

# GaN & GaAs MMIC and Module Technology Supporting the Needs of Phased Array Radars

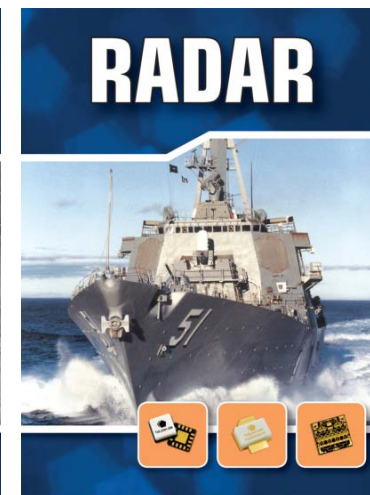
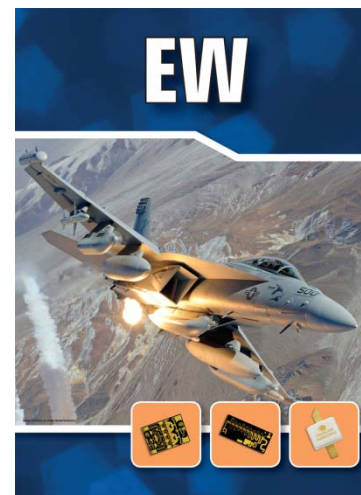
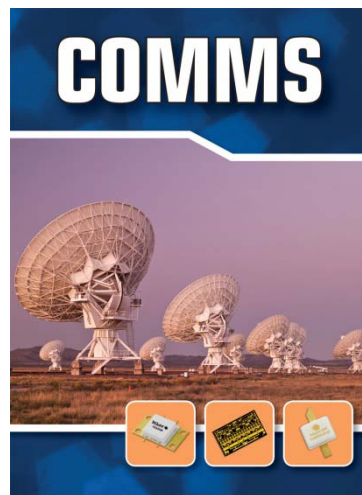
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# Outline

- ◆ Types of radar
- ◆ GaN vs. TWTs
- ◆ T/R module using COTs MMICs
- ◆ T/R module on a chip
- ◆ Summary



# GaN Building Blocks for Radars



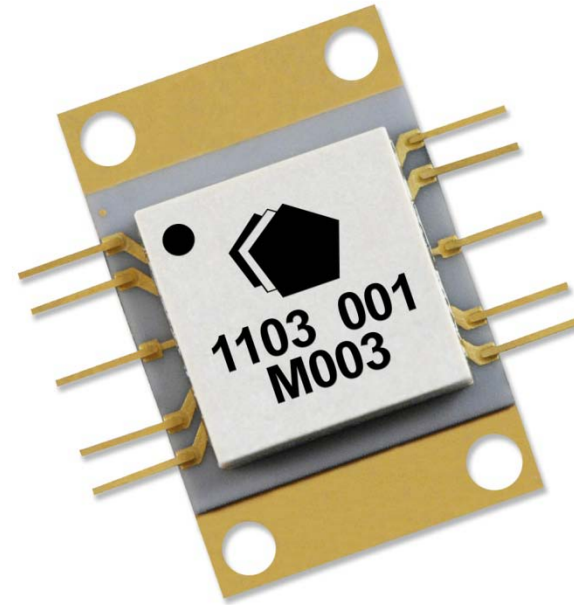
# Applications of Gallium Nitride: HPAs

- ◆ GaN offers unmatched performance for high power amplifiers
  - High power density
  - Excellent gain and efficiency
  - Robust operation and long pulse capability
  - High operating voltage reduces system current
- ◆ Today's technologies offer efficient power amplification at frequencies extending through Ku-band



# Hybrid Power Amplifier Platform

- ◆ GaN hybrids can be combined to reach 1 kilowatt levels
  - High power density
- ◆ GaN PA advantages
  - Very compact
  - Simplified DC power supply
  - Reliability
  - No warm-up time needed
- ◆ TWT advantages
  - Power-added-efficiencies



