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A novel method for extending the output power back-off range of an asymmetrical Doherty power amplifier

Key words: Doherty power amplifier; Output power back-off; Output impedance; Network phase

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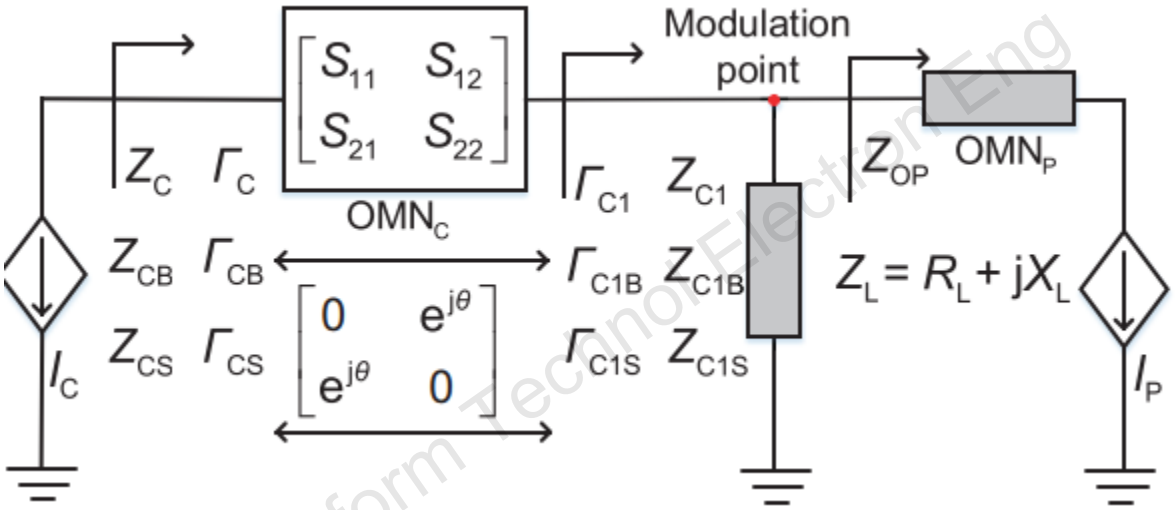
Motivation

The rapid development of wireless communication systems has changed our lives. Five-generation wireless communication (5G) is characterized by high data rate, massive connections, and low latency, which will cause a larger signal peak-to-average power ratio. Therefore, improving the efficiency of the amplifier in the output power back-off (OPBO) state is beneficial to improving the overall performance of the transmitter system.

Main idea

A novel method is proposed to extend the OPBO range of the Doherty power amplifier (DPA). This study reveals that the OPBO range of the DPA can be extended by tuning the output impedance of the peaking stage away from infinity and changing the phase delay of the output matching network of the carrier power amplifier. Based on this theory, a large-OPBO-range high-efficiency asymmetrical DPA working band from 1.55 to 2.2 GHz (35% relative bandwidth) is designed to verify the proposed method.

