IDEC Chip Design Contest

A +3dBm-EIRP 240-GHz Circular-Polarized Radiator Utilizing a Sub-THz PA in 65-nm CMOS

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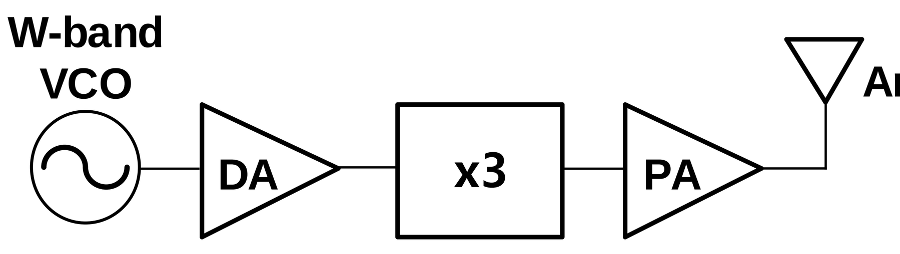
Introduction

- ❖ Common techniques to boost equivalent isotropically radiated power (EIRP) of a sub-terahertz radiator:
  - ➢ Using array of unit radiators
  - ➢ Using fundamental sub-terahertz amplifier
  - ➢ Using lens to focus the radiated beam
- ❖ This work presents a 240 GHz radiator which has block diagram as bellow
- ❖ By optimize the 240 GHz PA, a good output power is attained by using only single radiating cell



A block diagram of the proposed transmitter

Radiator Design

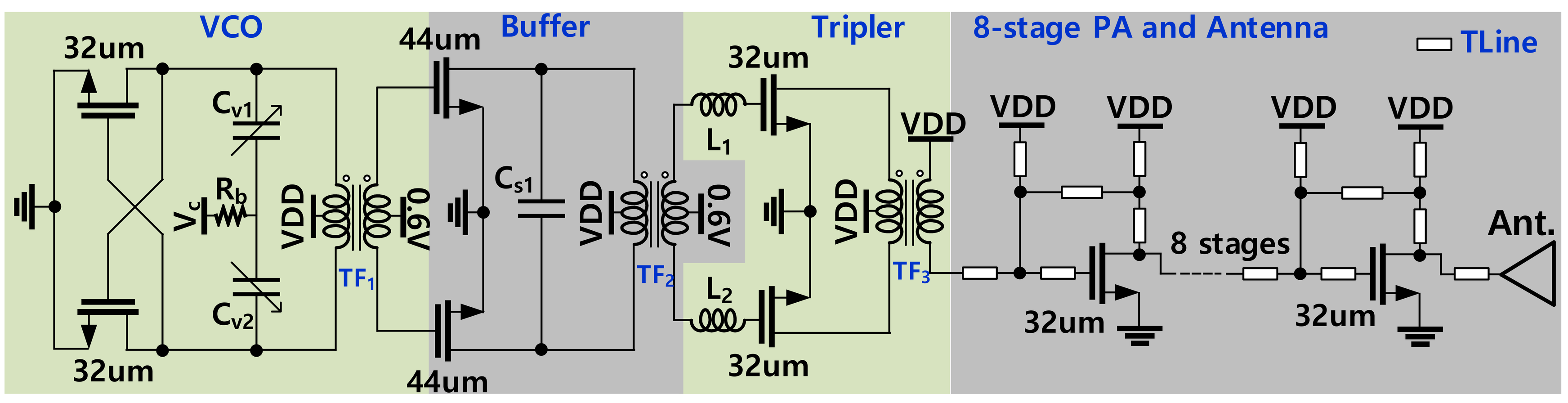


Fig. 1. Schematic of the propose inductive feedback push-pull power amplifier.

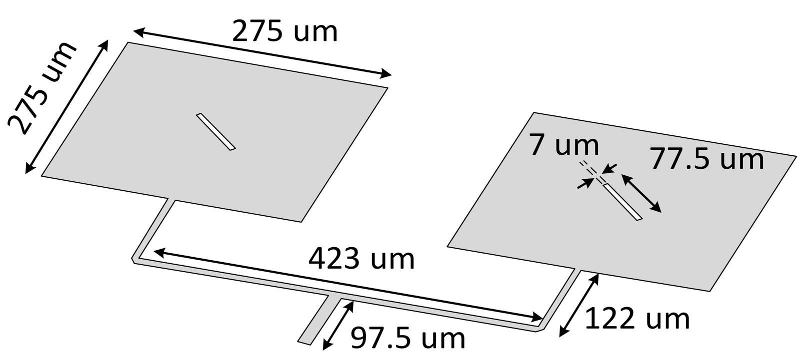


Fig. 2. The layout structure of the two-array patch antenna.