**135 W Pout**  
**35% PAE**

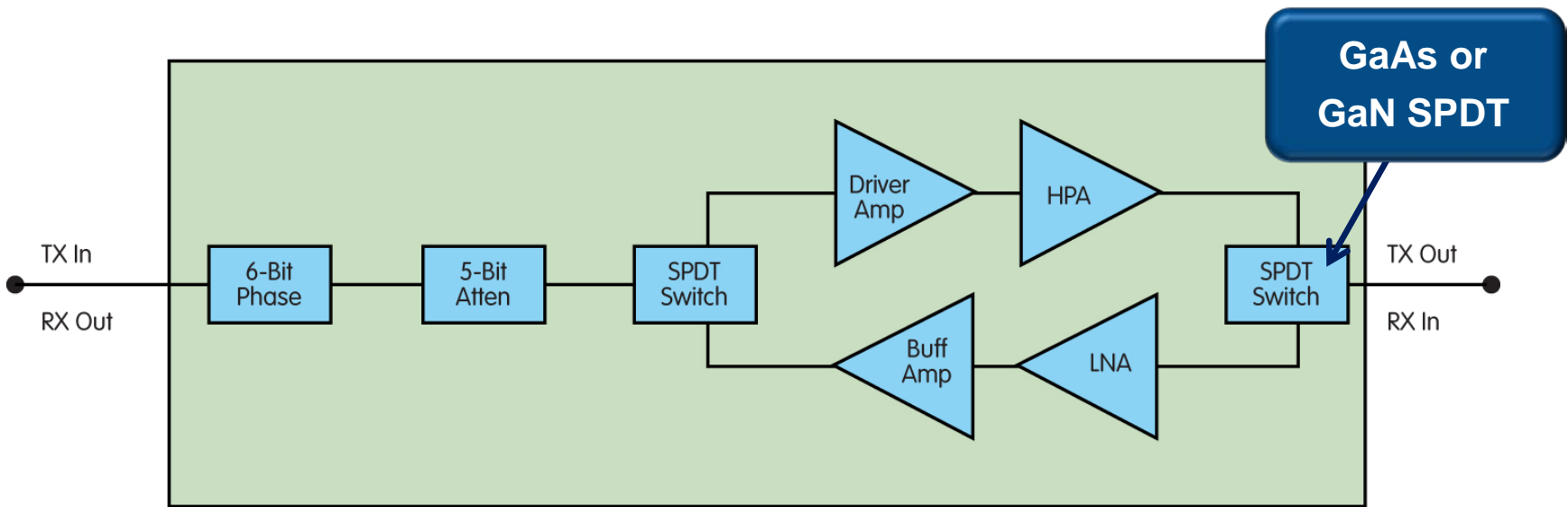


# Planar Array Radars

- ◆ UAV radar designers are very focused on size, weight and power (SWaP)



# Basic Transmit and Receive Block Diagram



# Applications of Gallium Nitride: Other Functions

## ◆ High power switches

- High breakdown voltage and high current carrying capacity enable high voltage and high power switches
- 40W through 6 GHz; 20W to 12 GHz and 10W to 18 GHz are available today

## ◆ Low noise amplifiers

- High input survivability for reduced system NF
- Comparable NF as similar pHEMT technologies but at higher voltage
- High TOI achievable

