

Modified Band-Limited Pulse-Width Modulated Polar Transmitter

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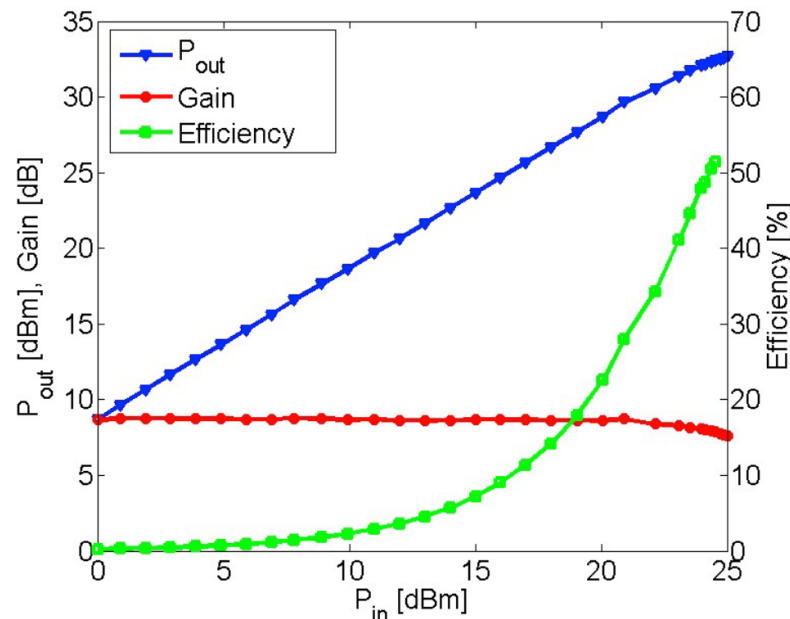
² ECE Faculty, NED University of Engineering Technology, Pakistan

Outline

- Introduction
- PWM transmitter architectures
- Modified Band-Limited Polar PWM Transmitter
- Results
- Conclusions

Introduction

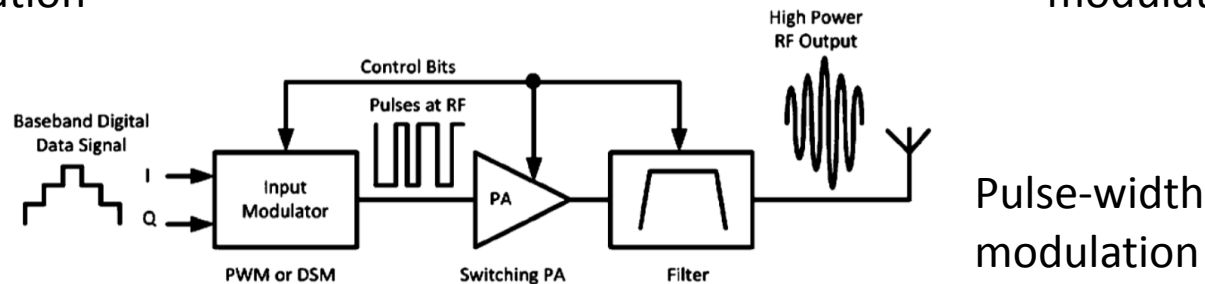
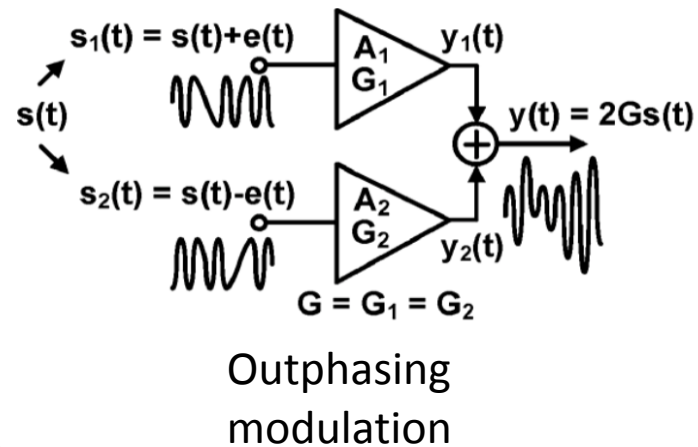
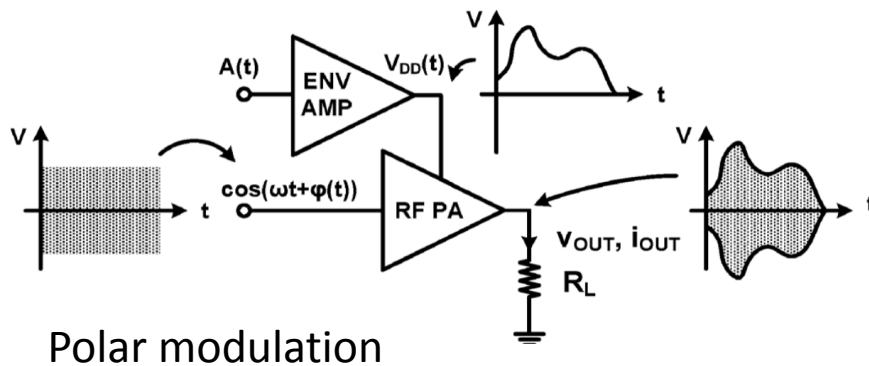
- Modern communication systems require transmitters and power amplifiers (PAs) with high linearity, high efficiency and high dynamic range.



