TH3G-1

High-Efficiency and Flat-Gain Doherty Type Transmitter Using A 180-Degree Hybrid-Combiner

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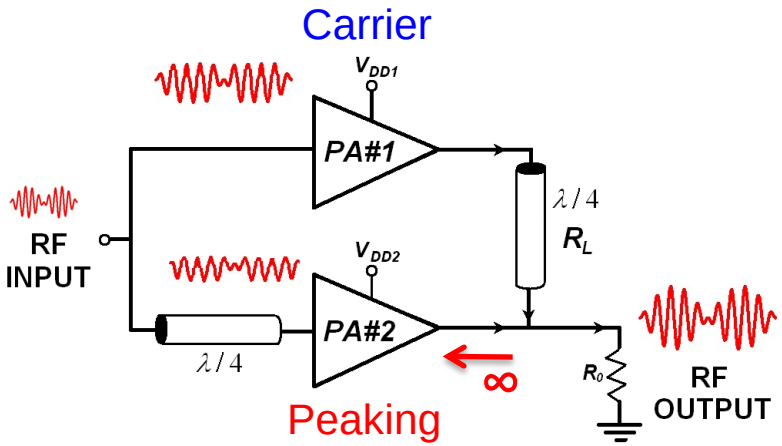
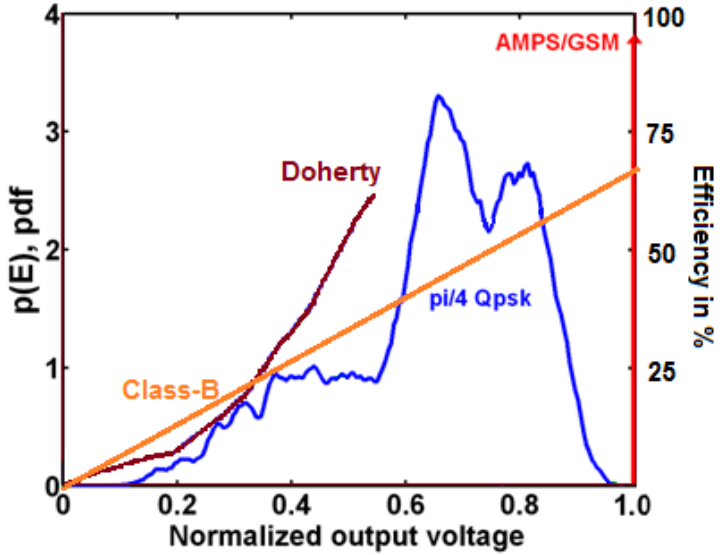
Efficiency of Doherty type transmitter

