A Wide Frequency Range 60GHz Static Frequency Divider Using Shunt-Series Peaking

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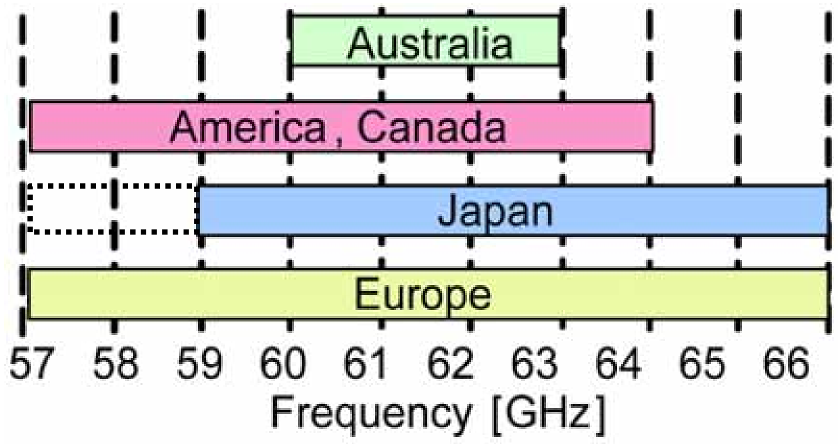
Outline

- Motivation
- Options for MM-wave Frequency Dividers
  - CML Divider, Miller Divider, ILFD
- Proposed MM-wave Frequency Divider using **Shunt-Series Peaking** Technique
- Simulation Results
- Conclusion

Motivation

- **9-GHz unlicensed bandwidth at 60 GHz**
- **Several Gbps wireless communication**