802.11a: average $P_{out} = 22 \% * P_{max}$

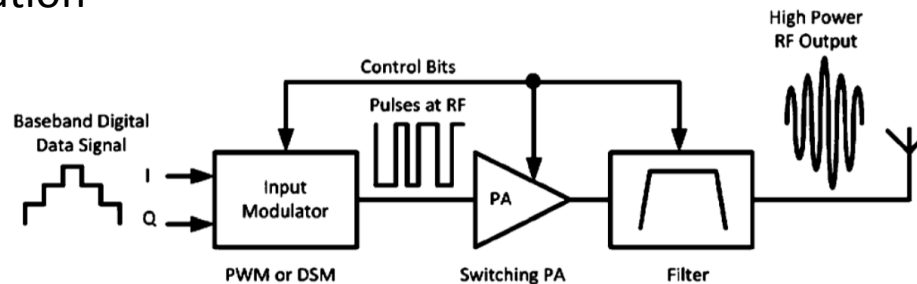
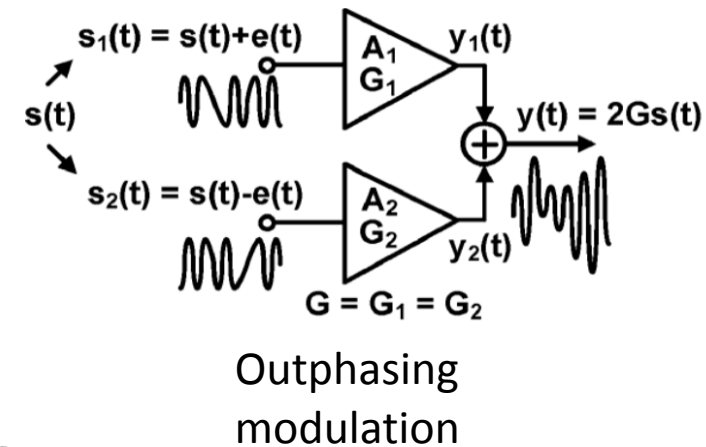
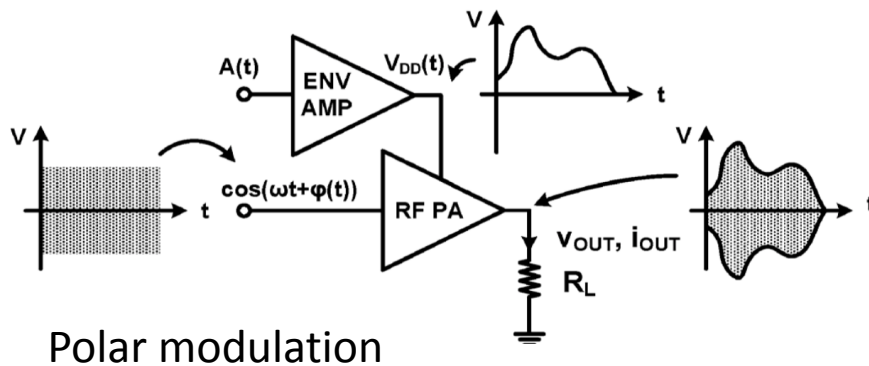
Switch-mode power amplifiers: class D, E, F, ...

- High efficiency, up to 100 %.
- But no amplitude control, so a transmitter architecture is needed to provide amplitude modulation.



Switch-mode power amplifiers: class D, E, F, ...

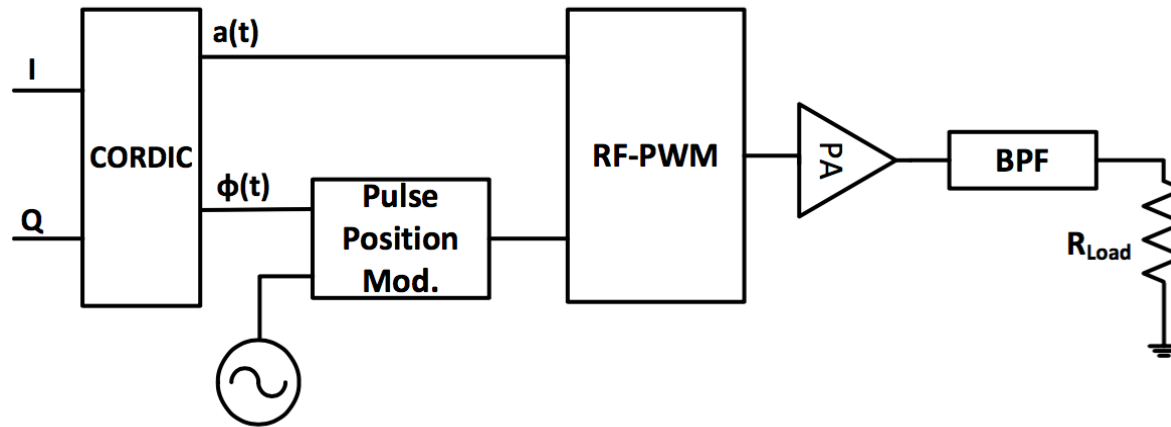
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SMPA -> High-efficiency
Pulse-width modulation

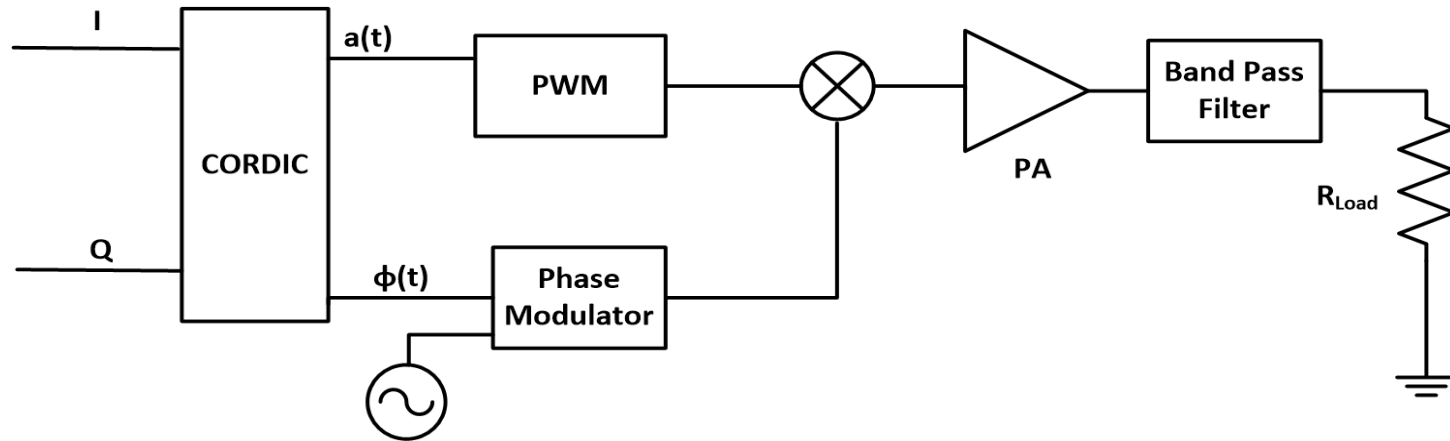
PWM transmitter architectures

RF PWM Transmitter (RF-PWMT)



