WE4C-2

Linearity Enhanced Broadband Darlington Power Amplifier IC Using InGaP-GaAs HBT for Handset Modules with Fractional Bandwidth of 50%

S. Bae[1], J. Jeon[2], S. Hwang[1], B. Yoon[1], J. Kim[1]

[1]Hanyang University, Republic of Korea

[2]Gangneung-Wonju National University, Republic of Korea

Outline

- Introduction
- Design and Analysis
  - Broadband Darlington Power Amplifiers
  - Linearization 1 : Using Input Transformer and C_{be}
  - Linearization 2 : Using Diodes and Capacitors
- Implementation and Experimental Results
- Conclusion

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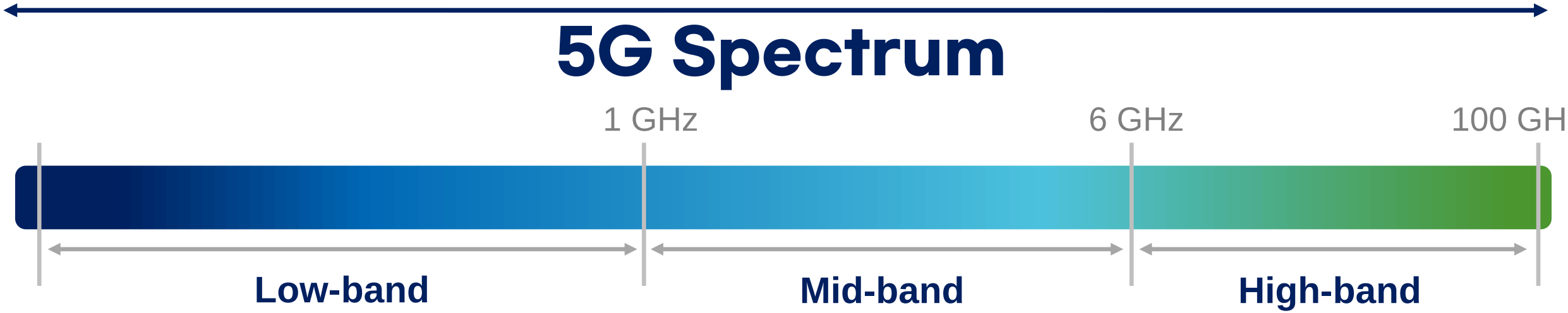
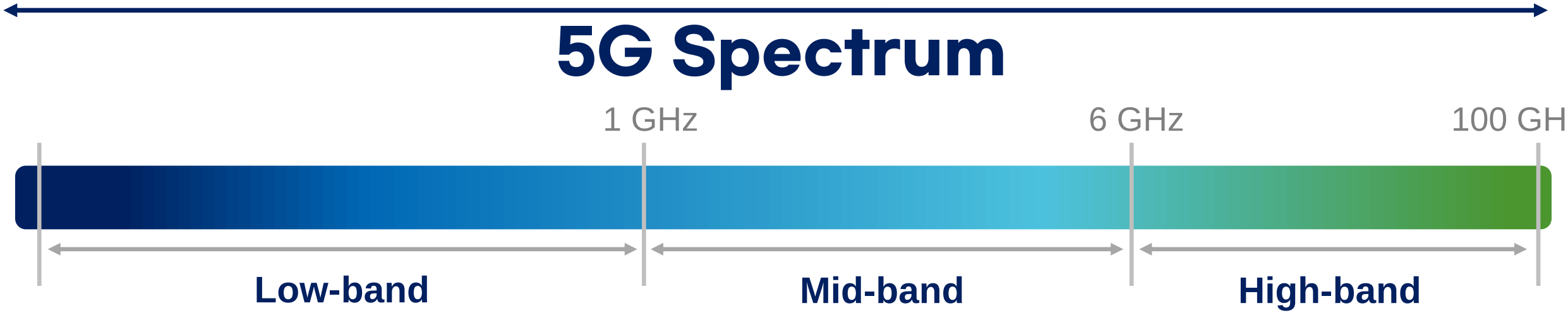
Introduction



☑ Why All Three Spectrum Layers Are Vital to 5G?



☑ Why All Three Spectrum Layers Are Vital to 5G?

Three properties that determine the performance of 5G

Bandwidth | **Latency** | **Coverage**

"What Is Low, Mid, and High-Band? The 5G Spectrum Layers Explained, " westbase.io, accessed May 2. 2023, https://www.westbase.io/blog/what-is-low-mid-and-high-band-the-5g-spectrum-layers-explained

Introduction

Low-band
(Coverage Layer)

- Bandwidth: Low
- Latency: Low
- Coverage: High

Sub-1 GHz , Hundreds of miles

Mid-band
(Capacity Layer)