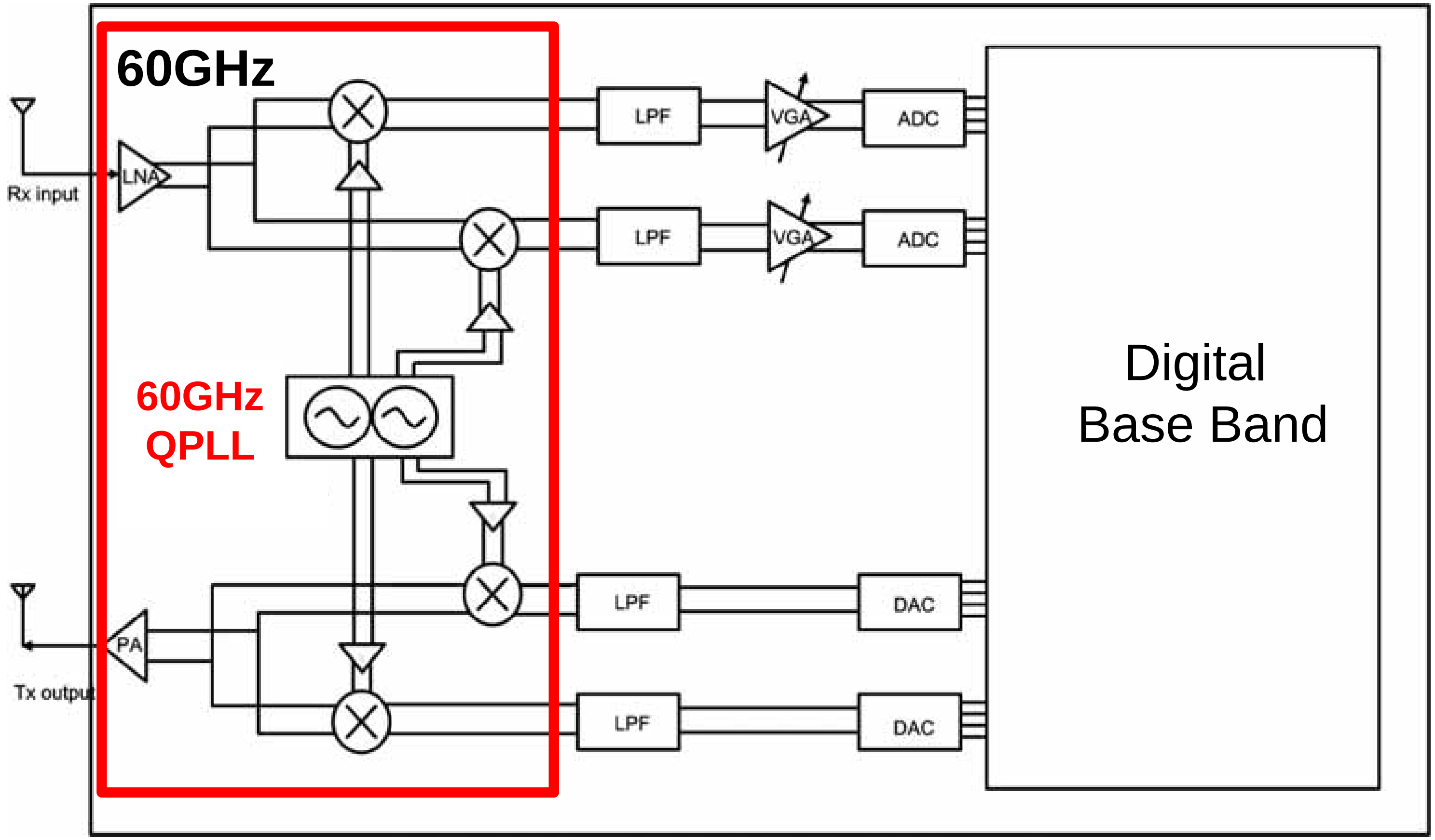


IEEE 802.15.3c **Wireless HD** **ECMA-387** **IEEE 802.11ad**

[1] http://www.tele.soumu.go.jp

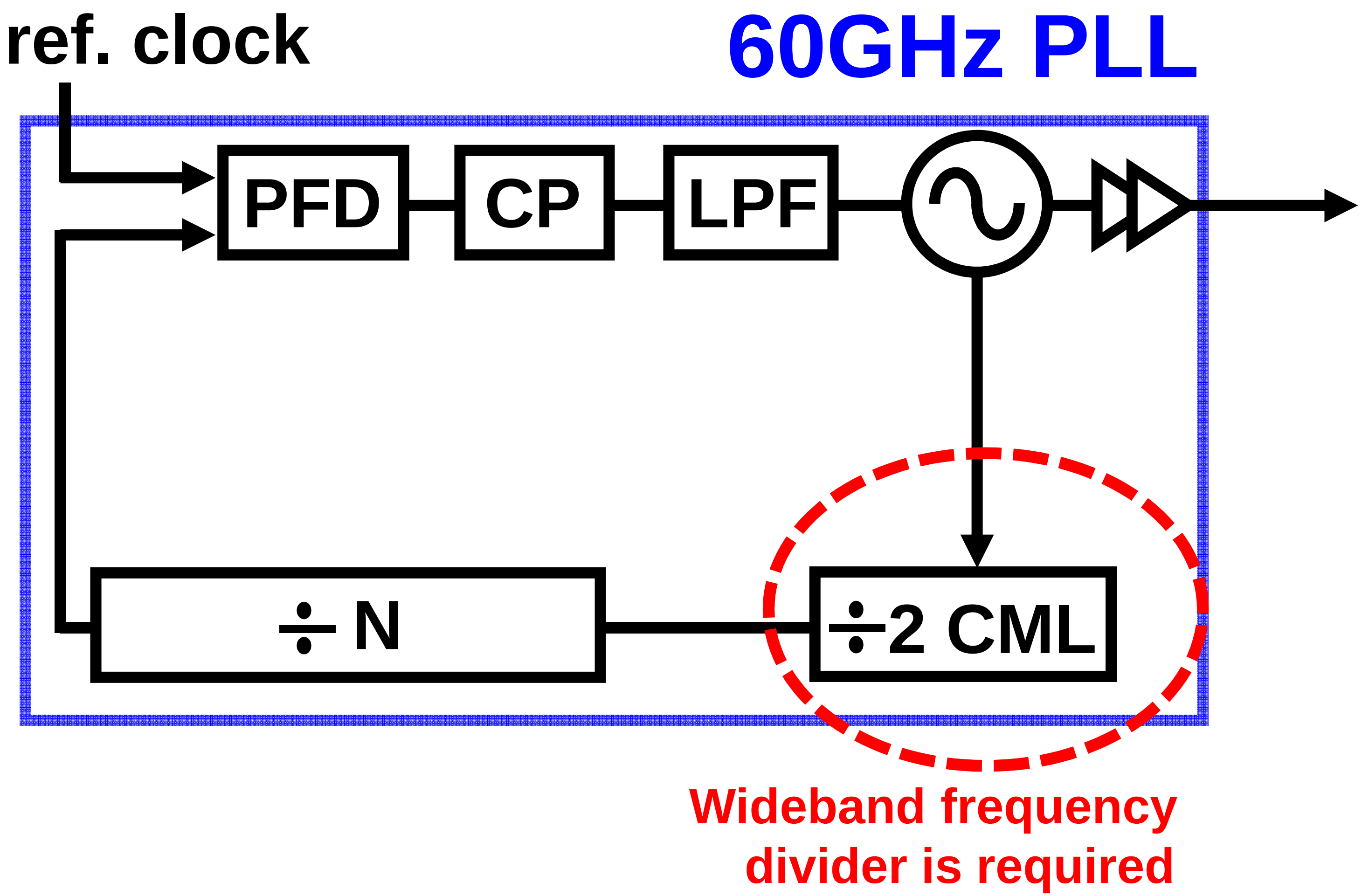
Transceiver Architecture

- Direct Conversion for single chip implementation
  - **Small area** and **lower power consumption**



Application

- MM-wave PLL



Options for MM-wave Frequency Dividers

- **CML Static Divider**
  - ✓ **Wide** frequency operating range
  - × Difficult to operate at MM-wave frequency
- **Regenerative (Miller) Divider**
  - – Relatively larger Locking range compared to ILFD
- **Injection-Locked Frequency Divider (ILFD)**
  - ✓ High frequencies and Low power
  - × **Narrow** locking range