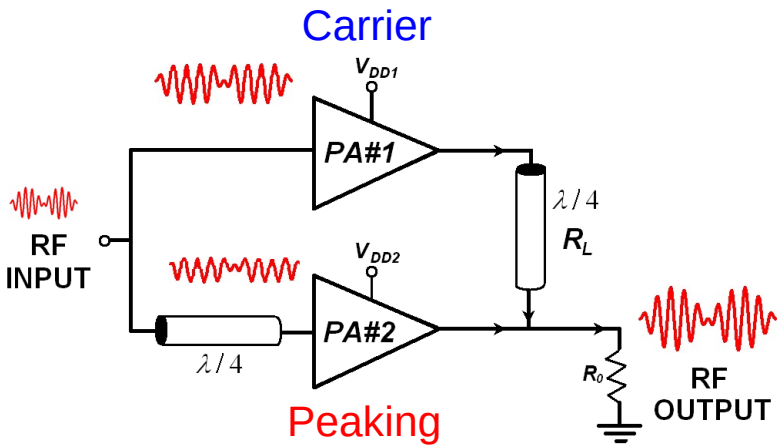


Low-power mode

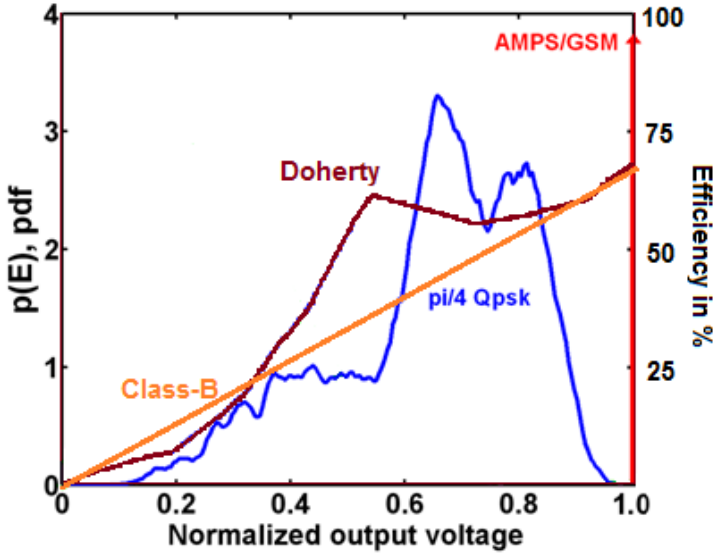


Doherty; higher average efficiency than single ended class-B Amplifier

Efficiency of Doherty type transmitter



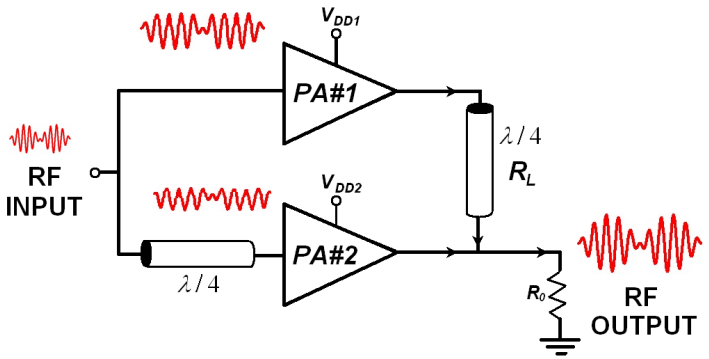
High-power mode

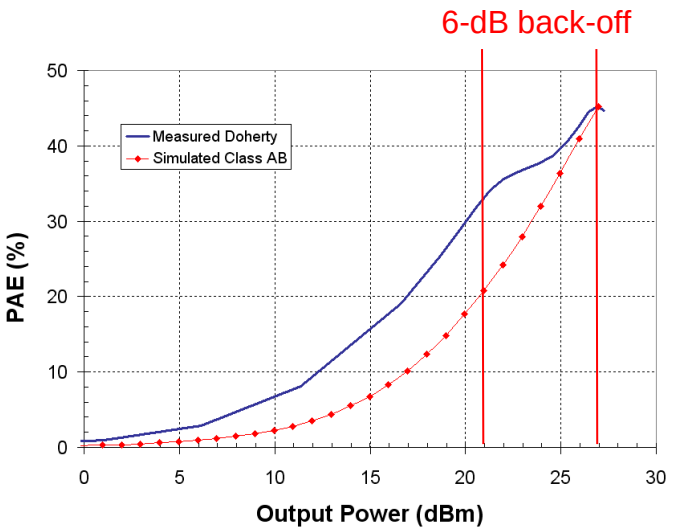


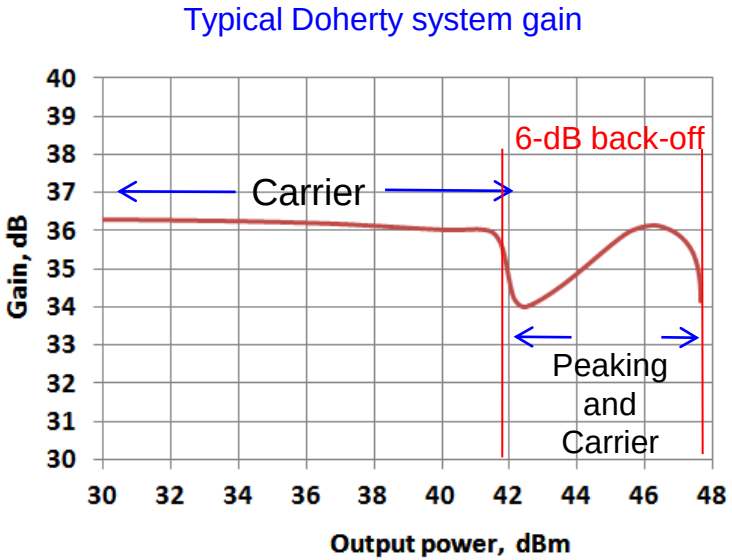
Doherty; higher average efficiency than single ended class-B Amplifier

