SOLID STATE AMPLIER DESIGN

USING RF MOSFET DEVICES

by

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polyfet rf devices

MTT 1999

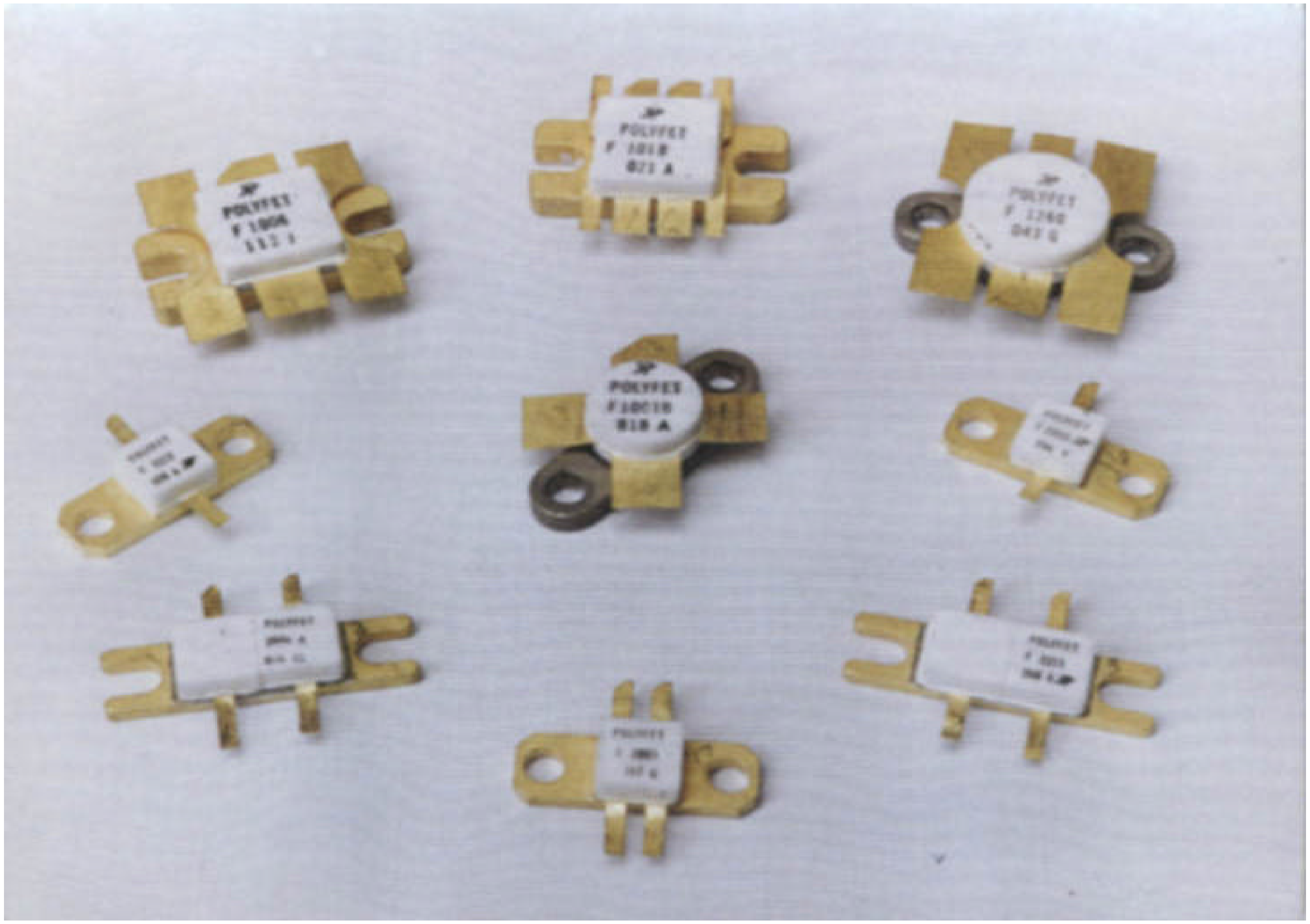
June 17th

Anaheim

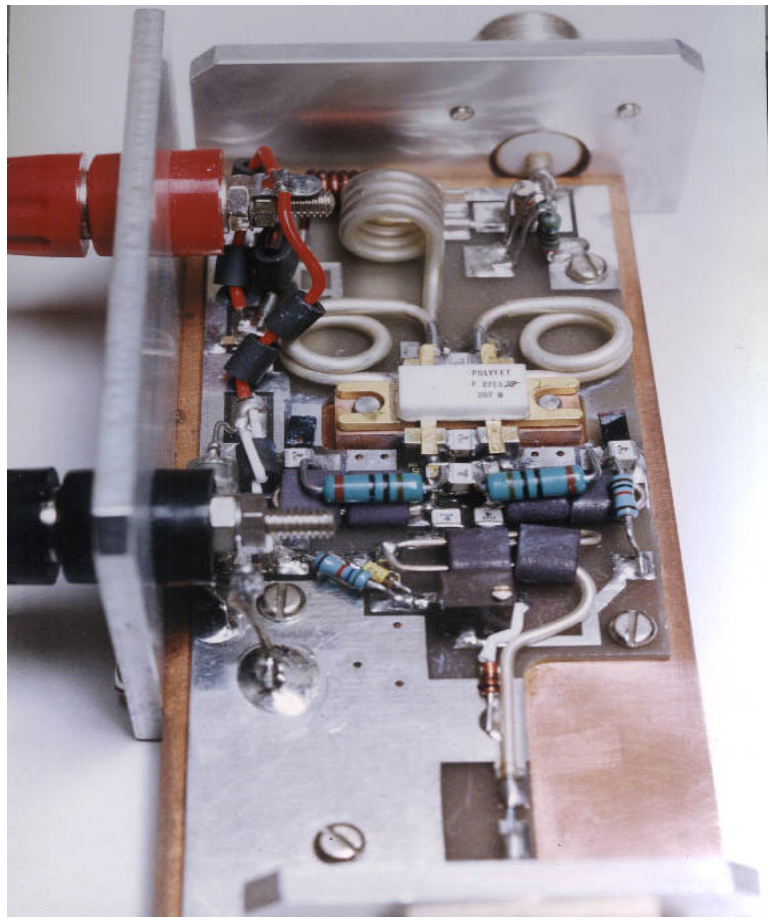
Selection of Proper Device

- Output Power / Gain / Bandwidth / Efficiency / Linearity / COST
- Package type
  - Single Ended / Push Pull
  - Surface mount or screw in metal flange
  - Relative package costs (floating source (AD) vs. grounded source (AR))
- Review junction temperature and thermal resistance
- Linearity Requirements
  - Using Pin versus Pout to determine linear region
  - Bias adjustment for optimal linearity
  - Back off > 8dB from Compressed power.
- Device operating voltage
  - 12.5 volt most rugged - trade off power.
  - 28 volt best overall frequency and power performance
  - 50-volt easier high power match, most fragile and somewhat lower frequency performance.