Conventional CML Divider

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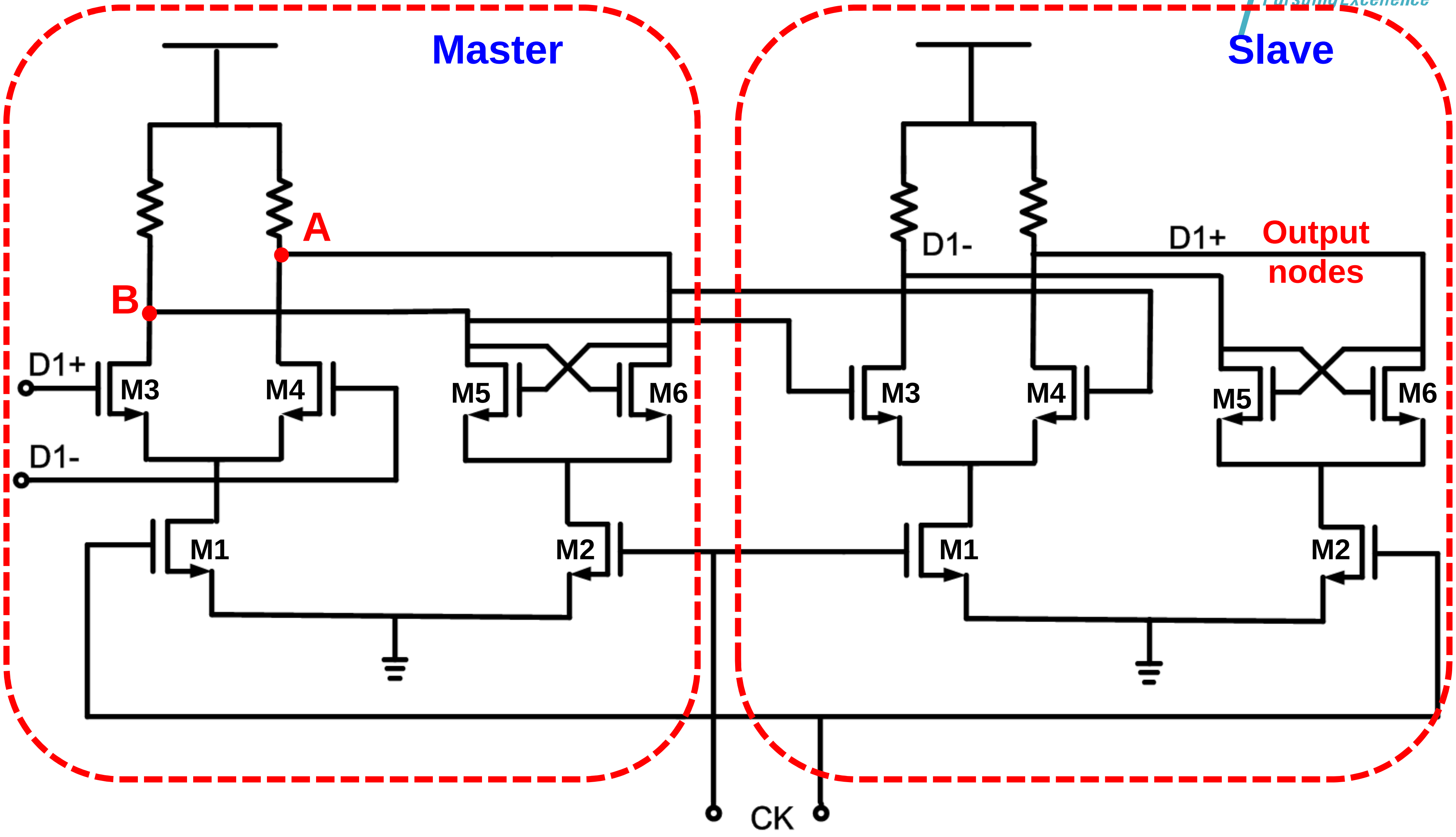
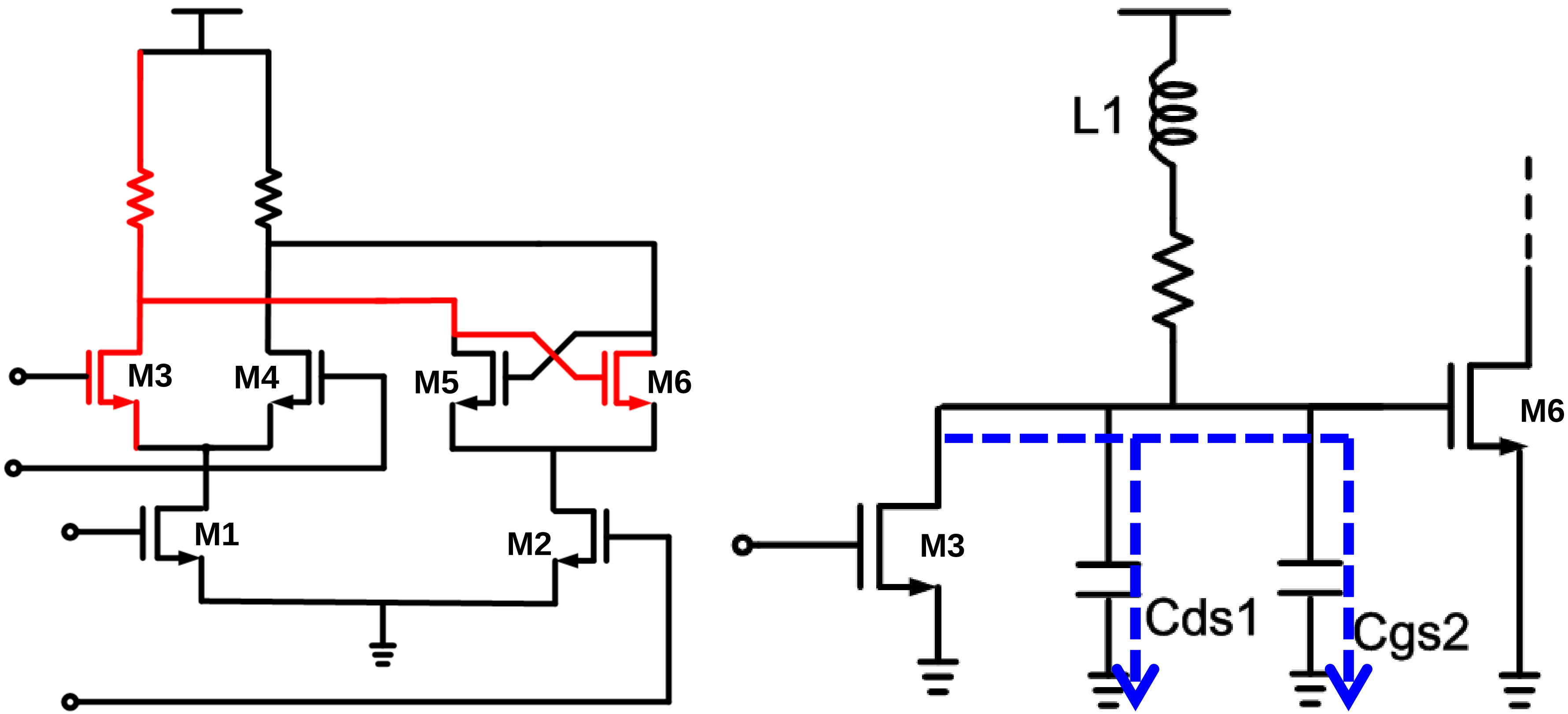