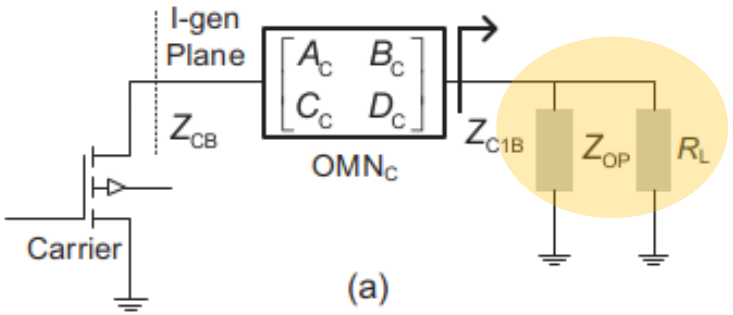
Framework

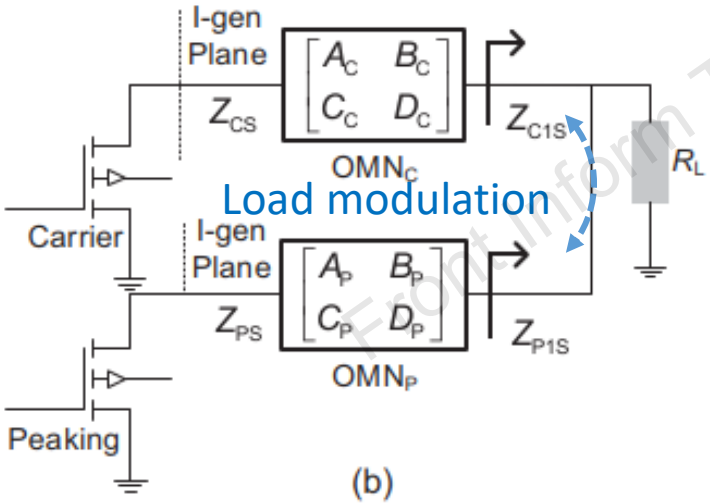


The asymmetric DPA block diagram consists of a carrier transistor, a peak transistor, the output matching network of the carrier power amplifier (OMNC), the output matching network of the peak power amplifier, and the impedance looking into the load from the modulation point.

