Ultra-Wideband Transmitter Design for Broadband Communication

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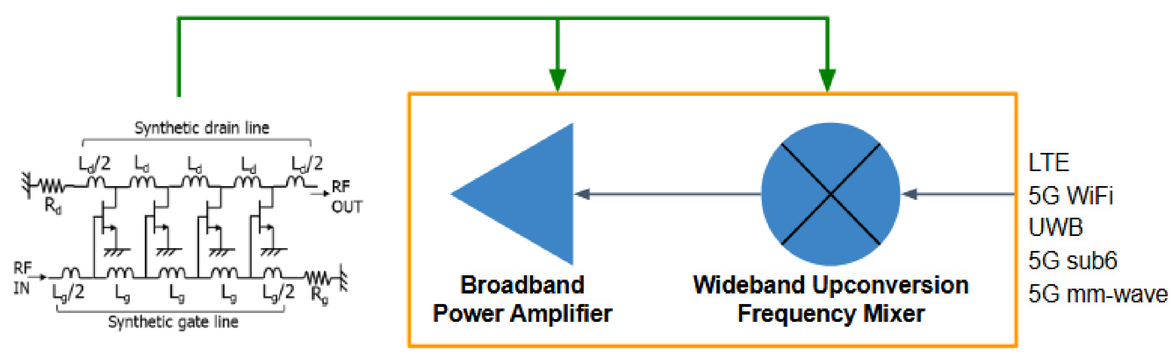
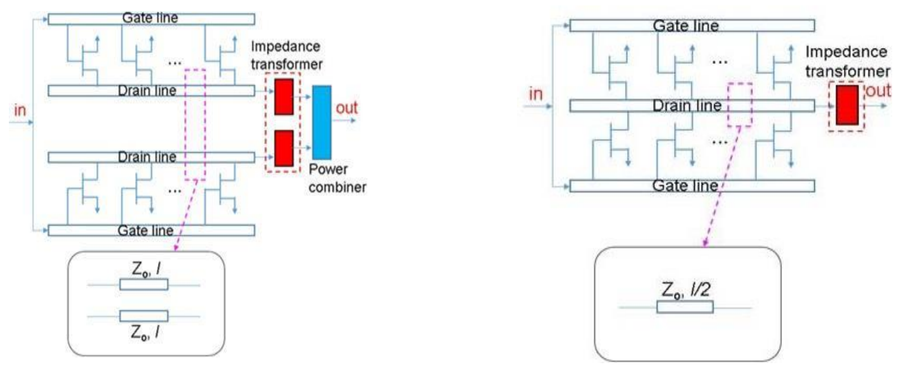
Introduction



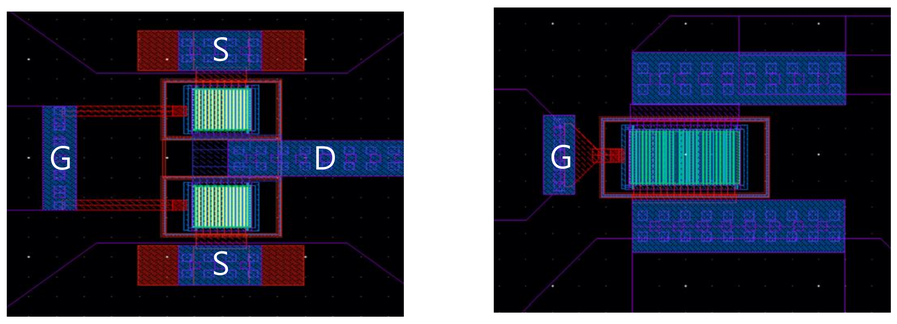
- Design a wideband transmitter circuit using a distributed amplification method
- LTE, WiFi, UWB, 5G communication bands used -> Aim to obtain available output power via broadband power amplifiers of 1 to 40 GHz

Design



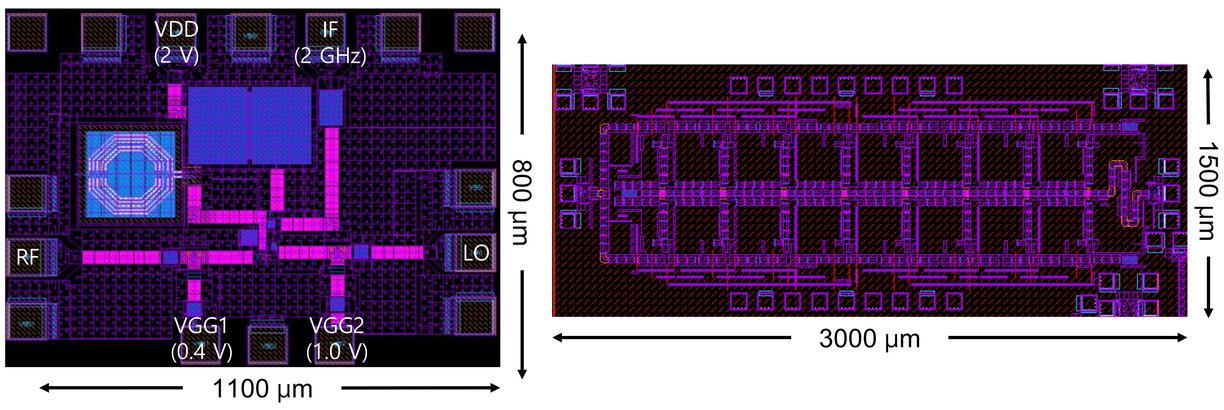
< Conventional power combining structure > < Proposed power combining structure >

The existing structure has a problem in that the size of the chip increases due to the power combiner for power-combining and the long drain / gate lines of each amplifier. Proposed power combining structure reduces the number of impedance transformers by sharing the drain line, does not use a power combiner, and by sharing the line, the length of the line can be halved, enabling more compact power combining.