Practical issues of Doherty type transmitter

- Improper amplifier operation
- Improper amplifiers loading
- Improper driving
- Phase misalignment
- Approximation to Doherty operation



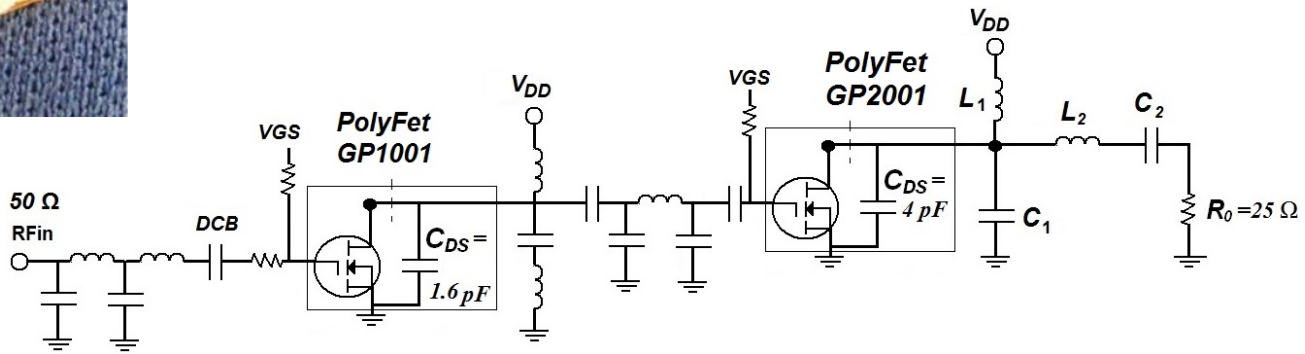




Outline

- Two-stage Power Amplifiers
- Hybrid combiner and lattice network
- Doherty type system
- High efficiency / flat gain trade-off
- Conclusions