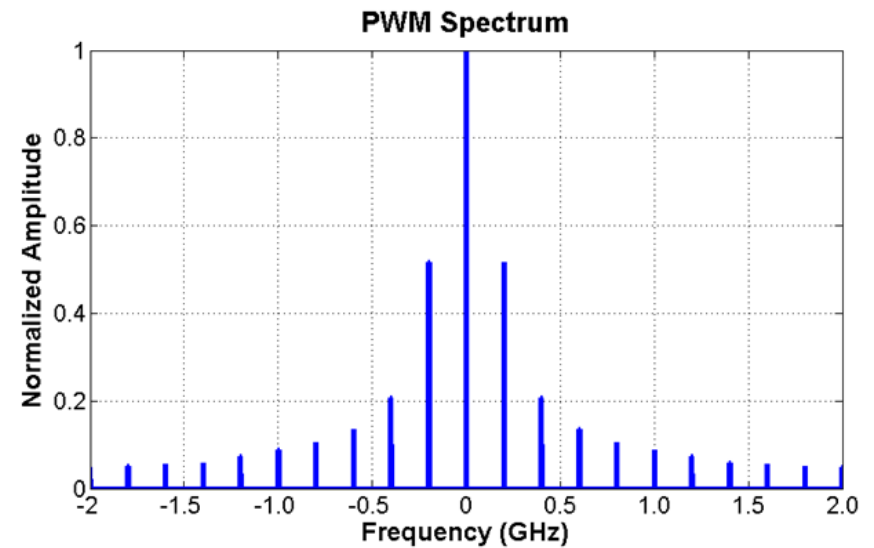
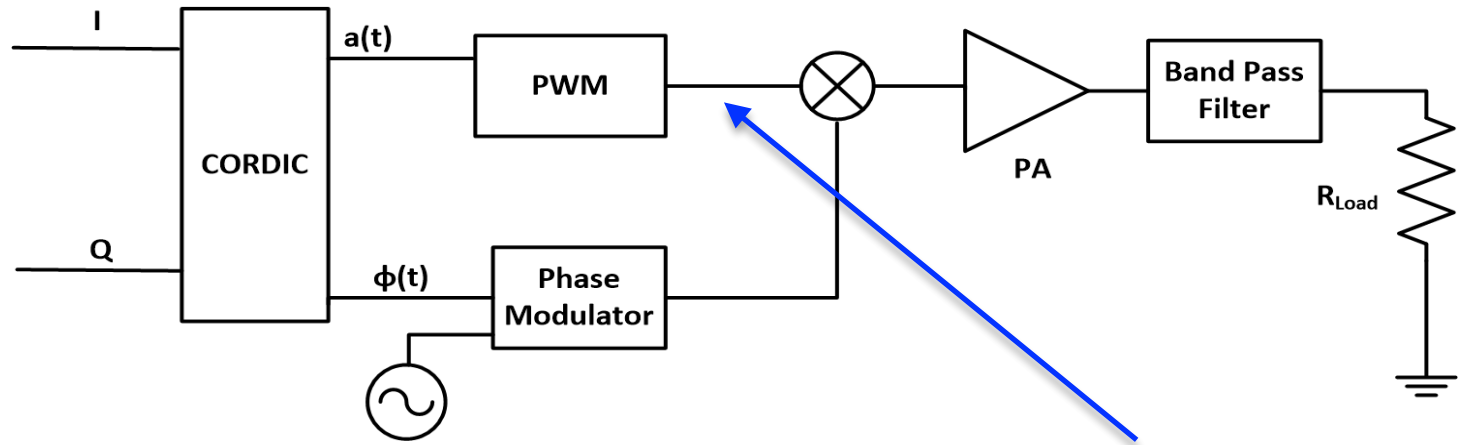
- Amplitude: controls the pulse-width of the RF-PWM block
- Phase: phase-modulates RF carrier
- PWM performed at RF
- Amplified by switch-mode PA
- Filtered

Polar PWM Transmitter (PPWMT)

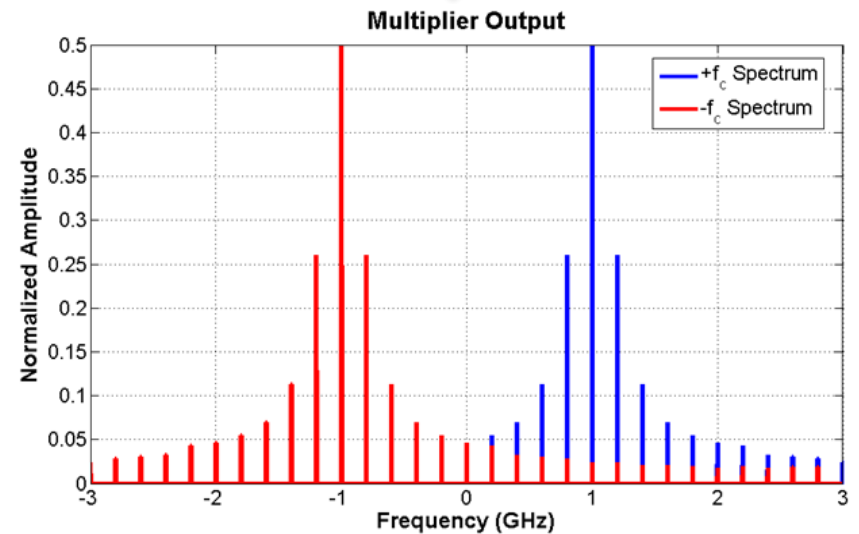
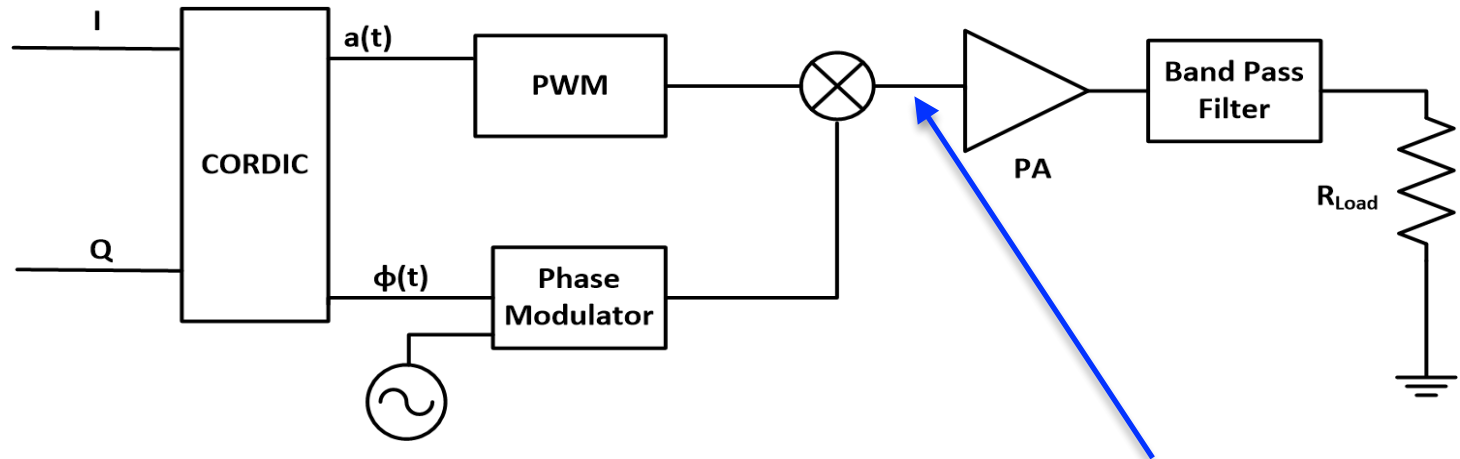