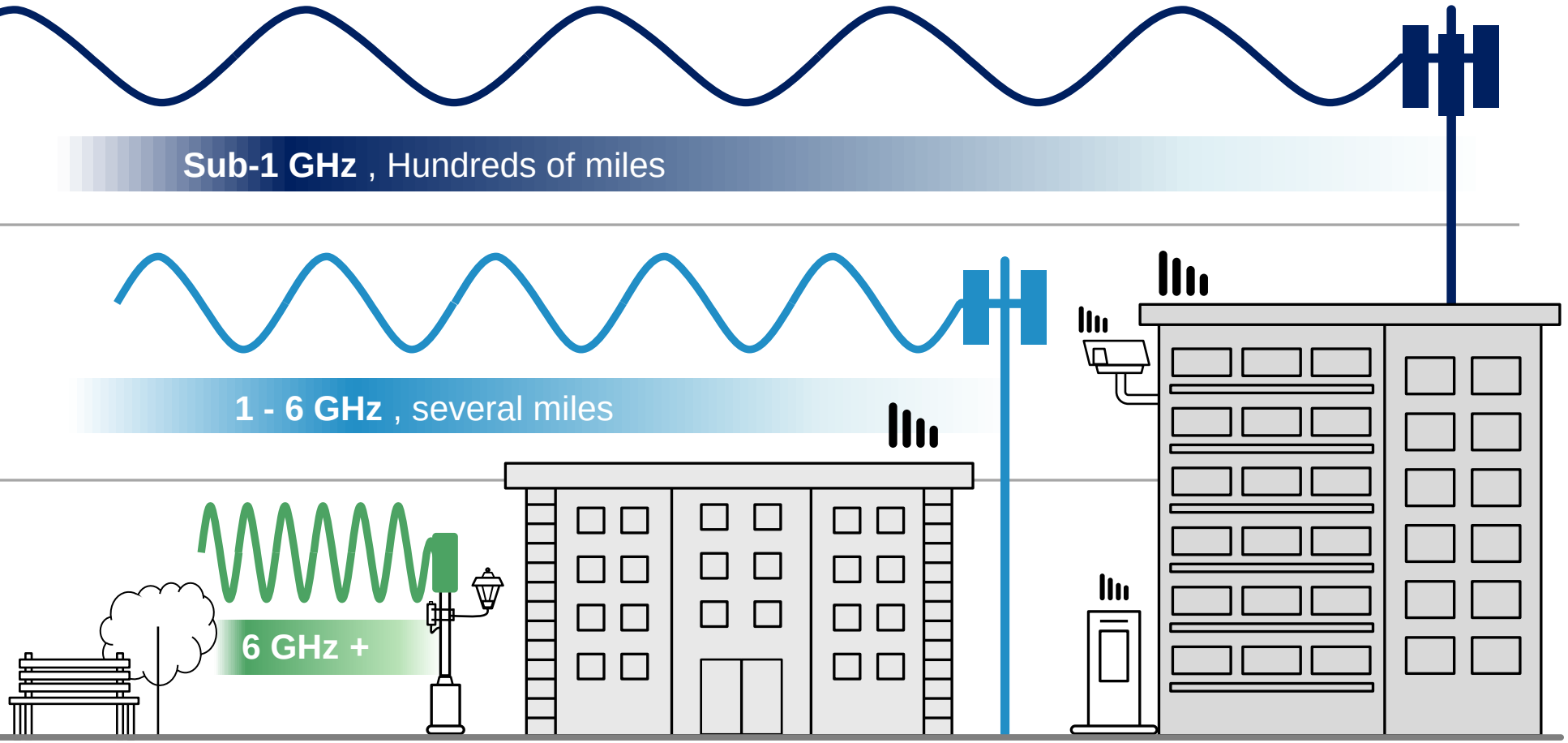
- Bandwidth: Medium
- Latency: Medium
- Coverage: Low

1 - 6 GHz , several miles

High-band
(High-Capacity Layer)

- Bandwidth: High
- Latency: High
- Coverage: Very Low

6 GHz +



☑ **The reality of 5G in various scenarios is all three spectrum layers are mixed so that users get the right blend of coverage and performance for their given situation.**

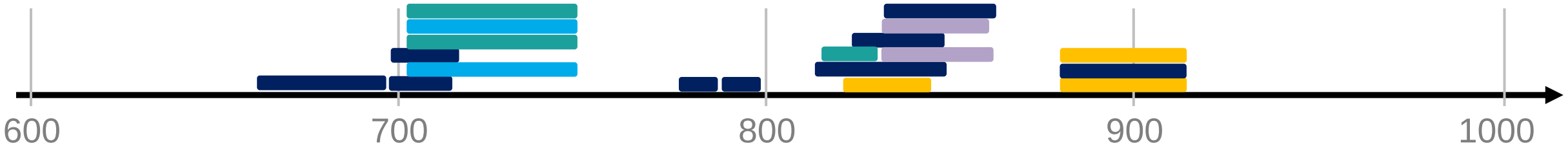
"5G Spectrum Layers, " cradlepoint, accessed May 2. 2023, https://cradlepoint.com/products/details/5g-services/

