Power Amplifier Efficiency

Part 2: Waveforms

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Class A Waveforms

“Theoretical Maximum Efficiency 50%”

Practical RF Amplifiers require a network between active device and load. Therefore waveform at load is not the same as waveform at device.
Overdriven Class A is probably most common microwave Power Amplifier

Class A Waveforms

Trade efficiency for deviation from pure sine wave at device
PA Load Network

Not a matching network -- three functions:
1. Transform 50 ohm to desired R
PA Load Network

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1. Transform 50 ohm to desired R
2. Present pure sine wave to Load
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1. Transform 50 ohm to desired $R$
2. Present pure sine wave to Load
3. Use device efficiently
PA Load Network -- circa 1947

Not a matching network -- three functions:
1. Transform 50 ohm to desired R
2. Present pure sine wave to Load
3. Use device efficiently

This is not really new...
Class B -- transformers

very common audio amplifier -- evolved into complementary symmetry

Class B zero bias

Class B with bias

good for differential circuits, symmetrical output waveform

very common at HF -- has other advantages...
Class C -- Resonant Network

reduced conduction angle -- transistor draws current from supply in short pulses like a steam engine. Network converts to sine wave.

loose coupling

classic high efficiency RF output stage at HF

energy in pulse a function of supply voltage

therefore easy power control and envelope modulation
Class C -- Frequency Multiplier

Greatly reduced conduction angle. Pulse comes less than once per cycle of output sine wave.

Classic driver stage at VHF

Efficiency is low because network is lossy

...and device dissipation isn’t well behaved....