- Amplitude: PWM at IF
- Phase: phase-modulates RF carrier
- Multiplied to generate carrier-based PWM signal
- Amplified by a linear or switch-mode PA
- Filtered

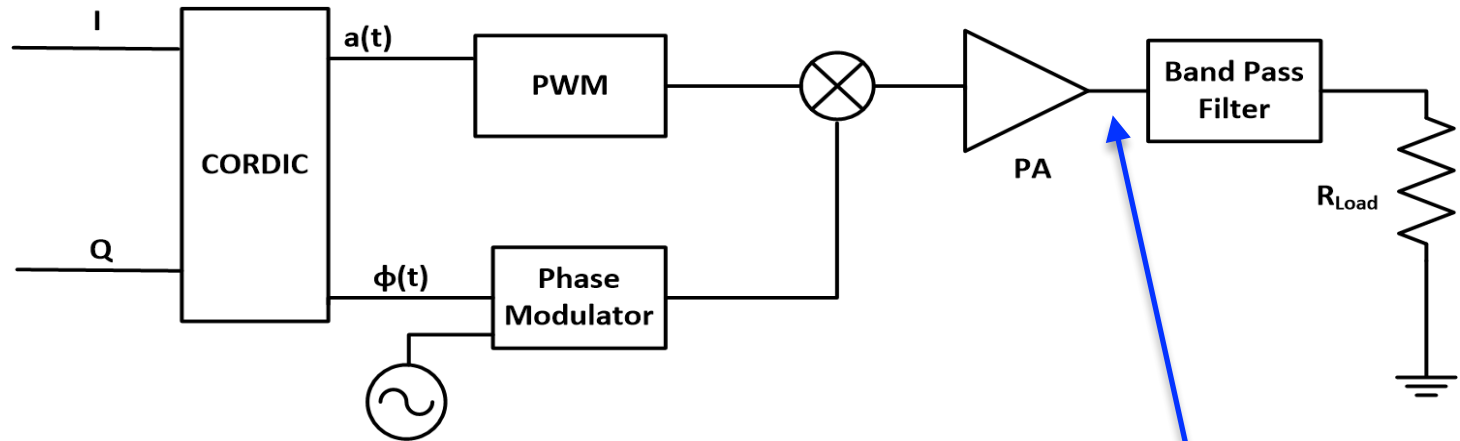
Polar PWM Transmitter (PPWMT)



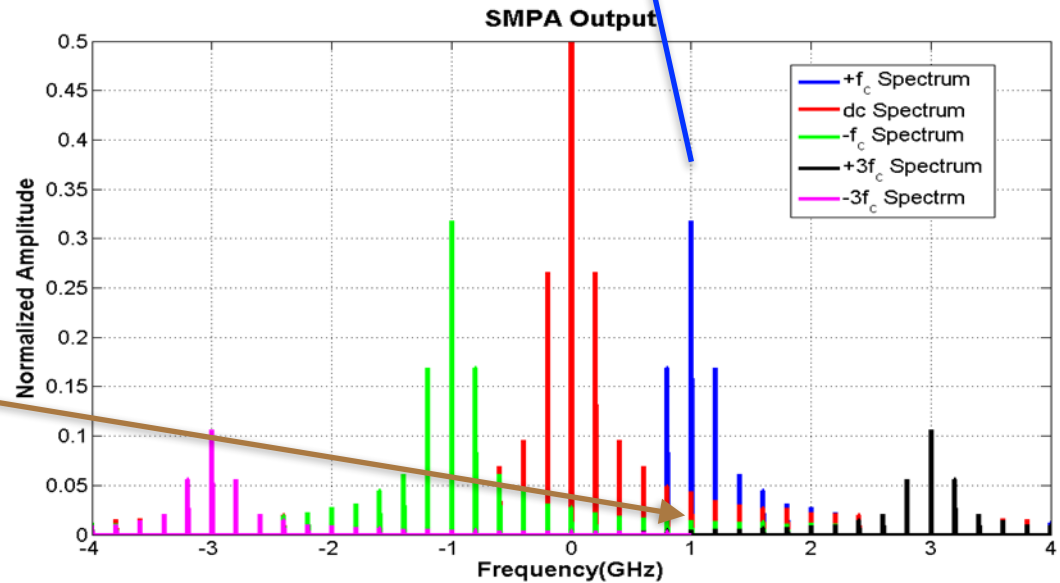
Polar PWM Transmitter (PPWMT)



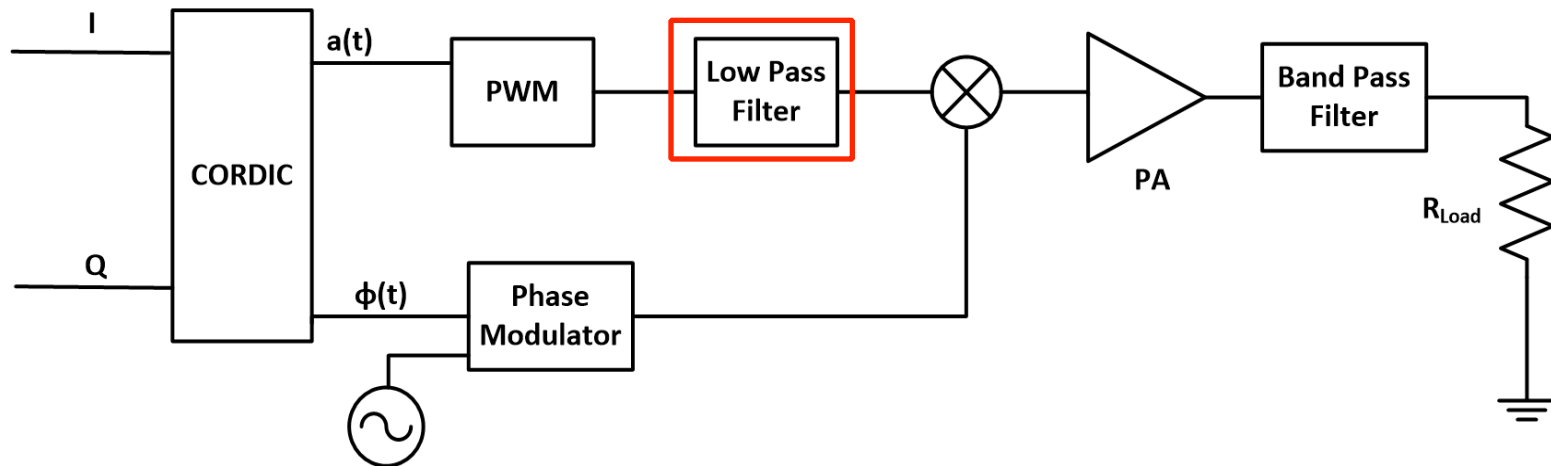
Polar PWM Transmitter (PPWMT)