Introduction

Global | NAR | EMEA | EU | APAC

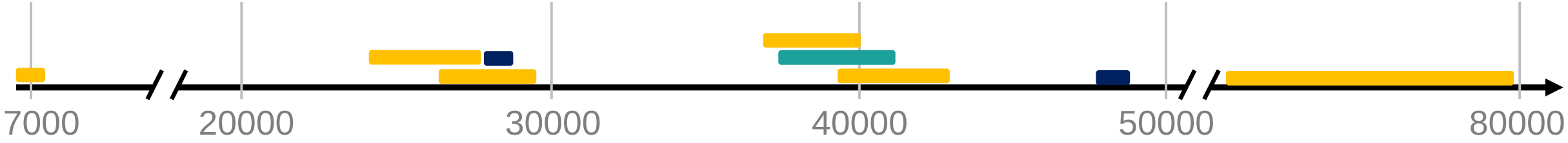
Uplink(MHz)

Low-band(Sub-1GHz)

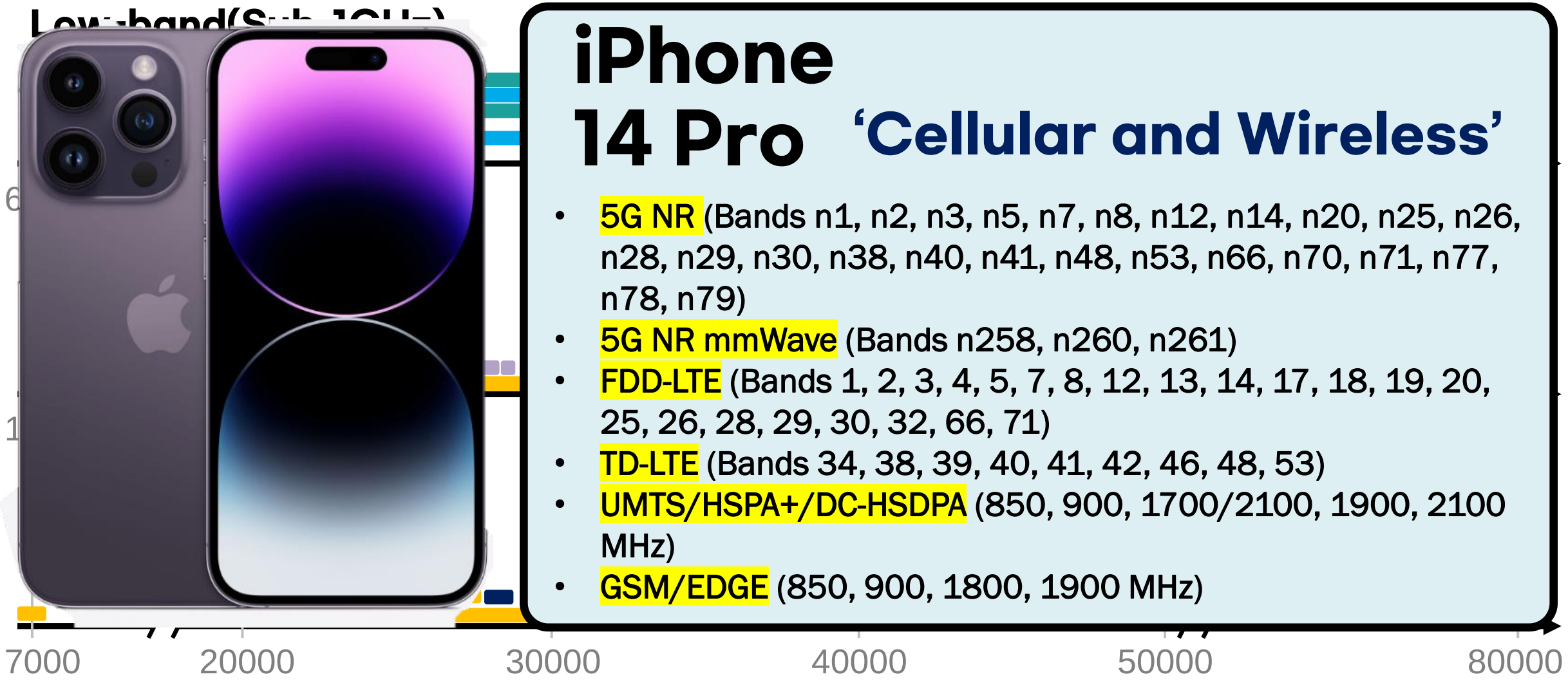


Mid-band(1-6 GHz)

High-band(6 GHz +)



"5G NR frequency band, " sqimway, accessed May 2. 2023, https://www.sqimway.com/nr_band.php



iPhone 14 Pro ‘Cellular and Wireless’

- 5G NR (Bands n1, n2, n3, n5, n7, n8, n12, n14, n20, n25, n26, n28, n29, n30, n38, n40, n41, n48, n53, n66, n70, n71, n77, n78, n79)
- 5G NR mmWave (Bands n258, n260, n261)
- FDD-LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 14, 17, 18, 19, 20, 25, 26, 28, 29, 30, 32, 66, 71)
- TD-LTE (Bands 34, 38, 39, 40, 41, 42, 46, 48, 53)
- UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
- GSM/EDGE (850, 900, 1800, 1900 MHz)