Two-stage carrier and peaking amplifiers at 300-MHz

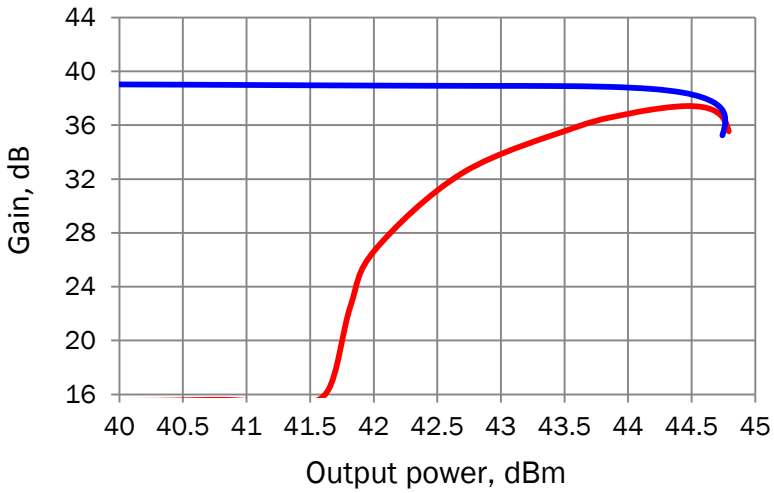


Carrier

Class-AB biased

V_{DD}=23-V
Efficiency: 78%
Output Power=28-W
Gain=39-dB

Measured Gain

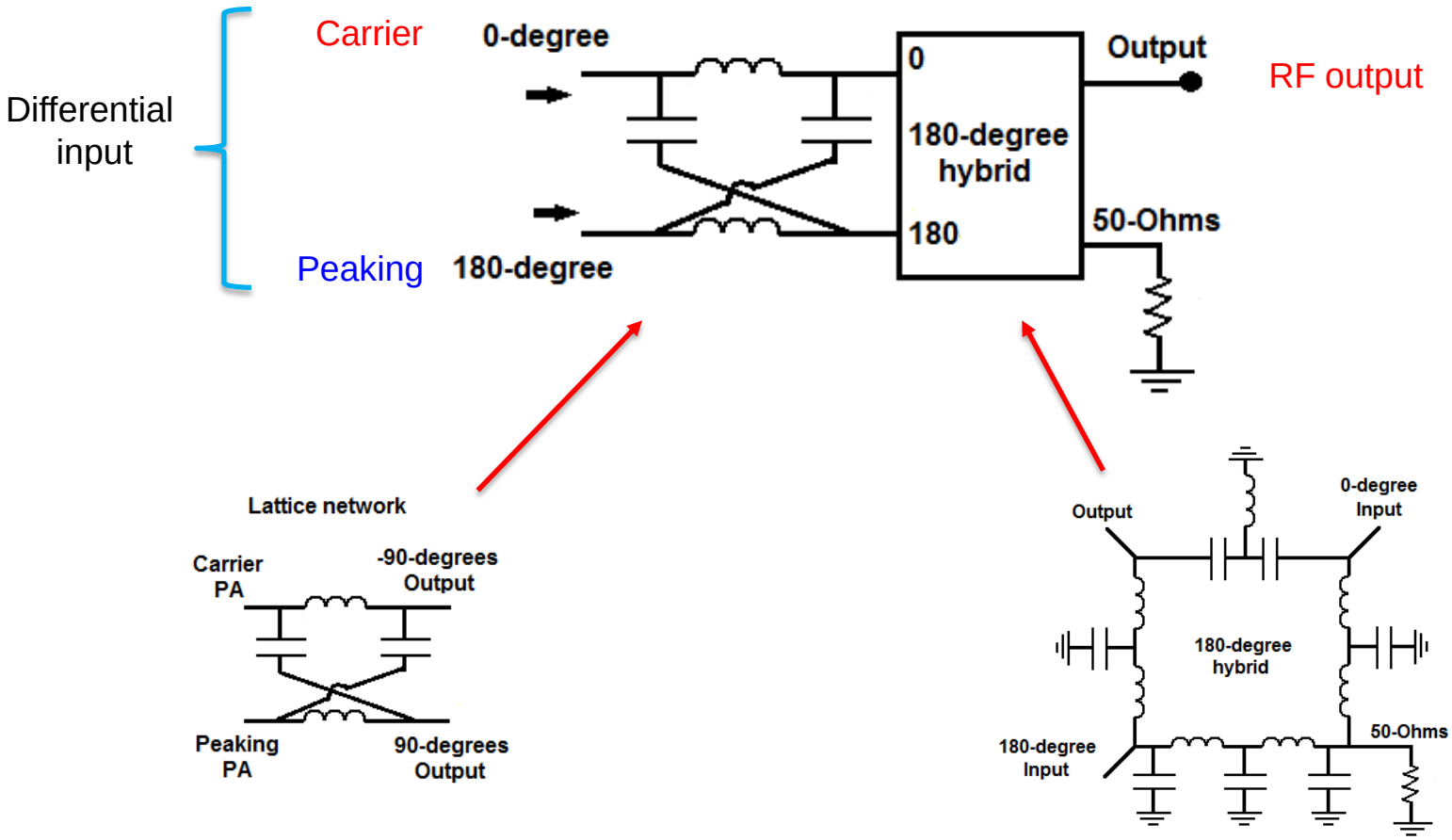


Peaking

Class-C biased