- Switch-mode PA increases imaging
- Distortion (non-linearities) in the transmitted signal

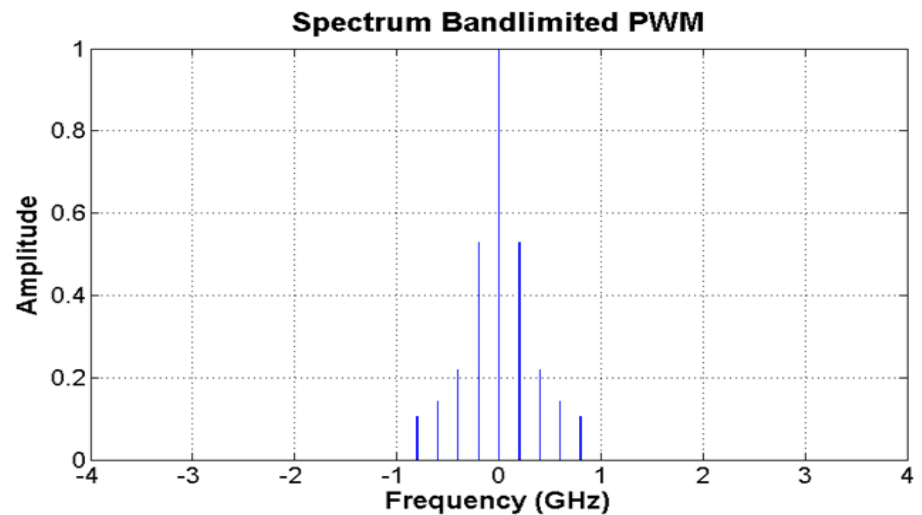
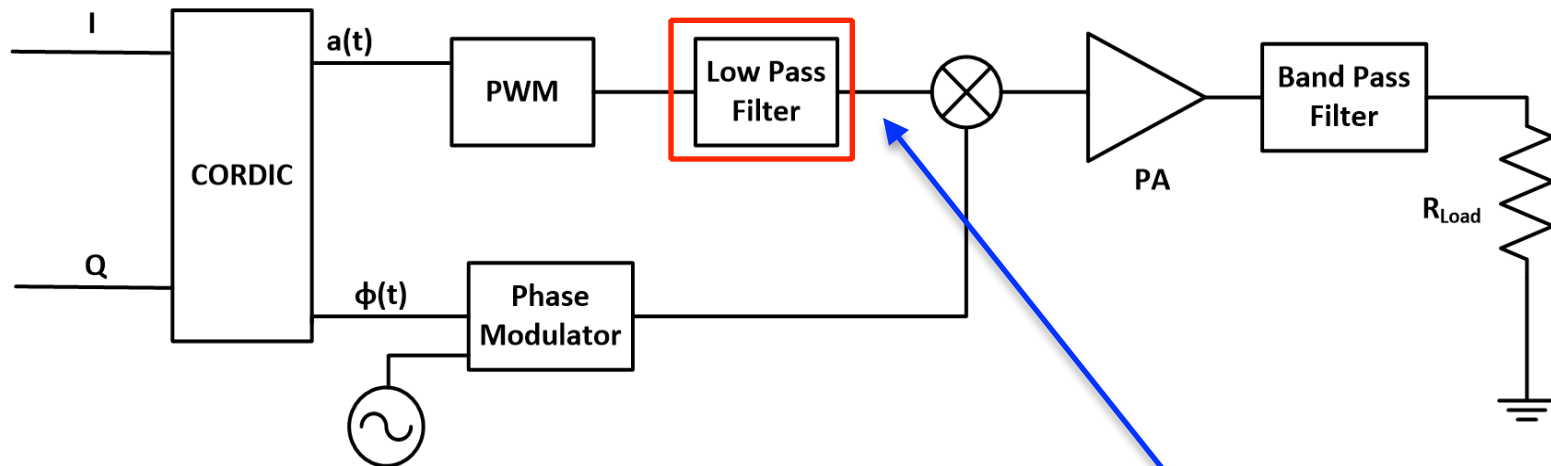


Band-Limited Polar PWM Transmitter (BL-PPWMT) ¹¹

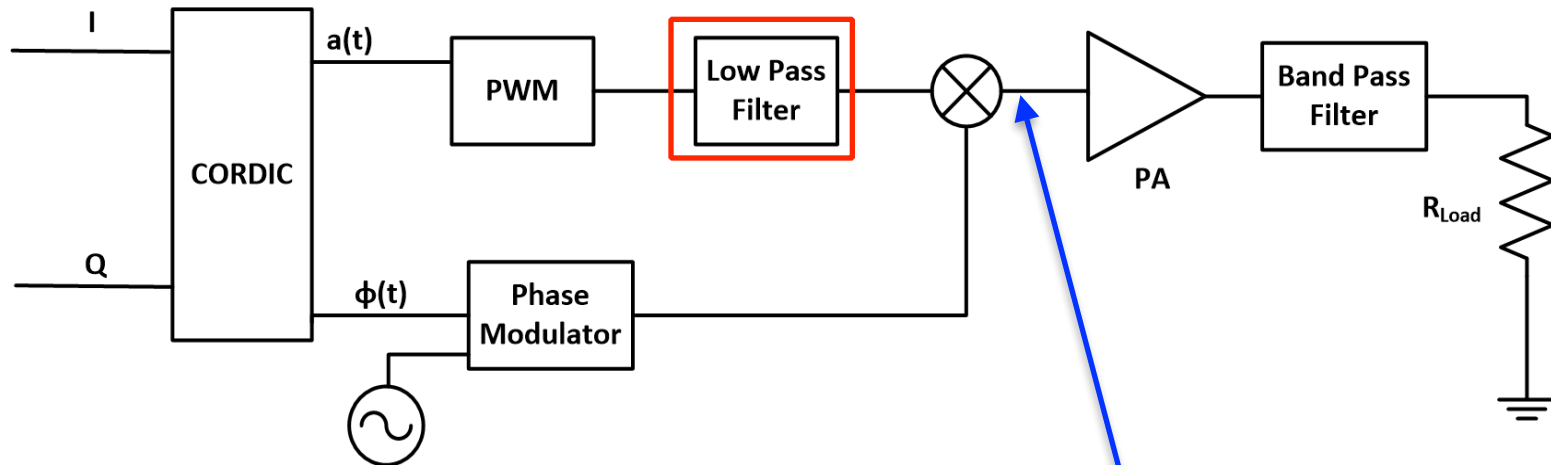


- Amplitude: PWM at IF, **low-pass filtered**
- Phase: phase-modulates RF carrier
- Multiplied to generate carrier-based PWM signal
- Amplified by a linear PA (switch-mode PA can not be used)
- Filtered