“5G NR frequency band, ” sqimway, accessed May 2. 2023, https://www.sqimway.com/nr_band.php

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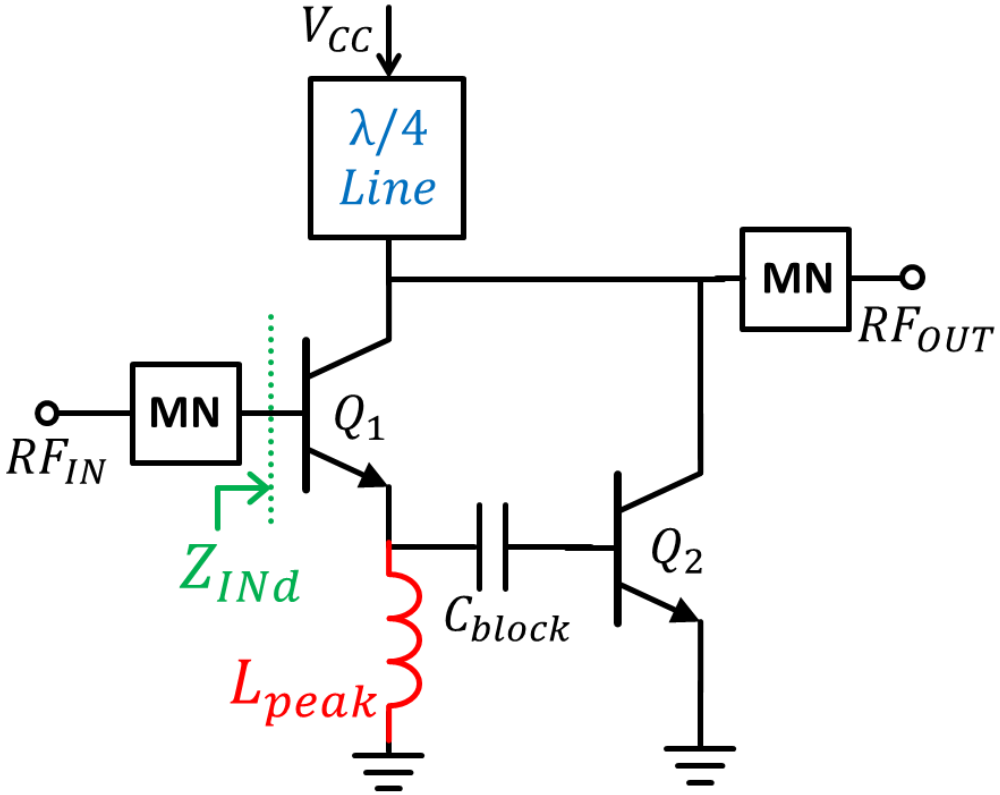
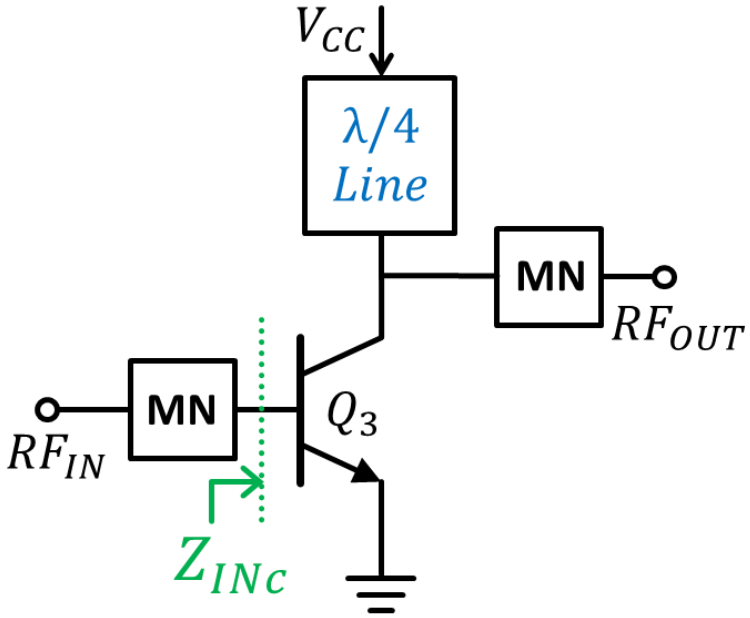
Design and Analysis : Broadband Darlington Power Amplifiers



(a)

Darlington



(b)