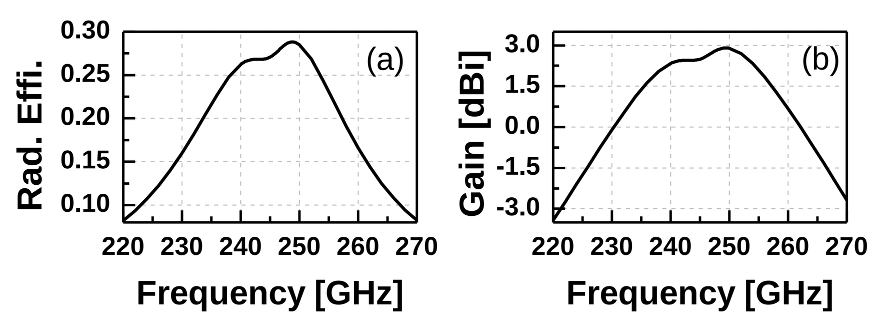


Fig. 3. The simulated (a) gain and (b) radiation efficiency of the antenna.

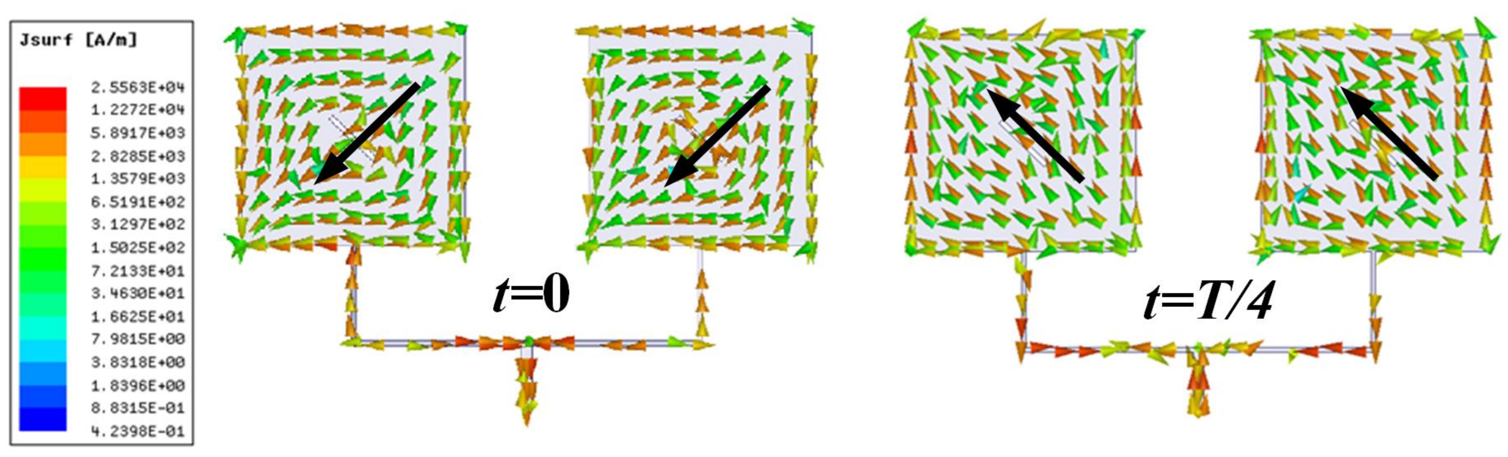


Fig. 4. Surface current density distribution of the patch antenna at t = 0, and t = T/4.