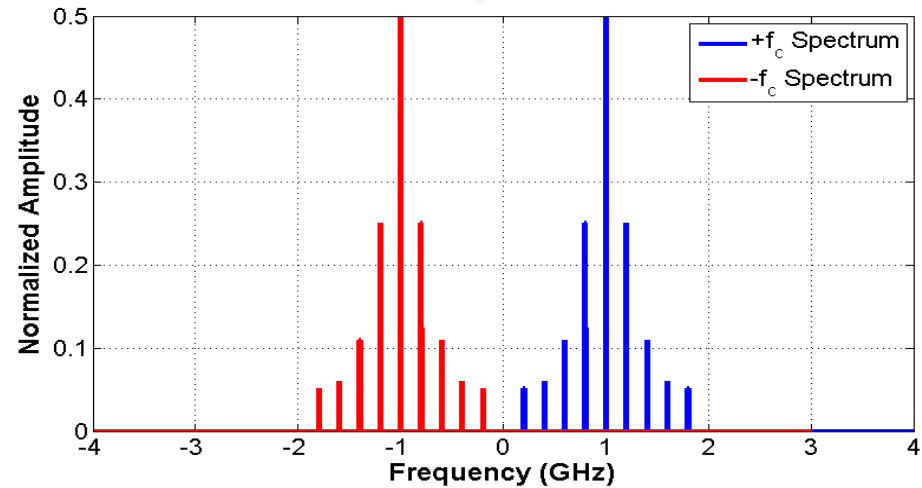
Band-Limited Polar PWM Transmitter (BL-PPWMT) ¹²



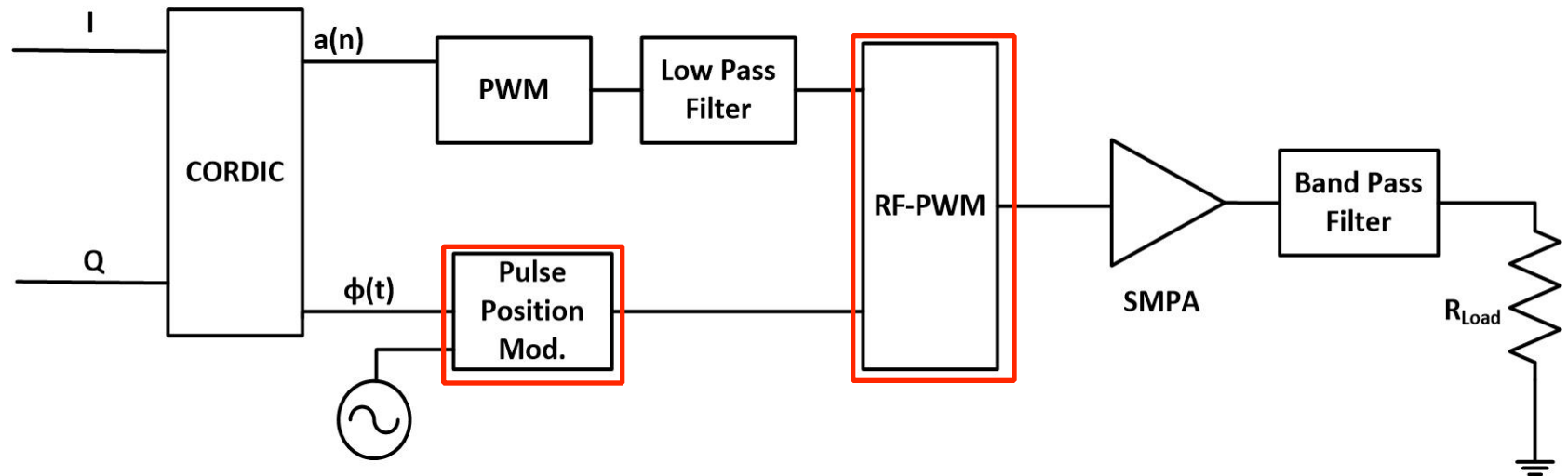
Band-Limited Polar PWM Transmitter (BL-PPWMT) ¹³



- No or little imaging after multiplication
- But has varying output amplitude
=> can not use switch-mode PA