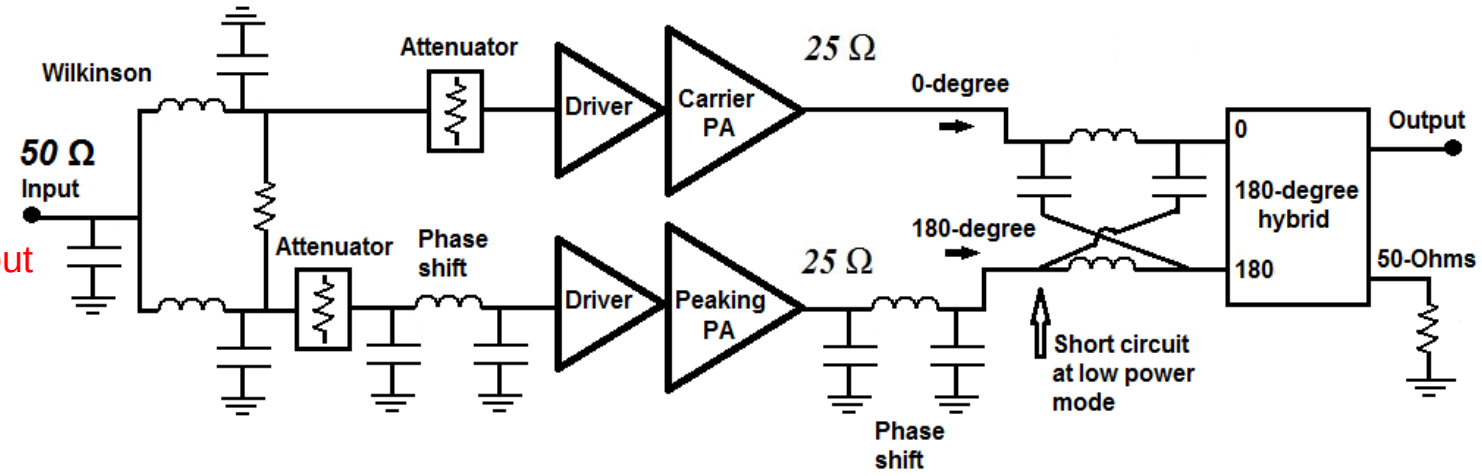
V_{DD}=23-V
Efficiency: 85%
Output Power=28-W
Peak Gain=37.5 dB

Hybrid combiner and lattice network

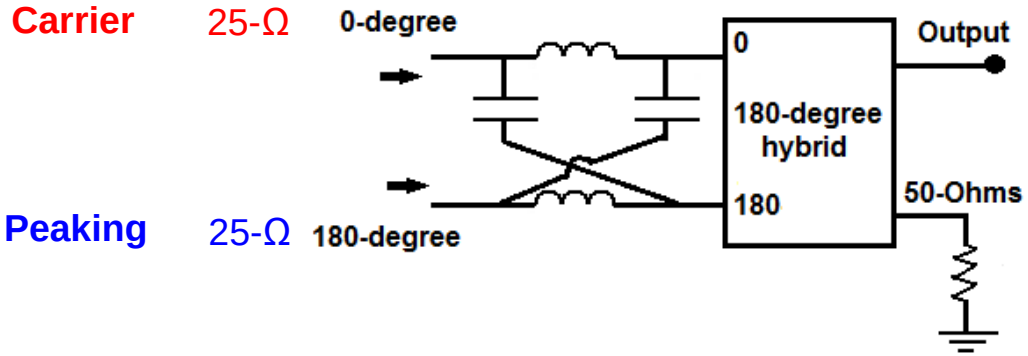


Doherty type system

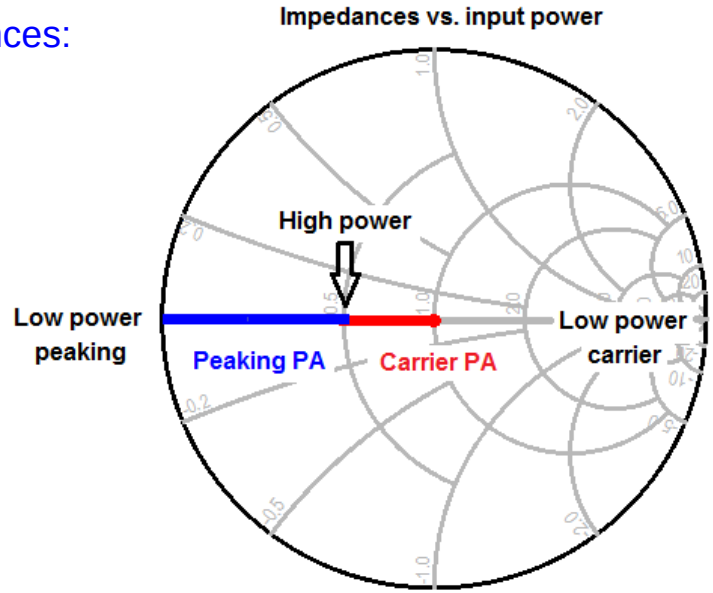
300-MHz
2-stage carrier and peaking !