Common-emitter

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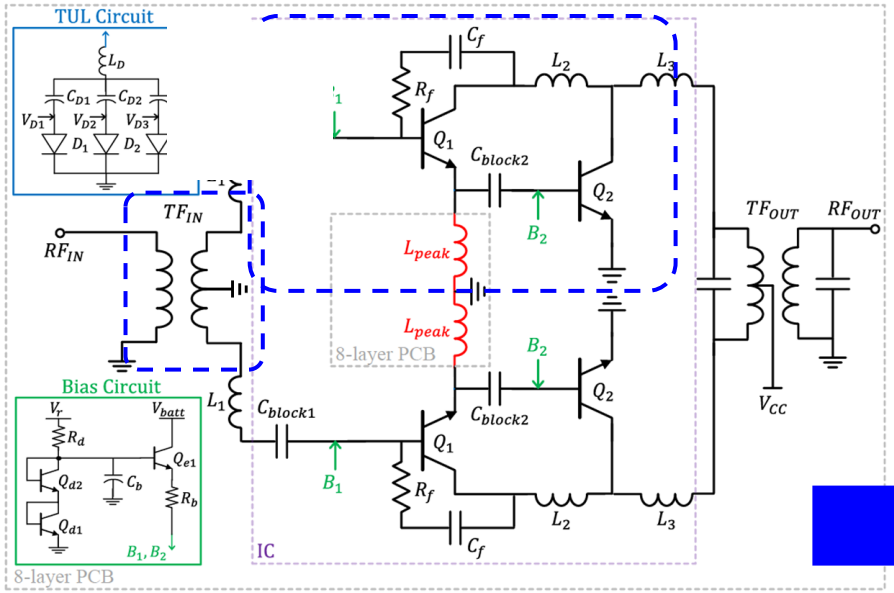
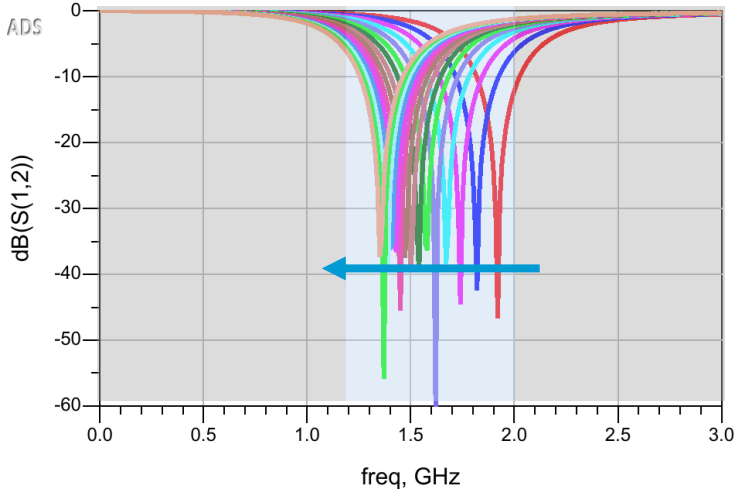
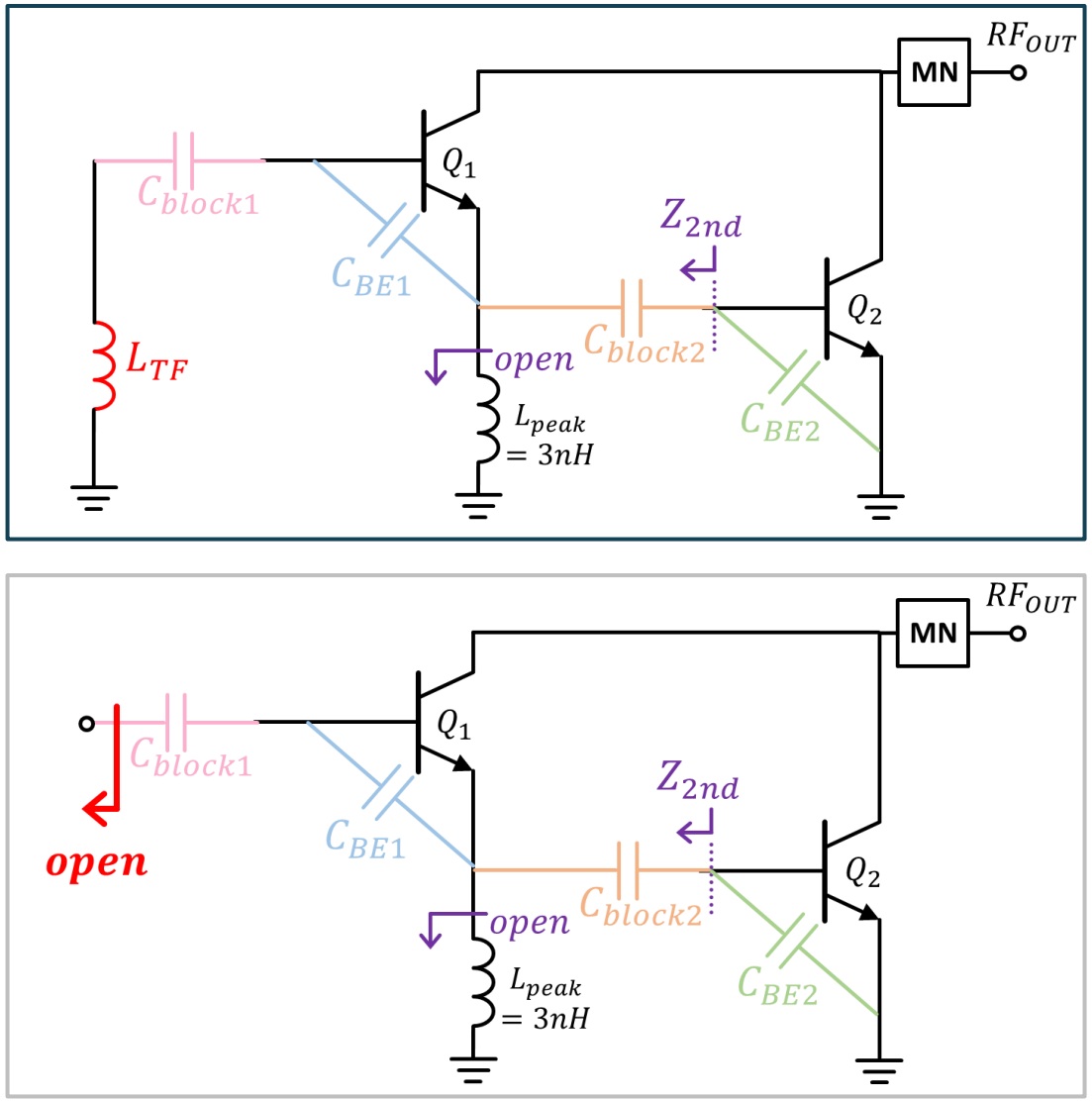
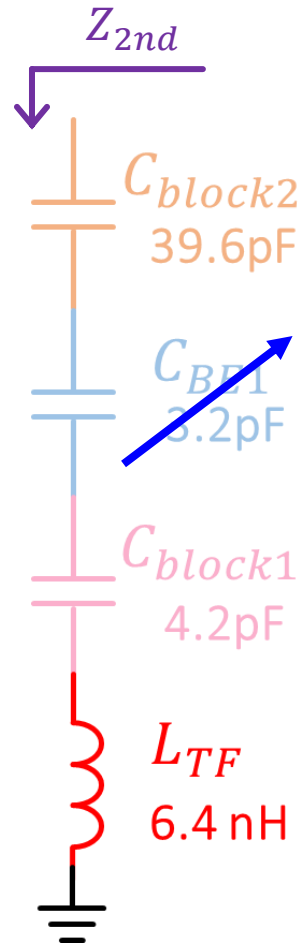
Design and Analysis : Linearization 1 : Using Input Transformer and Cbe