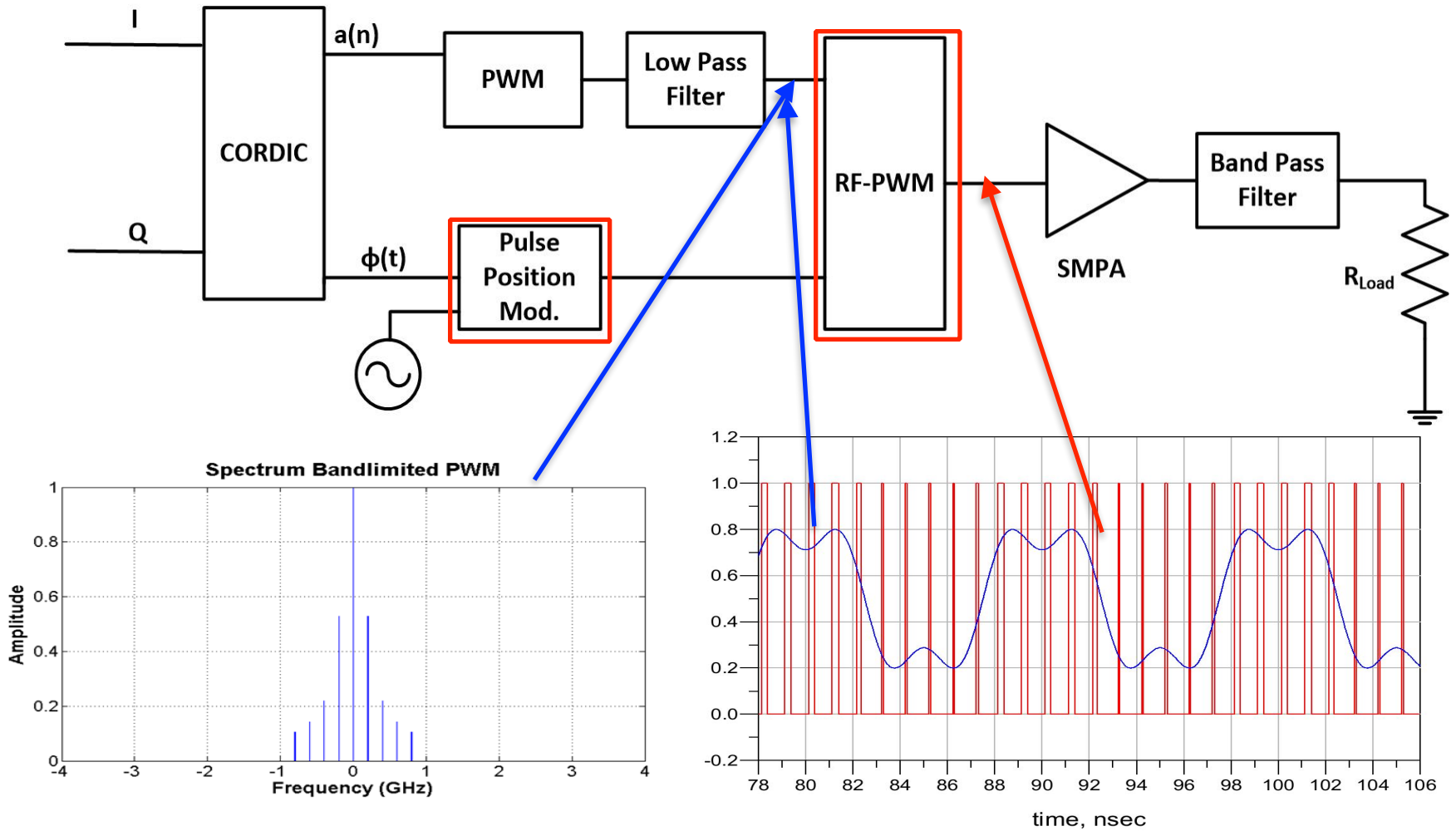


Modified Band-Limited Polar PWM Transmitter (MBL-PPWMT)

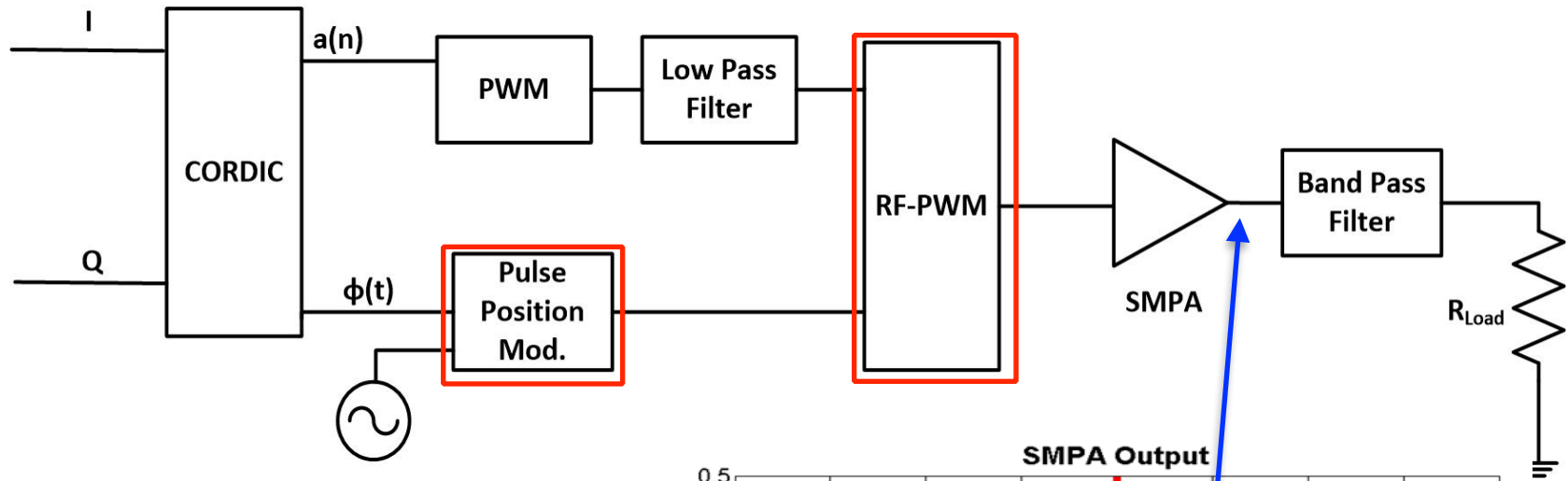


- Amplitude: PWM at IF, low-pass filtered
- Phase: **pulse-position modulated** carrier at RF
- An **RF-PWM** is used to generate the carrier-based PWM signal
- Amplified by a switch-mode PA
- Filtered

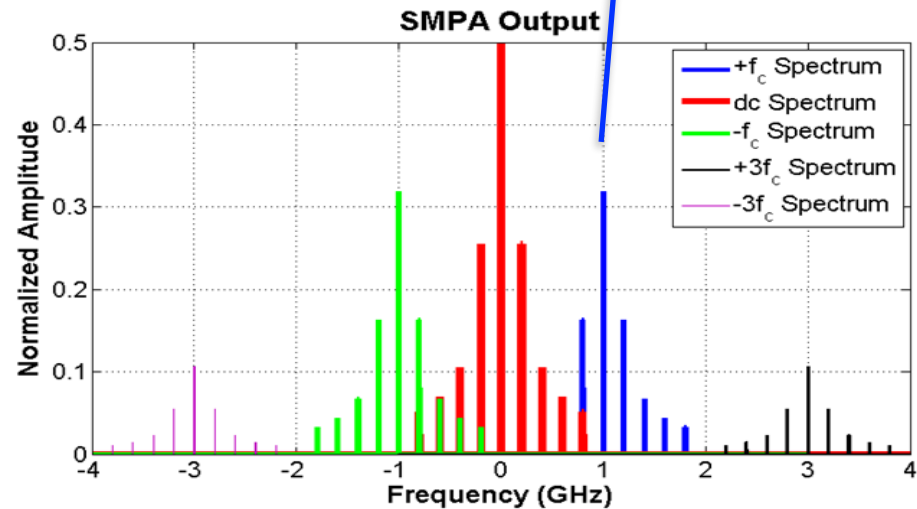
Modified Band-Limited Polar PWM Transmitter (MBL-PPWMT)



Modified Band-Limited Polar PWM Transmitter (MBL-PPWMT)



