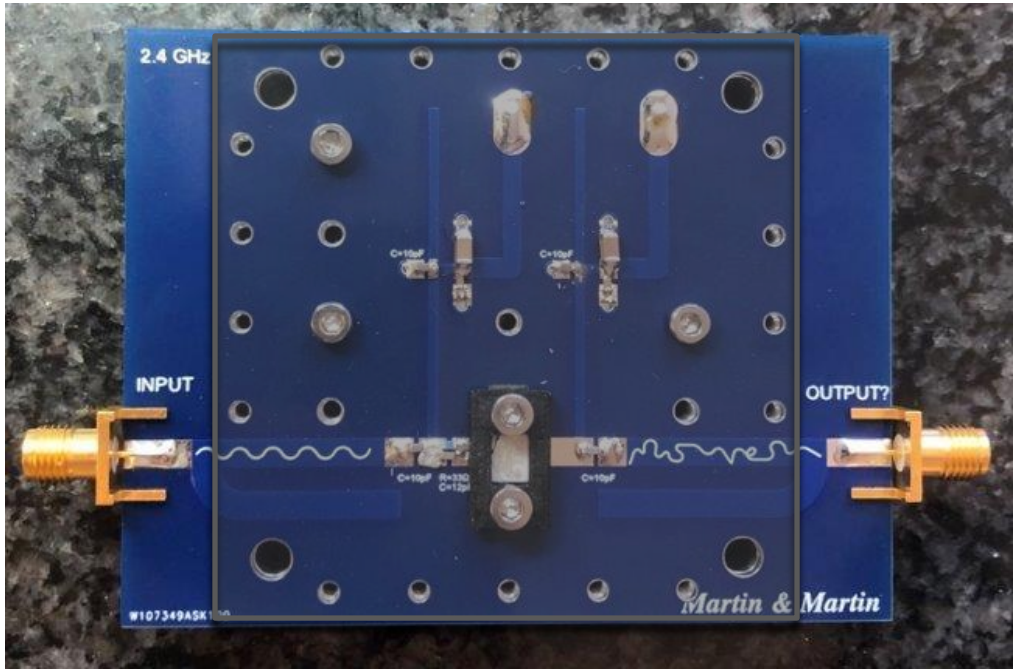
- Each group should target either
  - Maximum output power (maximizing P_{out} compared to the common specification) for single tone input.
  - Maximum power added efficiency (η_{PAE}) for a single-tone input, keeping the common specifications.

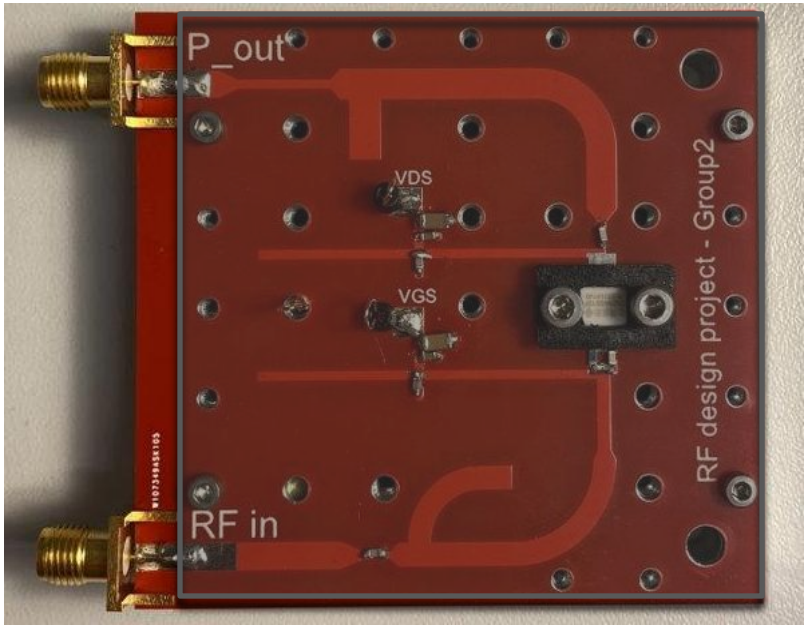
Layout

- The layout should fit on a 62.5 mm-by-62.5 mm area, as depicted in the figure
- You only must adjust your layout to agree with the placement of the screw holes for the transistor.



Examples


2.4 GHz
INPUT
OUTPUT?
Martin & Martin


P_out
VDS
VGS
RF in
RF design project - Group2