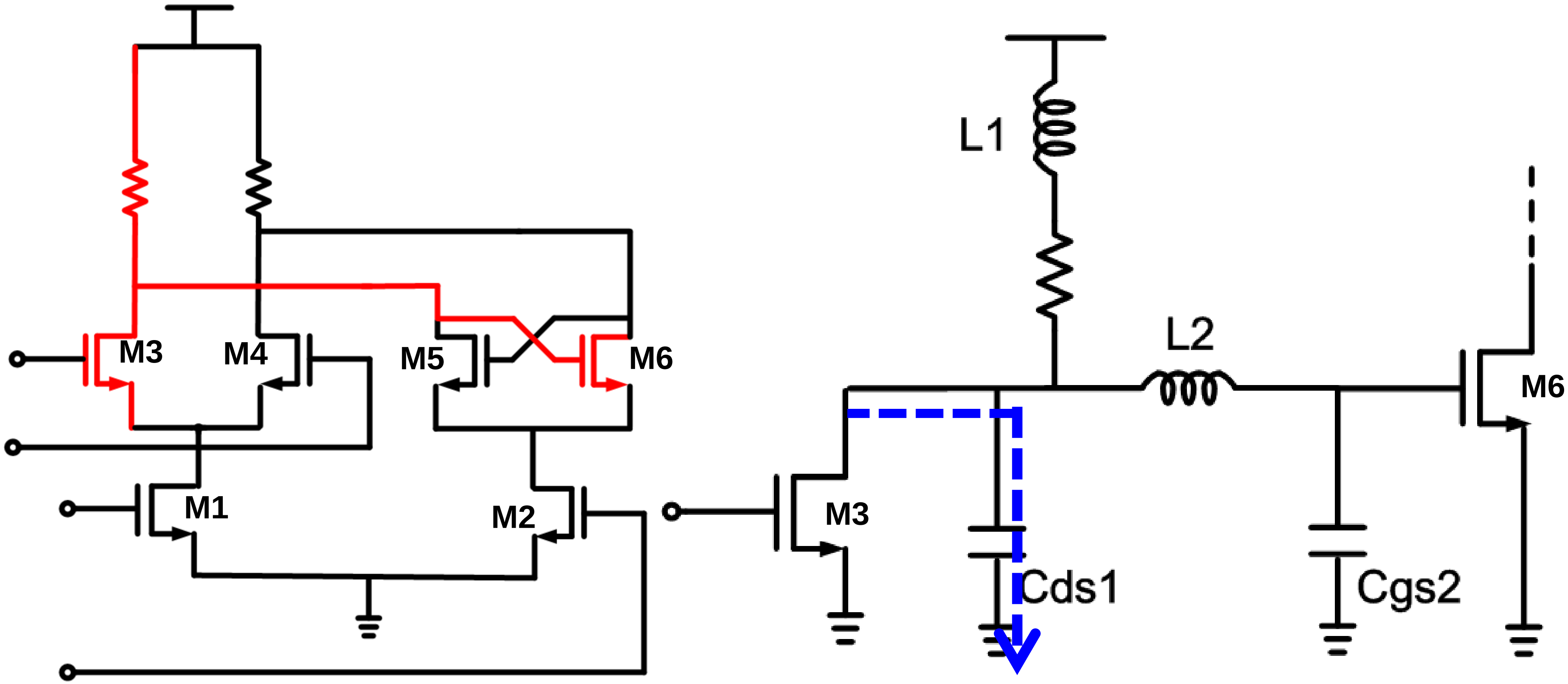
Conventional Shunt Peaking

- **L1** delays current flow to resistive branch
  - More current initially charges **C = Cds1 + Cgs2**
  - Reduces rise time