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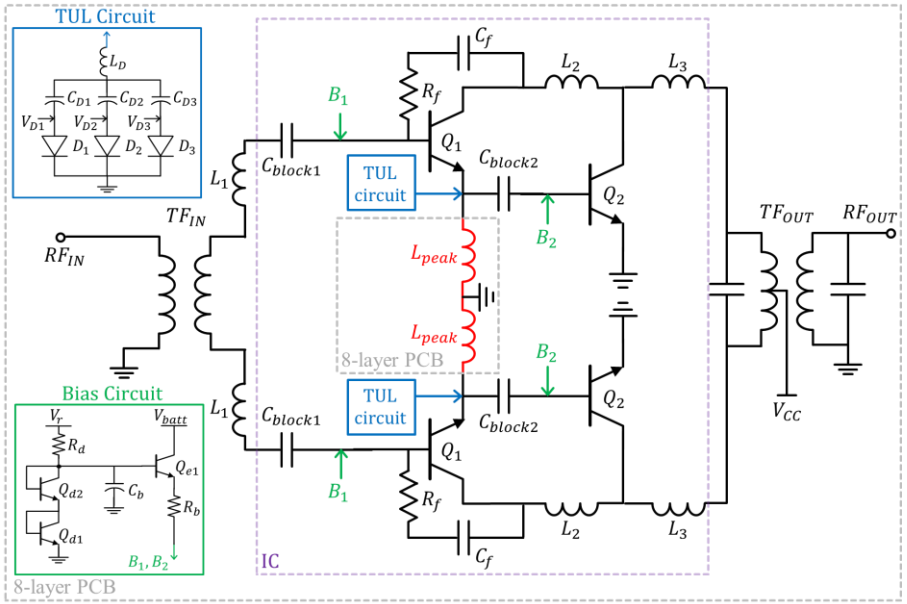
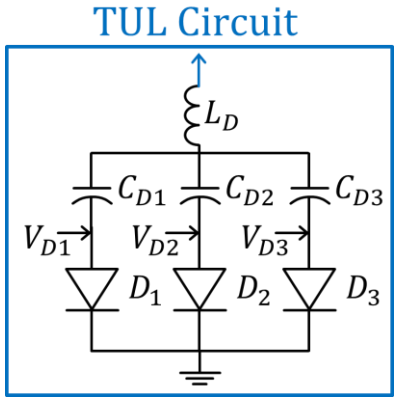
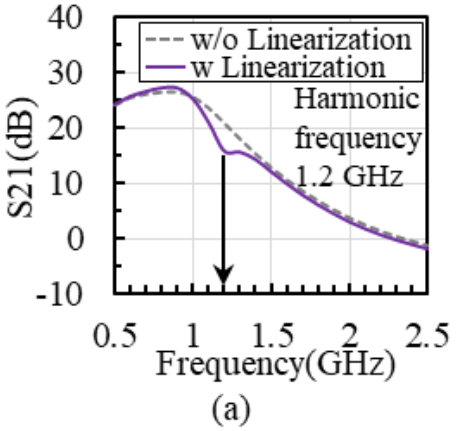
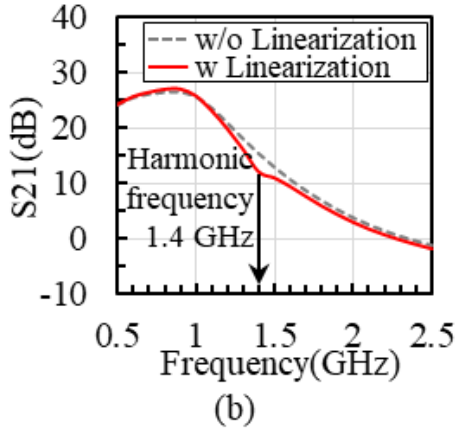
Design and Analysis : Linearization 2 : Using Diodes and Capacitors