## ◆ High power limiters

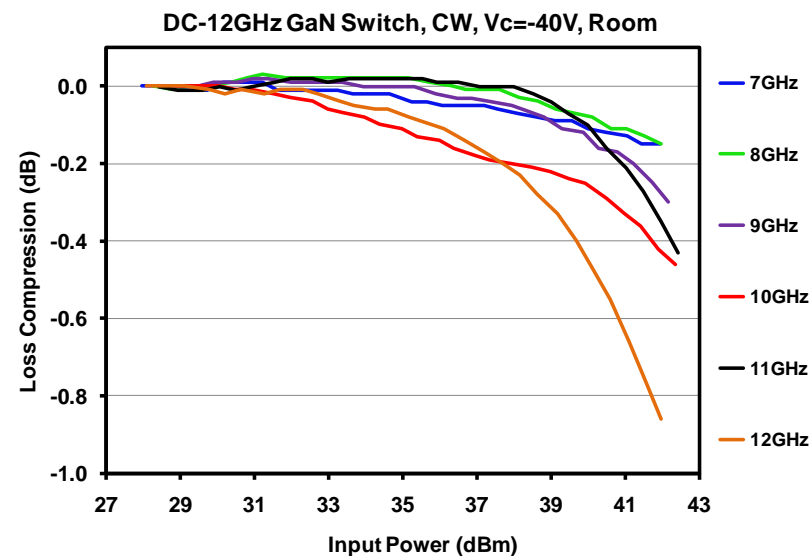
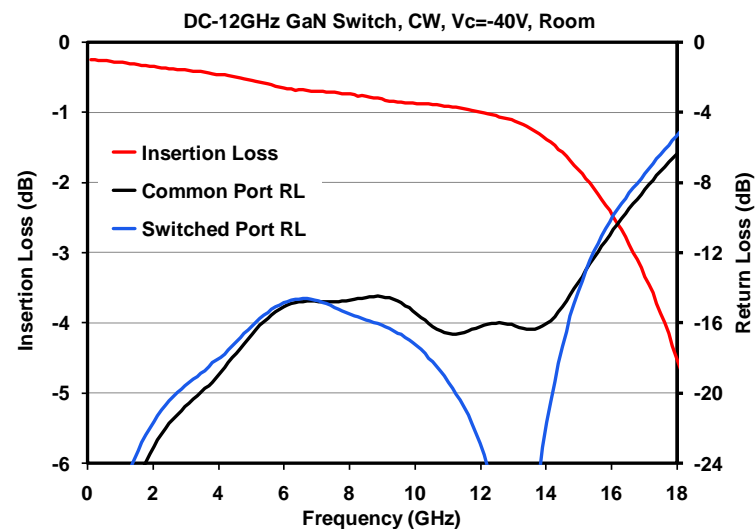
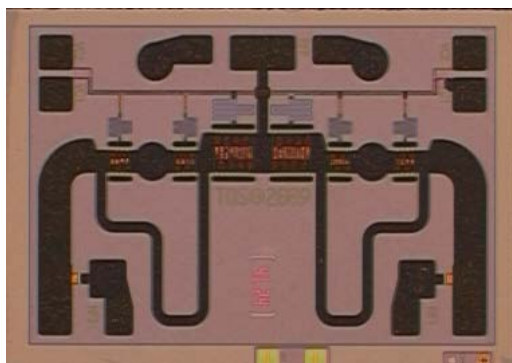
- Enabled by same attributes that are critical for high power switches



# DC-12 GHz High Power GaN SPDT Switch

## Key features and performance

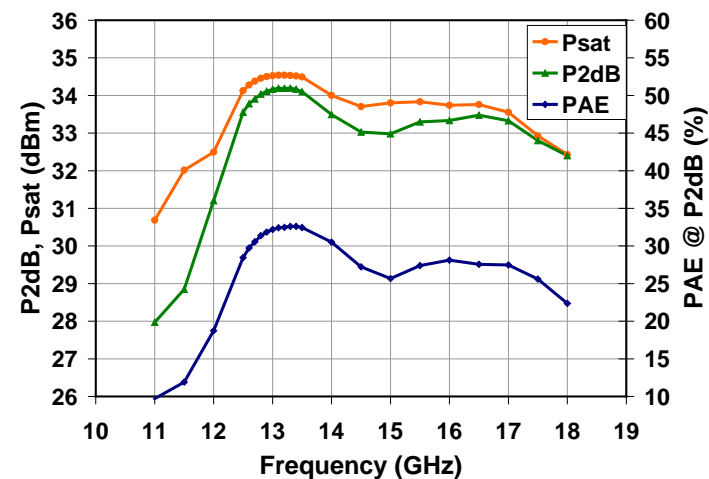
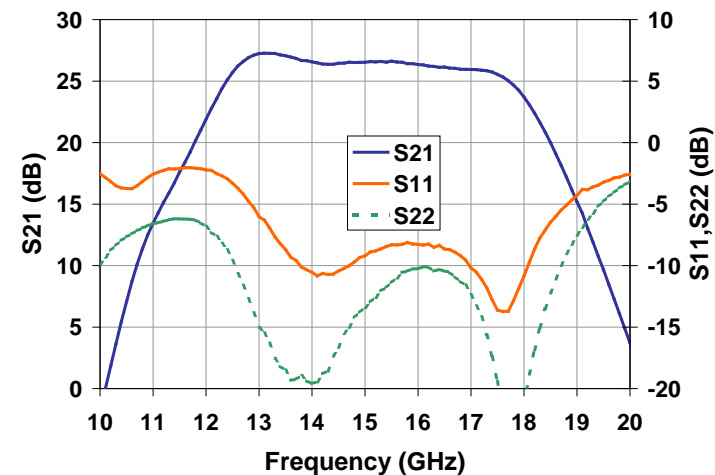
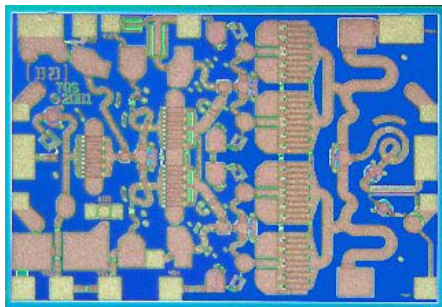
- DC-12 GHz frequency range
- Reflective topology
- Estimated 20W input power handling
- Off-state isolation:  $< -27\text{dB}$
- Control voltages: 0V / -40V
- 0.25 $\mu\text{m}$  GaN on SiC 3MI technology
- Die dimensions: 1.15x1.65x0.1mm