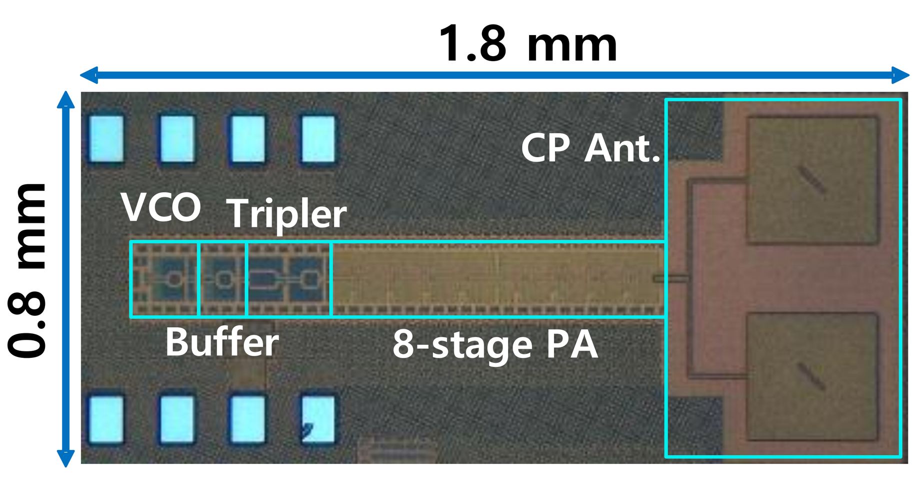


Fig. 5. A photograph of the fabricated radiator.

Acknowledgements

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Measurement results

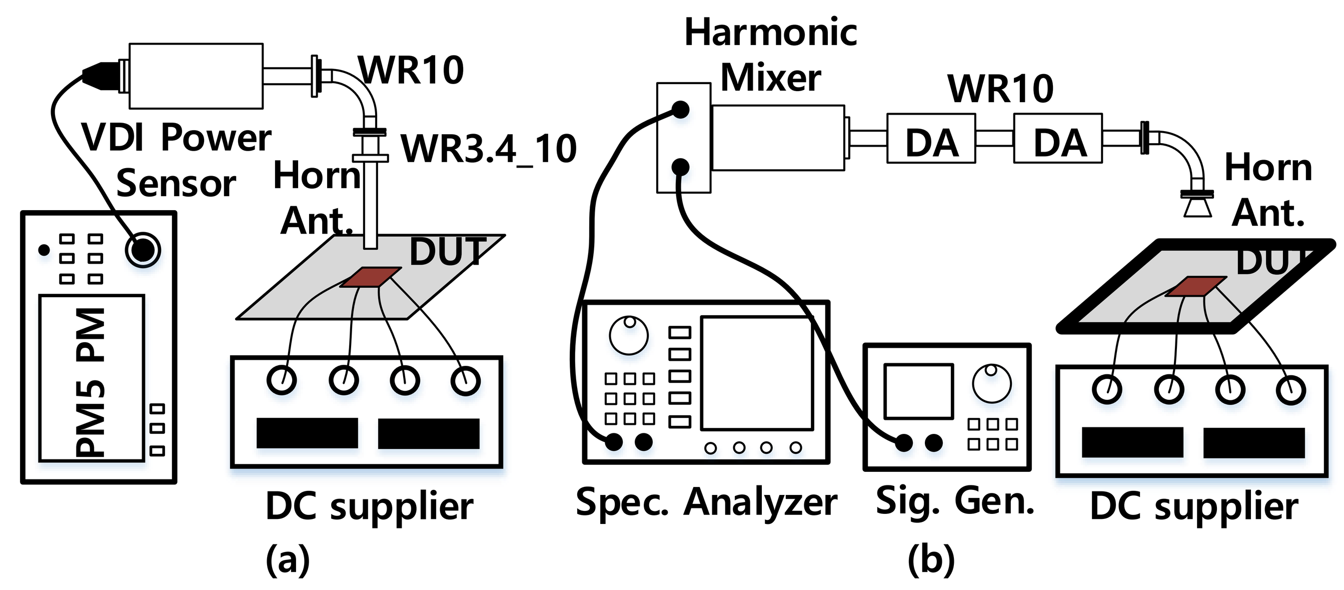

Fig. 6. Measurement setup of (a) EIRP and (b) the working frequency.