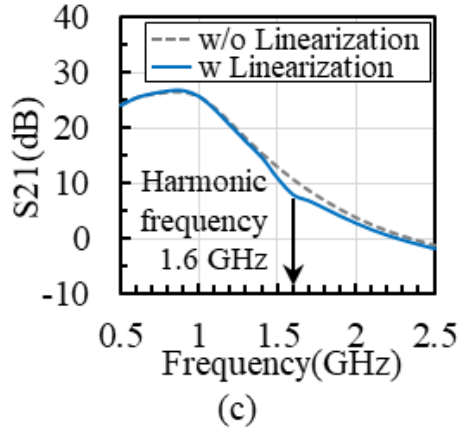


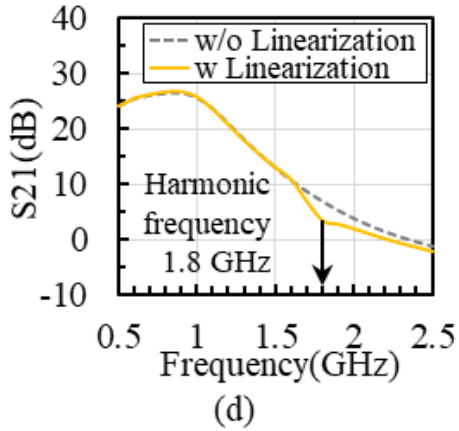


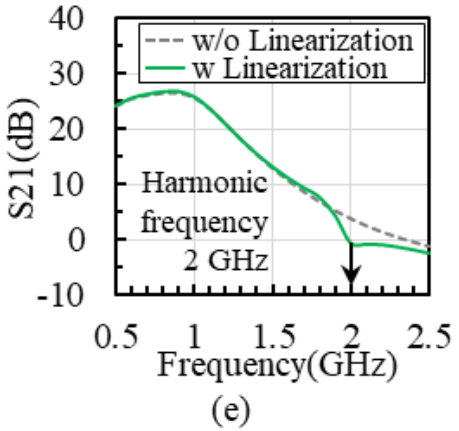
	V_{D1}	V_{D2}	V_{D3}
(a)	3 V	3 V	0 V
(b)	3 V	0 V	0 V
(c)	0 V	3 V	0 V
(d)	0 V	0 V	3 V
(e)	0 V	0 V	0 V