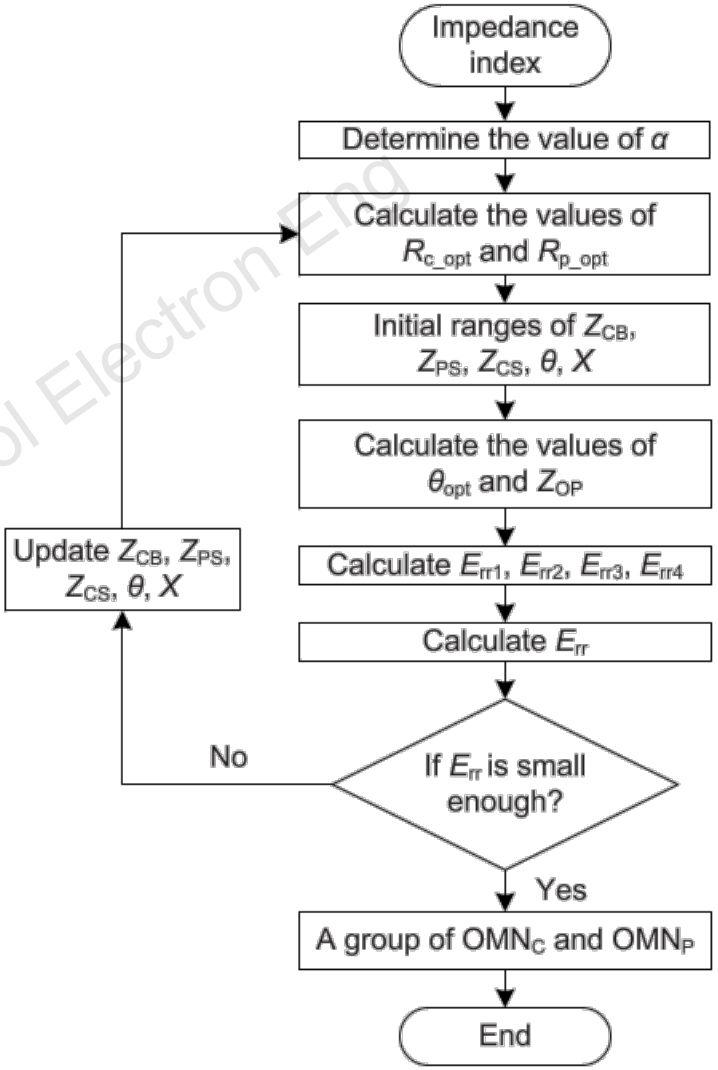
Method

Low power matching



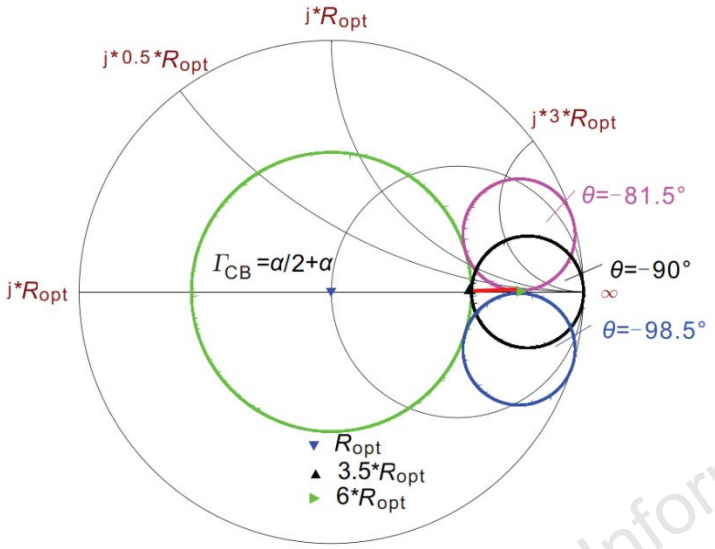


High power matching



Algorithm flowchart of design OMN_C and OMN_P

Major results



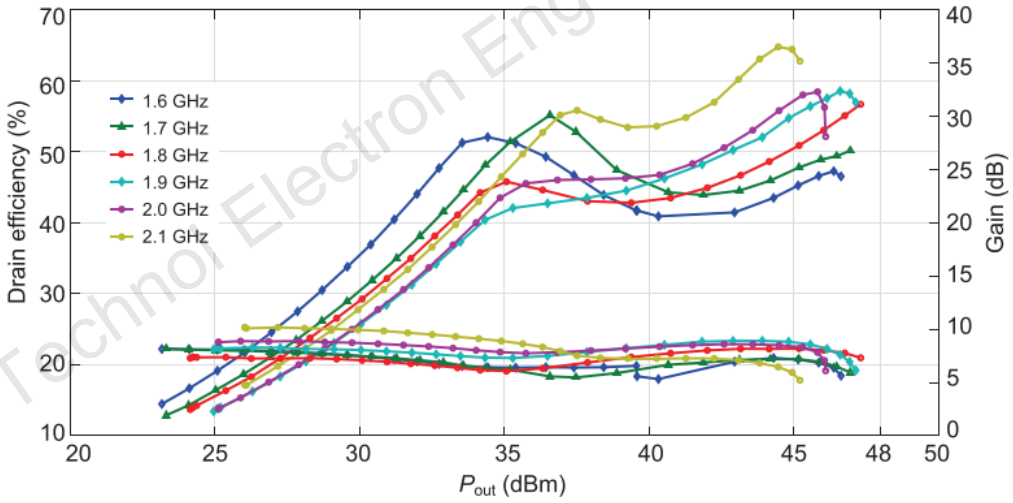


Table 1 Comparison between our Doherty power amplifier (DPA) and some DPAs in the literature

Reference	Frequency (GHz)	FBW (%)	Power (dBm)	OPBO (dB)	Eff-OPBO (%)	Eff-sat (%)
Özen et al., 2016	1.95	–	44	9	50	–
Hasin and Kitchen, 2019	2.2	–	43.6	9	50.7	71
Li C et al., 2019	1.9–2.4	23.2	44.1–44.8	8.5–9	44.2–49.7	65.2–71.8
Fang et al., 2018	1.35–1.7	22.9	42	9	50–56	71–76
This work	1.6–2.1	27	45.2–47.3	11.1–13.2	42.2–52.1	47–62.7

FBW: fractional bandwidth; OPBO: output power back-off; Eff-OPBO: efficiency in the OPBO state; Eff-sat: efficiency in the saturation state

Conclusions

- This paper presents a method for extending the OPBO range of the DPA. To verify the theory, a novel method of asymmetrical DPA with a large OPBO range is designed.
- Experimental results show that the designed asymmetric DPA operates at 1.6–2.1 GHz. The OPBO range is 11.1–13.2 dB and the maximum output power is 45.2–47.3 dBm. The efficiency range is 42.2%–52.1% in the OPBO state and 47%–62.7% in the saturation state. The theory can also be used to develop a symmetrical DPA.

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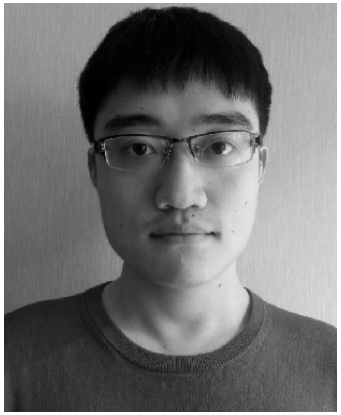

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