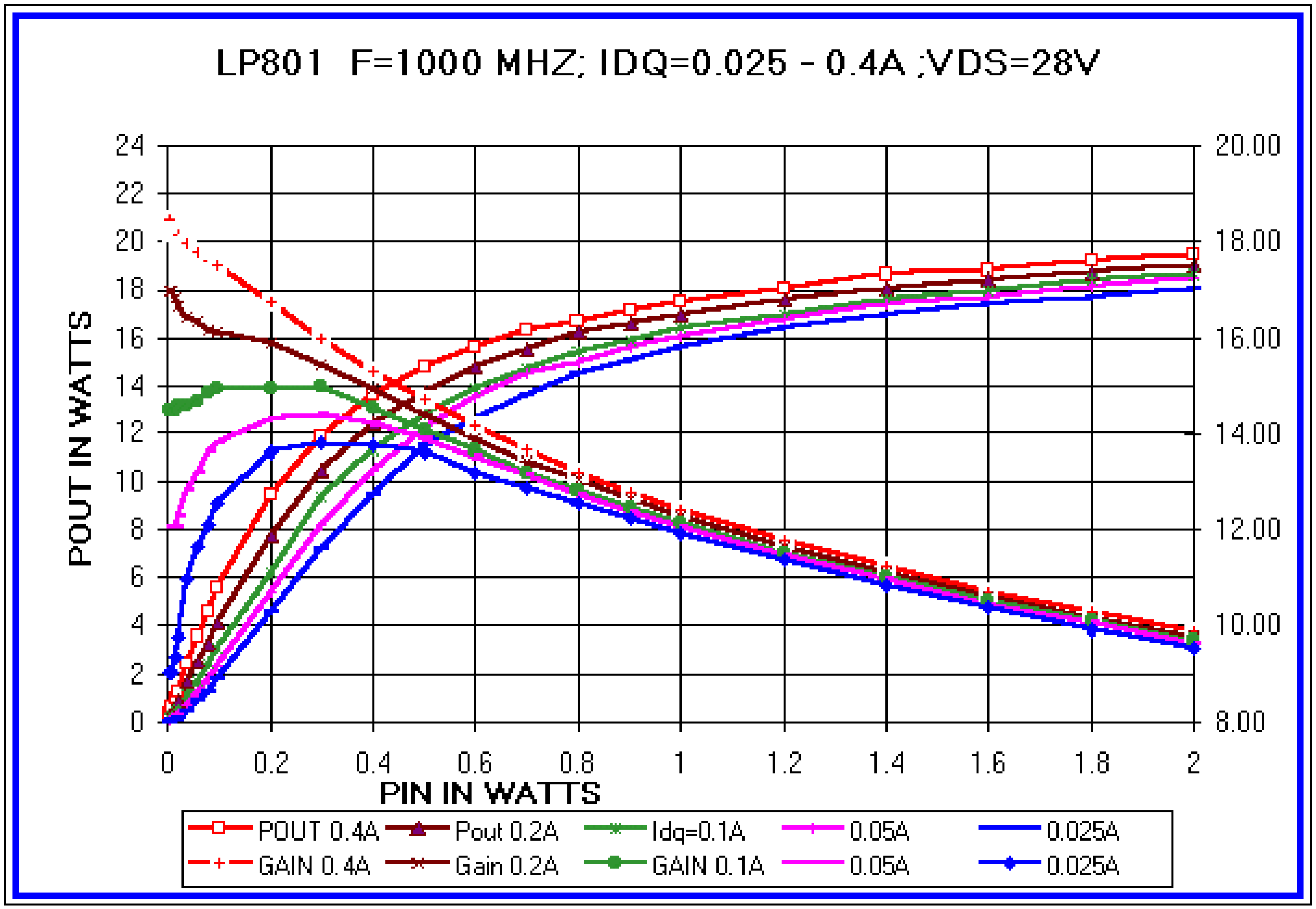
Picture of Rf Transistors



Push Pull Rf Amplifier



Bias for Linearity



Matching Topology Guidelines

- Wide band
  - Almost always uses transformers of some type
  - Designs below 100 MHz can use conventional tightly coupled windings
  - Design above 100 MHz almost always use some kind of transmission line transformer
  - High frequency designs use reactive matching to cover the last ½ octave with the transformer providing the matching at lower frequencies
- Narrow band
  - Use lumped components below 200 MHz
  - Use combination lumped-distributed components between 200 and 500 MHz.
  - Use mostly distributed components above 500 MHz

Input Matching

- Input circuit
  - Design objective is to transfer enough power to the device so as the frequency is lower the gain increase in the device is greater than the transmission loss due to miss matching. This will give a relative flat gain characteristic.
  - Isolators at higher frequencies or hybrid coupler at lower frequencies can absorb resulting reflections.
  - For multi-octave designs, gain slope networks can be used which will absorb the reflected energy from the device and present a reasonable input impedance for the circuit.
- Use Spice models to calculate Zin and Zout

Output Matching

- Approximate load line can be calculated by using Cripp's Law (Vdd -Vsat)^2/2*Pout. Push - Pull double value. Typical load line range between 15 ohms to 3 ohms.
- The imaginary component can be initially set at zero and adjusted both positive and negative until the optimum can be determined
- Next, tweak load line value to further optimize the design
- A few iterations may be required to achieve satisfactory results
- Optimal match is most likely - low pass, high pass and a transformer if necessary. Design objective is to allow the maximum voltage and current to be delivered to the real load impedance (maximum power).