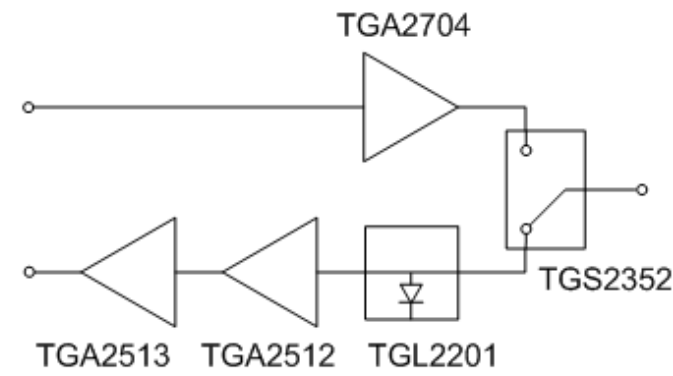
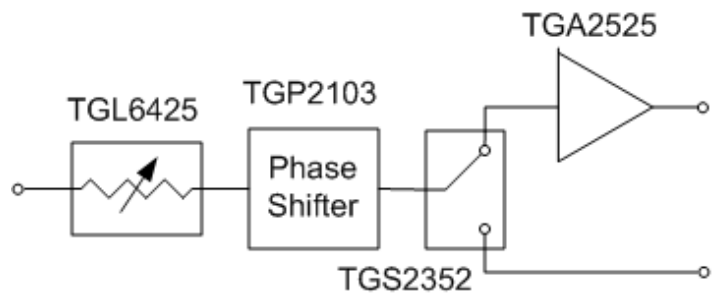
# TGA2510 Ku-Band HPA MMIC

## Key features and performance

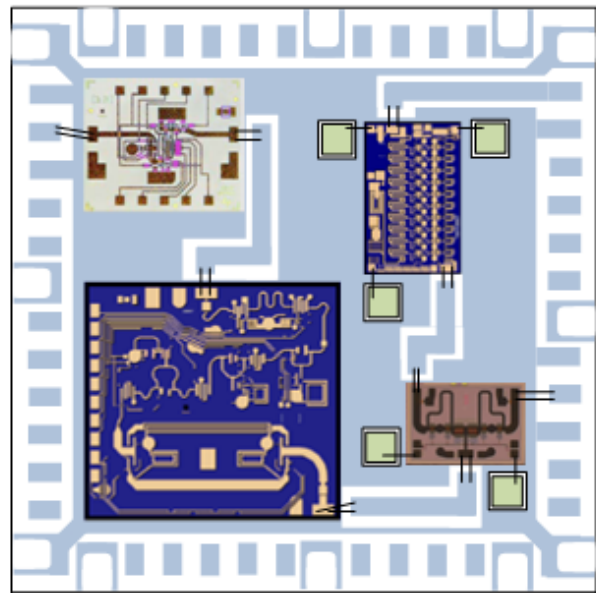
- 34dBm midband Psat
- 26dB nominal gain
- 7dB typical input return loss
- 12dB typical output return loss
- 12.5-17 GHz frequency range
- Directional power detector with reference
- 0.25um pHEMT 3MI technology
- Bias conditions: 7.5V, 650mA
- Chip dimensions: 2.02x1.38x0.10mm (0.08x0.054x0.004 inches)