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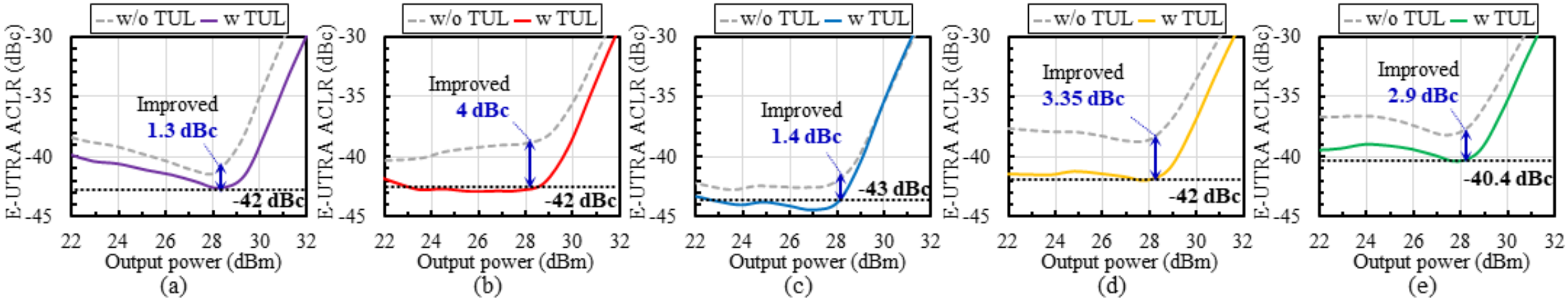
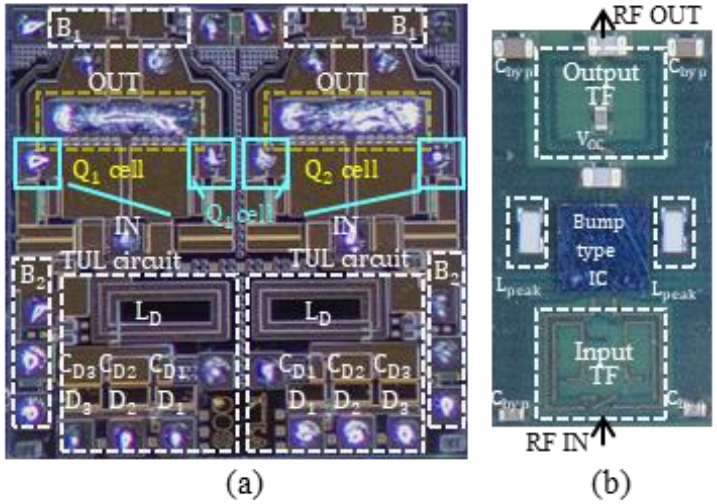
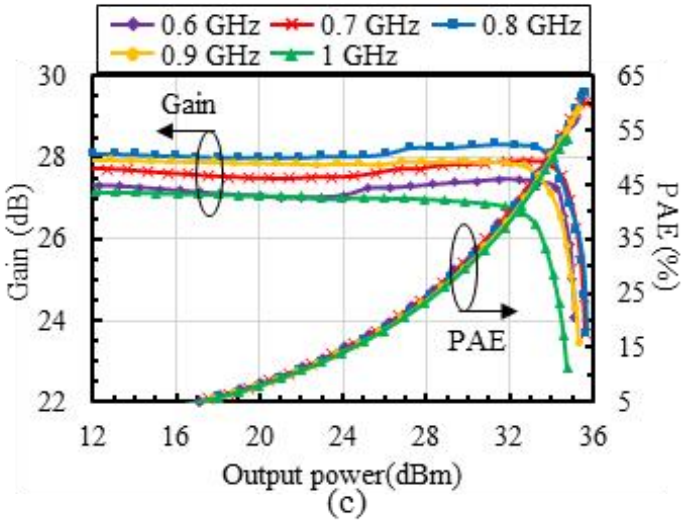
Implementation and Experimental Results







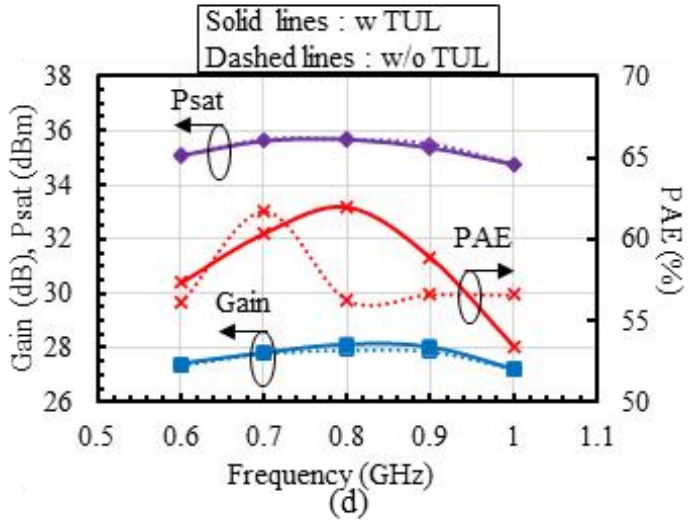


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Table 1. Performance comparison to the previously reported GaAs HBT ICs.

Ref.	2014 [18]	2016 [19]	2020 [20]	2020 [21]	2022 [22]	**This work**
Freq. (GHz)	0.9	0.88	0.851 - 0.894	0.88-0.915	0.728 - 0.768	**0.6-1**
Gain (dB)	31	29.2	36.5	29.5-33	33.5-34.5	**27.2-28.16**
Psat (dBm)	29.6*	33.5	32	33.8-34.5	35-36	**34.7-35.7**
PAE_{peak} (%)	35*	46.1	12-14#	50-57	27-31.5#	**53.4-62**
ACLR (dBc)	-40※	-45	-46.5	N/A	-30	**-40**
FBW (%)	N/A	N/A	5	4	5	**50**
Modulation	LTE 10 M	LTE 10 M	WCDMA 5 M	N/A	LTE 20 M	**LTE 20 M**

* : performance of P1dB, ※ : ACPR, # : PAE at Pavg

Thank You !
Any Question?

Contact e-mail : soouuji @hanyang.ac.kr