- Additionally in the case of class AB or class B, to terminate the harmonic voltages and currents to improve efficiency and prevent their transmission to the output
- Components must handle the current and voltage (power)

Stability Considerations

- Using S parameter to look at stability circles

  View input and output stability circles using device S parameters to determine at what frequencies where the device is only conditionally stable

- Practical solutions to stability issues

  A. Series gate resistance

  B. Parallel gate resistance

  C. Drain to gate feedback

- VDMOS devices are usually unstable at lower frequencies

  A. Use B. to stabilize device at lower frequencies

- LDMOS stability issues (more gain more pain)

  B. LDMOS devices are commonly unstable at lower frequencies, sometimes at the operating frequency and above operating frequency Use A & B ; plus try to keep load line and input impedance out of the unstable region

Non Linear RF Simulators

•MircroWave Office **
  Download from Web. Free Trial
  Layout Capability in Version 3.
  Low Cost
•HP EEsof
  ADS, MDS, Series IV.
•Ansoft
  Improved upgrade of previous Super Compact
•Pspice **, Intusoft Spice and others
  Missing many RF elements

** Direct import of Polyfet Spice models

References

- Radio Freq. Transistors - Norm Dye and Helge Granberg
- RF Circuit Design - Chris Bowick
- Polyfet Article - Rf Topics
- Transmission Line Transformers - Jerry Sevick Noble Power
- Amplifier Handbook - Rf Design Cardiff Publish Co.
- Proceedings RF Expo East 87
  - A. Thermal Consideration in Amp Design - Gregg Hollingsworth
  - B. Rf Design Practices - Dan Molina
  - C. Rf Combining and Protection Techniques - Joe Johnson
- Proceedings RF Expo West 1991
  - A. RF Power Device Impedances - Alan Wood.
- Proceedings RF Expo West 1993
  - A. 100-450 250Watt Power Amp - John de Blok
- Application Notes - RCA, Acrain, Motorola etc.