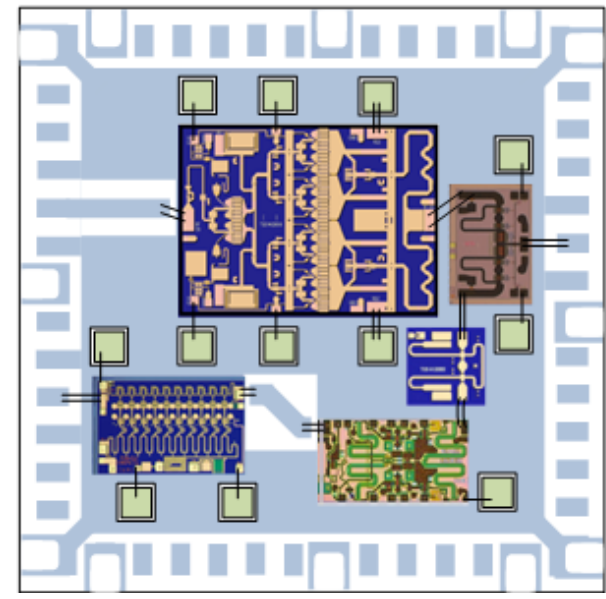
# Concept: T/R Element Layout Using Existing MMICs



Control Module



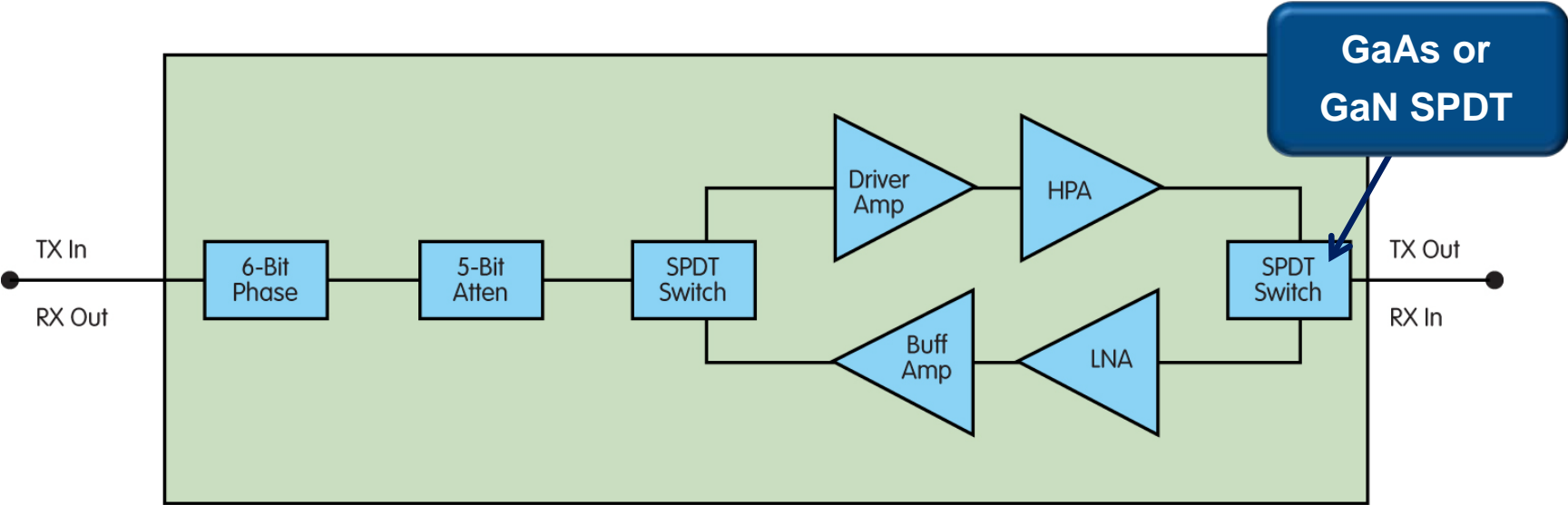
Front-End Module



8x8mm Ceramic Packages

# Transmit / Receive Module on a Single Chip

# Basic Transmit and Receive Block Diagram



**Transmit, Receive and Control Functions  
on a Single MMIC**



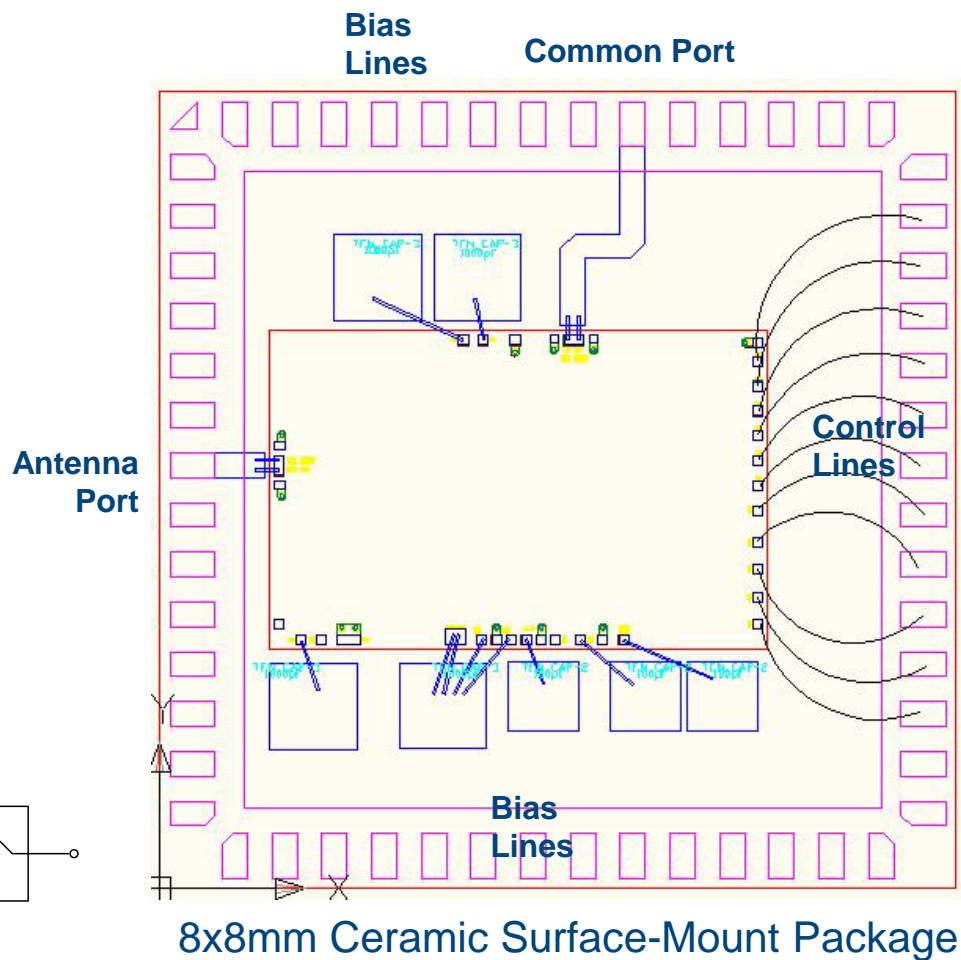
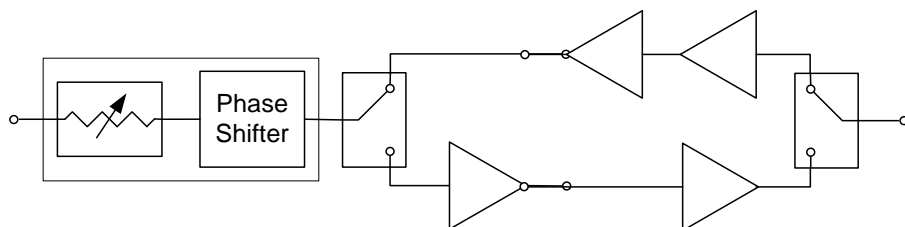
# T/R Module on a Chip

## Advantages

- Very compact
- Lower assembly cost

## Disadvantages

- One wafer process for
  - LNA, PA and control
- Stacked yields
- Complex MMIC design



- ◆ GaN power amplifiers key advantages
  - Simplified DC power supplies
  - Smaller size
  - Lower cost
- ◆ T/R module build with COTs MMICs
  - Lower NRE
  - Choice of the best wafer process for the right function
- ◆ T/R module-on-a-chip
  - Very compact
  - Low module assembly costs
  - High initial development NRE

# Thank You!

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