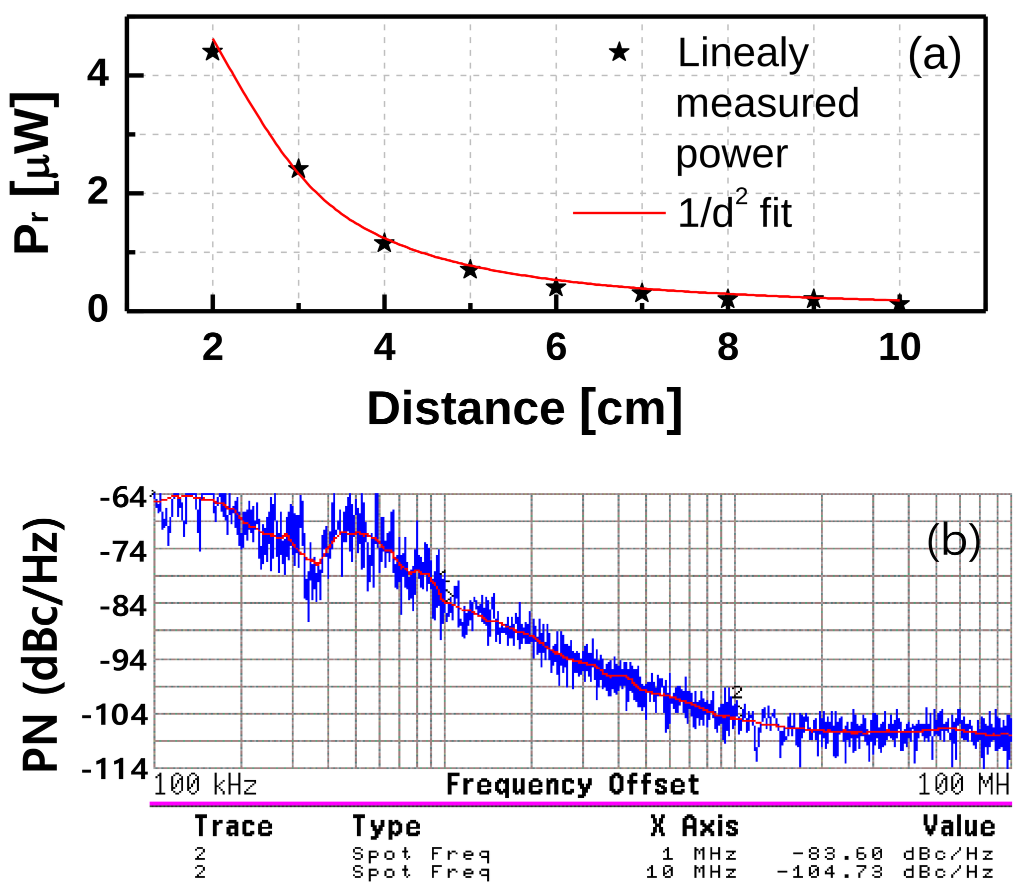

Fig. 7. (a) Received power (P_r) of the horn antenna versus distance and (b) the measured phase noise of the received W-band leakage.

Comparison table

Ref.	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	**Ours**
Tech.	130-nm SiGe	45-nm SOI CMOS	65-nm CMOS	130-nm SiGe	130-nm SiGe	65-nm CMOS	130-nm SiGe	65-nm CMOS	130nm SiGe	130nm SiGe	**65-nm CMOS**
Polar.	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	**Circ.**
Array size	2x2	1x8	4x4	1x4	4x4	8 ant.	1x4	1 ant.	1 ant.	1x4	**1 ant.**
Structure	Coupled Osc.	Ext. Power + Mult.	Coupled Osc.	PLL + Mult.	Coupled Osc. + PLL	Coupled Osc.	SWO Scaling	IL VCO + Tripler + PA	Mult.+ Mixer+ PA	VCO + PA + Doubler	**VCO + Tripler + PA**
Freq. (GHz)	344	390	338	320	317	260	342	240	240	245	**239.2**
P_{rad} (dBm)	-6.8	-7	-0.9	NA	5.2	0.5	-10.5	-0.5	-0.8	7	**0.5**
EIRP (dBm)	4.9	8	17	10.6	22.5 -lens	15.7 -lens	1.2	1	13.2 -lens	18	**3**
P_{rad}/unit (dBm)	-12.8	-16	-12.9	NA	-6.8	-8.5	-16.5	-0.5	-0.8	1	**0.5**
PN@10MHz (dBc/Hz)	-93.1	NA	-93 @1MHz	-89 @1MHz	-79 @1MHz	-78.3 @1MHz	-98.2	-113.4	NA	-85 @1MHz	**-95.2**
P_{DC} (mW)	450	1500	1540	1000	610	800	425	220	375	1500	**272**
Area (mm^2)	1.2	10.5	3.9	34.4	2.1	2.3	1.33	2	1.25	19.98	**1.44**

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