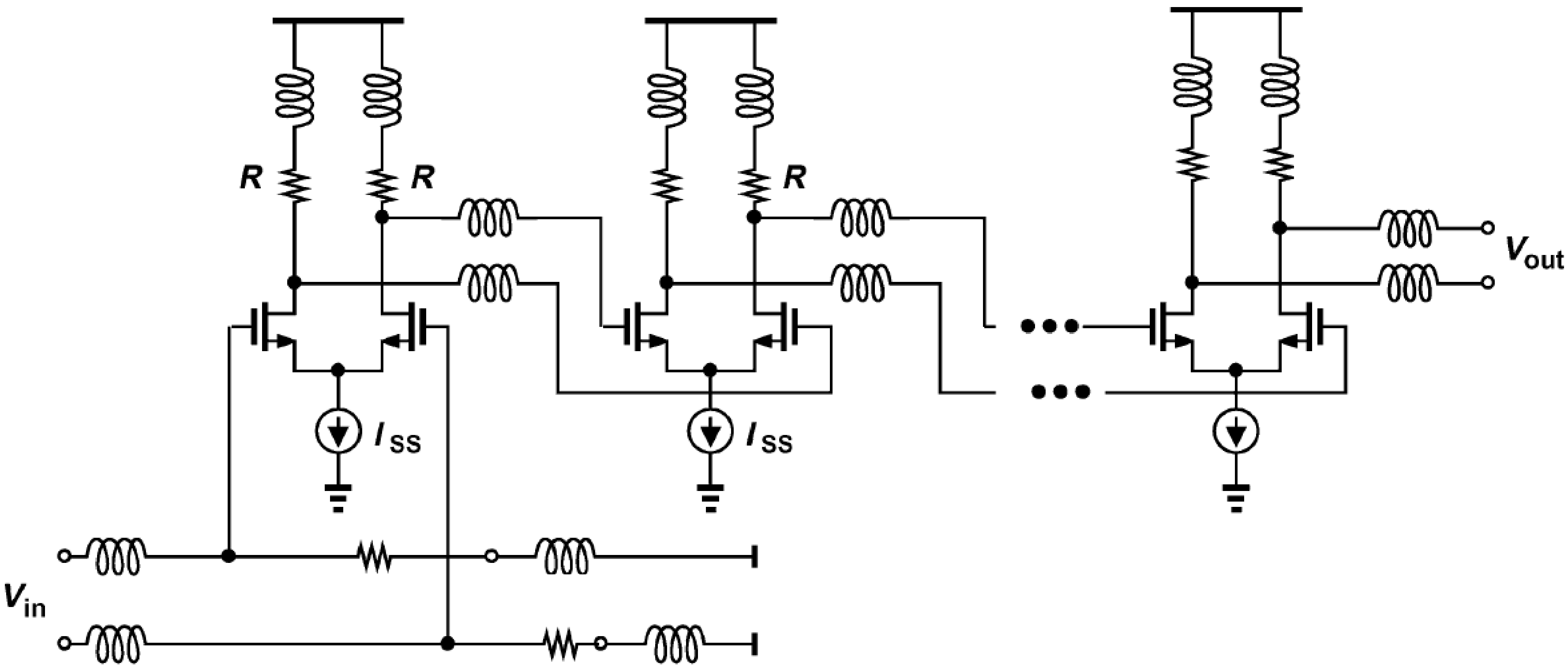
Shunt-Series Peaking Technique

- Utilized in this proposed Frequency Divider
- **L2** delays current to flow to the rest of the network.
  - Only **Cds1** is initially charged
  - Reducing rise time at drain and increasing bandwidth



Shunt-series Application

- 5 differential stage applied in a broadband amplifier



Tech.	Gain	BW	Gain*BW	VDD	Power
0.18um CMOS	**15dB**	**22GHz**	124GHz	2.2	190mW

S. Galal and B. Razavi, *JSSC*, Dec. 2004.

Simulation Results (I)