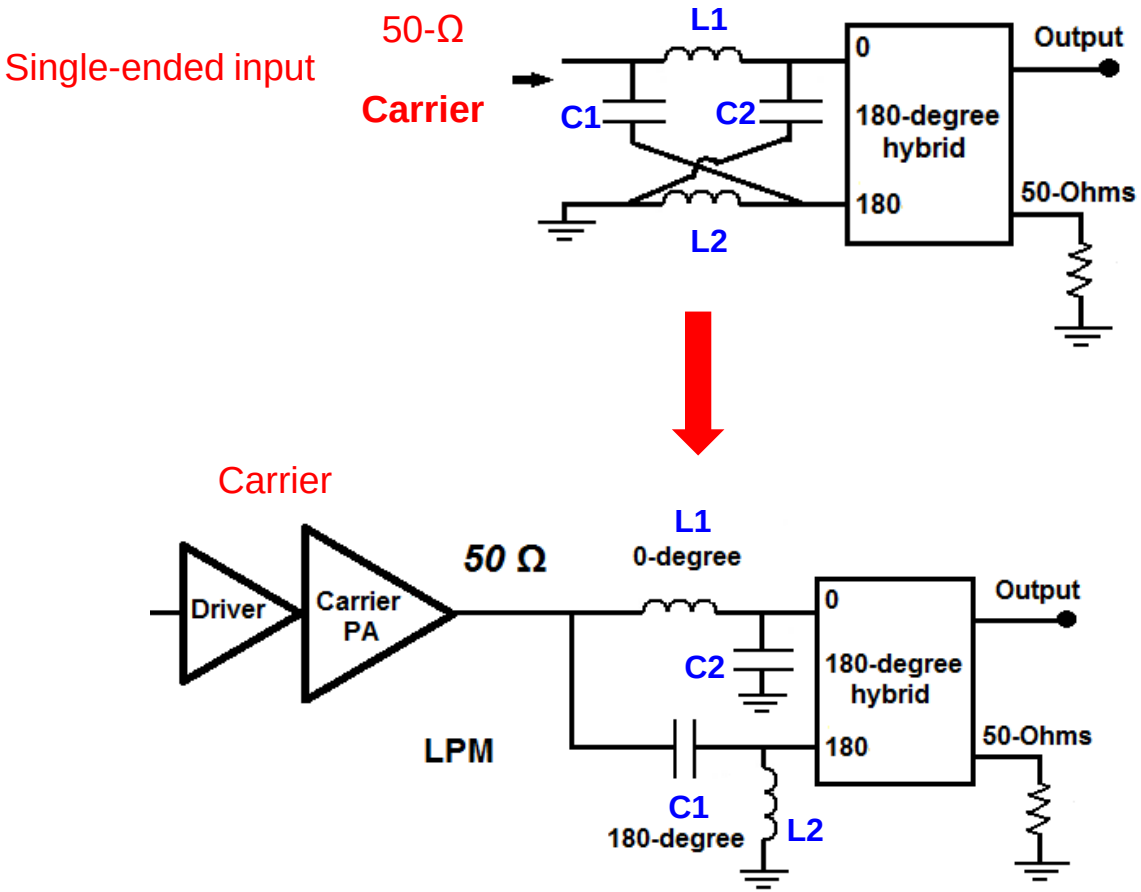
Load modulation at high-power mode



Idealized impedances:

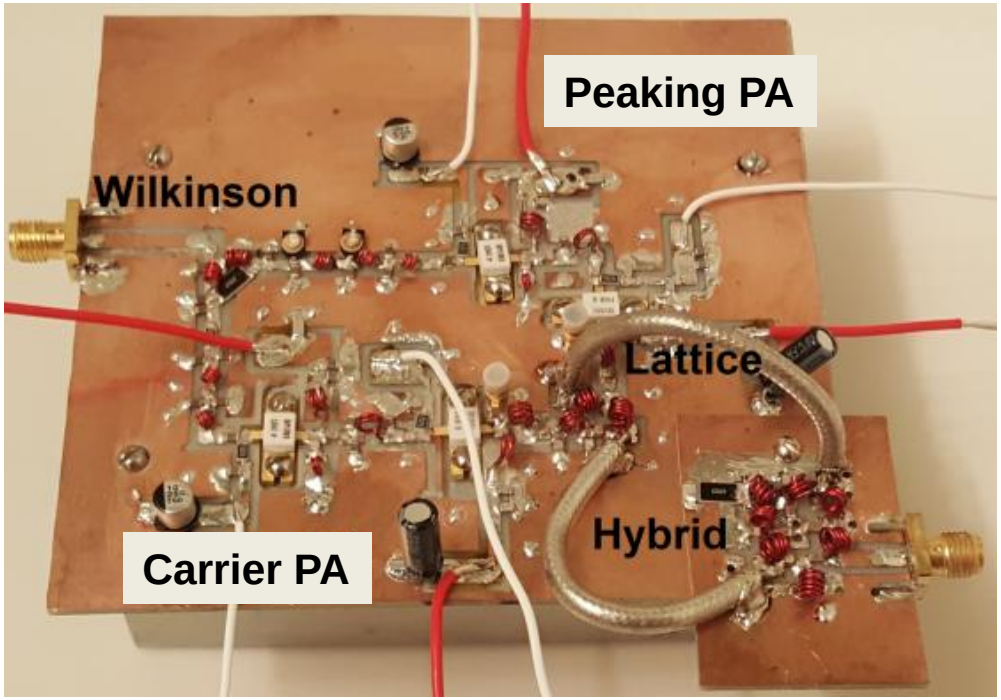


Load modulation at low-power mode



System prototype

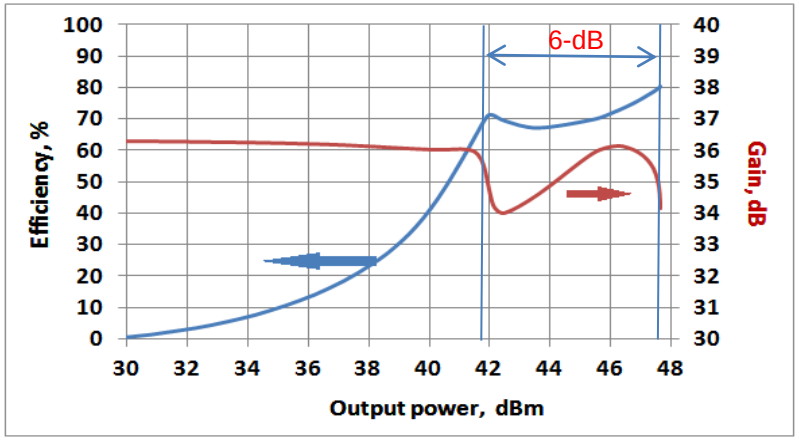
Inductors and trimmers for the 300-MHz amplifiers



Performance

Measured output power and drain efficiency

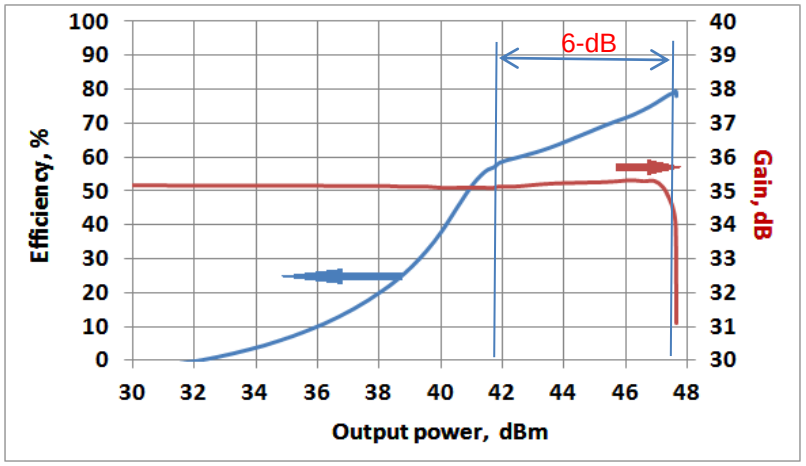
Second peak
at 6-dB back-off



Peaking PA biased
as deep class-C for
“sloppy” gain expansion

Flat gain;

An efficiency
bump at 6-dB
back-off still
better than single
ended class-B



Bias of peaking PA driver
is increased more than final

Closing remarks

- Doherty type transmitter tuning is an interactive process
- Phase, amplitude, load impedances are key parameters to optimize; special interest at the input of the system.
- A 2-stage amplifier desing allows gain margin and sloppy gain expansion which in turn promotes a high efficiency peak at back-off power.
- Flat gain can be obtained by scarifying efficiency at lower amplitudes
- A hybrid combiner can be used as Doherty combiner!
- The input circuit is as important as the output

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Thank you!

Clear skies
and
High Efficiency