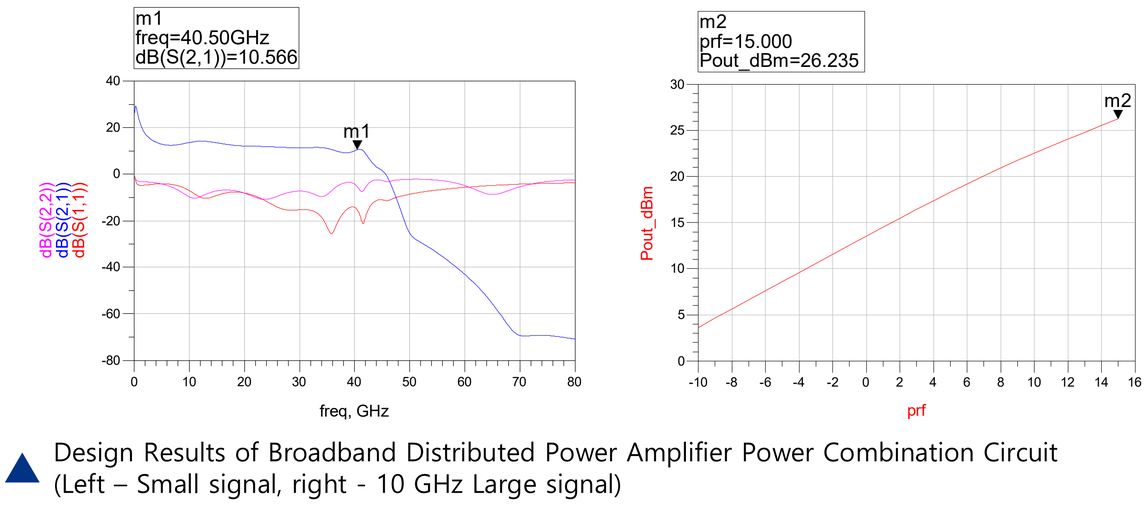
< symmetry type > < ring type >

Symmertry type has a smaller parasitic component than the ring type. This is likely due to the shorter drain feed line and reduced length of the gate ring with the Symmertry type, which results in smaller capacitance and less resistance to the surrounding source and drain.



▲ MIXER(symmetry type) & Broadband Distributed Power Amplifier Power layout

Simulation Result



▲ Design Results of Broadband Distributed Power Amplifier Power Combination Circuit (Left – Small signal, right - 10 GHz Large signal)

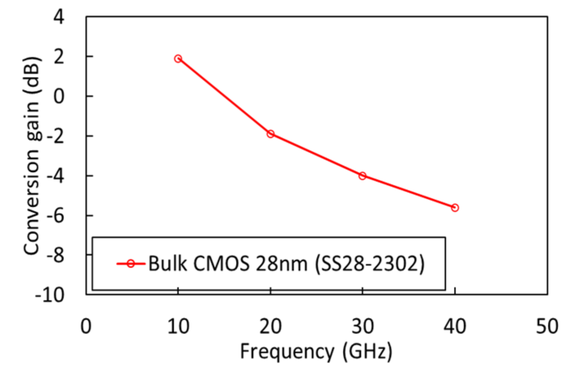
It shows the simulation result of power combining two single circuits. To further increase the power, two single distributed power amplifiers were designed by sharing a drain line according to the method proposed above. It showed a small signal gain of 10 dB or more up to approximately 40 GHz, and the expected output power at 10 GHz exceeded 25 dBm. Additional measurements could not be taken due to problems with the measuring equipment setup, and will be taken at a later date.

RF (GHz)	2GHz IF power (dBm) RF = - 20 dBm, LO = 5 dBm				
	No cap	10 x 5 um cap	10 x 10 um cap	15 x 10 um cap	15 x 15 um cap
10	-6.51	-6.73	-6.95	-7.19	-7.6
20	-5.45	-5.78	-6.09	-6.39	-6.87
30	-6.98	-6.24	-5.91	-5.99	-6.42
40	-9.2	-6.70	-6.13	-6.29	-6.84
50	-11.52	-8.48	-7.79	-7.8	-8.18
60	-12.28	-10.09	-9.81	-9.92	-10.13

▲ Results of IF Power Comparison by Cap Size

This table presents simulation results comparing IF power with varying capacitor sizes. Compared to the case without a capacitor, the performance improves by up to 3 dB for larger capacitors, particularly noticeable above 40 GHz.

Measurement Result



▲ Conversion gain of the fabricated cascode mixers according to frequencies

The fabricated mixer exhibits a conversion gain of -2 to 6 dB over a wide bandwidth from 10 to 40 GHz. A flatter conversion gain characteristic is expected after compensating for the cable loss over frequency.

Conclusions

The proposed research aims to provide a new approach to implementing communication semiconductor components. It also targets the development of key technologies for broadband circuits in future 5G/6G applications.

Acknowledgment

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