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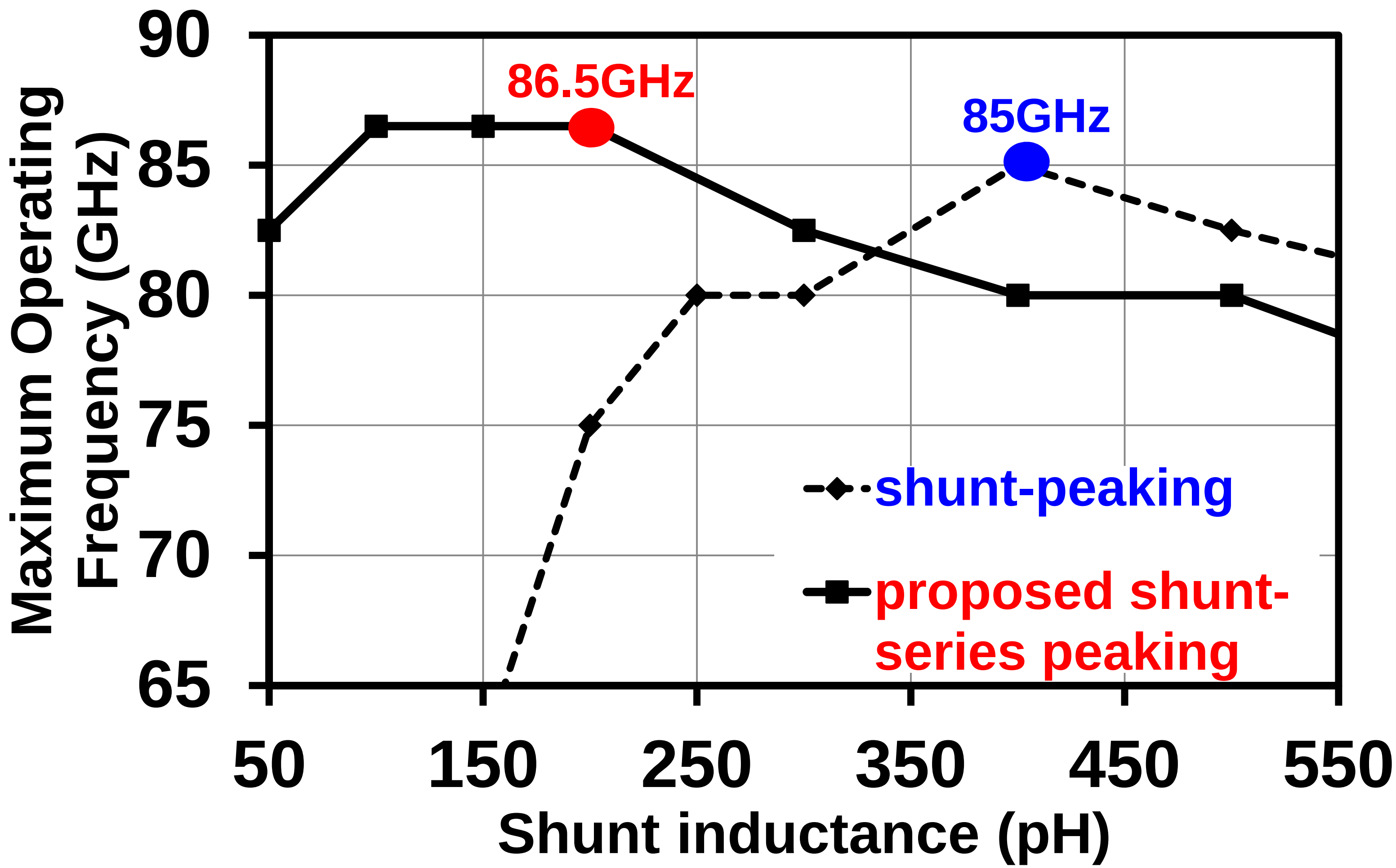
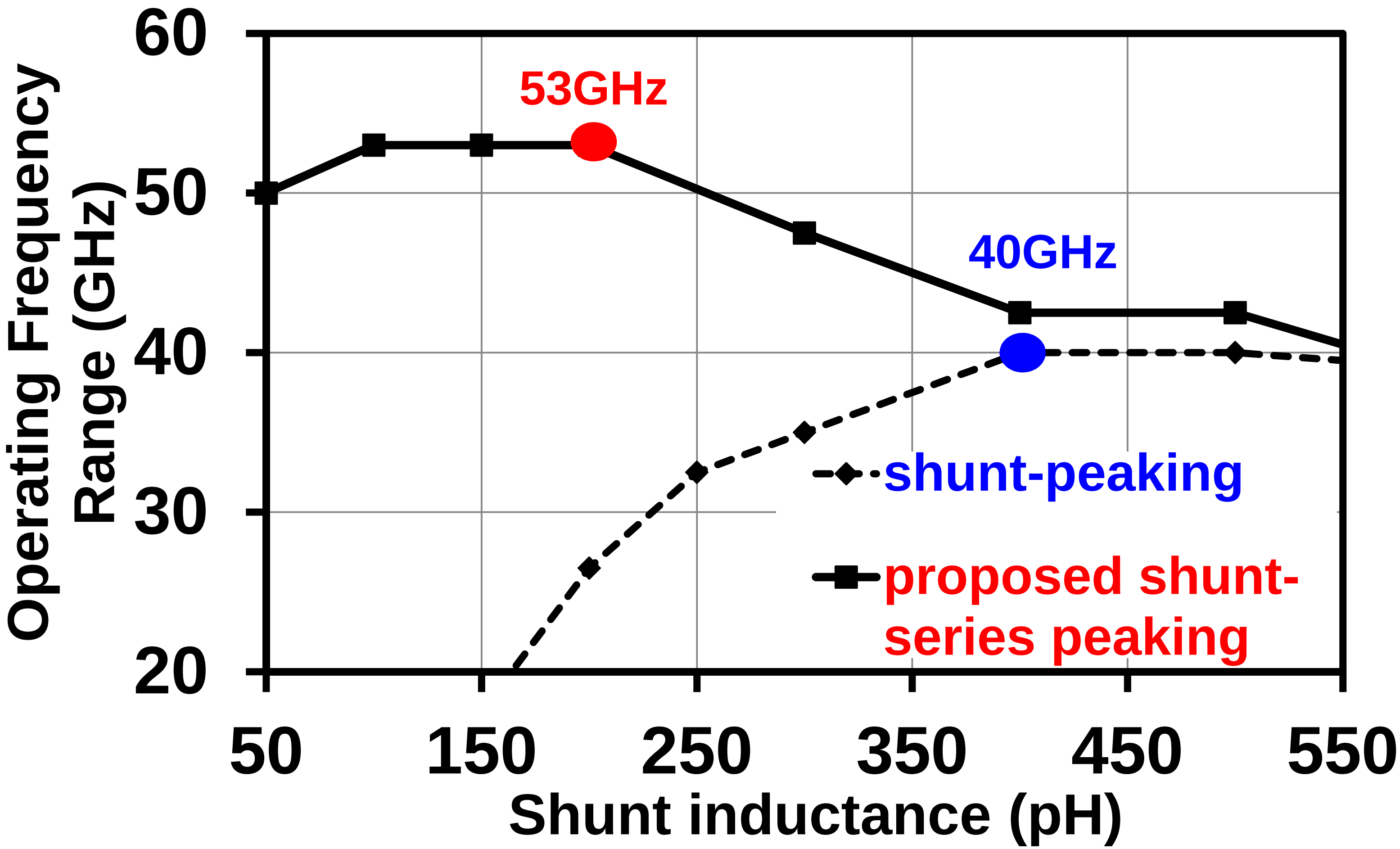


Series inductance is kept constant at 100pH

Simulation Results (II)



Series inductance is kept constant at 100pH

Performance Comparison

	Type	Operating Freq.	Range (GHz)	V supply	Power (mW)	Tech.
[1]	Bridged Shunt SFD	49-67	18	1.2	15.7	90 CMOS
[2]	SFD	70-85	15	1.2	19.2	65 GP CMOS
[3]	Pulsed-Latch SFD	21-37.8	16.8	1.8	22.5	130 CMOS
This	**Shunt-Series SFD**	**33.5-86.5**	**53**	1.2	22	65 CMOS

[1] *ESSCIRC*, 2010
[2] *CICC*, 2007
[3] *ASSCC*, 2007

Conclusion

- Employing **Shunt peaking**, the divider can work from 45-85 GHz **(40 GHz)**
- Employing **Shunt-Series peaking**, the divider can work from 33.5-86.5 GHz **(53GHz)**
- Shunt-series architecture can increase operating frequency range by **13GHz (32.5%)**