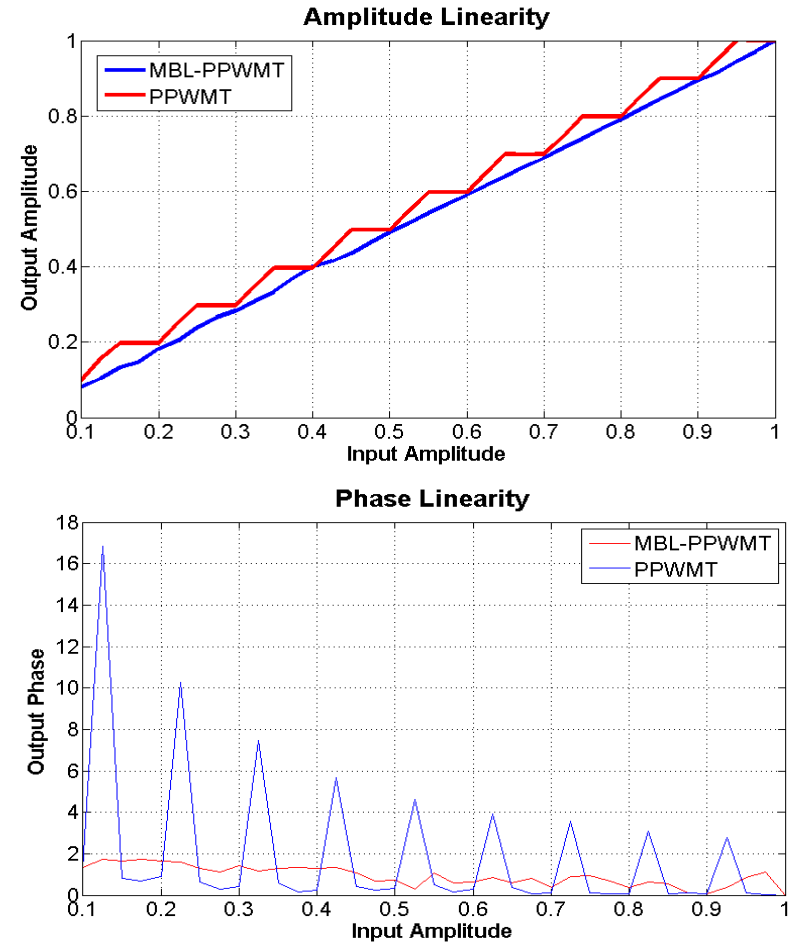
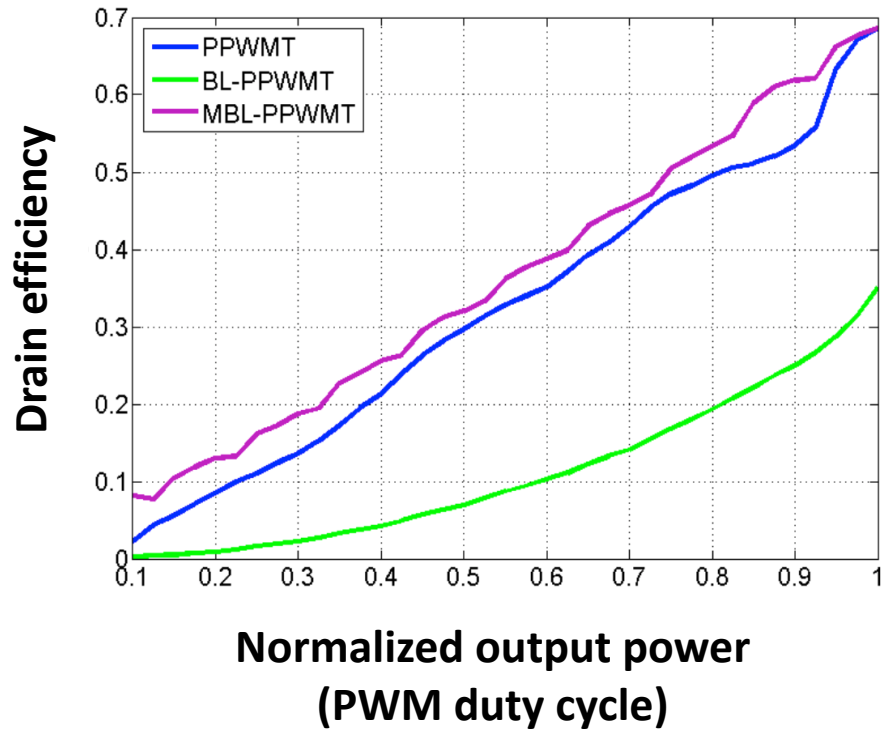
- No imaging after multiplication
- Can use switch-mode PA



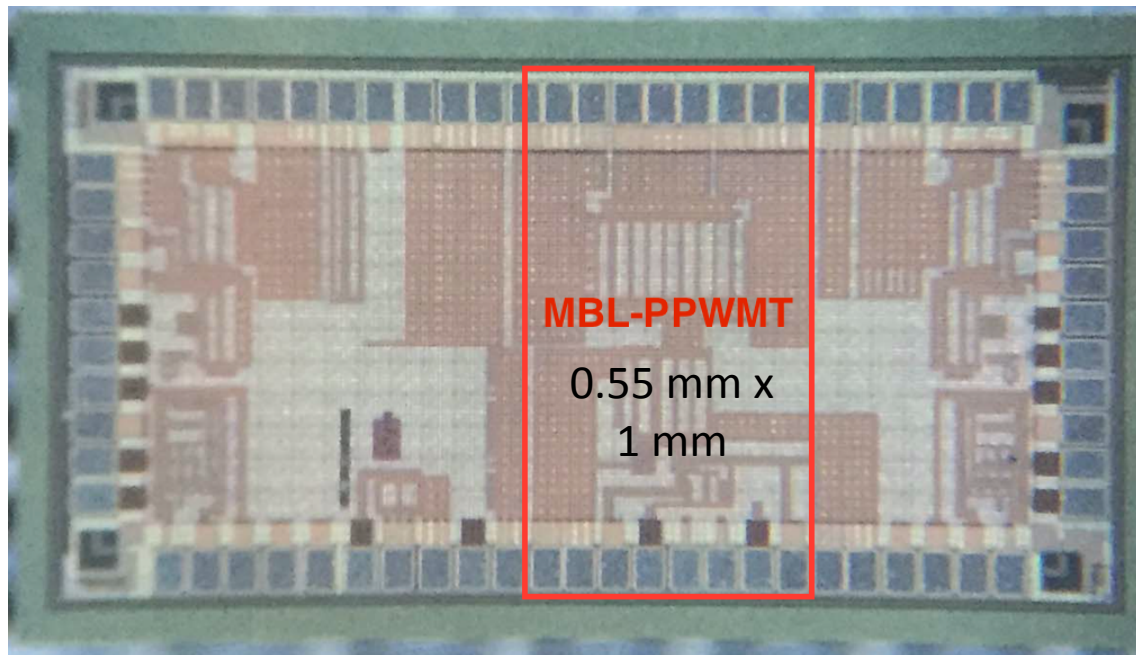
Results

Cadence/ADS, 130 nm CMOS by STM
1 W PA at output

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Fabricated 130 nm chip



- "proof-of-concept"
- class-D @ 2.5 V using thick-oxide transistors
- Simulated performance (worst corner, temp=120° C, incl. parasitics):
 - Pout = 25 dBm @ 890 MHz
 - Efficiency = 25 %
 - Dynamic Range = 20 dB

Conclusions

- A new Modified Band-Limited Polar PWM Transmitter architecture is proposed and verified by simulations using a 130 nm CMOS process.
- The efficiency is improved compared to both to the Polar PWM Transmitter (PPWMT) and the Band-Limited Polar PWM Transmitter (BL-PPWMT) architecture.
- The linearity (amplitude and phase) is improved compared to the Polar PWM Transmitter (PPWMT) architecture.

Thank you!

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